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RADSOLVER - A Computer Program for Calculating Spectrally-Dependent Radiative Heat Transfer in Solar Cavity Receivers

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RADSOLVER - A COMPUTER PROGRAM FOR CALCULATING SPECTRALLY-DEPENDENT RADIATIVE HEAT TRANSFER IN SOLAR CAVITY RECEIVERS

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ABSTRACT

RADSOLVER is a computer program which calculates the radiation energy transport in cavity type receivers having an arbitrary number of apertures through which collimated beams of solar radiation enter. In contrast to the common assumption of gray (or semi-gray) surfaces used in the modeling of radiation transport, RADSOLVER accounts for the wavelength-dependence of emission, absorption and reflection with a band model of the radiative properties. It is intended that this report serve both as an instruction manual for the use of the RADSOLVER code and a vehicle for presenting the underlying theory. Illustrative examples along with input and output are presented.

CONTENTS

Foreword

RADSOLVER was developed as a computational tool for predicting spectrally-dependent radiative energy transfer in solar cavity receivers. Although the capability of determining the radiation transport in enclosures exists in a number of general thermal analyzer codes (e.g., CINDA, MITAS, TACO, SAHARA, etc.), RADSOLVER is the only code which accounts for the wavelength-dependence of the properties of the enclosure surfaces. The inclusion of this dependence could be important in cavity-type receivers of solar energy. (It is noted, however, that RADSOLVER is solely a radiation code whereas the above-cited codes also include conduction and convection effects.)

It is intended that this report serve both as an instruction manual for the use of the RADSOLVER code and a method for presenting the underlying theory. Those concerned primarily with using the code can omit the "Theoretical Basis of RADSOLVER" and Appendix upon the first reading. It is recommended, however, that this material be studied later in order to properly interpret the computed output.

Acknowledgement

I thank Dr. Ralph Greif of the University of California at Berkeley for reading (and re-reading) the manuscript and making a number of helpful suggestions.

Nomenclature

a_{ij}^{k}	element of matrix; defined by Equation (16)
$\underset{\sim}{b}$	vector defined by Equation (17)
C_1, C_2	Planck function constants
E^k	emissive power of a zone in the k-th wavelength band (Equation (6))
$e_{b\lambda}$	Planck's function (Equation (7))
F_{ij}	fraction of the energy diffusely leaving the i-th zone which is intercepted by the j-th zone
G	irradiation of a zone by energies coming from all other cavity zones
G_s^k	direct solar irradiation in the k-th wavelength band
$\underset{\sim}{H}^k$	vector defined by Equation (11)
J	radiosity
Q	heat flux
r_{ij}^{k}	element of matrix; defined by Equation (9)
T	absolute temperature
ε^k	emittance of surface for energy in k-th wavelength band
λ	wavelength
ϕ^k	fraction of the solar spectrum in the k-th wavelength band
ρ^k	hemispherical reflectance of a zone in the k-th wavelength band
σ	Stefan-Boltzmann constant

Subscripts

i	refers to i-th zone
λ	denotes spectral quantity
$\sim$	denotes vector quantity

Superscripts

k	refers to k-th wavelength band

Introduction

RADSOLVER is a computer program which calculates the radiation energy transport in enclosures having an arbitrary number of apertures through which collimated beams of solar radiation enter. The special case of an enclosure without apertures may also be calculated. In contrast to the common assumption of gray surfaces used in the modeling of radiation transport, RADSOLVER accounts for the wavelength-dependence of emission and reflection with a band model of the radiative properties. The consideration of the wavelength-dependence may be important in solar receiver applications where surfaces may have significant variations in reflectance (emittance) over the wavelength range between solar and thermal radiation.

For an enclosure whose surface is subdivided into an arbitrary number of zones, RADSOLVER determines:

- the heat transfer -- the net energy flux into a zone that would be available, for example, for input to a working fluid, and
- the irradiation and radiosity -- the fluxes of incoming and leaving solar and thermal radiation at each zone.

RADSOLVER also calculates the temperatures of any adiabatic zones present in the enclosure. The phenomena included in RADSOLVER are thermal emission, the reflection and absorption of thermally emitted and solar energies, and the multiple reflections of both types of radiant energy among the zones of the enclosure.

The use of RADSOLVER requires that either the heat flux or the temperature at each zone be specified. The most common specification of the heat flux is zero -- a value which is associated with zones lying on adiabatic (refractory) surfaces. The specification of the temperature of a zone is usually more difficult because the temperature is controlled by the heat flux which is unknown at the outset. In situations where a zone lies on an evaporator panel in which a working fluid undergoes a change of phase, the zonal temperature may frequently be approximated by the saturation temperature. In other situations the zonal temperature must simply be guessed. When the computations are completed, however, and the heat flux results available, the accuracy of the temperature specifications can be checked (by determining surface temperatures in independent calculations), and the RADSOLVER computations repeated until the desired degree of convergence is achieved.

Energy that would be transported within and from the enclosure by convection (natural or forced) is not taken into account and RADSOLVER is therefore strictly applicable to enclosures whose interior air mass is stably stratified in a windless environment. It should be noted, however, that since radiation transport is the principal mode of energy transfer in solar cavity receivers, the neglect of convection may not be overly conservative in design studies aimed at determining the survivability of materials under high temperature conditions. It would be possible, however, to determine the effects of convection within the framework of RADSOLVER if the distribution of the film conductance over the enclosure interior were known *a priori*.

1. Background and Underlying Assumptions

RADSOLVER is based on the zonal (or radiosity) method of analysis which was developed in the 1930's by several different investigators. The method is described in a number of texts such as [1-3]. The earliest applications of the zonal method have been to enclosures whose walls were approximated as being gray and where the only source of radiant energy was thermal emission from the enclosure walls. The assumption of grayness, however, is generally unsuitable in solar cavities where there is the transport of both short wavelength solar radiation and the longer wavelength thermal radiation originating at the cavity surfaces.

In the present work the zonal method is extended to include an external source of radiant (solar) energy and the effects of the spectral dependence of surface properties via the use of a band model. These extensions are described in the "Theoretical Basis of RADSOLVER" section. (It should be noted that both Sparrow and Cess [2] and Ozisik [3] have indicated the feasibility of this type of calculation but there is no known instance of it having been implemented.) The following assumptions, which are implicit in the zonal method, are employed in the present work:

(1) Each zone of the enclosure is isothermal.

(2) The radiosity* and irradiation are distributed uniformly over a zone.

(3) All enclosure surfaces are diffuse. This implies that the intensity of the radiation reflected and emitted from a surface is independent of direction regardless of the directional distribution of the incoming energy.

*The radiosity is defined as the combined reflected plus emitted energy flux from a surface.

It should be noted that the first two assumptions are not truly restrictive since, in principle, zone sizes can be decreased to the point where the zonal temperature and radiosity distributions approach uniformity. Limited data (cf. [4,5]) and experience indicate good agreement between predictions based on the zonal method and measurements in situations where the above assumptions are applicable. However, there have been too few experimental appraisals of radiative transfer theories to enable the estimation of the error of the zonal method when it is applied to enclosures containing non-diffuse surfaces. In certain tests in such enclosures there were significant discrepancies between measurements and predictions [6,7]; while in others the discrepancies were relatively minor [8].

The Monte Carlo method [9,10] is an alternative to the zonal method which potentially can account for the actual spectral and directional characteristics of the surfaces involved. A commercial computer program based on it has in fact been written [11]. It must be recognized however, that the acquisition of the spectral bi-directional reflectance data, necessary to take full advantage of the Monte Carlo method, would be a formidable task for the engineering materials and surfaces (e.g. tube banks) used in solar central receivers.

Our recommendations to the cavity designer are that he use a zonal method of analysis (such as that described here), understand fully its limitations, and then be prepared to make measurements of radiant fluxes and temperatures under actual conditions.

2. The Band Model

In addition to assumptions 1-3 listed above, the present study employs a band model of the radiative properties of the enclosure surfaces. In this model it is assumed that the wavelength spectrum $\lambda=0$ to $\lambda=\infty$ is subdivided into a finite but arbitrary number (K) of wavelength bands

$$0-\lambda_1,\ \lambda_1-\lambda_2,\ \ldots\ \lambda_{K-2}-\lambda_{K-1},\ \lambda_{K-1}-\infty$$

over which the reflectances (emittances) of the enclosure surfaces are approximated by constants. In principle, the band approximation becomes exact as the number of bands becomes infinite. Practically, the reflectance-versus-wavelength characteristics of most engineering surfaces can be adequately approximated with just several bands.

Finally, it should be noted that the approach taken here differs from the so-called "semi-gray" approach sometimes used in the analysis of radiation heat transfer in solar cavity receivers, e.g., [12]. In the "semi-gray" approach, in essence, two different reflectances are used, one characterizing the transport of solar radiation and the other the transport of thermally emitted radiation. Embodied in the "semi-gray" approach is the assumption that there is negligible thermal emission from the receiver surfaces at solar wavelengths, i.e., at wavelengths less than 2.5μm. (In the present study thermal emission at all wavelengths is taken into account.) Predictions of thermal radiation using the "semi-gray" approach therefore tend to become increasingly inaccurate with increasing cavity temperature as thermal emission is shifted to the shorter wavelengths. For instance, 21% of the energy emitted from a black surface at 1100°K (1520°F) is at wavelengths less than 2.5μm. Furthermore, at high temperature (e.g., 1100°K), emission is predominantly in a wavelength range within which the reflectance (emittance) of many engineering materials is strongly wavelength-dependent and a single constant value of the reflectance (emittance) is inadequate.

Theoretical Basis of RADSOLVER

1. The Radiosity, Irradiation, and Heat Transfer

The determination of the radiosity at each zonal area is the key to the computations since, once it is known, the irradiation and heat flux distributions over the cavity interior are calculable. The radiosity, defined as the radiant energy flux leaving a surface, is expressed as

$$J_i^k = \rho_i^k \left(G_i^k + G_{s,i}^k\right) + E_i^k \tag{1}^*$$

for the i-th zone. G_i^k represents the irradiation of zone i by energies coming from the other cavity zones, $G_{s,i}^k$ represents the direct solar irradiation, and E_i^k represents the thermally emitted energy. The superscript k indicates that the radiant energy being considered is in the k-th wavelength band, i.e., from λ_{k-1} to λ_k. ρ_i^k is the reflectance of zone i in this band.

Under the diffuse surface approximation, the irradiation G_i^k is expressed as

$$G_i^k = \sum_{j=1}^{N} J_j^k F_{ij} \text{ or equivalently as } \underset{\sim}{G}^k = [F_{ij}]\underset{\sim}{J}^k \tag{2}$$

where F_{ij} is the configuration factor between zones i and j, and $\underset{\sim}{G}^k$ and $\underset{\sim}{J}^k$ represent the column vectors

$$\underset{\sim}{G}^k = \begin{bmatrix} G_1^k \\ G_2^k \\ G_3^k \\ \cdot \\ \cdot \\ \cdot \\ G_N^k \end{bmatrix}, \quad \underset{\sim}{J}^k = \begin{bmatrix} J_1^k \\ J_2^k \\ J_3^k \\ \cdot \\ \cdot \\ \cdot \\ J_N^k \end{bmatrix} \tag{3,4}$$

*Equation (1) is actually obtained by integrating the spectral radiosity equation. The details are given in the Appendix.

The direct total solar irradiation $G_{s,i}$, is assumed to be known a priori, e.g., from ray trace calculations which follow the paths of rays from the heliostats to the i-th zone. The solar irradiation in the k-th wavelength band, $G^k_{s,i}$, is calculated by RADSOLVER from the relationship

$$G^k_{s,i} = \Phi^k G_{s,i} \tag{5}$$

where Φ^k represents the prescribed fraction of the solar spectrum lying in the k-th band. The thermally emitted energy in the k-th band, i.e., the emissive power, is given by

$$E^k_i = \varepsilon^k_i \int_{\lambda_{k-1}}^{\lambda_k} e_{b\lambda}(T_i)d\lambda \tag{6}$$

where $e_{b\lambda}$ is Planck's function

$$e_{b\lambda} = \frac{2\pi C_1}{\lambda^5[\exp(C_2/\lambda T)-1]} \tag{7}$$

Equation (2) is substituted into Equation (1) and the relationship thus obtained is written for each zone of the enclosure. The resultant set of equations in matrix form is

$$[r^k_{ij}]\underset{\sim}{J}^k = \underset{\sim}{E}^k + \underset{\sim}{H}^k \tag{8}$$

where

$$r^k_{ij} = \delta_{ij} - \rho^k_i F_{ij} \tag{9}$$

and $\underset{\sim}{E}^k$ and $\underset{\sim}{H}^k$ represent the column vectors

$$\underset{\sim}{E}^k = \begin{bmatrix} E^k_1 \\ E^k_2 \\ E^k_3 \\ \cdot \\ \cdot \\ \cdot \\ E^k_N \end{bmatrix} \quad \text{and} \quad \underset{\sim}{H}^k = \begin{bmatrix} \rho^k_1 G^k_{s,1} \\ \rho^k_2 G^k_{s,2} \\ \rho^k_3 G^k_{s,3} \\ \cdot \\ \cdot \\ \cdot \\ \rho^k_N G^k_{s,N} \end{bmatrix} \tag{10,11}$$

The radiosity is determined from the solution of Equation (8), i.e.,

$$\underset{\sim}{J}^k = [r_{ij}^k]^{-1} (\underset{\sim}{E}^k + \underset{\sim}{H}^k) \tag{12}$$

Radiative energy transfers at zones lying in the apertures are described by these formalisms by considering such zones as hypothetical black surfaces having the temperature of absolute zero.

Two situations are now considered: (1) the temperatures of all zones of the enclosure are prescribed; and (2) the temperatures of only certain zones are prescribed and the heat fluxes are prescribed at the remaining zones. In the first case, the radiosity is computed immediately from Equation (12) since, with known zonal temperatures, all of the elements of the vector $\underset{\sim}{E}^k$ are calculable at the outset (cf. Equation (6)). In the second case, the temperatures of those zones having prescribed heat fluxes are computed by a method described later (this allows the computation of the vector $\underset{\sim}{E}^k$), and then Equation (12) is used for the radiosity.

With values of the radiosity available, the irradiations G_i^k are calculated from Equation (2); and the net heat flux at zone i, defined as the difference between the incoming and the leaving radiant energies summed over all of the wavelength bands, is calculated from

$$Q_i = \sum_{k=1}^{K} (G_i^k + G_{s,i}^k - J_i^k) \tag{13}$$

2. The Temperatures of Zones Having Prescribed Heat Fluxes

We describe now the method of determining the temperatures of the zones having prescribed heat fluxes. The starting point is to write Equation (13) in matrix form, i.e.,

$$\underset{\sim}{Q} = \sum_{k=1}^{K} (\underset{\sim}{G}^k + \underset{\sim}{G}_s^k - \underset{\sim}{J}^k) \tag{14}$$

The substitution of Equations (2) and (12) into Equation (14) gives upon rearrangement

$$\sum_{k=1}^{K} [a_{ij}^k]\underset{\sim}{E}^k = \underset{\sim}{Q} - \sum_{k=1}^{K} ([a_{ij}^k]\underset{\sim}{H}^k + \underset{\sim}{G}_s^k) \tag{15}$$

where the matrix $[a_{ij}^k]$ represents the product

$$[a_{ij}^k] = [F_{ij}-\delta_{ij}]\ [r_{ij}^k]^{-1} \tag{16}$$

Note that, in spite of its complexity, the right hand side of Equation (15) is simply a column vector. To ease the notation we designate this column vector by $\underset{\sim}{b}$, i.e.,

$$\underset{\sim}{b} \equiv \underset{\sim}{Q} - \sum_{k=1}^{K} ([a_{ij}^k]\underset{\sim}{H}^k + \underset{\sim}{G}_s^k) \tag{17}$$

Thus Equation (15) may be written as

$$\sum_{k=1}^{K} [a_{ij}^k]\underset{\sim}{E}^k = \underset{\sim}{b} \tag{18}$$

To illustrate the solution procedure, assume that the temperatures of zones 1 through m are prescribed and that the temperatures of zones m+1 through N are to be determined.* Expanding Equation (18) gives

*RADSOLVER does not require that the zones be numbered in this manner.

$$\sum_{k=1}^{K}\begin{bmatrix} a^k_{11} & a^k_{12} & \cdots & a^k_{1m} & a^k_{1,m+1} & \cdots & a^k_{1N} \\ a^k_{21} & a^k_{22} & \cdots & a^k_{2m} & a^k_{2,m+1} & \cdots & a^k_{2N} \\ \vdots & \vdots & & \vdots & \vdots & & \vdots \\ a^k_{m1} & a^k_{m2} & \cdots & a^k_{mm} & a^k_{m,m+1} & \cdots & a^k_{mN} \\ a^k_{m+1,1} & a^k_{m+1,2} & \cdots & a^k_{m+1,m} & a^k_{m+1,m+1} & \cdots & a^k_{m+1,N} \\ \vdots & \vdots & & \vdots & \vdots & & \vdots \\ a^k_{N1} & a^k_{N2} & \cdots & a^k_{Nm} & a^k_{N,m+1} & \cdots & a^k_{NN} \end{bmatrix} \begin{bmatrix} E^k_1 \\ E^k_2 \\ \vdots \\ E^k_m \\ E^k_{m+1} \\ \vdots \\ E^k_N \end{bmatrix} \begin{matrix} \left.\vphantom{\begin{matrix}a\\a\\a\\a\end{matrix}}\right\} \text{known} \\ \left.\vphantom{\begin{matrix}a\\a\\a\end{matrix}}\right\} \text{unknown} \end{matrix} = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_m \\ b_{m+1} \\ \vdots \\ b_N \end{bmatrix} \begin{matrix} \left.\vphantom{\begin{matrix}a\\a\\a\\a\end{matrix}}\right\} \text{unknown} \\ \left.\vphantom{\begin{matrix}a\\a\\a\end{matrix}}\right\} \text{known} \end{matrix} \tag{19}$$

We now multiply the vector $\underset{\sim}{E}^k$ by rows m+1 through N of the $[a^k_{ij}]$ matrix in order to obtain a set of N-m equations for the N-m unknowns $E^k_{m+1}, \ldots E^k_N$. The result, after transferring to the righthand side all the terms containing the known elements of the $\underset{\sim}{E}^k$ vector, is

$$\sum_{k=1}^{K}\begin{bmatrix} a^k_{m+1,m+1} & \cdots & a^k_{m+1,N} \\ a^k_{m+2,m+1} & \cdots & a^k_{m+2,N} \\ \vdots & & \vdots \\ a^k_{N,m+1} & \cdots & a^k_{N,N} \end{bmatrix} \begin{bmatrix} E^k_{m+1} \\ E^k_{m+2} \\ \vdots \\ E^k_N \end{bmatrix} = \begin{bmatrix} b_{m+1} - \sum_{k=1}^{K}\sum_{j=1}^{m} a^k_{m+1,j}\, E^k_j \\ b_{m+2} - \sum_{k=1}^{K}\sum_{j=1}^{m} a^k_{m+2,j}\, E^k_j \\ \vdots \\ b_N - \sum_{k=1}^{K}\sum_{j=1}^{m} a^k_{N,j}\, E^k_j \end{bmatrix} \tag{20}$$

The known elements of the $\underset{\sim}{E}^k$ vector correspond to the zones having prescribed temperatures, i.e., the zones 1 through m. Note also that the quantities b_{m+1} through b_N are known since the heat fluxes are prescribed at the corresponding zones (cf. Equation (17)). Thus, the only unknowns in Equation (20) are the quantities E^k_{m+1} through E^k_N which depend upon the unknown temperatures T_{m+1} through T_N.

In the case of a gray cavity, the solution of Equation (20) for the unknown temperatures is straightforward. There is only one wavelength band which extends from $\lambda=0$ to $\lambda=\infty$ (i.e., K=1) and Equation (6) may be integrated to give

$$E = \varepsilon\sigma T^4 \tag{21}$$

where σ is the Stefan-Boltzmann constant. Hence, for the gray case, the $\underset{\sim}{E}^k$ vector in Equation (20) is simply

$$\begin{bmatrix} \varepsilon_{m+1}\sigma T^4_{m+1} \\ \varepsilon_{m+2}\sigma T^4_{m+2} \\ \cdot \\ \cdot \\ \cdot \\ \varepsilon_N \ \ \sigma \ T^4_N \end{bmatrix} \tag{22}$$

and the solution of Equation (20) is that of a set of simultaneous linear algebraic equations. In the non-gray case (i.e., K > 1), Equation (20) is non-linear. In this situation an initial guess of the unknown temperatures is computed and then a generalized non-linear equation solver is employed.

Description of the RADSOLVER Program

RADSOLVER, in essence, constructs and solves the equations that were presented above in order to determine (a) the heat fluxes at zones whose temperatures have been specified; and (b) the temperatures of zones whose heat fluxes have been specified. A cavity efficiency and the radiosity and irradiation of each zone are also determined. A listing of RADSOLVER is given on microfiche included on the back cover of this report.

The solution of sets of linear algebraic equations, which is a frequent operation within RADSOLVER (cf. Equation (12)), is accomplished by the SMPL* subroutine SAXB. The solution of non-linear equations (cf. Equation (20) for $K > 1$) is accomplished by the IMSL** subroutine ZSYSTM. Both of these subroutines and the subroutines which they call are included in RADSOLVER. The emissive power within a given wavelength band (Equation (6)) is calculated as described in the Appendix by the summation of series.

RADSOLVER is applicable to enclosures of arbitrary geometry having an arbitrary number of apertures. The user must, in general, supply the configuration factor matrix $[F_{ij}]$ and the zonal areas corresponding to his particular application. Configuration factor tabulations (cf. Siegel and Howell [1]) and computer programs such as CONFACII [15], TRASYSII [16], and SHAPEFACTOR [17] can be used for this purpose. There is the option within RADSOLVER to calculate the configuration factors for a cylindrical enclosure that has been subdivided into zones which are discs, flat annular rings, and cylindrical segments. This option should be used if the cavity aperture is in an end-plane of a cylinder and if the distribution of the direct solar irradiation is axially symmetric. Examples illustrating the use of RADSOLVER for both cylindrical and non-cylindrical cavities are presented later.

*Sandia Mathematical Program Library [13].
**International Mathematical and Statistical Libraries [14].

The logical structure of RADSOLVER is depicted in Figure 1. Descriptions of the various subroutines follow.

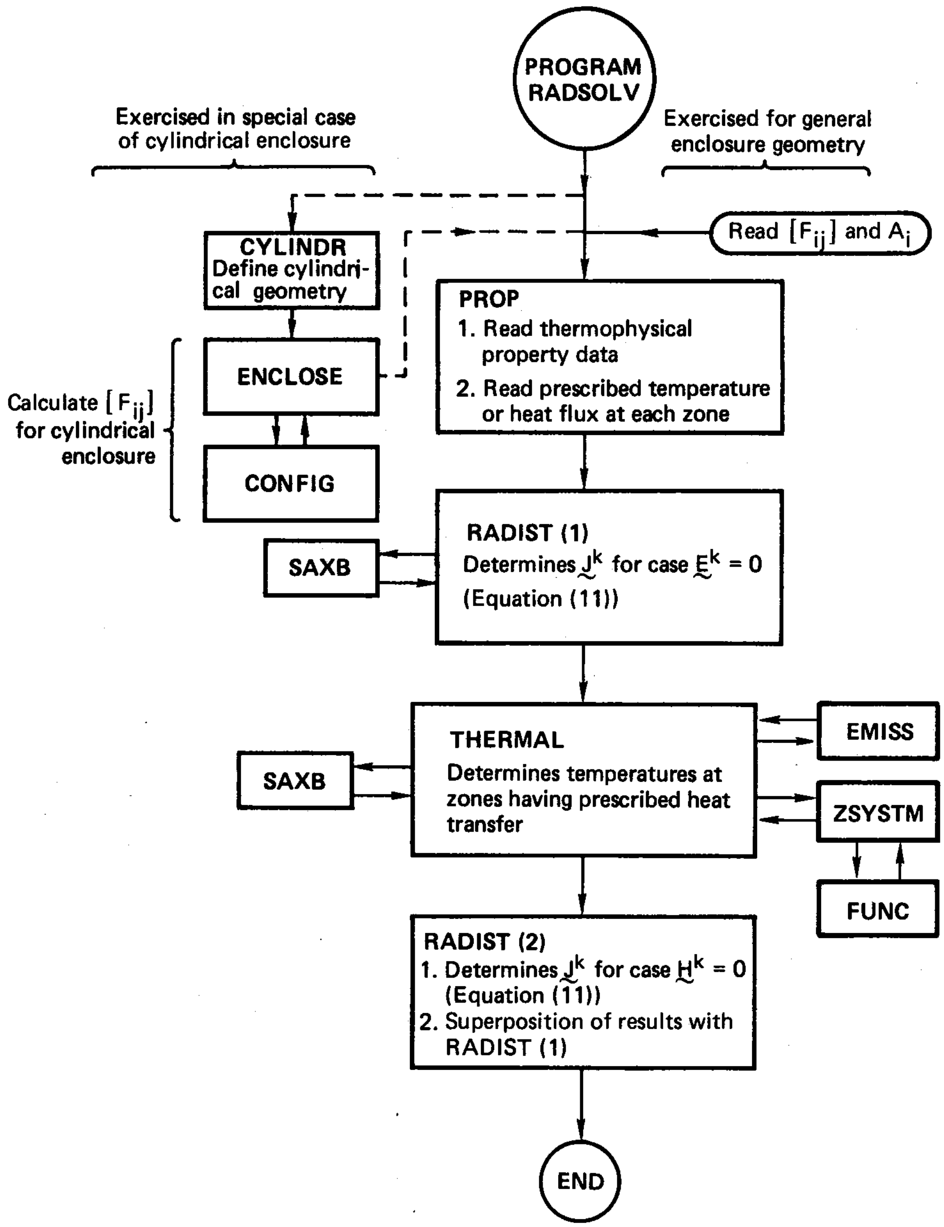


Figure 1. RADSOLVER Logical Structure.

1. Subroutine PROP

This subroutine reads and prints the non-geometrical data required in the solution. These data are:

(a) NBDS: The number of bands to be considered in the energy spectrum. This quantity is read in as 1 if the gray approximation is used.

(b) XLAM(K): The sequence of wavelengths in microns, which demarcates the bounds of the wavelength bands. For instance, the sequence 0., .522, 1000. corresponds to a 2-band approximation in which the first band covers the wavelength range 0 to .522 microns and the second band the range .522 to 1000 microns. In principle, the last wavelength in the sequence should be infinite; however, a value of 1000 microns is sufficient. The wavelength sequence corresponding to a gray enclosure is 0., 1000.

(c) NSET: The number of different reflectance-versus-wavelength characteristics associated with the enclosure. The minimum number for NSET is 2. One characteristic with $\rho=0$ for all wavelength bands must always be included. This characteristic is assigned to zones located within the cavity aperture(s).

(d) REFL(J,K): The reflectance of the J-th reflectance-versus-wavelength characteristic in the K-th band. Note that, by specifying the reflectance in the K-th band, the emittance is determined since $\varepsilon^k=1-\rho^k$.

(d) PHI(K): The fraction of the solar spectrum lying in the K-th wavelength band. This fraction is used in Equation (5).

(f) IZMIN, IZMAX, J: A sequence assigning the J-th reflectance-versus-wavelength characteristic to the zones IZMIN through IZMAX.

(g) IZMIN, IZMAX, FLUX: A sequence assigning the zones IZMIN through IZMAX the value "FLUX" as the direct total solar irradiation, $G_{s,i}$. The units of $G_{s,i}$ are kw/m^2.

(h) IZMIN, IZMAX, ITYP, VALUE: The sequence which assigns either a prescribed temperature or a prescribed heat flux to the zones IZMIN through IZMAX. If the temperature is to be prescribed, ITYP is read in as 3, and "VALUE" represents temperature. If the heat flux is to be prescribed, ITYP is read in as 2, and "VALUE" represents heat flux. For zones lying within the aperture plane(s), ITYP is read in as 1 and VALUE is read in as 0. The units of temperature and heat flux are, respectively, degrees-Kelvin and kw/m^2.

2. Subroutine RADIST(IOPT)

RADIST is called twice in the computations (cf. Figure 1). It is called first with the argument IOPT=1 followed by a call to the subroutine THERMAL. RADIST is then called with the argument IOPT=2.

With the argument IOPT=1, RADIST determines the radiosity, irradiation, and heat flux for the case in which the zonal temperatures are set artificially to absolute zero. This suppresses the transport of thermally emitted energies, and thus the resultant energy fluxes are due only to the transport of solar energy. Equations (2), (12) and (13) are used with the vectors $\underset{\sim}{E}^k=0$. The results of RADIST with IOPT=1 quantify the allocation of the solar energy over the enclosure interior.

For IOPT=2, RADIST determines the radiosity, irradiation, and heat flux in the situation in which no solar energy enters the enclosure and in which the zonal temperatures are those which have either been prescribed or computed by the subroutine THERMAL. Equations (2), (12) and (13) are again used -- this time with the vectors $\underset{\sim}{G}_s^k$ and $\underset{\sim}{H}^k$ set equal to 0. The results for IOPT=2 quantify the allocation of the thermally emitted energies over the cavity interior. Because of the linearity of the governing equations, when both solar and thermal transport are present, the radiosity, irradiation and heat flux are simply obtained by the superposition of the respective results for IOPT=1 and IOPT=2. The details of this superposition procedure are shown in the Appendix.

3. Subroutine THERMAL

The essential purpose of this subroutine is to solve Equation (20) in order to determine the temperatures and emissive powers of those zones having prescribed heat fluxes. In the case of a gray enclosure (i.e., K=1), Equation (20) is linear in the unknown emissive powers and the subroutine SAXB is employed. In the case of a non-gray enclosure, Equation (20) is non-linear and the subroutine ZSYSTM is employed. The required emissive powers (i.e., the quantities E_i^k) are determined by the function EMISS. The method used in SAXB is Gaussian elimination. That used in ZSYSTM is Brown's method [18], which is a Newton-like method requiring $N^2/2 + 3N/2$* function evaluations per iterative step. An initial estimate for the unknown temperatures, required to start the ZSYSTM solution procedure, is obtained by regarding the enclosure as gray.

4. Function FUNC

This is a function called by ZSYSTM to evaluate the i-th difference between the right and left hand side of Equation (20). Specifically, FUNC calculates the quantity

$$b_i - \sum_{k=1}^{K} \sum_{j=1}^{m} a_{i,j}^k \, E_j^k - \sum_{k=1}^{K} \sum_{j=m+1}^{N} a_{i,j}^k \, E_j^k = \text{i-th difference} \qquad (23)$$

which represents the expansion of the i-th row of Equation (20) where $m+1 \leq i \leq N$. The solution of Equation (20) corresponds to the situation in which the magnitude of all such differences has become less than a preset quantity.

*N is the number of unknowns.

5. Function EMISS

This function evaluates the integral

$$\int_{\lambda_{k-1}}^{\lambda_k} e_{b\lambda}(T)d\lambda \qquad (24)$$

which is used to calculate the emissive power in the k-th wavelength band, E_i^k (cf. Equation (6)). The basis for this computation is presented in the Appendix.

6. Subroutines CYLINDR, ENCLOSE, CONFIG

These subroutines are used to input and output the geometrical properties of a cylindrical enclosure and to subdivide the enclosure into zones consisting of discs, flat annular rings and cylindrical segments. The configuration factor between each pair of zones is also determined. This group of subroutines should be used only in the case of a cylindrical enclosure where the solar energy enters axisymmetrically through an end plane. In cases which are not axially symmetric, or where the enclosure is not cylindrical, the configuration factor matrix and zonal areas must be input. The option to use the cylindrical enclosure subroutines is in program RADSOLV. See Figure 1.

Because of the simplicity of the cylindrical enclosure, the exact analytical expressions for the configuration factors are available. These are included in the subroutine CONFIG and correspond to the following geometrical arrangements:

(a) disc at one end-plane of the cylinder to a co-axial disc at the opposite end

(b) flat annular ring at one end-plane of the cylinder to a co-axial disc at the opposite end

(c) flat annular ring at one end plane of the cylinder to a co-axial, flat annular ring at the opposite end

(d) cylindrical segment to another cylindrical segment

(e) cylindrical segment to itself

(f) cylindrical segment to a flat annular ring at an end plane of the cylinder

(g) cylindrical segment to a disc at an end plane of the cylinder.

The respective formulas and their sources are listed in the Appendix.

Illustrative Examples

1. Cylindrical Enclosure With Wavelength-Dependent Reflectance

The cylindrical enclosure in this example is subdivided into zones as depicted in Figure 2. Solar radiation enters axisymmetrically through the lower end plane and irradiates the enclosure walls with the average solar irradiation at each zone listed in Table 1. These irradiations correspond to a hypothetical 1MW diffuse source of energy in the cavity aperture. The temperature of the cylindrical portion of the enclosure is assumed to be 1100°K, and the roof is assumed to be a refractory where the heat flux is specified as zero.

A two-band reflectance versus wavelength characteristic is assumed to characterize the entire interior surface of the enclosure. The first band extends from 0 to 2.5 microns and the reflectance in this band is 0.5; the second band extends from 2.5 microns to infinity and the reflectance in it is 0.9. All of the solar energy is assumed to lie in the first band. RADSOLVER is used to determine the radiosity, irradiation, heat flux, and the temperatures of the adiabatic zones. The cards input for this example are described in Table 2 and an annotated output follows. The program execution time on the CDC 6600 computer was 2.4 seconds.

TABLE 1. Average Solar Irradiation in Cylindrical Enclosure Example

Zone	Irradiation (kW/m^2)
1	0.
2	1304.8
3	850.3
4	548.3
5	356.39
6	236.45
7	161.12
8	104.53
9	279.31
10	300.45
11	315.35
12	318.02

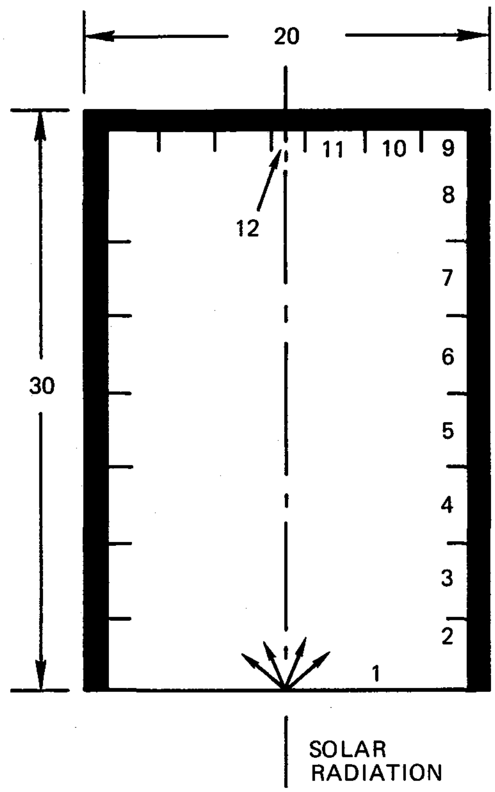


Figure 2. Cylindrical Enclosure in Illustrative Example 1. Dimensions in meters.

TABLE 2. Description of the Cards Input to RADSOLVER for the Cylindrical Enclosure Example

Card No.	Fortran Variable(s), Format	Value(s) Input	Description
1	IGEOM (I5)	0	Indicates the type of enclosure geometry under consideration. IGEOM=0 for cylindrical geometry. IGEOM≠0 for other geometry. Read by RADSOLV.
2	D,L (8E10.4)	20.,30.	Respectively, the diameter and length of the cylindrical enclosure (in meters). Read in by Subroutine CYLINDR.
3	NZB,NZC,NZT (5I5)	1,7,4	Respectively, the number of zones in the base of the cylinder, the cylindrical surface, and the roof. Read by Subroutine CYLINDR.
4	R(I),(I=1,"NZB+1") (8E10.4)	0.,10.	Radii of zones in the base of the cylinder (meters). Read by Subroutine CYLINDR.
5	Z(I),(I=1,"NZC+1") (8E10.4)	0.,4.,8.,12.,16.,20.,24.,30.	Elevations of the planes which divide the cylindrical surface into segments (meters). Read by Subroutine CYLINDR.
6	R(I),(I=1,"NZT+1") (8E10.4)	0.,1.,4.,7.,10.	Radii of zones in the roof of the cylinder (meters). Read by Subroutine CYLINDR.
7	NBDS (10I5)	2	The number of wavelength bands. Read by Subroutine PROP.
8	XLAM(K),(K=1,"NBDS+1") (8E10.4)	0.,2.5,1000.	Wavelengths (microns) demarcating the bounds of the wavelength bands. Read by Subroutine PROP.
9	NSET (10I5)	2	Number of Reflectance-versus-wavelength characteristics associated with the enclosure. Read by Subroutine PROP.
10	REFL(1,K),(K=1,NBDS) (8E10.4)	.5,.9	Respectively, the reflectance in the first and second bands in the first reflectance characteristic. Read by Subroutine PROP.

(continued)

TABLE 2. (Continued)

Card No.	Fortran Variable(s), Format	Value(s) Input	Description
11	REFL(2,K),(K=1,NBDS) (8E10.4)	.0,.0	Respectively, the reflectance in the first and second bands in the second reflectance characteristic. Read by Subroutine PROP.
12	PHI(K),(K=1,NBDS) (8E10.4)	1.,0.	Respectively, the fraction of the solar irradiation lying in the first and second bands. Read by Subroutine PROP.
13	IZMIN,IZMAX,J (10I5)	1,1,2	Sequence which assigns the 2nd reflectance-versus-wavelength characteristic to zone 1 (the aperture). Read by Subroutine PROP.
14	IZMIN,IZMAX,J (10I5)	2,12,1	Sequence which assigns the 1st reflectance-versus-wavelength characteristic to zones 2 through 12. Read by Subroutine PROP.
15	IZMIN,IZMAX,FLUX (2I5,E10.4)	1,1,0.	The sequence on each of these cards assigns the direct irradiation "FLUX" to the zones IZMIN through IZMAX. For instance, zone 6 through zone 6, is assigned the irradiation 236.45 kw/m^2. Read by Subroutine PROP.
16	" " "	2,2,1304.8	
17	" " "	3,3,850.30	
18	" " "	4,4,548.30	
19	" " "	5,5,356.39	
20	" " "	6,6,236.45	
21	" " "	7,7,161.12	
22	" " "	8,8,104.53	
23	" " "	9,9,279.31	
24	" " "	10,10,300.45	
25	" " "	11,11,315.35	
26	" " "	12,12,318.02	
27	IZMIN,IZMAX,ITYP,VALUE (3I5,E10.4)	1,1,1,0.	The sequence on each of these cards specifies the boundary condition type (ITYP) and either the temperature or the heat flux at the zones IZMIN through IZMAX. If ITYP=2, the heat flux is specified and "VALUE" represents heat flux. If ITYP=3, the temperature is specified and "VALUE" represents temperature. The boundary condition ITYP=1 is assigned to zones lying within the aperture plane, and "VALUE" is set equal to zero for such zones.
28	" " "	2,8,3,1100.	
29	" " "	9,12,2,0.	

RADSOLVER OUTPUT - CYLINDRICAL ENCLOSURE EXAMPLE
(Page 1)

GEOMETRICAL DATA THAT HAVE BEEN INPUT (DIMENSIONS IN METERS)

```
DIAMETER OF CYLINDER   20.0000
LENGTH OF CYLINDER   30.0000

     NO. ZONES IN BASE     1      NO. OF ZONES IN CYLINDER     7     NO. ZONES IN TOP     4

     RADII OF ZONES IN BASE OF CYLINDER
              0.0000    10.0000

     ELEVATIONS OF PLANES WHICH DIVIDE THE CYLINDRICAL SURFACE INTO SEGMENTS
              0.0000     4.0000     8.0000    12.0000    16.0000    20.0000    24.0000    30.0000

     RADII OF ZONES IN UPPER END-PLANE OF CYLINDER
              0.0000     1.0000     4.0000     7.0000    10.0000
```

RADSOLVER OUTPUT - CYLINDRICAL ENCLOSURE EXAMPLE
(Page 2)

CONFIGURATION FACTOR MATRIX FOR CYLINDRICAL ENCLOSURE CALCULATED BY THIS PROGRAM

0.000000000000	.327921561087	.213704808054	.137802085621	.089571301216	.059427368768	.040492719689	.039407068761
.044752058886	.031148510960	.014773416238	.000999100720				
.409901951359	.180196097281	.142770941292	.094878403041	.060288480507	.037679915560	.023668311348	.020603584845
.013876847258	.010531844604	.005241480638	.000360142267				
.267131010068	.142770941292	.180196097281	.142770941292	.094878403041	.060288480507	.037679915560	.032056789744
.019037573655	.015024303493	.007637185362	.000528358706				
.172252607027	.094878403041	.142770941292	.180196097281	.142770941292	.094878403041	.060288480507	.050860631599
.026617935244	.022131829445	.011548300495	.000805429737				
.111964126520	.060288480507	.094878403041	.142770941292	.180196097281	.142770941292	.094878403041	.081334429188
.037861465660	.033700938077	.018085044309	.001270729792				
.074284210960	.037679915560	.060288480507	.094878403041	.142770941292	.180196097281	.142770941292	.128526263252
.054840562513	.052950122204	.028793223402	.002020838697				
.050615899611	.023668311348	.037679915560	.060288480507	.094878403041	.142770941292	.180196097281	.195382453590
.083387217797	.084913380644	.043280049282	.002938850047				
.032839223967	.013735723230	.021371193163	.033907087732	.054222952792	.085684175501	.130254969060	.255969349109
.230624216177	.102874628555	.036298630810	.002217849904				
.087749135070	.021770740796	.029862860636	.041753623913	.059390534369	.086024411785	.130803478897	.542645214534
0.000000000000	0.000000000000	0.000000000000	0.000000000000				
.094389427153	.025531744494	.036422553921	.053652919867	.081699243823	.128363932617	.205850619744	.374089558383
0.000000000000	0.000000000000	0.000000000000	0.000000000000				
.098489441588	.027954567405	.040731655262	.061590935973	.096453569648	.153563858144	.230826929502	.290389046477
0.000000000000	0.000000000000	0.000000000000	0.000000000000				
.099910071953	.028811381348	.042268696498	.064434378928	.101658383360	.161667095727	.235108003729	.266141988459
0.000000000000	0.000000000000	0.000000000000	0.000000000000				

RADSOLVER OUTPUT - CYLINDRICAL ENCLOSURE EXAMPLE
(Page 3)

REFLECTANCE DATA

	BAND 1	BAND 2	BAND 3	BAND 4	BAND 5
MICRONS	0.000 -- 2.500	2.500 -- 1000.000			
CHRTISTC 1	.50000	.90000			
CHRTISTC 2	0.00000	0.00000			
FRACTION OF SOLAR RAD. IN THIS BAND	1.00000	0.00000			

SUMMARY OF THE NON-GEOMETRICAL ZONAL DATA WHICH HAVE BEEN INPUT

ZONE	REFLEC-TANCE CHRTISTC	TYPE OF B. C.	DIRECT SOLAR IRRADIATION (KW/METER-SQ)	HEAT FLUX IF SPECIFIED (KW/METER-SQ)	TEMPERATURE IF SPECIFIED (DEG-K)
1	2	1	0.		0.
2	1	3	.130480E+04		.11000E+04
3	1	3	.850300E+03		.11000E+04
4	1	3	.548300E+03		.11000E+04
5	1	3	.356390E+03		.11000E+04
6	1	3	.236450E+03		.11000E+04
7	1	3	.161120E+03		.11000E+04
8	1	3	.104530E+03		.11000E+04
9	1	2	.279310E+03	0.	
10	1	2	.300450E+03	0.	
11	1	2	.315350E+03	0.	
12	1	2	.318020E+03	0.	

NOTE THAT B. C. TYPE 1... CORRESPONDS TO ZONE IN APERTURE PLANE
TYPE 2... HEAT FLUX IS SPECIFIED
TYPE 3... TEMPERATURE OF ZONE IS SPECIFIED

SOLAR POWER INTO ENCLOSURE (KW) .10001E+07

Calculated from:

$$\text{Solar power in} = \sum_{i=1}^{N} \text{Area}_{i\text{-th zone}} \times G_{s,i}$$

RADSOLVER OUTPUT - CYLINDRICAL ENCLOSURE EXAMPLE
(Page 4)

THE FOLLOWING FLUX DISTRIBUTIONS ARE FOR AN ENCLOSURE WHOSE SURFACES ARE AT 0-DEG ABSOLUTE, AND INTO WHICH THE FOREGOING DIRECT SOLAR RADIATION ENTERS

RADIOSITY DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	0.	0.	0.
2	.81436E+03	.81436E+03	0.
3	.60720E+03	.60720E+03	0.
4	.45329E+03	.45329E+03	0.
5	.34347E+03	.34347E+03	0.
6	.26725E+03	.26725E+03	0.
7	.21603E+03	.21603E+03	0.
8	.17798E+03	.17798E+03	0.
9	.25116E+03	.25116E+03	0.
10	.27055E+03	.27055E+03	0.
11	.28324E+03	.28324E+03	0.
12	.28632E+03	.28632E+03	0.

†IRRADIATION DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ
1	.54582E+03	.54582E+03	0.
2	.16287E+04	.16287E+04	0.
3	.12144E+04	.12144E+04	0.
4	.90658E+03	.90658E+03	0.
5	.68695E+03	.68695E+03	0.
6	.53450E+03	.53450E+03	0.
7	.43206E+03	.43206E+03	0.
8	.35595E+03	.35595E+03	0.
9	.50232E+03	.50232E+03	0.
10	.54109E+03	.54109E+03	0.
11	.56648E+03	.56648E+03	0.
12	.57264E+03	.57264E+03	0.

DISTRIBUTION OF HEAT FLUX

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	.54582E+03	.54582E+03	0.
2	.81436E+03	.81436E+03	0.
3	.60720E+03	.60720E+03	0.
4	.45329E+03	.45329E+03	0.
5	.34347E+03	.34347E+03	0.
6	.26725E+03	.26725E+03	0.
7	.21603E+03	.21603E+03	0.
8	.17798E+03	.17798E+03	0.
9	.25116E+03	.25116E+03	0.
10	.27055E+03	.27055E+03	0.
11	.28324E+03	.28324E+03	0.
12	.28632E+03	.28632E+03	0.

TOTAL POWER LEAVING ENCLOSURE APERTURE (IOPT=1) .17147E+06 KW

ENERGY BALANCE OF ENCLOSURE (FOR IOPT=1) (KW)

SOLAR POWER INPUT TO ENCLOSURE............... .10001E+07
SOLAR POWER ABSORBED IN ENCLOSURE............ .82862E+06*
EFFECTIVE ABSORPTANCE OF ENCLOSURE........... .82854**

*Solar power input - solar power leaving through aperture.
**Solar power absorbed/solar power input.
†The irradiations listed include the direct solar irradiation.

RADSOLVER OUTPUT - CYLINDRICAL ENCLOSURE EXAMPLE
(Page 5)

THE FOLLOWING FLUX DISTRIBUTIONS ARE FOR AN ENCLOSURE INTO WHICH NO EXTERNAL RADIATION ENTERS, AND WHICH HAS THE TEMPERATURES LISTED ABOVE AND/OR THOSE CALCULATED BY THE SUBROUTINE THERMAL

RADIOSITY DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	0.	0.	0.
2	.49806E+02	.22728E+02	.27078E+02
3	.61153E+02	.27576E+02	.33577E+02
4	.72765E+02	.33219E+02	.39547E+02
5	.85231E+02	.40218E+02	.45014E+02
6	.99444E+02	.49354E+02	.50090E+02
7	.11648E+03	.61572E+02	.54903E+02
8	.14286E+03	.82124E+02	.60736E+02
9	.36348E+03	.28666E+03	.76821E+02
10	.37510E+03	.29939E+03	.75704E+02
11	.38347E+03	.30834E+03	.75134E+02
12	.38517E+03	.31028E+03	.74894E+02

IRRADIATION DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	.97319E+02	.57208E+02	.40111E+02
2	.50339E+02	.27478E+02	.22862E+02
3	.67257E+02	.37175E+02	.30082E+02
4	.85176E+02	.48460E+02	.36715E+02
5	.10525E+03	.62458E+02	.42790E+02
6	.12916E+03	.80730E+02	.48430E+02
7	.15894E+03	.10517E+03	.53779E+02
8	.20653E+03	.14627E+03	.60259E+02
9	.11232E+03	.61958E+02	.50365E+02
10	.10455E+03	.56384E+02	.48166E+02
11	.10023E+03	.53323E+02	.46904E+02
12	.98855E+02	.52361E+02	.46494E+02

DISTRIBUTION OF HEAT FLUX

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	.97319E+02	.57208E+02	.40111E+02
2	.53346E+00	.47500E+01	-.42165E+01
3	.61042E+01	.95986E+01	-.34944E+01
4	.12410E+02	.15241E+02	-.28311E+01
5	.20016E+02	.22240E+02	-.22237E+01
6	.29717E+02	.31376E+02	-.16596E+01
7	.42469E+02	.43594E+02	-.11248E+01
8	.63670E+02	.64147E+02	-.47673E+00
9	-.25116E+03	-.22471E+03	-.26456E+02
10	-.27055E+03	-.24301E+03	-.27538E+02
11	-.28324E+03	-.25501E+03	-.28230E+02
12	-.28632E+03	-.25792E+03	-.28400E+02

TOTAL POWER LEAVING ENCLOSURE APERTURE (IOPT=2) .30574E+05 KW
THIS IS THE SO-CALLED RERADIATION LOSS

RADSOLVER OUTPUT - CYLINDRICAL ENCLOSURE EXAMPLE
(Page 6)

THE HEAT TRANSFFR TO EACH ZONE FOR THE COMBINED C ASES OF
A)ENCLOSURE AT 0-DEG ABSOLUTE WITH INCOMING SOLAR RADIATION
PLUS
B) ENCLOSURE WITH SPECI FIED (AND/OR CALCULATED) SURFACE TEMPERATURES AND NO INCOMING SOLAR RADIATION

ZONE	HEAT TRANSFER (KW/METER-SQ)	†IRRADIATION (KW/METER-SQ)
1	.64313842E+03	.64313842E+03
2	.81489524E+03	.16790628E+04
3	.61330725E+03	.12816631E+04
4	.46570149E+03	.99175830E+03
5	.36349030E+03	.79219540E+03
6	.29696501E+03	.66365715E+03
7	.25850144E+03	.59100874E+03
8	.24164685E+03	.56248405E+03
9	-.45474735E-11	.61464675E+03
10	.14551915E-10	.64564502E+03
11	.16370905E-10	.66671104E+03
12	-.76068318E-07	.67149143E+03

TEMPERATURES OF ZONES HAVING TYPE 2 B. C.

ZONE	TEMPERATURE
9	.19539E+04
10	.19769E+04
11	.19919E+04
12	.19954E+04

PROBLEM SUMMARY

POWER (KW) LEAVING CAVITY APERTURE DUE TO ALL RADIATIVE MECHANISMS .20205E+06*
CAVITY EFFICIENCY .79797 **

- END OF CYLINDRICAL ENCLOSURE EXAMPLE -

*Solar plus thermal.
**[Absorbed Solar-Emitted Thermal]/Solar Input.
† This is the quantity that would be measured by a radiometer.

2. Gray Non-Cylindrical Enclosure

As an illustration of the use of RADSOLVER for non-cylindrical cavities, we consider the CESA-I solar central receiver being built in Spain under the direction of the Centro de Estudios de La Energia (Figure 3). In the example described below the CESA-I was assumed to be subdivided into 115 zones as depicted in Figure 4. The SHAPEFACTOR program [17] was then used to determine the configuration factor matrix $[F_{ij}]$ and the MIRVAL program [19]* was used to predict the direct solar irradiation at each of the zones for the conditions at 10:00 A.M. winter solstice. It should be again noted that the configuration factor matrix and zonal areas are required inputs to RADSOLVER for non-cylindrical cavity geometries.

The heat fluxes at the refractory zones were specified as zero and the temperatures at all of the other zones were assumed to be 598°K. It was assumed, further, that the cavity surfaces were gray with a reflectance of 0.1 at zones within the evaporator-superheater region and a reflectance of 0.4 at the refractory zones. Additional RADSOLVER computations (not reported here) were also performed using a model consisting of 199 zones and other specifications of the temperatures and reflectances.

Because the amount of input and output data involved in this example is extensive, only a synopsis is given below. The complete input and output data sets are given on microfiche included on the back cover of this report. As an illustration of the quantities predicted by RADSOLVER, Figure 5 depicts the radiosities, irradiations and heat fluxes at the zones along traverse 1 in Figure 4. (The program execution time on the CDC 6600 computer was 91.3 seconds.)

*These computations were performed, respectively, by V. K. Gabrielson and P. L. Leary of the Applied Mathematics Division.

The significance of the transport of thermally emitted energies along this traverse should be noted. It should also be observed that at zone 32, a zone where the heat flux is specified as zero, the radiosity is just offset by the irradiation.

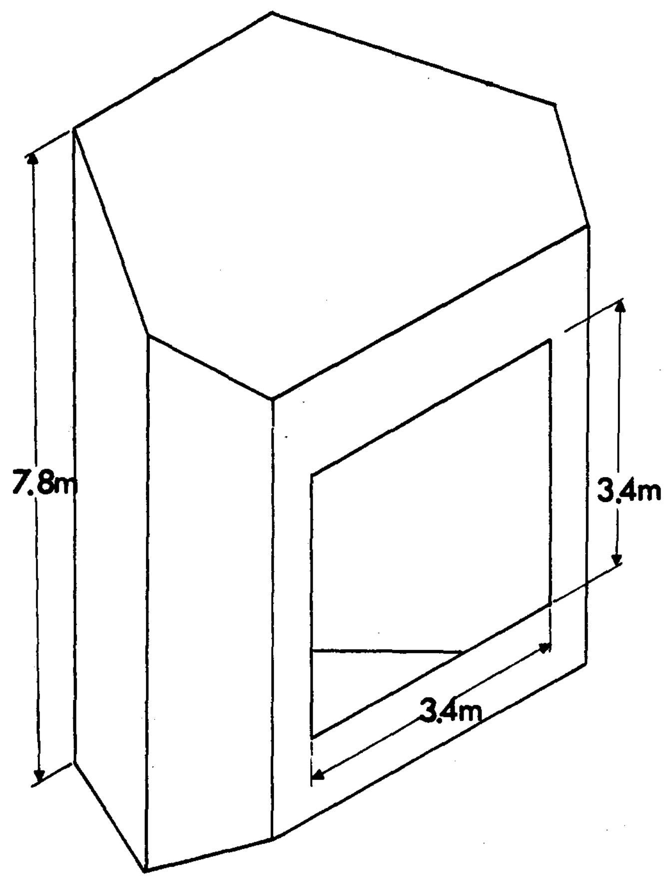


Figure 3. The CESA-I Cavity.

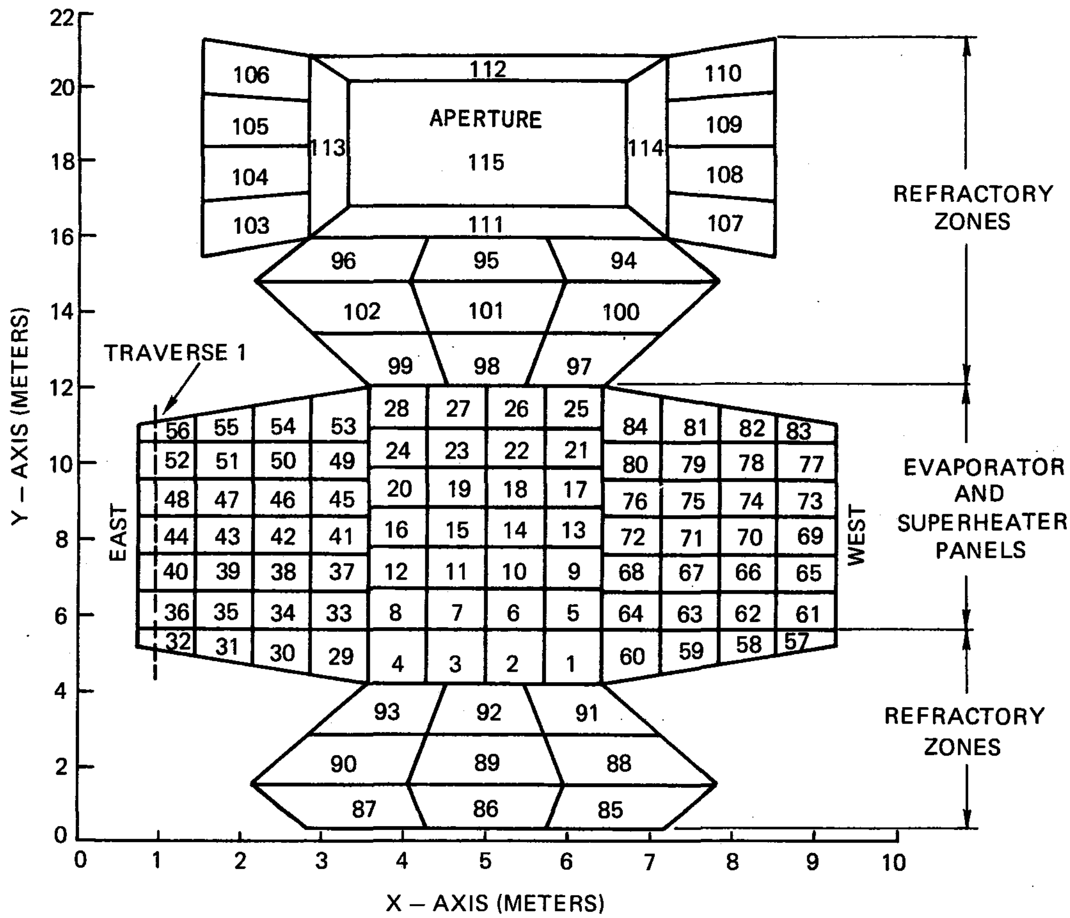


Figure 4. Zonal Model of the CESA-I Cavity.

SYNOPSIS OF RADSOLVER INPUT - CESA-I CAVITY

CARD 1:* NGEOM (I5) (≠0 for non-cylindrical cavity)
CARD 2: NZONE (I5)

```
    1
  115
```

CARDS 3-17: Zonal areas (m^2) Area(J),(J=1,115) (8E10.4)

```
 .1022E+01 .1022E+01 .1022E+01 .1022E+01 .7547E+00 .7547E+00 .7547E+00 .7547E+00
 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00
 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00
 .7562E+00 .7562E+00 .7562E+00 .7562E+00 .9345E+00 .7591E+00 .5848E+00 .4108E+00
 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00
 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00
 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .9334E+00 .7573E+00 .5834E+00 .4094E+00
 .4108E+00 .5848E+00 .7591E+00 .9345E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00
 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00
 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00
 .4094E+00 .5834E+00 .7573E+00 .9334E+00 .2041E+01 .2084E+01 .2041E+01 .2179E+01
 .2226E+01 .2179E+01 .1570E+01 .1563E+01 .1570E+01 .2037E+01 .2079E+01 .2037E+01
 .1572E+01 .1565E+01 .1572E+01 .2181E+01 .2227E+01 .2181E+01 .1774E+01 .1774E+01
 .1774E+01 .1774E+01 .1774E+01 .1774E+01 .1774E+01 .1774E+01 .2589E+01 .3381E+01
 .2009E+01 .2009E+01 .1156E+02
```

CARDS 18-1742: Configuration factor matrix F(1,J),(J=1,115)
⋮
F(115,J),(J=1,115) (8E10.4)

```
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        .3229E-02 .4566E-02 .3155E-02 .1722E-02
 .1940E-02 .3328E-02 .3150E-02 .2555E-02 .1014E-02 .2053E-02 .2156E-02 .1897E-02
 .5008E-03 .1129E-02 .1321E-02 .1273E-02 .2502E-03 .6107E-03 .7801E-03 .8144E-03
 .1323E-03 .3409E-03 .4644E-03 .5166E-03 .8916E-04 .2090E-03 .2435E-03 .2096E-03
 .1468E-02 .4756E-02 .1830E-01 .1018E+00 .1839E-02 .3488E-02 .7216E-02 .1217E-01
 .1013E-02 .1444E-02 .1769E-02 .1060E-02 .5005E-03 .5655E-03 .5102E-03 .2253E-03
 .2501E-03 .2437E-03 .1884E-03 .7401E-04 .1322E-03 .1176E-03 .8371E-04 .3109E-04
 .4787E-04 .5383E-04 .4423E-04 .1812E-04 .1419E-01 .1288E-01 .4843E-02 .5860E-01
 .4234E-01 .8088E-02 .3071E+00 .6053E-01 .6248E-02 .6566E-02 .6479E-02 .4890E-02
 .1014E-02 .9657E-03 .8121E-03 .4418E-02 .4380E-02 .3273E-02 .1403E-01 .9781E-02
 .5861E-02 .3334E-02 .2907E-01 .1573E-01 .7186E-02 .3330E-02 .4140E-01 .7947E-02
 .8703E-02 .1737E-01 .8973E-01
           ⋮
```

CARD 1743: NBDS (10I5)
CARD 1744: XLAM(1),XLAM(2) (8E10.4)
CARD 1745: NSET (10I5)

```
    1
0.        .1000E+04
    3
```

CARDS 1746-1748: REFL(1,1) (8E10.4)
⋮
REFL(3,1) (8E10.4)

```
0.
 .1000E+00
 .4000E+00
```

CARD 1749: PHI(1) (8E10.4)

```
 .1000E+01
```

CARDS 1750-1757: IZMIN,IZMAX,J (10I5) (Assignment of the J-th reflectance characteristic to zones IZMIN through IZMAX)

```
    1    4    3
    5   28    2
   29   32    3
   33   56    2
   57   60    3
   61   84    2
   85  114    3
  115  115    1
```

CARDS 1758-1831: IZMIN,IZMAX,FLUX (2I5,E10.4) (Assignment of the direct solar irradiation "FLUX" kw/m^2 to zones IZMIN through IZMAX)

```
    1   40.
    5    5 .5640E+02
    6    6 .6620E+02
    7    7 .6710E+02
    8    8 .6340E+02
    9    9 .2477E+03
         ⋮
   76   76 .1904E+03
   77   77 .5000E+00
   78   78 .8100E+01
   79   79 .3230E+02
   80   80 .4630E+02
   81   810.
   82   82 .3000E+00
   83   83 .1800E+01
   84   84 .5100E+01
   85  1150.
```

*The input was actually read from a permanent file on which the data was placed in the format indicated.

SYNOPSIS OF RADSOLVER INPUT - CESA-I CAVITY (continued)

```
  1    4    20.
  5   28    3 .5980E+03
 29   32    20.
 33   56    3 .5980E+03      CARDS 1832-1839:  IZMIN,IZMAX,ITYP,VALUE
 57   60    20.                                (3I5,10E10.4)
 61   84    3 .5980E+03                        (Assignment of boundary condition type
 85  114    20.                                and either the temperature or the
115  115    10.                                heat flux to the zones IZMIN
                                               through IZMAX)
```

SYNOPSIS OF RADSOLVER OUTPUT - CESA-I CAVITY

REFLECTANCE DATA

	BAND 1	BAND 2
MICRONS	0.000 -- 1000.000	
CHRTISTC 1	0.00000	
CHRTISTC 2	.10000	
CHRTISTC 3	.40000	
FRACTION OF SOLAR RAD. IN THIS BAND	1.00000	

SUMMARY OF THE NON-GEOMETRICAL ZONAL DATA WHICH HAVE BEEN INPUT

ZONE	REFLEC- TANCE CHRTISTC	TYPE OF B. C.	DIRECT SOLAR IRRADIATION (KW/METER-SQ)	HEAT FLUX IF SPECIFIED (KW/METER-SQ)	TEMPERATURE IF SPECIFIED (DEG-K)
1	3	2	0.	0.	
2	3	2	0.	0.	
3	3	2	0.	0.	
4	3	2	0.	0.	
5	2	3	.564000E+02		.59800E+03
6	2	3	.662000E+02		.59800E+03
7	2	3	.671000E+02		.59800E+03
8	2	3	.634000E+02		.59800E+03
107	3	2	0.	0.	
108	3	2	0.	0.	
109	3	2	0.	0.	
110	3	2	0.	0.	
111	3	2	0.	0.	
112	3	2	0.	0.	
113	3	2	0.	0.	
114	3	2	0.	0.	
115	1	1	0.		C.

NOTE THAT B. C. TYPE 1... CORRESPONDS TO ZONE IN APERTURE PLANE
TYPE 2... HEAT FLUX IS SPECIFIED
TYPE 3... TEMPERATURE OF ZONE IS SPECIFIED

SOLAR POWER INTO ENCLOSURE (KW) .52008E+04

SYNOPSIS OF RADSOLVER OUTPUT - CESA-I CAVITY
(continued)

THE FOLLOWING FLUX DISTRIBUTIONS ARE FOR AN ENCLOSURE WHOSE SURFACES ARE AT 0-DEG ABSOLUTE, AND INTO WHICH THE FOREGOING DIRECT SOLAR RADIATION ENTERS

RADIOSITY DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	.75617E+00	.75617E+00	
2	.84472E+00	.84472E+00	
3	.84688E+00	.84688E+00	
4	.75941E+00	.75941E+00	
5	.59394E+01	.59394E+01	
6	.69143E+01	.69143E+01	
7	.70066E+01	.70066E+01	
8	.66459E+01	.66459E+01	
9	.25292E+02	.25292E+02	
10	.28834E+02	.28834E+02	
11	.28468E+02	.28468E+02	
12	.26737E+02	.26737E+02	
13	.36215E+02	.36215E+02	
14	.39525E+02	.39525E+02	
15	.39875E+02	.39875E+02	
16	.36789E+02	.36789E+02	
17	.15461E+02	.15461E+02	
18	.16033E+02	.16033E+02	

†IRRADIATION DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	.18904E+01	.18904E+01	
2	.21118E+01	.21118E+01	
3	.21172E+01	.21172E+01	
4	.18985E+01	.18985E+01	
5	.59394E+02	.59394E+02	
6	.69143E+02	.69143E+02	
7	.70066E+02	.70066E+02	
8	.66459E+02	.66459E+02	
9	.25292E+03	.25292E+03	
10	.28834E+03	.28834E+03	
11	.28468E+03	.28468E+03	
12	.26737E+03	.26737E+03	
13	.36215E+03	.36215E+03	
14	.39525E+03	.39525E+03	
15	.39875E+03	.39875E+03	
16	.36789E+03	.36789E+03	
17	.15461E+03	.15461E+03	
18	.16033E+03	.16033E+03	

DISTRIBUTION OF HEAT FLUX

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	.11342E+01	.11342E+01	
2	.12671E+01	.12671E+01	
3	.12703E+01	.12703E+01	
4	.11391E+01	.11391E+01	
5	.53455E+02	.53455E+02	
6	.62229E+02	.62229E+02	
7	.63059E+02	.63059E+02	
8	.59813E+02	.59813E+02	
9	.22763E+03	.22763E+03	
10	.25951E+03	.25951E+03	
11	.25621E+03	.25621E+03	
12	.24064E+03	.24064E+03	
13	.32594E+03	.32594E+03	
14	.35573E+03	.35573E+03	
15	.35888E+03	.35888E+03	
16	.33110E+03	.33110E+03	
17	.13915E+03	.13915E+03	
18	.14429E+03	.14429E+03	

TOTAL POWER LEAVING ENCLOSURE APERTURE (IOPT=1) .10571E+03 KW

ENERGY BALANCE OF ENCLOSURE (FOR IOPT=1) (KW)

SOLAR POWER INPUT TO ENCLOSURE............... .52008E+04
SOLAR POWER ABSORBED IN ENCLOSURE............ .50951E+04*
EFFECTIVE ABSORPTANCE OF ENCLOSURE........... .97967 **

*Solar power input - solar power leaving through the aperture.
**Solar power absorbed/solar power.
†Includes the direct solar irradiation.

SYNOPSIS OF RADSOLVER OUTPUT - CESA-I CAVITY (continued)

THE FOLLOWING FLUX DISTRIBUTIONS ARE FOR AN ENCLOSURE INTO WHICH NO EXTERNAL RADIATION ENTERS, AND WHICH HAS THE TEMPERATURES LISTED ABOVE AND/OR THOSE CALCULATED BY THE SUBROUTINE THERMAL

RADIOSITY DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	.12895E+02	.12895E+02	
2	.12860E+02	.12860E+02	
3	.12867E+02	.12867E+02	
4	.12911E+02	.12911E+02	
5	.75447E+01	.75447E+01	
6	.75583E+01	.75583E+01	
7	.75586E+01	.75586E+01	
8	.75454E+01	.75454E+01	
9	.74643E+01	.74643E+01	
10	.74697E+01	.74697E+01	
11	.74698E+01	.74698E+01	
12	.74647E+01	.74647E+01	
13	.74384E+01	.74384E+01	
14	.74390E+01	.74390E+01	
15	.74390E+01	.74390E+01	
16	.74385E+01	.74385E+01	
17	.74601E+01	.74601E+01	
18	.74647E+01	.74647E+01	

IRRADIATION DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	.11760E+02	.11760E+02	
2	.11593E+02	.11593E+02	
3	.11597E+02	.11597E+02	
4	.11772E+02	.11772E+02	
5	.10198E+02	.10198E+02	
6	.10334E+02	.10334E+02	
7	.10336E+02	.10336E+02	
8	.10204E+02	.10204E+02	
9	.93940E+01	.93940E+01	
10	.94473E+01	.94473E+01	
11	.94485E+01	.94485E+01	
12	.93972E+01	.93972E+01	
13	.91349E+01	.91349E+01	
14	.91401E+01	.91401E+01	
15	.91402E+01	.91402E+01	
16	.91352E+01	.91352E+01	
17	.93512E+01	.93512E+01	
18	.93978E+01	.93978E+01	

DISTRIBUTION OF HEAT FLUX

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)
1	-.11342E+01	-.11342E+01	
2	-.12671E+01	-.12671E+01	
3	-.12703E+01	-.12703E+01	
4	-.11391E+01	-.11391E+01	
5	.26533E+01	.26533E+01	
6	.27756E+01	.27756E+01	
7	.27778E+01	.27778E+01	
8	.26589E+01	.26589E+01	
9	.19297E+01	.19297E+01	
10	.19776E+01	.19776E+01	
11	.19787E+01	.19787E+01	
12	.19325E+01	.19325E+01	
13	.16965E+01	.16965E+01	
14	.17012E+01	.17012E+01	
15	.17013E+01	.17013E+01	
16	.16967E+01	.16967E+01	
17	.18912E+01	.18912E+01	
18	.19331E+01	.19331E+01	

TOTAL POWER LEAVING ENCLOSURE APERTURE (IOPT=2) .10780E+03 KW
THIS IS THE SO-CALLED RERADIATION LOSS

SYNOPSIS OF RADSOLVER OUTPUT - CESA-I CAVITY
(continued)

THE HEAT TRANSFER TO EACH ZONE FOR THE COMBINED C ASES OF
A)ENCLOSURE AT 0-DEG ABSOLUTE WITH INCOMING SOLAR RADIATION
PLUS
B) ENCLOSURE WITH SPECI FIED (AND/OR CALCULATED) SURFACE TEMPERATURES AND NO INCOMING SOLAR RADIATION

ZONE	HEAT TRANSFER (KW/METER-SQ)	†IRRADIATION (KW/METER-SQ)
1	-.50945914E-11	.13650780E+02
2	-.48316906E-11	.13704563E+02
3	-.47180038E-11	.13714115E+02
4	-.49240612E-11	.13670287E+02
5	.56107960E+02	.69592109E+02
6	.65004465E+02	.79477114E+02
7	.65837137E+02	.80402305E+02
8	.62471636E+02	.76662860E+02
9	.22956153E+03	.26231830E+03
10	.26148351E+03	.29778716E+03
11	.25818836E+03	.29412589E+03
12	.24256935E+03	.27677143E+03
13	.32763459E+03	.37128837E+03
14	.35743043E+03	.40439485E+03
15	.36057910E+03	.40789337E+03
16	.33279397E+03	.37702100E+03
17	.14103829E+03	.16395914E+03
18	.14622648E+03	.16972380E+03

TEMPERATURES OF ZONES HAVING TYPE 2 B. C.

ZONE	TEMPERATURE
1	.70050E+03
2	.70119E+03
3	.70131E+03
4	.70075E+03
29	.70614E+03
30	.70944E+03
31	.71199E+03
32	.71465E+03
57	.71437E+03
58	.71181E+03
59	.70943E+03
60	.70619E+03
85	.72542E+03
86	.73079E+03
87	.72626E+03
88	.72073E+03
89	.73024E+03
90	.72172E+03
91	.71199E+03
92	.71536E+03
93	.71245E+03
94	.72198E+03
95	.73117E+03
96	.72137E+03
97	.66941E+03
98	.68130E+03
99	.66683E+03
100	.69909E+03
101	.72121E+03
102	.69750E+03
103	.72785E+03
104	.73089E+03
105	.72761E+03

PROBLEM SUMMARY

POWER (KW) LEAVING CAVITY APERTURE DUE TO ALL RADIATIVE MECHANISMS	.21351E+03 *
CAVITY EFFICIENCY	.95895 **

- END NON-CYLINDRICAL CAVITY EXAMPLE -

*Solar plus thermal.
**[Absorbed Solar-Emitted Thermal]/Solar Input.
†This is the quantity that would be measured by a radiometer.

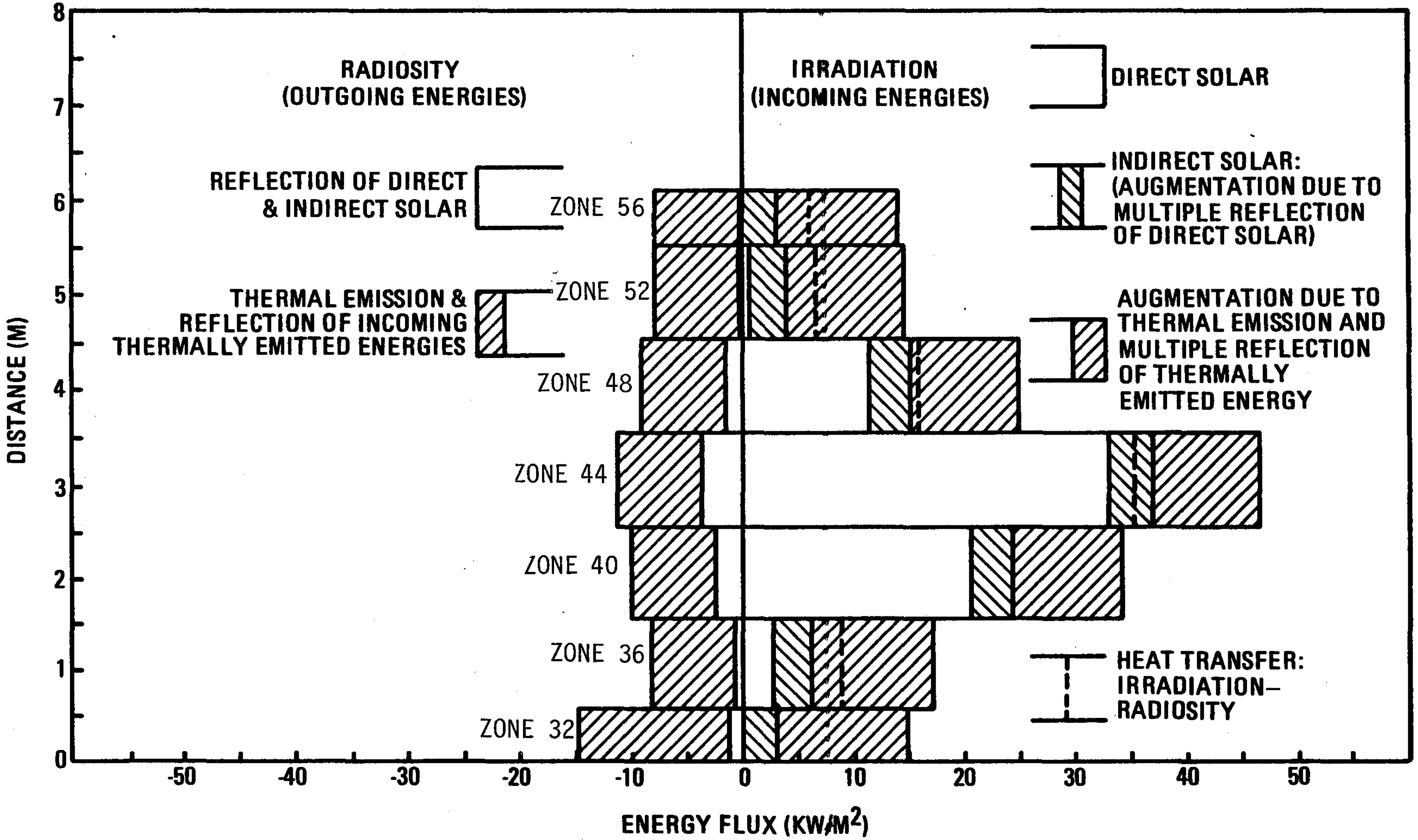


Figure 5. Radiative Energy Transfers Along Traverse 1 in Figure 4.

Appendix

1. Spectral Radiosity Equation

In this section Equation (1) is derived by integrating the fundamental relationship for the spectral radiosity. The spectral radiosity, defined as the energy per unit wavelength leaving a surface, is expressed as

$$J_\lambda = \rho_\lambda(G_\lambda + G_{s,\lambda}) + \varepsilon_\lambda e_{b\lambda} \tag{A1}$$

where the terms on the right represent, respectively, the reflected and emitted spectral energies. (The subscript i, denoting a particular surface, is dropped for simplicity.) Equation (A1) is integrated over the wavelength range λ_{k-1} to λ_k where λ_{k-1} and λ_k are the bounds of the k-th wavelength band in the band model of the surface properties. In accordance with this model (cf. page 13) it is assumed that the properties ρ_λ and ε_λ are constants over a band. The result of integrating Equation (1) is thus

$$\int_{\lambda_{k-1}}^{\lambda_k} J_\lambda d\lambda = \rho^k \int_{\lambda_{k-1}}^{\lambda_k} G_\lambda d\lambda + \int_{\lambda_{k-1}}^{\lambda_k} G_{s,\lambda} d\lambda + \varepsilon^k \int_{\lambda_{k-1}}^{\lambda_k} e_{b\lambda} d\lambda \tag{A2}$$

Equation (A2) is seen to be identical to Equation (1) by noting the definitions:

$$\int_{\lambda_{k-1}}^{\lambda_k} J_\lambda d\lambda \equiv J^k ,$$

$$\int_{\lambda_{k-1}}^{\lambda_k} G_\lambda d\lambda \equiv G^k , \tag{A3}$$

$$\int_{\lambda_{k-1}}^{\lambda_k} G_{s,\lambda} d\lambda \equiv G_s^k ,$$

and $$\varepsilon^k \int_{\lambda_{k-1}}^{\lambda_k} e_{b\lambda} d\lambda \equiv E^k .$$

2. Superposition of the Radiant Energy Fluxes

In this section it is demonstrated that the radiosity, irradiation and heat flux vectors ($\tilde{J}^k$, $\tilde{G}^k$ and $\tilde{Q}$) may also be determined by superimposing these energy fluxes obtained from the two subproblems:

A) The cavity is at zero degrees absolute with the prescribed distribution of the external (solar) irradiation over the cavity interior.

B) The temperatures of the cavity zones are those which have been prescribed (or computed) and no external (solar) radiation enters.

The radiative energy fluxes for subproblem A are obtained by setting the emissive power vector $\tilde{E}^k$ to zero in Equation (12). The radiosity is thus expressed as

$$\tilde{J}_A^k = [r_{ij}^k]^{-1} \tilde{H}^k . \qquad \text{(A4)}^*$$

The corresponding irradiation is given by (cf. Equation (2))

$$\tilde{G}_A^k = [F_{ij}] \tilde{J}_A^k . \qquad \text{(A5)}$$

The corresponding heat flux is given by (cf. Equation (13))

$$\tilde{Q}_A = \sum_{k=1}^{K} (\tilde{G}_A^k + \tilde{G}_s^k - \tilde{J}_A^k) . \qquad \text{(A6)}$$

The radiative energy fluxes for subproblem B are obtained by setting the external radiation vectors $\tilde{H}^k$ and $\tilde{G}_s^k$ to zero in Equations (12) and (13). The results are

$$\tilde{J}_B^k = [r_{ij}^k]^{-1} \tilde{E}^k , \qquad \text{(A7)}$$

$$\tilde{G}_B^k = [F_{ij}] \tilde{J}_B^k , \qquad \text{(A8)}$$

*The following additional notation is used in this section: A radiative quantity ($\tilde{J}^k$, $\tilde{G}^k$ or $\tilde{Q}$) with the subscript A pertains to subproblem A, etc. A radiative quantity without an A or B subscript pertains to the case where both solar and thermally emitted energies are present.

and $$\underset{\sim}{Q}_B = \sum_{k=1}^{K} (\underset{\sim}{G}_B^k - \underset{\sim}{J}_B^k) \; . \tag{A9}$$

The superposition of the radiosities of the two subproblems yields

$$\underset{\sim}{J}_B^k + \underset{\sim}{J}_A^k = [r_{ij}]^{-1} (\underset{\sim}{E}^k + \underset{\sim}{H}^k) \tag{A10}$$

the right hand side of which is identical to the radiosity result that has been determined in the situation where both solar and thermally emitted energies are present (cf. Equation (12)). Thus,

$$\underset{\sim}{J}_B^k + \underset{\sim}{J}_A^k = \underset{\sim}{J}^k \tag{A11}$$

The superposition of the irradiations of the two subproblems yields

$$\underset{\sim}{G}_B^k + \underset{\sim}{G}_A^k = [F_{ij}] (\underset{\sim}{J}_B^k + \underset{\sim}{J}_A^k) \tag{A12}$$

which, using Equation (A11), becomes

$$\underset{\sim}{G}_B^k + \underset{\sim}{G}_A^k = [F_{ij}]\underset{\sim}{J}^k \tag{A13}$$

It is noted from Equation (2) that the product $[F_{ij}]\underset{\sim}{J}^k = \underset{\sim}{G}^k$. Hence,

$$\underset{\sim}{G}_B^k + \underset{\sim}{G}_A^k = \underset{\sim}{G}^k \tag{A14}$$

Finally, the superposition of the heat fluxes of the two subproblems yields

$$\underset{\sim}{Q}_B + \underset{\sim}{Q}_A = \sum_{k=1}^{K} [\underset{\sim}{G}_B^k + \underset{\sim}{G}_A^k + \underset{\sim}{G}_s^k - (\underset{\sim}{J}_B^k + \underset{\sim}{J}_A^k)] \tag{A15}$$

Using Equations (A11) and (A14), this becomes

$$\underset{\sim}{Q}_B + \underset{\sim}{Q}_A = \sum_{k=1}^{K} [\underset{\sim}{G}^k + \underset{\sim}{G}_s^k - \underset{\sim}{J}^k] \tag{A16}$$

It is noted that the right hand side of equation (A16) is the heat flux result that has been determined for the situation where both solar and thermally emitted energies are present (cf. Equation (13)). Thus,

$$\underset{\sim}{Q}_B + \underset{\sim}{Q}_A = \underset{\sim}{Q} = \sum_{k=1}^{K} [\underset{\sim}{G}^k + \underset{\sim}{G}_s^k - \underset{\sim}{J}^k] \tag{A17}$$

3. Computation of the Emissive Power Over a Prescribed Wavelength Interval

This section presents the method of computing the integral

$$\int_{\lambda_{k-1}}^{\lambda_k} e_{b\lambda} d\lambda = \int_0^{\lambda_k} e_{b\lambda} d\lambda - \int_0^{\lambda_{k-1}} e_{b\lambda}\, d\lambda \tag{A18}$$

which is used in the calculation of the emissive power (cf. Equation (6)). In essence, the method is based on the series representation of the integral

$$I = \int_0^{\lambda} e_{b\lambda} d\lambda = \int_0^{\lambda} \frac{2\pi C_1 d\lambda}{\lambda^5[\exp(C_2/\lambda T) - 1]} \tag{A19}$$

With this method, two series, corresponding to the two integrals on the right hand side of Equation (A18), are constructed and summed and then the difference between the sums is calculated.

The key to the method is the transformation of the Planck function integral (Equation (A19)) into Debye functions which have known series representations [20]. The Debye functions are defined below. The transformation is accomplished by making the variable substitution

$$z = C_2/\lambda T \tag{A20}$$

and using the fact that the Planck function constants C_1 and C_2 and the Stefan-Boltzmann constant σ are related by

$$\sigma = \frac{2\pi^5 C_1}{15 C_2^4} \tag{A21}$$

The results of the transformation are either of the following equivalent relationships:

$$I = \sigma T^4 \frac{15}{\pi^4} \int_{C_2/\lambda T}^{\infty} \frac{z^3 dz}{e^z - 1} \tag{A22}$$

or

$$I = \sigma T^4 \left[1 - \frac{15}{\pi^4} \int_0^{C_2/\lambda T} \frac{z^3 dz}{e^z - 1}\right] . \tag{A23}$$

The integrals

$$\int_{C_2/\lambda T}^{\infty} \frac{z^3 dz}{e^z - 1} \quad \text{and} \quad \int_{0}^{C_2/\lambda T} \frac{z^3 dz}{e^z - 1}$$

are both known as Debye functions and have the following infinite series representations (cf. [20, p.998]):

$$\int_{x}^{\infty} \frac{z^3 dz}{e^z - 1} = \sum_{j=1}^{\infty} e^{-jx}\left(\frac{x^3}{j} + \frac{3x^2}{j^2} + \frac{6x}{j^3} + \frac{6}{j^4}\right) \tag{A24}$$

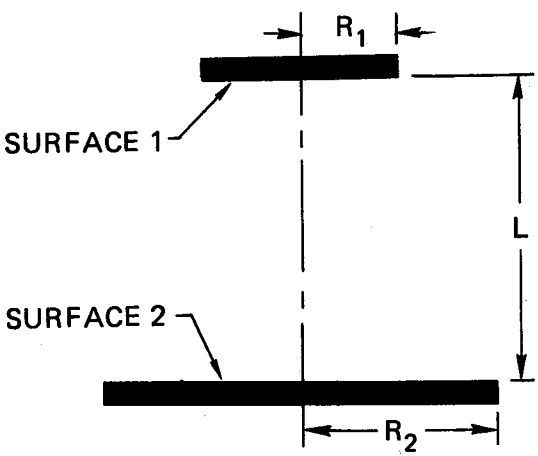
and

$$\int_{0}^{x} \frac{z^3 dz}{e^z - 1} = x^3\left[\frac{1}{3} - \frac{x}{8} + \sum_{j=1}^{\infty} \frac{B_{2j} x^{2j}}{(2j+3)(2j)!}\right] \tag{A25}$$

where $x \equiv C_2/\lambda T$ and B_{2j} represents the Bernoulli number of 2j-th order. It is found that Equation (A24) converges more rapidly than Equation (A25) when $x > 2$, and vice versa. The appropriate series and the appropriate relationship for I (Equation (A22) or Equation (A23)) are selected automatically in the computations.

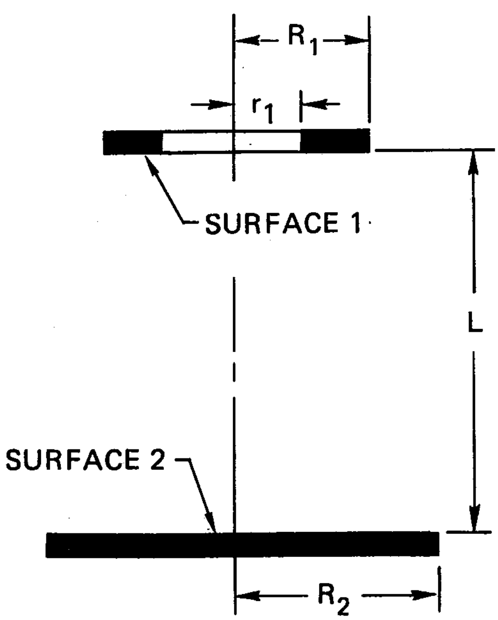
4. Formulas for the Configuration Factors Between the Zones of a Cylindrical Enclosure

a. Disc at one end-plane of the cylinder to a co-axial disc at the opposite end [2].



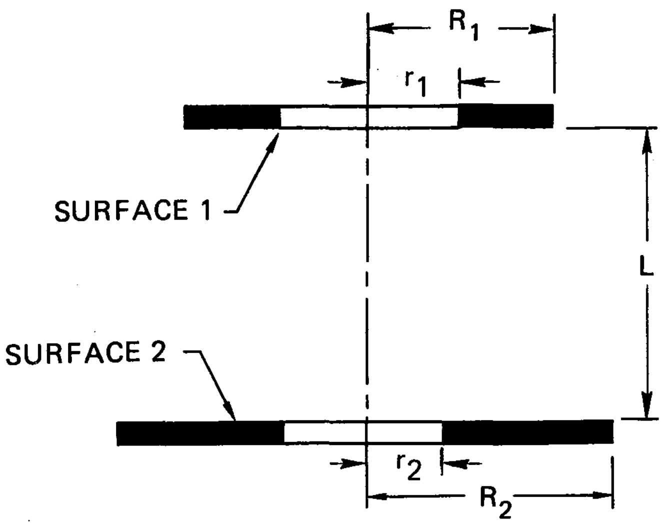
$$F_{12} = \frac{1}{2}\left\{\left(1 + \frac{R_2^2}{R_1^2} + \frac{L^2}{R_1^2}\right) - \sqrt{\left(1 + \frac{R_2^2}{R_1^2} + \frac{L^2}{R_1^2}\right)^2 - 4\frac{R_2^2}{R_1^2}}\right\} \quad \text{(A26)}$$

b. Flat annular ring at one end-plane of the cylinder to a co-axial disc at the opposite end [21].



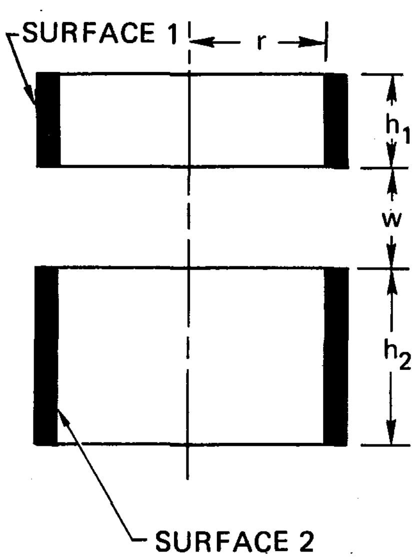
$$F_{12} = \frac{1}{2}\left\{1 + \frac{1}{R_1^2 - r_1^2}\left[\sqrt{\left(R_2^2 + r_1^2 + L^2\right)^2 - 4R_2^2 r_1^2} - \sqrt{\left(R_1^2 + R_2^2 + L^2\right)^2 - 4R_1^2 R_2^2}\right]\right\} \quad \text{(A27)}$$

c. Flat annular ring at one end plane of the cylinder to a co-axial flat annular ring at the opposite end [21].



$$F_{12} = \frac{1}{2(R_1^2 - r_1^2)}\Big[\sqrt{(R_1^2 + r_2^2 + L^2)^2 - 4r_2^2R_1^2}$$
$$-\sqrt{(R_1^2 + R_2^2 + L^2)^2 - 4R_1^2R_2^2}$$
$$+\sqrt{(R_2^2 + r_1^2 + L^2)^2 - 4r_1^2R_2^2}$$
$$-\sqrt{(r_1^2 + r_2^2 + L^2)^2 - 4r_1^2r_2^2}\Big] \quad \text{(A28)}$$

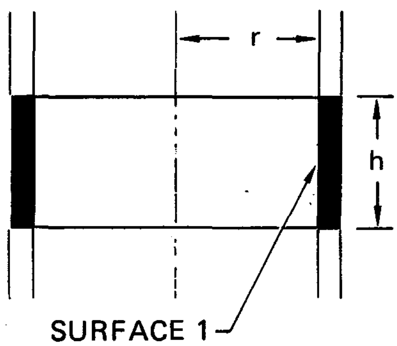
d. Cylindrical segment to another cylindrical segment [22].



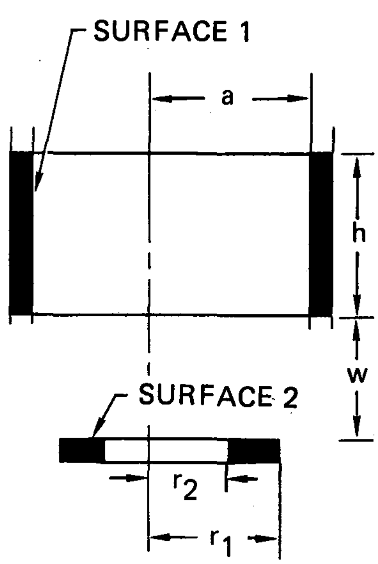
$$F_{12} = \frac{1}{4rh_1}\Big[2h_1h_2 + (w+h_1)\sqrt{(w+h_1)^2 + 4r^2}$$
$$- w\sqrt{w^2 + 4r^2}$$
$$- (h_1+h_2+w)\sqrt{(h_1+h_2+w)^2 + 4r^2}$$
$$+ (h_2+w)\sqrt{(h_2+w)^2 + 4r^2}\Big] \quad \text{(A29)}$$

e. Cylindrical segment to itself. (Based on disc-to-disc result (Equation (A26)) and configuration factor algebra.)

$$F_{11} = (1 + \frac{h}{2r}) - \sqrt{1 + (\frac{h}{2r})^2} \qquad \text{(A30)}$$



f. Cylindrical segment to a flat annular ring in an end plane of the cylinder [22].



$$F_{12} = \frac{1}{4ah}\Bigg[\sqrt{(w+h)^4 + 2(a^2+r_1^2)(w+h)^2 + (a^2-r_1^2)^2} - \sqrt{(w+h)^4 + 2(a^2+r_2^2)(w+h)^2 + (a^2-r_2^2)^2} + \sqrt{(w^4 + 2(a^2+r_2^2)w^2 + (a^2-r_2^2)^2} - \sqrt{w^4 + 2(a^2+r_1^2)w^2 + (a^2-r_1^2)^2}\Bigg] \qquad \text{(A31)}$$

g. Cylindrical segment to a disc at an end plane of the cylinder. Obtained from Equation (A31) with r_2 taken as zero.

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RFBS	117357	306	LGO	07/23/81	FTN	4.6 439	666X I	OPT=0 TRACE
RLUD	117665	370	LGO	07/23/81	FTN	4.6 439	666X I	OPT=0 TRACE
SAXB	120255	240	LGO	07/23/81	FTN	4.6 439	666X I	OPT=0 TRACE
UERTST	120515	300	LGO	07/23/81	FTN	4.6 439	666X I	OPT=0 TRACE
UGETIO	121015	37	LGO	07/23/81	FTN	4.6 439	666X I	OPT=0 TRACE
ZSYSTM	121054	1562	LGO	07/23/81	FTN	4.6 439	666X I	OPT=0 TRACE
/STP.END/	122636	1						
/FCL.C./	122637	23						
/Q8.IO./	122662	142						
Q8NTRY=	123024	0	SL-FORTRAN	01/20/77	COMPASS	3. 3-439		FCL INITILALIZATION ROUTINE.
COMIO=	123024	100	SL-FORTRAN	01/20/77	COMPASS	3. 3-439		COMMON CODED I/O ROUTINES AND CONSTANTS.63-CHA
FECMSK=	123124	41	SL-FORTRAN	01/20/77	COMPASS	3. 3-439		INITIALIZE CONSTANTS.

FLTOUT=	123165	311	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	COMMON FLOATING OUTPUT CODE
FORSYS=	123476	603	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	FORTRAN OBJECT LIBRARY UTILITIES.
GETFIT=	124301	42	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	LOCATE AN FIT GIVEN A FILE NAME.
/IO.BUF./	124343	227					
INPB=	124572	321	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	BINARY READ FORTRAN RECORD.
KRAKER=	125113	371	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	PROCESS FORMATTED FORTRAN INPUT.
OUTB=	125504	203	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	BINARY WRITE FORTRAN RECORD.
OUTCOM=	125707	154	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	COMMON OUTPUT CODE
REWIND=	126063	41	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	POSITION FILE AT BEGINNING-OF-INFORMATION.
GOTOER=	126124	14	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	COMPUTED GO TO ERROR PROCESSOR.
ALOG	126140	73	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	COMPUTE COMMON AND NATURAL LOGARITHMS. OPT=ALL
EXP	126233	75	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	EXPONENTIAL FUNCTION. E TO POWER X. OPT=ALL.
SQRT	126330	43	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	COMPUTE THE SQUARE ROOT OF X. OPT=ALL.
SYS=1ST	126373	62	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	MATH LIBRARY LINK TO ERROR MESSAGE PROCESSOR.
XTOI*	126455	26	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	REAL BASE TO INTEGER POWER.
XTOY*	126503	51	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	REAL BASE TO REAL POWER.
FLTIN=	126554	156	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	COMMON FLOATING INPUT CONVERTER.
FMTAP=	126732	352	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	CRACK APLIST AND FORMAT FOR KODER/KRAKER.
FORUTL=	127304	16	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	FCL MISC. UTILITIES.
FTNRPV=	127322	155	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	FORTRAN REPRIEVE.
INCOM=	127477	302	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	COMMON INPUT FORMATTING CODE
INPC=	130001	160	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	FORMATTED READ FORTRAN RECORD.
KODER=	130161	456	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	OUTPUT FORMAT INTERPRETER.
OUTC=	130637	175	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	FORMATTED WRITE FORTRAN RECORD.
SYSAID=	131034	1	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	LINK BETWEEN SYS=AID AND INITIALIZATION CODE.
XTOI=	131035	10	SL-FORTRAN	01/28/77	COMPASS	3. 3-439	REAL TO INTEGER EXPONENTIATION.
SYS.AM	131045	37	SL-SYSIO	01/13/77	COMPASS	3. 3-439	PROCESS SYSTEM REQUEST.
/COR.AM/	131104	6					
CIO.AM	131112	40	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/AOB.AM/	131152	10					
MOVE.AM	131162	64	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
MCT.AM	131246	233	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/JMPS.AM/	131501	11					
/MEMC.AM/	131512	3					
/OPES.FO/	131515	1					
/OPEN.FO/	131516	7					
OPEN.AM	131525	237	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/TERM.AM/	131764	1					
/PUT.FO/	131765	7					
PUT.SQ	131774	1413	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
WAR.SQ	133407	260	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/CLSF.FO/	133667	7					
CLSF.AM	133676	22	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/GET.BT/	133720	5					
BTRT.SQ	133725	115	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
WEOI.SQ	134042	150	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/SKFL.FO/	134212	7					
SKFL.SQ	134221	51	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
ERR.AM	134272	406	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
CMMR.SQ	134700	7	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
OSUB.AM	134707	71	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
OPEN.SQ	135000	257	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
OPEX.SQ	135257	14	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/PUT.RT/	135273	11					
RLEQ.AM	135304	42	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
CLSF.SQ	135346	134	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/CLSV.FO/	135502	7					

CLSV.SQ	135511	137	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/REW.FO/	135650	7					
REW.SQ	135657	42	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
/GET.FO/	135721	7					
/RPAR.XX/	135730	1					
/GET.RT/	135731	11					
GET.SQ	135742	1062	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
Z.SQ	137024	101	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
W.SQ	137125	50	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
FSU.SQ	137175	106	SL-SYSIO	03/18/77	COMPASS	3. 3-439	
RECOVR	137303	166	SL-SYSLIB	01/13/77	COMPASS	3. 3-439	REPRIEVE INTERFACE

1.387 CP SECONDS   153500B CM STORAGE USED   105 TABLE MOVES

REFLECTANCE DATA

	BAND 1	BAND 2	BAND 3	BAND 4	BAND 5
MICRONS	0.000 -- 1000.000				
CHRTISTC 1	0.00000				
CHRTISTC 2	.10000				
CHRTISTC 3	.40000				
FRACTION OF SOLAR RAD. IN THIS BAND	1.00000				

SUMMARY OF THE NON-GEOMETRICAL ZONAL DATA WHICH HAVE BEEN INPUT

ZONE	REFLEC-TANCE CHRTISTC	TYPE OF B. C.	DIRECT SOLAR IRRADIATION (KW/METER-SQ)	HEAT FLUX IF SPECIFIED (KW/METER-SQ)	TEMPERATURE IF SPECIFIED (DEG-K)
1	3	2	0.	0.	
2	3	2	0.	0.	
3	3	2	0.	0.	
4	3	2	0.	0.	
5	2	3	.564000E+02		.59800E+03
6	2	3	.662000E+02		.59800E+03
7	2	3	.671000E+02		.59800E+03
8	2	3	.634000E+02		.59800E+03
9	2	3	.247700E+03		.59800E+03
10	2	3	.284400E+03		.59800E+03
11	2	3	.280700E+03		.59800E+03
12	2	3	.262000E+03		.59800E+03
13	2	3	.355700E+03		.59800E+03
14	2	3	.390900E+03		.59800E+03
15	2	3	.394400E+03		.59800E+03

16	2	3	.361500E+03		.59800E+03
17	2	3	.150000E+03		.59800E+03
18	2	3	.156700E+03		.59800E+03
19	2	3	.154300E+03		.59800E+03
20	2	3	.141700E+03		.59800E+03
21	2	3	.364000E+02		.59800E+03
22	2	3	.368000E+02		.59800E+03
23	2	3	.363000E+02		.59800E+03
24	2	3	.264000E+02		.59800E+03
25	2	3	.420000E+01		.59800E+03
26	2	3	.390000E+01		.59800E+03
27	2	3	.360000E+01		.59800E+03
28	2	3	.230000E+01		.59800E+03
29	3	2	0.	0.	
30	3	2	0.	0.	
31	3	2	0.	0.	
32	3	2	0.	0.	
33	2	3	.372000E+02		.59800E+03
34	2	3	.272000E+02		.59800E+03
35	2	3	.147000E+02		.59800E+03
36	2	3	.280000E+01		.59800E+03
37	2	3	.182300E+03		.59800E+03
38	2	3	.160900E+03		.59800E+03
39	2	3	.899000E+02		.59800E+03
40	2	3	.206000E+02		.59800E+03
41	2	3	.300600E+03		.59800E+03
42	2	3	.294500E+03		.59800E+03
43	2	3	.151000E+03		.59800E+03
44	2	3	.331000E+02		.59800E+03
45	2	3	.159100E+03		.59800E+03
46	2	3	.162600E+03		.59800E+03
47	2	3	.700000E+02		.59800E+03
48	2	3	.113000E+02		.59800E+03
49	2	3	.244000E+02		.59800E+03
50	2	3	.244000E+02		.59800E+03
51	2	3	.310000E+01		.59800E+03
52	2	3	.500000E+00		.59800E+03
53	2	3	.190000E+01		.59800E+03
54	2	3	.120000E+01		.59800E+03
55	2	3	0.		.59800E+03
56	2	3	0.		.59800E+03
57	3	2	0.	0.	
58	3	2	0.	0.	
59	3	2	0.	0.	
60	3	2	0.	0.	
61	2	3	.240000E+01		.59800E+03
62	2	3	.106000E+02		.59800E+03
63	2	3	.242000E+02		.59800E+03
64	2	3	.349000E+02		.59800E+03
65	2	3	.197000E+02		.59800E+03
66	2	3	.840000E+02		.59800E+03
67	2	3	.146800E+03		.59800E+03
68	2	3	.169900E+03		.59800E+03
69	2	3	.322000E+02		.59800E+03
70	2	3	.141800E+03		.59800E+03
71	2	3	.272900E+03		.59800E+03
72	2	3	.302000E+03		.59800E+03
73	2	3	.141000E+02		.59800E+03
74	2	3	.763000E+02		.59800E+03
75	2	3	.166200E+03		.59800E+03
76	2	3	.190400E+03		.59800E+03

77	2	3	.500000E+00		.59800E+03
78	2	3	.810000E+01		.59800E+03
79	2	3	.323000E+02		.59800E+03
80	2	3	.463000E+02		.59800E+03
81	2	3	0.		.59800E+03
82	2	3	.300000E+00		.59800E+03
83	2	3	.180000E+01		.59800E+03
84	2	[illegible]	.510000E+01		.59800E+03
85	3	2	0.	0.	
86	3	2	0.	0.	
87	3	2	0.	0.	
88	3	2	0.	0.	
89	3	2	0.	0.	
90	3	2	0.	0.	
91	3	2	0.	0.	
92	3	2	0.	0.	
93	3	2	0.	0.	
94	3	2	0.	0.	
95	3	2	0.	0.	
96	3	2	0.	0.	
97	3	2	0.	0.	
98	3	2	0.	0.	
99	3	2	0.	0.	
100	3	2	0.	0.	
101	3	2	0.	0.	
102	3	2	0.	0.	
103	3	2	0.	0.	
104	3	2	0.	0.	
105	3	2	0.	0.	
106	3	2	0.	0.	
107	3	2	0.	0.	
108	3	2	0.	0.	
109	3	2	0.	0.	
110	3	2	0.	0.	
111	3	2	0.	0.	
112	3	2	0.	0.	
113	3	2	0.	0.	
114	3	2	0.	0.	
115	1	1	0.		0.

NOTE THAT B. C. TYPE 1... CORRESPONDS TO ZONE IN APERTURE PLANE
TYPE 2... HEAT FLUX IS SPECIFIED
TYPE 3... TEMPERATURE OF ZONE IS SPECIFIED

SOLAR POWER INTO ENCLOSURE (KW) .52008E+04

THE FOLLOWING FLUX DISTRIBUTIONS ARE FOR AN ENCLOSURE
WHOSE SURFACES ARE AT 0-DEG ABSOLUTE, AND INTO WHICH
THE FOREGOING DIRECT SOLAR RADIATION ENTERS

RADIOSITY DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)	BAND 3 (KW/METER-SQ)	BAND 4 (KW/METER-SQ)	BAND 5 (KW/METER-SQ)
1	[illegible]	[illegible]				
2	[illegible]	[illegible]				
3	[illegible]	[illegible]				
4	[illegible]	[illegible]				
5	[illegible]	[illegible]				
6	[illegible]	[illegible]				
7	[illegible]	[illegible]				
8	[illegible]	[illegible]				
9	[illegible]	[illegible]				
10	[illegible]	[illegible]				
11	[illegible]	[illegible]				
12	[illegible]	[illegible]				
13	[illegible]	[illegible]				
14	[illegible]	[illegible]				
15	[illegible]	[illegible]				
16	[illegible]	[illegible]				
17	[illegible]	[illegible]				
18	[illegible]	[illegible]				
19	[illegible]	[illegible]				
20	[illegible]	[illegible]				
21	[illegible]	[illegible]				
22	[illegible]	[illegible]				
23	[illegible]	[illegible]				
24	[illegible]	[illegible]				
25	[illegible]	[illegible]				
26	[illegible]	[illegible]				
27	[illegible]	[illegible]				
28	[illegible]	[illegible]				
29	[illegible]	[illegible]				
30	[illegible]	[illegible]				
31	[illegible]	[illegible]				
32	[illegible]	[illegible]				
33	[illegible]	[illegible]				
34	[illegible]	[illegible]				
35	[illegible]	[illegible]				
36	[illegible]	[illegible]				
37	[illegible]	[illegible]				
38	[illegible]	[illegible]				
39	[illegible]	[illegible]				
40	[illegible]	[illegible]				
41	[illegible]	[illegible]				
42	[illegible]	[illegible]				
43	[illegible]	[illegible]				
44	[illegible]	[illegible]				
45	[illegible]	[illegible]				
46	[illegible]	[illegible]				
47	[illegible]	[illegible]				
48	.15014E+01	.15014E+01				
49	[illegible]	[illegible]				
50	[illegible]	[illegible]				
51	[illegible]	[illegible]				
52	[illegible]	[illegible]				
53	[illegible]	[illegible]				
54	[illegible]	[illegible]				
55	[illegible]	[illegible]				
56	[illegible]	[illegible]				
57	[illegible]	[illegible]				
58	[illegible]	[illegible]				
59	[illegible]	[illegible]				
60	[illegible]	[illegible]				
61	[illegible]	[illegible]				
62	[illegible]	[illegible]				
63	[illegible]	[illegible]				
64	[illegible]	[illegible]				
65	[illegible]	[illegible]				
66	[illegible]	[illegible]				
67	[illegible]	[illegible]				
68	[illegible]	[illegible]				
69	[illegible]	[illegible]				
70	[illegible]	[illegible]				
71	[illegible]	[illegible]				
72	[illegible]	[illegible]				
73	[illegible]	[illegible]				
74	[illegible]	[illegible]				
75	[illegible]	[illegible]				
76	[illegible]	[illegible]				
77	[illegible]	[illegible]				
78	[illegible]	[illegible]				
79	[illegible]	[illegible]				
80	[illegible]	[illegible]				
81	[illegible]	[illegible]				
82	[illegible]	[illegible]				
83	[illegible]	[illegible]				
84	[illegible]	[illegible]				
85	[illegible]	[illegible]				
86	[illegible]	[illegible]				
87	[illegible]	[illegible]				
88	[illegible]	[illegible]				
89	[illegible]	[illegible]				
90	[illegible]	[illegible]				
91	[illegible]	[illegible]				
92	[illegible]	[illegible]				
93	[illegible]	[illegible]				
94	[illegible]	[illegible]				
95	[illegible]	[illegible]				
96	[illegible]	[illegible]				
97	[illegible]	[illegible]				
98	[illegible]	[illegible]				
99	[illegible]	[illegible]				
100	[illegible]	[illegible]				
101	[illegible]	[illegible]				
102	[illegible]	[illegible]				
103	[illegible]	[illegible]				
104	[illegible]	[illegible]				
105	[illegible]	[illegible]				
106	[illegible]	[illegible]				
107	[illegible]	[illegible]				
108	[illegible]	[illegible]				

.27586E+01

.21197E+01
.27124E+01
.27042E+01
.28813E+01
.28659E+01
0.

IRRADIATION DISTRIBUTION

BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)	BAND 3 (KW/METER-SQ)	BAND 4 (KW/METER-SQ)	BAND 5 (KW/METER-SQ)
.18904E+01				
.21118E+01				
.21172E+01				
.18985E+01				
.59394E+02				
.69143E+02				
.70066E+02				
.66459E+02				
.25292E+03				
.28834E+03				
.28468E+03				
.26737E+03				
.36215E+03				
.39525E+03				
.39875E+03				
.36789E+03				
.15461E+03				
.16033E+03				
.15787E+03				
.14597E+03				
.38986E+02				
.39425E+02				
.38878E+02				
.28771E+02				
.59213E+01				
.58538E+01				
.55308E+01				
.39497E+01				
.25550E+01				
.29549E+01				
.31437E+01				
.30643E+01				
.41711E+02				
.31458E+02				
.10868E+02				
.61728E+01				
.19000E+03				
.16655E+03				
.94307E+02				
.24324E+02				
.31001E+03				
.30080E+03				
.19568E+03				
.36952E+02				
.16629E+03				

.16813E+03

.74379E+02
.19014E+02
.28767E+02
.28561E+02
.68157E+01
.38498E+01
.44036E+01
.41202E+01
.30731E+01
.30069E+01
.30677E+01
.31522E+01
.30088E+01
.25693E+01
.57820E+01
.14379E+02
.20468E+02
.39362E+02
.23431E+02
.88417E+02
.15244E+03
.17748E+03
.36051E+02
.14648E+03
.27918E+03
.31132E+03
.17805E+02
.80659E+02
.17171E+03
.19757E+03
.38367E+01
.11796E+02
.36441E+02
.50721E+02
.29987E+01
.33610E+01
.47107E+01
.76229E+01
.56906E+01
.70263E+01
.57572E+01
.52317E+01
.70691E+01
.53102E+01
.33879E+01
.41918E+01
.34208E+01
.56208E+01
.69614E+01
.55779E+01
.32627E+01
.40648E+01
.30901E+01
.50329E+01
.69237E+01
.49106E+01
.54579E+01
.70154E+01
.68996E+01
.52830E+01

.54264E+01

.69653E+01
.68965E+01
.52993E+01
.67809E+01
.67606E+01
.72032E+01
.71647E+01
.91445E+01

DISTRIBUTION OF HEAT FLUX

BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)	BAND 3 (KW/METER-SQ)	BAND 4 (KW/METER-SQ)	BAND 5 (KW/METER-SQ)
[illegible]				
[illegible]				
[illegible]				
[illegible]				
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.32594E+03				
.35573E+03				
.35808E+03				
.33110E+03				
.13915E+03				
.14429E+03				
.14208E+03				
.13137E+03				
.35087E+02				
.35482E+02				
.34990E+02				
.25894E+02				
.53292E+01				
.52684E+01				
.49777E+01				
.35547E+01				
.15330E+01				
.17967E+01				
.18862E+01				
.18306E+01				
.37540E-02				
.28312E-02				
.16614E+02				
.55555E+01				
.17100E+03				
.14989E+03				
.84876E+02				
.21891E+02				
.27901E+03				
.27072E+03				
.14012E+03				

.33257E+02

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.72593E+02				
.15454E+03				
.17781E+03				
.34530E+01				
.10616E+02				
.32797E+02				
.45649E+02				
.26989E+01				
.30249E+01				
.42396E+01				
.68606E+01				
.34144E+01				
.42158E+01				
.34543E+01				
.31390E+01				
.42415E+01				
.31861E+01				
.20328E+01				
.25151E+01				
.20525E+01				
.33773E+01				
.41768E+01				
.33467E+01				
.19576E+01				
.24389E+01				
.18541E+01				
.30198E+01				
.41542E+01				
.29464E+01				
.32745E+01				
.42092E+01				

105	.41398E+01	.41398E+01
106	.31698E+01	.31698E+01
107	.32558E+01	.32558E+01
108	.41792E+01	.41792E+01
109	.41379E+01	.41379E+01
110	.31796E+01	.31796E+01
111	.40685E+01	.40685E+01
112	.40563E+01	.40563E+01
113	.43219E+01	.43219E+01
114	.42988E+01	.42988E+01
115	.91445E+01	.91445E+01

TOTAL POWER LEAVING ENCLOSURE APERTURE (IOPT=1) .10571E+03 KW

ENERGY BALANCE OF ENCLOSURE (FOR IOPT=1) (KW)

SOLAR POWER INPUT TO ENCLOSURE.................. .52008E+04
SOLAR POWER ABSORBED IN ENCLOSURE............. .50951E+04
EFFECTIVE ABSORPTANCE OF ENCLOSURE............ .97967

THE FOLLOWING FLUX DISTRIBUTIONS ARE FOR AN ENCLOSURE
INTO WHICH NO EXTERNAL RADIATION ENTERS, AND WHICH HAS
THE TEMPERATURES LISTED ABOVE AND/OR THOSE CAL-
CULATED BY THE SUBROUTINE THERMAL

RADIOSITY DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)	BAND 3 (KW/METER-SQ)	BAND 4 (KW/METER-SQ)	BAND 5 (KW/METER-SQ)
1	.12895E+02	.12895E+02				
2	.12860E+02	.12860E+02				
3	.12867E+02	.12867E+02				
4	.12911E+02	.12911E+02				
5	.75447E+01	.75447E+01				
6	.75583E+01	.75583E+01				
7	.75586E+01	.75586E+01				
8	.75454E+01	.75454E+01				
9	.74643E+01	.74643E+01				
10	.74697E+01	.74697E+01				
11	.74698E+01	.74698E+01				
12	.74647E+01	.74647E+01				
13	.74384E+01	.74384E+01				
14	.74390E+01	.74390E+01				
15	.74390E+01	.74390E+01				
16	.74385E+01	.74385E+01				
17	.74601E+01	.74601E+01				
18	.74647E+01	.74647E+01				
19	.74646E<01	.74646E+01				
20	.74597E+01	.74597E+01				
21	.74959E+01	.74959E+01				
22	.75108E+01	.75108E+01				
23	.75103E+01	.75103E+01				
24	.74946E+01	.74946E+01				
25	.75001E+01	.75001E+01				
26	.75270E+01	.75270E+01				
27	.75255E+01	.75255E+01				
28	.74359E+01	.74959E+01				
29	.13074E+02	.13074E+02				
30	.13163E+02	.13163E+02				
31	.13311E+02	.13311E+02				
32	.13562E+02	.13562E+02				
33	.75257E+01	.75257E+01				
34	.75474E+01	.75474E+01				
35	.75685E+01	.75685E+01				
36	.76206E+01	.76206E+01				
37	.74434E+01	.74434E+01				
38	.74514E+01	.74514E+01				
39	.74633E+01	.74633E+01				
40	.75172E+01	.75172E+01				
41	.74087E+01	.74087E+01				
42	.74092E+01	.74092E+01				
43	.74175E+01	.74175E+01				
44	.74735E+01	.74735E+01				
45	.74177E+01	.74177E+01				
46	.74277E+01	.74277E+01				
47	.74466E+01	.74466E+01				
48	.75050E+01	.75050E+01				
49	.74505E+01	.74505E+01				
50	.74802E+01	.74802E+01				
51	.75186E+01	.75186E+01				
52	.75828E+01	.75828E+01				
53	.74653E+01	.74653E+01				
54	.75048E+01	.75048E+01				
55	.75596E+01	.75596E+01				
56	.76137E+01	.76137E+01				
57	.13538E+02	.13538E+02				
58	.13293E+02	.13293E+02				
59	.13157E+02	.13157E+02				
60	.13072E+02	.13072E+02				
61	.76191E+01	.76191E+01				
62	.75674E+01	.75674E+01				
63	.75467E+01	.75467E+01				
64	.75254E+01	.75254E+01				
65	.75162E+01	.75162E+01				
66	.74628E+01	.74628E+01				
67	.74511E+01	.74511E+01				
68	.74434E+01	.74434E+01				
69	.74730E+01	.74730E+01				
70	.74173E+01	.74173E+01				
71	.74091E+01	.74091E+01				
72	.74088E+01	.74088E+01				
73	.75052E+01	.75052E+01				
74	.74468E+01	.74468E+01				
75	.74279E+01	.74279E+01				
76	.74178E+01	.74178E+01				
77	.75841E+01	.75841E+01				
78	.75198E+01	.75198E+01				
79	.74811E+01	.74811E+01				
80	.74511E+01	.74511E+01				
81	.76170E+01	.76170E+01				
82	.75628E+01	.75628E+01				
83	.75082E+01	.75082E+01				
84	.74685E+01	.74685E+01				
85	.13423E+02	.13423E+02				
86	.13359E+02	.13359E+02				
87	.13469E+02	.13469E+02				
88	.13205E+02	.13205E+02				
89	.13294E+02	.13294E+02				
90	.13258E+02	.13258E+02				
91	.13214E+02	.13214E+02				
92	.13170E+02	.13170E+02				
93	.13239E+02	.13239E+02				
94	.13153E+02	.13153E+02				
95	.13419E+02	.13419E+02				
96	.13120E+02	.13120E+02				
97	.10079E+02	.10079E+02				
98	.10589E+02	.10589E+02				
99	.99735E+01	.99735E+01				
100	.11528E+02	.11528E+02				
101	.12569E+02	.12569E+02				
102	.11455E+02	.11455E+02				
103	.13728E+02	.13728E+02				
104	.13373E+02	.13373E+02				
105	.13130E+02	.13130E+02				
106	.12949E+02	.12949E+02				
107	.13696E+02	.13696E+02				

108	.13341E+02	.13341E+02
109	.13130E+02	.13130E+02
110	.12967E+02	.12967E+02
111	.14571E+02	.14571E+02
112	.13596E+02	.13596E+02
113	.14129E+02	.14129E+02
114	.14103E+02	.14103E+02
115	0.	0.

IRRADIATION DISTRIBUTION

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)	BAND 3 (KW/METER-SQ)	BAND 4 (KW/METER-SQ)	BAND 5 (KW/METER-SQ)
1	.11760E+02	.11760E+02				
2	.11593E+02	.11593E+02				
3	.11597E+02	.11597E+02				
4	.11772E+02	.11772E+02				
5	.10198E+02	.10198E+02				
6	.10334E+02	.10334E+02				
7	.10336E+02	.10336E+02				
8	.10204E+02	.10204E+02				
9	.93940E+01	.93940E+01				
10	.94473E+01	.94473E+01				
11	.94485E+01	.94485E+01				
12	.93972E+01	.93972E+01				
13	.91349E+01	.91349E+01				
14	.91401E+01	.91401E+01				
15	.91402E+01	.91402E+01				
16	.91352E+01	.91352E+01				
17	.93512E+01	.93512E+01				
18	.93978E+01	.93978E+01				
19	.93962E+01	.93962E+01				
20	.93473E+01	.93473E+01				
21	.97097E+01	.97097E+01				
22	.98590E+01	.98590E+01				
23	.98537E+01	.98537E+01				
24	.96963E+01	.96963E+01				
25	.97512E+01	.97512E+01				
26	.10020E+02	.10020E+02				
27	.10005E+02	.10005E+02				
28	.97100E+01	.97100E+01				
29	.11541E+02	.11541E+02				
30	.11367E+02	.11367E+02				
31	.11425E+02	.11425E+02				
32	.11724E+02	.11724E+02				
33	.10007E+02	.10007E+02				
34	.10224E+02	.10224E+02				
35	.10436E+02	.10436E+02				
36	.10957E+02	.10957E+02				
37	.91845E+01	.91845E+01				
38	.92642E+01	.92642E+01				
39	.93839E+01	.93839E+01				
40	.99229E+01	.99229E+01				
41	.88380E+01	.88380E+01				
42	.88424E+01	.88424E+01				
43	.89254E+01	.89254E+01				
44	.94855E+01	.94855E+01				
45	.89276E+01	.89276E+01				
46	.90280E+01	.90280E+01				
47	.92162E+01	.92162E+01				
48	.98006E+01	.98006E+01				
49	.92560E+01	.92560E+01				
50	.95527E+01	.95527E+01				
51	.99367E+01	.99367E+01				
52	.10579E+02	.10579E+02				
53	.94033E+01	.94033E+01				
54	.97983E+01	.97983E+01				
55	.10346E+02	.10346E+02				
56	.10887E+02	.10887E+02				
57	.11697E+02	.11697E+02				
58	.11402E+02	.11402E+02				
59	.11352E+02	.11352E+02				
60	.11531E+02	.11531E+02				
61	.10942E+02	.10942E+02				
62	.10425E+02	.10425E+02				
63	.10218E+02	.10218E+02				
64	.10005E+02	.10005E+02				
65	.99124E+01	.99124E+01				
66	.93785E+01	.93785E+01				
67	.92619E+01	.92619E+01				
68	.91843E+01	.91843E+01				
69	.94809E+01	.94809E+01				
70	.89236E+01	.89236E+01				
71	.88413E+01	.88413E+01				
72	.88382E+01	.88382E+01				
73	.98023E+01	.98023E+01				
74	.92185E+01	.92185E+01				
75	.90300E+01	.90300E+01				
76	.89283E+01	.89283E+01				
77	.10592E+02	.10592E+02				
78	.99482E+01	.99482E+01				
79	.95620E+01	.95620E+01				
80	.92618E+01	.92618E+01				
81	.10920E+02	.10920E+02				
82	.10379E+02	.10379E+02				
83	.98330E+01	.98330E+01				
84	.94354E+01	.94354E+01				
85	.10009E+02	.10009E+02				
86	.91436E+01	.91436E+01				
87	.10015E+02	.10015E+02				
88	.10066E+02	.10066E+02				
89	.90520E+01	.90520E+01				
90	.10072E+02	.10072E+02				
91	.11181E+02	.11181E+02				
92	.10655E+02	.10655E+02				
93	.11186E+02	.11186E+02				
94	.97753E+01	.97753E+01				
95	.92420E+01	.92420E+01				
96	.97736E+01	.97736E+01				
97	.81212E+01	.81212E+01				
98	.81496E+01	.81496E+01				
99	.81195E+01	.81195E+01				
100	.85081E+01	.85081E+01				
101	.84147E+01	.84147E+01				
102	.85083E+01	.85083E+01				
103	.10453E+02	.10453E+02				
104	.91635E+01	.91635E+01				
105	.89901E+01	.89901E+01				

106	.97794E+01	.97794E+01
107	.10441E+02	.10441E+02
108	.91623E+01	.91623E+01
109	.89920E+01	.89920E+01
110	.97872E+01	.97872E+01
111	.10502E+02	.10502E+02
112	.95399E+01	.95399E+01
113	.98068E+01	.98068E+01
114	.98043E+01	.98043E+01
115	.93248E+01	.93248E+01

DISTRIBUTION OF HEAT FLUX

ZONE	TOTAL (KW/METER-SQ)	BAND 1 (KW/METER-SQ)	BAND 2 (KW/METER-SQ)	BAND 3 (KW/METER-SQ)	BAND 4 (KW/METER-SQ)	BAND 5 (KW/METER-SQ)
1	-.11342E+01	-.11342E+01				
2	-.12671E+01	-.12671E+01				
3	-.12703E+01	-.12703E+01				
4	-.11391E+01	-.11391E+01				
5	.26533E+01	.26533E+01				
6	.27756E+01	.27756E+01				
7	.27778E+01	.27778E+01				
8	.26589E+01	.26589E+01				
9	.19297E+01	.19297E+01				
10	.19776E+01	.19776E+01				
11	.19787E+01	.19787E+01				
12	.19325E+01	.19325E+01				
13	.16965E+01	.16965E+01				
14	.17012E+01	.17012E+01				
15	.17013E+01	.17013E+01				
16	.16967E+01	.16967E+01				
17	.18912E+01	.18912E+01				
18	.19331E+01	.19331E+01				
19	.19317E+01	.19317E+01				
20	.18876E+01	.18876E+01				
21	.22138E+01	.22138E+01				
22	.23482E+01	.23482E+01				
23	.23434E+01	.23434E+01				
24	.22017E+01	.22017E+01				
25	.22511E+01	.22511E+01				
26	.24933E+01	.24933E+01				
27	.24799E+01	.24799E+01				
28	.22140E+01	.22140E+01				
29	-.15330E+01	-.15330E+01				
30	-.17967E+01	-.17967E+01				
31	-.18862E+01	-.18862E+01				
32	-.18386E+01	-.18386E+01				
33	.24818E+01	.24818E+01				
34	.26769E+01	.26769E+01				
35	.28674E+01	.28674E+01				
36	.33361E+01	.33361E+01				
37	.17411E+01	.17411E+01				
38	.18129E+01	.18129E+01				
39	.19206E+01	.19206E+01				
40	.24057E+01	.24057E+01				
41	.14293E+01	.14293E+01				
42	.14332E+01	.14332E+01				
43	.15080E+01	.15080E+01				
44	.20120E+01	.20120E+01				
45	.15099E+01	.15099E+01				
46	.16003E+01	.16003E+01				
47	.17696E+01	.17696E+01				
48	.22956E+01	.22956E+01				
49	.18054E+01	.18054E+01				
50	.20725E+01	.20725E+01				
51	.24181E+01	.24181E+01				
52	.29961E+01	.29961E+01				
53	.19380E+01	.19380E+01				
54	.22935E+01	.22935E+01				
55	.27866E+01	.27866E+01				
56	.32737E+01	.32737E+01				
57	-.18406E+01	-.18406E+01				
58	-.18913E+01	-.18913E+01				
59	-.18053E+01	-.18053E+01				
60	-.15416E+01	-.15416E+01				
61	.33229E+01	.33229E+01				
62	.28576E+01	.28576E+01				
63	.26713E+01	.26713E+01				
64	.24794E+01	.24794E+01				
65	.23962E+01	.23962E+01				
66	.19157E+01	.19157E+01				
67	.18107E+01	.18107E+01				
68	.17409E+01	.17409E+01				
69	.20079E+01	.20079E+01				
70	.15063E+01	.15063E+01				
71	.14322E+01	.14322E+01				
72	.14294E+01	.14294E+01				
73	.22971E+01	.22971E+01				
74	.17718E+01	.17718E+01				
75	.16020E+01	.16020E+01				
76	.15105E+01	.15105E+01				
77	.30078E+01	.30078E+01				
78	.24285E+01	.24285E+01				
79	.20808E+01	.20808E+01				
80	.18107E+01	.18107E+01				
81	.33033E+01	.33033E+01				
82	.28163E+01	.28163E+01				
83	.23248E+01	.23248E+01				
84	.19669E+01	.19669E+01				
85	-.34144E+01	-.34144E+01				
86	-.42158E+01	-.42158E+01				
87	-.34543E+01	-.34543E+01				
88	-.31390E+01	-.31390E+01				
89	-.42415E+01	-.42415E+01				
90	-.31861E+01	-.31861E+01				
91	-.20328E+01	-.20328E+01				
92	-.25151E+01	-.25151E+01				
93	-.20525E+01	-.20525E+01				
94	-.33773E+01	-.33773E+01				
95	-.41768E+01	-.41768E+01				
96	-.33467E+01	-.33467E+01				
97	-.19576E+01	-.19576E+01				
98	-.24389E+01	-.24389E+01				
99	-.18541E+01	-.18541E+01				
100	-.30198E+01	-.30198E+01				
101	-.41542E+01	-.41542E+01				
102	-.29464E+01	-.29464E+01				
103	-.32745E+01	-.32745E+01				

104	-.42092E+01	-.42092E+01
105	-.41398E+01	-.41398E+01
106	-.31698E+01	-.31698E+01
107	-.32558E+01	-.32558E+01
108	-.41792E+01	-.41792E+01
109	-.41379E+01	-.41379E+01
110	-.31796E+01	-.31796E+01
111	-.40685E+01	-.40685E+01
112	-.40563E+01	-.40563E+01
113	-.43219E+01	-.43219E+01
114	-.42988E+01	-.42988E+01
115	.93248E+01	.93248E+01

TOTAL POWER LEAVING ENCLOSURE APERTURE (IOPT=2)   .10780E+03 KW
THIS IS THE SO-CALLED RERADIATION LOSS

THE HEAT TRANSFER TO EACH ZONE FOR THE COMBINED C ASES OF
A)ENCLOSURE AT 0-DEG ABSOLUTE WITH INCOMING SOLAR RADIATION
PLUS
B) ENCLOSURE WITH SPECI FIED (AND/OR CALCULATED) SURFACE TEMPERATURES AND NO INCOMING SOLAR RADIATION

ZONE	HEAT TRANSFER (KW/METER-SQ)	IRRADIATION (KW/METER-SQ)
1	-.50945914E-11	.13650780E+02
2	-.48316906E-11	.13704563E+02
3	-.47180038E-11	.13714115E+02
4	-.49240612E-11	.13670287E+02
5	.56107960E+02	.69592109E+02
6	.65004465E+02	.79477114E+02
7	.65837137E+02	.80402305E+02
8	.62471636E+02	.76662860E+02
9	.22956153E+03	.26231830E+03
10	.26148351E+03	.29778716E+03
11	.25818836E+03	.29412589E+03
12	.24256935E+03	.27677143E+03
13	.32763459E+03	.37128837E+03
14	.35743043E+03	.40439485E+03
15	.36057910E+03	.40789337E+03
16	.33279397E+03	.37702100E+03
17	.14103829E+03	.16395914E+03
18	.14622648E+03	.16972380E+03
19	.14401452E+03	.16726607E+03
20	.13325623E+03	.15531241E+03
21	.37301034E+02	.48695524E+02
22	.37830440E+02	.49283753E+02
23	.37333240E+02	.48731308E+02
24	.28095666E+02	.38467338E+02
25	.75802891E+01	.15672474E+02
26	.77617263E+01	.15874071E+02
27	.74575416E+01	.15536088E+02
28	.57687850E+01	.13659692E+02
29	-.26858515E-11	.14095615E+02
30	-.25295321E-11	.14361296E+02
31	-.28990144E-11	.14568950E+02
32	-.31263880E-11	.14788129E+02
33	.40021860E+02	.51718664E+02
34	.30989159E+02	.41682330E+02
35	.19481125E+02	.28895625E+02
36	.88916064E+01	.17129494E+02
37	.17274448E+03	.19918824E+03
38	.15170586E+03	.17581200E+03
39	.86796846E+02	.10369087E+03
40	.24296907E+02	.34246495E+02
41	.28044124E+03	.31885131E+03
42	.27215180E+03	.30964082E+03
43	.14162393E+03	.16460986E+03
44	.35268633E+02	.46437301E+02
45	.15113811E+03	.17518117E+03
46	.15291655E+03	.17715721E+03
47	.68707034E+02	.83591080E+02
48	.15808549E+02	.24814985E+02
49	.27695527E+02	.38022738E+02
50	.27777045E+02	.38113315E+02
51	.85522628E+01	.16752445E+02
52	.64609114E+01	.14428721E+02
53	.59012504E+01	.13806876E+02
54	.60017363E+01	.13918527E+02
55	.55523708E+01	.13419232E+02
56	.59798924E+01	.13834256E+02
57	-.61106675E-12	.14764653E+02
58	-.66791017E-12	.14554087E+02
59	-.71054274E-13	.14360680E+02
60	-.45474735E-12	.14100041E+02
61	.85266564E+01	.16723994E+02
62	.15794854E+02	.24799769E+02
63	.28292885E+02	.38686470E+02
64	.37905452E+02	.49367100E+02
65	.23484150E+02	.33343431E+02
66	.81490918E+02	.97795395E+02
67	.13900911E+03	.16170450E+03
68	.16147083E+03	.18666196E+03
69	.34453674E+02	.45531790E+02
70	.13333940E+03	.15540482E+03
71	.25269393E+03	.28802096E+03
72	.28161787E+03	.32015868E+03
73	.18321523E+02	.27607179E+02
74	.74364925E+02	.89877625E+02
75	.15613971E+03	.18073850E+03
76	.17931921E+03	.20649350E+03
77	.64607654E+01	.14428559E+02
78	.13044743E+02	.21744089E+02
79	.34878152E+02	.46003433E+02
80	.47459278E+02	.59982462E+02
81	.60021034E+01	.13918935E+02
82	.58411595E+01	.13740108E+02
83	.65644003E+01	.14543709E+02
84	.88275041E+01	.17058269E+02
85	.14779289E-11	.15699553E+02
86	.15347723E-11	.16169867E+02
87	.12789769E-11	.15771998E+02
88	.15631940E-11	.15297827E+02
89	.21032065E-11	.16121176E+02
90	.17905677E-11	.15381831E+02
91	.10942358E-11	.14569236E+02
92	.15347723E-11	.14846474E+02

93	.78159701E-12	.14606831E+02
94	.17337243E-11	.15404090E+02
95	.1C200374E-11	.16203441E+02
96	.19610980E-11	.15351509E+02
97	.19895197E-11	.11383926E+02
98	.23021585E-11	.12214457E+02
99	.20605739E-11	.11209592E+02
100	.24726887E-11	.13541017E+02
101	.27853275E-11	.15338401E+02
102	.27853275E-11	.13418912E+02
103	.20747848E-11	.15910639E+02
104	.25011104E-11	.16178882E+02
105	.25295321E-11	.15889648E+02
106	.19895197E-11	.15062369E+02
107	.19326762E-11	.15866965E+02
108	.21600499E-11	.16127525E+02
109	.28421709E-11	.15888429E+02
110	.21884716E-11	.15086485E+02
111	.25579538E-11	.17283140E+02
112	.27853275E-11	.16300504E+02
113	.30979663E-11	.17010028E+02
114	.28705927E-11	.16968968E+02
115	.18469365E+02	.18469365E+02

TEMPERATURES OF ZONES HAVING TYPE 2 B. C.

ZONE	TEMPERATURE
1	.70050E+03
2	.70119E+03
3	.70131E+03
4	.70075E+03
29	.70614E+03
30	.70944E+03
31	.71199E+03
32	.71465E+03
57	.71437E+03
58	.71181E+03
59	.70943E+03
60	.70619E+03
85	.72542E+03
86	.73079E+03
87	.72626E+03
88	.72073E+03
89	.73024E+03
90	.72172E+03
91	.71199E+03
92	.71536E+03
93	.71245E+03
94	.72198E+03
95	.73117E+03
96	.72137E+03
97	.66941E+03
98	.68130E+03
99	.66683E+03
100	.69909E+03
101	.72121E+03
102	.69750E+03
103	.72785E+03
104	.73089E+03
105	.72761E+03
106	.71794E+03
107	.72735E+03
108	.73031E+03
109	.72759E+03
110	.71823E+03
111	.74306E+03
112	.73226E+03
113	.74011E+03
114	.73966E+03

PROBLEM SUMMARY

POWER (KW) LEAVING CAVITY APERTURE DUE TO ALL RADIATIVE MECHANISMS .21351E+03

CAVITY EFFICIENCY .95895

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***  UNCLASSIFIED  ***          MARTI,TO60,KUNC.  CREATION OF INPUT DATA TAPE FOR CESA-I  ABRAMS EXT 2107 BOX 33
***  UNCLASSIFIED  ***          MARTI,TO60,KUNC.  CREATION OF INPUT DATA TAPE FOR CESA-I  ABRAMS EXT 2107 BOX 33
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xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81    14.08.21.   MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81    14.08.21.   MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81    14.08.21.   MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81    14.08.21.   MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
***  UNCLASSIFIED  ***          MARTI,TO60,KUNC.  CREATION OF INPUT DATA TAPE FOR CESA-I  ABRAMS EXT 2107 BOX 33
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***  UNCLASSIFIED  ***          MARTI,TO60,KUNC.  CREATION OF INPUT DATA TAPE FOR CESA-I  ABRAMS EXT 2107 BOX 33
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***   UNCLASSIFIED   ***                                  MARTI,TOGO,KUNC.  CREATION OF INPUT DATA TAPE FOR CESA-I  ABRAMS EXT 2107 BOX 33

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx   07/23/81          14.08.21.     MFB  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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FWA OF THE LOAD           111
LWA+1 OF THE LOAD       56737

TRANSFER ADDRESS -- CAVADAT        10334
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PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER	LEVEL	HARDWARE	COMMENTS
CAVADAT	111	44067	LGO	07/23/81	FTN	4.6	439	666X I	OPT=0 TRACE
/STP.END/	44200	1							
/FCL.C./	44201	23							
/Q8.IO./	44224	142							
Q8NTRY=	44366	0	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		FCL INITILALIZATION ROUTINE.
COMIO=	44366	100	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		COMMON CODED I/O ROUTINES AND CONSTANTS.63-CHA
FECMSK=	44466	41	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		INITIALIZE CONSTANTS.
FLTOUT=	44527	311	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		COMMON FLOATING OUTPUT CODE
FORSYS=	45040	603	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		FORTRAN OBJECT LIBRARY UTILITIES.
GETFIT=	45643	42	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		LOCATE AN FIT GIVEN A FILE NAME.
/IO.BUF./	45705	227							
INPB=	46134	321	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		BINARY READ FORTRAN RECORD.
KODER=	46455	456	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		OUTPUT FORMAT INTERPRETER.
OUTC=	47133	175	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		FORMATTED WRITE FORTRAN RECORD.
FMTAP=	47330	352	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		CRACK APLIST AND FORMAT FOR KODER/KRAKER.
FORUTL=	47702	16	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		FCL MISC. UTILITIES.
FTNRPV=	47720	155	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		FORTRAN REPRIEVE.
OUTCOM=	50075	154	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		COMMON OUTPUT CODE
REWIND=	50251	41	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		POSITION FILE AT BEGINNING-OF-INFORMATION.
SYSAID=	50312	1	SL-FORTRAN	01/28/77	COMPASS	3.	3-439		LINK BETWEEN SYS=AID AND INITIALIZATION CODE.
SYS.RM	50313	37	SL-SYSIO	01/13/77	COMPASS	3.	3-439		PROCESS SYSTEM REQUEST.
/CON.RM/	50352	6							
CIO.RM	50360	40	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
/AOB.RM/	50420	10							
MOVE.RM	50430	64	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
MCT.RM	50514	233	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
/JMPS.RM/	50747	11							
/MEMC.RM/	50760	3							
/OPES.FO/	50763	1							
/OPEN.FO/	50764	7							
OPEN.RM	50773	237	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
/TERM.RM/	51232	1							
/PUT.FO/	51233	7							
PUT.SQ	51242	1413	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
WAR.SQ	52655	260	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
/CLSF.FO/	53135	7							
CLSF.RM	53144	22	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
/GET.BT/	53166	5							
BTRT.SQ	53173	115	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
WEOX.SQ	53310	150	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
/SKFL.FO/	53460	7							
SKFL.SQ	53467	51	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
ERR.RM	53540	406	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
CHWR.SQ	54146	7	SL-SYSIO	03/18/77	COMPASS	3.	3-439		
OSUB.RM	54155	71	SL-SYSIO	03/18/77	COMPASS	3.	3-439		

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       LOAD MAP - CAVADAT                                        CYBER LOADER 1.2-439      07/23/81  14.13.16.      PAGE     2

       OPEN.SQ        54246       257 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       OPEX.SQ        54525        14 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       /PUT.RT/       54541        11
       RLEQ.RM        54552        42 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       CLSF.SQ        54614       134 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       /CLSV.FO/      54750         7
       CLSV.SQ        54757       137 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       /REW.FO/       55116         7
       REW.SQ         55125        42 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       /GET.FO/       55167         7
       /RPAR.XX/      55176         1
       /GET.RT/       55177        11
       GET.SQ         55210      1062 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       Z.SQ           56272       101 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       W.SQ           56373        50 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       FSU.SQ         56443       106 SL-SYSIO    03/18/77 COMPASS  3. 3-439
       RECOVR         56551       166 SL-SYSLIB   01/13/77 COMPASS  3. 3-439              REPRIEVE INTERFACE


          .769 CP SECONDS             71500B CM STORAGE USED                    49 TABLE MOVES


  1
 115
 .1022E+01 .1022E+01 .1022E+01 .1022E+01 .7547E+00 .7547E+00 .7547E+00 .7547E+00
 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00 .7547E+00
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 .7562E+00 .7562E+00 .7562E+00 .7562E+00 .9345E+00 .7591E+00 .5848E+00 .4108E+00
 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00 .7016E+00
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 .2226E+01 .2179E+01 .1570E+01 .1563E+01 .1570E+01 .2037E+01 .2079E+01 .2037E+01
 .1572E+01 .1565E+01 .1572E+01 .2181E+01 .2227E+01 .2181E+01 .1774E+01 .1774E+01
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 .4787E-04 .5383E-04 .4423E-04 .1812E-04 .1419E-01 .1288E-01 .4843E-02 .5860E-01
 .4234E-01 .8088E-02 .3071E+00 .6053E-01 .6248E-02 .6566E-02 .6479E-02 .4890E-02
 .1014E-02 .9657E-03 .8121E-03 .4418E-02 .4380E-02 .3273E-02 .1403E-01 .9781E-02
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 .1217E-01 .7216E-02 .3488E-02 .1839E-02 .1060E-02 .1769E-02 .1444E-02 .1013E-02
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 .1737E-01 .8703E-02 .8973E-01
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 .2081E-02 .4192E-02 .9629E-02 .2084E-01 .1194E-02 .1796E-02 .2363E-02 .1519E-02
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 .2081E-01 .2846E-01 .5276E-02 .9855E-02 .1656E-01 .2141E-01 .9311E-02 .6702E-01
 .1947E-01 .1493E-01 .1286E+00
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .3256E-04 .7831E-04 .9251E-04 .7907E-04
 .6368E-C4 .1645E-03 .2170E-03 .2273E-03 .1823E-03 .4274E-03 .4934E-03 .4518E-03
 .7566E-03 .1404E-02 .1248E-02 .9216E-03 .6347E-02 .5791E-02 .3149E-02 .1737E-02
 .7574E-01 .1667E-01 .5637E-02 .2493E-02 .4888E-01 .1389E-01 .4406E-02 .1472E-02
 .3096E-03 .3731E-03 .3311E-03 .1447E-03 .7665E-03 .7260E-03 .5613E-03 .2274E-03
 .1203E-02 .1232E-02 .1036E-02 .4521E-03 .1816E-02 .2037E-02 .1904E-02 .9222E-03
 .2495E-02 .3052E-02 .3187E-02 .1737E-02 .2936E-02 .3778E-02 .4227E-02 .2493E-02
 .1723E-02 .3075E-02 .4259E-02 .2844E-02 .6441E-02 .9065E-02 .9258E-02 .4455E-02
 .6371E-02 .6484E-02 .1141E-02 .1422E-02 .1513E-02 .1037E-01 .2703E-01 .2975E-01
 .8982E-02 .4377E-01 .8274E-01 .1522E-01 .6620E-01 .8551E-01 .5351E-02 .1180E-01
 .2415E-01 .3512E-01 .4778E-02 .8219E-02 .1268E-01 .1563E-01 .8875E-02 .6159E-01
 .2359E-01 .1095E-01 .1187E+00
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .7977E-04 .1882E-03 .2211E-03 .1922E-03
 .1163E-03 .3029E-03 .4180E-03 .4709E-03 .2167E-03 .5374E-03 .6988E-03 .7417E-03
 .4291E-03 .9897E-03 .1186E-02 .1166E-02 .8758E-03 .1825E-02 .1969E-02 .1768E-02
 .1670E-02 .3090E-02 .2982E-02 .2452E-02 .3242E-02 .4542E-02 .3121E-02 .1697E-02
 .4272E-04 .4753E-04 .3878E-04 .1582E-04 .1163E-03 .1017E-03 .7128E-04 .2622E-04
 .2166E-03 .2052E-03 .1544E-03 .5949E-04 .4289E-03 .4624E-03 .3951E-03 .1668E-03
 .8752E-03 .1162E-02 .1272E-02 .6671E-03 .1669E-02 .2958E-02 .5200E-02 .5209E-02
 .1422E-02 .4619E-02 .1807E-01 .1039E+00 .6078E-02 .6008E-02 .4600E-02 .4033E-02
 .4006E-02 .3041E-02 .9242E-03 .8829E-03 .7506E-03 .9824E-02 .8929E-02 .3377E-02
 .3729E+00 .6145E-01 .5180E-02 .4716E-01 .3343E-01 .6121E-02 .3056E-02 .5386E-02
 .9146E-02 .1358E-01 .2966E-02 .6335E-02 .1401E-01 .2734E-01 .5219E-02 .5011E-01
 .7881E-02 .1519E-01 .7430E-01
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .6590E-04 .1576E-03 .1873E-03 .1642E-03
 .1016E-03 .2675E-03 .3710E-03 .4178E-03 .2052E-03 .5124E-03 .6646E-03 .6984E-03
 .4625E-03 .1059E-02 .1242E-02 .1185E-02 .1162E-02 .2309E-02 .2334E-02 .1968E-02
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 .2958E-02 .4795E-02 .4042E-02 .2980E-02 .7338E-02 .3246E-02 .4634E-02 .2176E-02


 .1147E-03 .1294E-03 .1072E-03 .4415E-04 .3028E-03 .2675E-03 .1906E-03 .7127E-04
 .5371E-03 .5123E-03 .3920E-03 .1544E-03 .9890E-03 .1059E-02 .9126E-03 .3951E-03
 .1823E-02 .2308E-02 .2434E-02 .1273E-02 .3088E-02 .4794E-02 .6858E-02 .5202E-02
 .2424E-02 .6304E-02 .1558E-01 .2179E-01 .5742E-02 .6263E-02 .5224E-02 .3804E-02
 .4175E-02 .3457E-02 .8946E-03 .9187E-03 .8336E-03 .7623E-02 .1070E-01 .5242E-02
 .1505E+00 .3026E+00 .2026E-01 .2844E-01 .5070E-01 .1337E-01 .3205E-02 .6044E-02
 .1118E-01 .1800E-01 .3192E-02 .6434E-02 .1304E-01 .2305E-01 .5421E-02 .5421E-01
 .1030E-01 .1292E-01 .7951E-01
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .4415E-04 .1072E-03 .1294E-03 .1147E-03
 .7127E-04 .1906E-03 .2675E-03 .3028E-03 .1544E-03 .3920E-03 .5123E-03 .5371E-03
 .3951E-03 .9126E-03 .1059E-02 .9890E-03 .1273E-02 .2434E-02 .2308E-02 .1823E-02
 .5202E-02 .6858E-02 .4794E-02 .3088E-02 .2179E-01 .1558E-01 .6304E-02 .2424E-02
 .1642E-03 .1873E-03 .1576E-03 .6590E-04 .4178E-03 .3710E-03 .2675E-03 .1016E-03
 .6984E-03 .6646E-03 .5124E-03 .2052E-03 .1185E-02 .1242E-02 .1059E-02 .4625E-03
 .1968E-02 .2334E-02 .2309E-02 .1162E-02 .2980E-02 .4042E-02 .4795E-02 .2958E-02
 .2176E-02 .4634E-02 .8246E-02 .7338E-02 .5224E-02 .6263E-02 .5742E-02 .3457E-02
 .4175E-02 .3804E-02 .8336E-03 .9187E-03 .8946E-03 .5242E-02 .1070E-01 .7623E-02
 .2026E-01 .3026E+00 .1505E+00 .1337E-01 .5070E-01 .2844E-01 .3192E-02 .6434E-02
 .1304E-01 .2305E-01 .3205E-02 .6044E-02 .1118E-01 .1800E-01 .5421E-02 .5421E-01
 .1292E-01 .1030E-01 .7951E-01
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .1582E-04 .3878E-04 .4754E-04 .4272E-04
 .2622E-04 .7129E-04 .1017E-03 .1163E-03 .5949E-04 .1544E-03 .2052E-03 .2166E-03
 .1668E-C3 .3951E-03 .4625E-03 .4289E-03 .6672E-03 .1272E-02 .1162E-02 .8753E-03
 .5210E-02 .5200E-02 .2958E-02 .1669E-02 .1039E+00 .1807E-01 .4619E-02 .1422E-02
 .1922E-03 .2211E-03 .1882E-03 .7978E-04 .4709E-03 .4180E-03 .3030E-03 .1163E-03
 .7418E-03 .6988E-03 .5374E-03 .2167E-03 .1166E-02 .1186E-02 .9898E-03 .4292E-03
 .1768E-02 .1969E-02 .1825E-02 .8758E-03 .2452E-02 .2982E-02 .3090E-02 .1670E-02
 .1697E-02 .3121E-02 .4542E-02 .3242E-02 .4600E-02 .6009E-02 .6079E-02 .3041E-02
 .4006E-02 .4033E-02 .7506E-03 .8830E-03 .9243E-03 .3377E-02 .8929E-02 .9824E-02
 .5180E-02 .6145E-01 .3730E+00 .6122E-02 .3343E-01 .4716E-01 .2966E-02 .6335E-02
 .1401E-01 .2734E-01 .3056E-02 .5386E-02 .9146E-02 .1358E-01 .5219E-02 .5011E-01
 .1519E-01 .7881E-02 .7430E-01
 .3532E-02 .7968E-02 .2349E-01 .1114E+00 .1965E-02 .3755E-02 .7829E-02 .1340E-01
 .1028E-02 .1441E-02 .1718E-02 .9946E-03 .4788E-03 .5277E-03 .4628E-03 .2000E-03
 .2285E-03 .2176E-03 .1646E-03 .6379E-04 .1169E-03 .1020E-03 .7142E-04 .2630E-04
 .6455E-04 .5332E-04 .3572E-04 .1280E-040.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
 .3533E-02 .7151E-02 .1294E-01 .2068E-01 .5362E-02 .7412E-02 .9997E-02 .1257E-01
 .4159E-02 .5419E-02 .6808E-02 .7921E-02 .2923E-02 .3550E-02 .4118E-02 .4413E-02
 .1949E-02 .2216E-02 .2397E-02 .2402E-02 .1277E-02 .1376E-02 .1408E-02 .1343E-02
 .5320E-03 .7462E-03 .9028E-03 .9666E-03 .5131E-02 .1148E-01 .9143E-02 .9483E-02
 .3810E-01 .5284E-01 .1146E-01 .4821E-01 .2711E+00 .6372E-02 .5950E-02 .3082E-02
 .2878E-02 .2129E-02 .7920E-03 .5755E-02 .4935E-02 .1823E-02 .6446E-02 .3121E-02
 .1305E-02 .5747E-03 .2038E-01 .1476E-01 .9187E-02 .5380E-02 .3357E-01 .6229E-02
 .8362E-02 .9618E-02 .7261E-01
 .6150E-02 .1118E-01 .2119E-01 .2465E-01 .3783E-02 .6275E-02 .1004E-01 .9004E-02
 .2272E-02 .3037E-02 .3455E-02 .1959E-02 .1188E-02 .1309E-02 .1166E-02 .5182E-03
 .6130E-03 .5915E-03 .4578E-03 .1816E-03 .3292E-03 .2916E-03 .2083E-03 .7786E-04
 .1875E-03 .1570E-03 .1068E-03 .3863E-040.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
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 .3886E-02 .7224E-02 .1161E-01 .1593E-01 .6026E-02 .7742E-02 .9436E-02 .1043E-01


 .4791E-02 .5884E-02 .6829E-02 .7205E-02 .3442E-02 .3996E-02 .4375E-02 .4379E-02
 .2335E-02 .2568E-02 .2665E-02 .2548E-02 .1550E-02 .1628E-02 .1618E-02 .1492E-02
 .6502E-03 .8951E-03 .1061E-02 .1112E-02 .4515E-02 .1430E-01 .2006E-01 .6773E-02
 .3694E-01 .1789E+00 .5939E-02 .2161E-01 .2076E+00 .6501E-02 .6494E-02 .3606E-02
 .2677E-02 .2046E-02 .7877E-03 .5573E-02 .5056E-02 .1977E-02 .1245E-01 .4448E-02
 .1456E-02 .5563E-03 .2067E-01 .1522E-01 .9559E-02 .5616E-02 .4375E-01 .6075E-02
 .1286E-01 .8730E-02 .8355E-01
 .5516E-02 .8222E-02 .1126E-01 .8315E-02 .3682E-02 .5269E-02 .6754E-02 .4572E-02
 .2519E-02 .3147E-02 .3325E-02 .1790E-02 .1490E-02 .1614E-02 .1429E-02 .6445E-03
 .8424E-03 .8162E-03 .6405E-03 .2598E-03 .4815E-03 .4311E-03 .3131E-03 .1194E-03
 .2859E-03 .2422E-03 .1673E-03 .6147E-040.          0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
 .3824E-02 .6507E-02 .9379E-02 .1143E-01 .6069E-02 .7209E-02 .7981E-02 .7930E-02
 .4978E-02 .5731E-02 .6154E-02 .5968E-02 .3689E-02 .4075E-02 .4210E-02 .3961E-02
 .2572E-02 .2725E-02 .2711E-02 .2479E-02 .1745E-02 .1782E-02 .1717E-02 .1534E-02
 .7418E-03 .1001E-02 .1162E-02 .1193E-02 .3364E-02 .1401E-01 .4911E-01 .4029E-02
 .2275E-01 .3853E+00 .2728E-02 .7362E-02 .2257E-01 .6368E-02 .6783E-02 .4059E-02
 .2397E-02 .1883E-02 .7480E-03 .5181E-02 .4943E-02 .2047E-02 .2815E-01 .5631E-02
 .1340E-02 .4413E-03 .1944E-01 .1470E-01 .9443E-02 .5634E-02 .5431E-01 .5418E-02
 .2022E-01 .7033E-02 .8793E-01
 .4285E-02 .5516E-02 .6180E-02 .3653E-02 .3019E-02 .3830E-02 .4197E-02 .2412E-02
 .2288E-02 .2670E-02 .2619E-02 .1331E-02 .1507E-02 .1590E-02 .1380E-02 .6198E-03
 .9317E-03 .8982E-03 .7069E-03 .2903E-03 .5688E-03 .5115E-03 .3753E-03 .1453E-03
 .3538E-03 .3022E-03 .2111E-03 .7864E-040.          0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
 .3467E-02 .5444E-02 .7183E-02 .8037E-02 .5627E-02 .6209E-02 .6337E-02 .5816E-02
 .4770E-02 .5160E-02 .5177E-02 .4697E-02 .3667E-02 .3855E-02 .3777E-02 .3374E-02
 .2645E-02 .2698E-02 .2579E-02 .2268E-02 .1846E-02 .1832E-02 .1713E-02 .1486E-02
 .7991E-03 .1057E-02 .1203E-02 .1212E-02 .2060E-02 .9481E-02 .1476E+00 .2022E-02
 .9463E-02 .3152E+00 .1141E-02 .2315E-02 .3238E-02 .5978E-02 .6738E-02 .4348E-02
 .2071E-02 .1661E-02 .6783E-03 .4629E-02 .4601E-02 .2010E-02 .9222E-01 .3837E-02
 .6590E-03 .1920E-03 .1706E-01 .1335E-01 .8869E-02 .5432E-02 .5922E-01 .4223E-02
 .3004E-01 .4840E-02 .7842E-01
 .2681E-02 .5081E-02 .1051E-01 .1773E-01 .2754E-02 .6342E-02 .1951E-01 .1009E+00
 .2095E-02 .4055E-02 .8540E-02 .1304E-01 .1102E-02 .1555E-02 .1854E-02 .1062E-02
 .5134E-03 .5681E-03 .4989E-03 .2151E-03 .2447E-03 .2336E-03 .1770E-03 .6850E-04
 .1254E-03 .1095E-03 .7681E-04 .2826E-040.          0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
 .3405E-02 .6609E-02 .1128E-01 .1674E-01 .6049E-02 .8610E-02 .1204E-01 .1578E-01
 .5556E-02 .7734E-02 .1052E-01 .1335E-01 .4386E-02 .5769E-02 .7324E-02 .8612E-02
 .3112E-02 .3815E-02 .4467E-02 .4830E-02 .2083E-02 .2387E-02 .2602E-02 .2624E-02
 .8672E-03 .1276E-02 .1612E-02 .1786E-02 .1319E-01 .2770E-01 .2139E-01 .2046E-01
 .5943E-01 .5185E-01 .1858E-01 .4203E-01 .4128E-01 .8962E-02 .9346E-02 .5066E-02
 .4404E-02 .3527E-02 .1371E-02 .8461E-02 .8164E-02 .3185E-02 .8283E-02 .6006E-02
 .2759E-02 .1155E-02 .2239E-01 .1977E-01 .1385E-01 .8475E-02 .3847E-01 .1115E-01
 .1378E-01 .1301E-01 .1156E+00
 .4850E-02 .7841E-02 .1213E-01 .1051E-01 .4642E-02 .8518E-02 .1639E-01 .1950E-01
 .3752E-02 .6170E-02 .9738E-02 .8535E-02 .2236E-02 .2961E-02 .3320E-02 .1852E-02
 .1168E-02 .1278E-02 .1129E-02 .4987E-03 .6038E-03 .5802E-03 .4471E-03 .1770E-03
 .3265E-03 .2883E-03 .2054E-03 .7683E-040.          0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
 .3709E-02 .6651E-02 .1021E-01 .1331E-01 .6587E-02 .8611E-02 .1070E-01 .1204E-01
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 .6078E-02 .7810E-02 .9520E-02 .1052E-01 .4856E-02 .5970E-02 .6935E-02 .7323E-02


 .3498E-02 .4067E-02 .4458E-02 .4466E-02 .2377E-02 .2617E-02 .2719E-02 .2601E-02
 .9994E-03 .1428E-02 .1747E-02 .1873E-02 .1218E-01 .3479E-01 .4347E-01 .1574E-01
 .5887E-01 .9362E-01 .1139E-01 .2577E-01 .3213E-01 .8828E-02 .9980E-02 .5941E-02
 .3817E-02 .3161E-02 .1282E-02 .7762E-02 .7983E-02 .3358E-02 .1685E-01 .1026E-01
 .3415E-02 .1156E-02 .2222E-01 .1962E-01 .1377E-01 .8445E-02 .5002E-01 .1077E-01
 .2253E-01 .1146E-01 .1360E+00
 .4590E-02 .6368E-02 .7839E-02 .5083E-02 .4126E-02 .6181E-02 .8517E-02 .6340E-02
 .3517E-02 .4939E-02 .6169E-02 .4054E-02 .2350E-02 .2876E-02 .2960E-02 .1554E-02
 .1379E-02 .1470E-02 .1278E-02 .5677E-03 .7810E-03 .7479E-03 .5801E-03 .2335E-03
 .4505E-03 .3999E-03 .2883E-03 .1096E-030.          0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
 .3634E-02 .6007E-02 .8375E-02 .9867E-02 .6440E-02 .7715E-02 .8610E-02 .8608E-02
 .5984E-02 .7082E-02 .7810E-02 .7733E-02 .4869E-02 .5581E-02 .5969E-02 .5768E-02
 .3592E-02 .3951E-02 .4066E-02 .3814E-02 .2499E-02 .2638E-02 .2616E-02 .2387E-02
 .1069E-02 .1482E-02 .1757E-02 .1829E-02 .9836E-02 .3569E-01 .8803E-01 .1049E-01
 .4213E-01 .1173E+00 .6271E-02 .1251E-01 .1488E-01 .8257E-02 .1001E-01 .6560E-02
 .3169E-02 .2683E-02 .1126E-02 .6779E-02 .7316E-02 .3299E-02 .4122E-01 .1771E-01
 .3476E-02 .9247E-03 .2043E-01 .1811E-01 .1288E-01 .8015E-02 .6157E-01 .9333E-02
 .3810E-01 .8865E-02 .1455E+00
 .3723E-02 .4586E-02 .4845E-02 .2680E-02 .3195E-02 .4127E-02 .4642E-02 .2754E-02
 .2830E-02 .3516E-02 .3751E-02 .2094E-02 .2066E-02 .2350E-02 .2235E-02 .1102E-02
 .1338E-02 .1379E-02 .1168E-02 .5131E-03 .8246E-03 .7809E-03 .6037E-03 .2445E-03
 .5075E-03 .4503E-03 .3263E-03 .1253E-030.          0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
 .3296E-02 .5062E-02 .6526E-02 .7146E-02 .5828E-02 .6447E-02 .6593E-02 .6054E-02
 .5459E-02 .5990E-02 .6083E-02 .5561E-02 .4538E-02 .4874E-02 .4860E-02 .4390E-02
 .3444E-02 .3595E-02 .3501E-02 .3114E-02 .2468E-02 .2502E-02 .2379E-02 .2085E-02
 .1078E-02 .1453E-02 .1675E-02 .1700E-02 .6916E-02 .2757E-01 .1468E+00 .6226E-02
 .2248E-01 .8179E-01 .3239E-02 .5473E-02 .5301E-02 .7349E-02 .9382E-02 .6726E-02
 .2543E-02 .2177E-02 .9365E-03 .5675E-02 .6310E-02 .3013E-02 .1324E+00 .2036E-01
 .1740E-02 .3773E-03 .1757E-01 .1570E-01 .1140E-01 .7277E-02 .6523E-01 .6899E-02
 .6006E-01 .5801E-02 .1288E+00
 .1477E-02 .2104E-02 .2579E-02 .1544E-02 .2239E-02 .4513E-02 .1036E-01 .2242E-01
 .2748E-02 .6313E-02 .1934E-01 .9807E-01 .2020E-02 .3828E-02 .7710E-02 .1041E-01
 .1046E-02 .1445E-02 .1673E-02 .9277E-03 .4864E-03 .5312E-03 .4600E-03 .1961E-03
 .2336E-03 .2212E-03 .1664E-03 .6412E-040.          0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
 .2749E-02 .4974E-02 .7795E-02 .1054E-01 .5556E-02 .7734E-02 .1052E-01 .1335E-01
 .6048E-02 .8609E-02 .1204E-01 .1578E-01 .5556E-02 .7734E-02 .1052E-01 .1335E-01
 .4386E-02 .5769E-02 .7323E-02 .8611E-02 .3112E-02 .3814E-02 .4467E-02 .4830E-02
 .1324E-02 .2062E-02 .2752E-02 .3194E-02 .1582E-01 .2758E-01 .1914E-01 .2038E-01
 .3944E-01 .2360E-01 .1464E-01 .2074E-01 .1213E-01 .1178E-01 .1404E-01 .8065E-02
 .6571E-02 .5871E-02 .2434E-02 .1188E-01 .1336E-01 .5633E-02 .6779E-02 .8132E-02
 .5046E-02 .2210E-02 .2063E-01 .2224E-01 .1831E-01 .1224E-01 .3222E-01 .1866E-01
 .1764E-01 .1523E-01 .1479E+00
 .2991E-02 .3976E-02 .4516E-02 .2578E-02 .3952E-02 .6672E-02 .1102E-01 .1035E-01
 .4634E-02 .8490E-02 .1630E-01 .1935E-01 .3646E-02 .5915E-02 .9115E-02 .7705E-02
 .2141E-02 .2792E-02 .3066E-02 .1672E-02 .1114E-02 .1206E-02 .1052E-02 .4597E-03
 .5792E-03 .5522E-03 .4225E-03 .1664E-030.          0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
 .3030E-02 .5129E-02 .7387E-02 .9062E-02 .6077E-02 .7810E-02 .9519E-02 .1052E-01
 .6586E-02 .8610E-02 .1070E-01 .1204E-01 .6077E-02 .7810E-02 .9519E-02 .1052E-01
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.4855E-02	.5969E-02	.6935E-02	.7322E-02	.3498E-02	.4066E-02	.4458E-02	.4466E-02
.1505E-02	.2255E-02	.2878E-02	.3188E-02	.1529E-01	.3355E-01	.3224E-01	.1695E-01
.3915E-01	.3192E-01	.1041E-01	.1537E-01	.1028E-01	.1159E-01	.1546E-01	.1018E-01
.5462E-02	.5080E-02	.2235E-02	.1066E-01	.1308E-01	.6163E-02	.1225E-01	.1638E-01
.7884E-02	.2562E-02	.2050E-01	.2207E-01	.1819E-01	.1219E-01	.3957E-01	.1925E-01
.3033E-01	.1348E-01	.1820E+00					
.3143E-02	.3846E-02	.3975E-02	.2104E-02	.3658E-02	.5218E-02	.6671E-02	.4510E-02
.4121E-02	.6167E-02	.8489E-02	.6314E-02	.3441E-02	.4793E-02	.5914E-02	.3827E-02
.2270E-02	.2749E-02	.2792E-02	.1444E-02	.1325E-02	.1400E-02	.1206E-02	.5308E-03
.7532E-03	.7163E-03	.5521E-03	.2212E-03	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
.3020E-02	.4775E-02	.6365E-02	.7213E-02	.5984E-02	.7082E-02	.7809E-02	.7733E-02
.6440E-02	.7715E-02	.8610E-02	.8608E-02	.5984E-02	.7082E-02	.7809E-02	.7733E-02
.4869E-02	.5581E-02	.5969E-02	.5768E-02	.3592E-02	.3951E-02	.4066E-02	.3814E-02
.1574E-02	.2266E-02	.2772E-02	.2947E-02	.1331E-01	.3503E-01	.4980E-01	.1266E-01
.3167E-01	.3378E-01	.6800E-02	.9770E-02	.6851E-02	.1069E-01	.1566E-01	.1191E-01
.4300E-02	.4084E-02	.1876E-02	.8988E-02	.1169E-01	.6091E-02	.2329E-01	.3943E-01
.1142E-01	.2408E-02	.1892E-01	.2030E-01	.1686E-01	.1146E-01	.4470E-01	.1771E-01
.5399E-01	.1043E-01	.2049E+00					
.2765E-02	.3140E-02	.2989E-02	.1477E-02	.2916E-02	.3659E-02	.3953E-02	.2238E-02
.3192E-02	.4121E-02	.4632E-02	.2748E-02	.2783E-02	.3440E-02	.3645E-02	.2019E-02
.2010E-02	.2269E-02	.2140E-02	.1045E-02	.1295E-02	.1325E-02	.1114E-02	.4861E-03
.7994E-03	.7528E-03	.5788E-03	.2335E-03	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
.2790E-02	.4145E-02	.5180E-02	.5533E-02	.5450E-02	.5981E-02	.6073E-02	.5551E-02
.5818E-02	.6436E-02	.6582E-02	.6044E-02	.5450E-02	.5981E-02	.6073E-02	.5551E-02
.4531E-02	.4866E-02	.4852E-02	.4383E-02	.3439E-02	.3589E-02	.3495E-02	.3109E-02
.1542E-02	.2138E-02	.2519E-02	.2589E-02	.1044E-01	.3008E-01	.6203E-01	.8689E-02
.2121E-01	.2606E-01	.4213E-02	.5659E-02	.3859E-02	.9229E-02	.1442E-01	.1251E-01
.3247E-02	.3093E-02	.1457E-02	.7172E-02	.9590E-02	.5[illegible]89E-02	.3325E-01	.1261E+00
.8820E-02	.1120E-02	.1634E-01	.1744E-01	.1466E-01	.1020E-01	.4204E-01	.1362E-01
.8811E-01	.6787E-02	.1898E+00					
.7298E-03	.8241E-03	.7433E-03	.3284E-03	.1285E-02	.1934E-02	.2545E-02	.1634E-02
.2309E-02	.4739E-02	.1134E-01	.2886E-01	.2733E-02	.6256E-02	.1901E-01	.9352E-01
.1945E-02	.3606E-02	.6941E-02	.8394E-02	.9920E-03	.1343E-02	.1511E-02	.8139E-03
.4625E-03	.4985E-03	.4259E-03	.1798E-03	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
.1975E-02	.3301E-02	.4737E-02	.5874E-02	.4386E-02	.5768E-02	.7323E-02	.8611E-02
.5555E-02	.7733E-02	.1052E-01	.1335E-01	.6048E-02	.8609E-02	.1204E-01	.1578E-01
.5555E-02	.7733E-02	.1052E-01	.1335E-01	.4386E-02	.5768E-02	.7323E-02	.8611E-02
.1969E-02	.3294E-02	.4729E-02	.5869E-02	.1461E-01	.2071E-01	.1292E-01	.1622E-01
.2279E-01	.1092E-01	.9932E-02	.1055E-01	.4908E-02	.1456E-01	.2067E-01	.1290E-01
.9953E-02	.1059E-01	.4927E-02	.1627E-01	.2291E-01	.1099E-01	.4137E-02	.7586E-02
.7600E-02	.4150E-02	.1667E-01	.2163E-01	.2165E-01	.1670E-01	.2201E-01	.3011E-01
.1899E-01	.1600E-01	.1588E+00					
.1645E-02	.1828E-02	.1648E-02	.7434E-03	.2536E-02	.3520E-02	.4221E-02	.2542E-02
.4048E-02	.6913E-02	.1166E-01	.1133E-01	.4614E-02	.8436E-02	.1613E-01	.1902E-01
.3539E-02	.5659E-02	.8510E-02	.6936E-02	.2049E-02	.2632E-02	.2831E-02	.1510E-02
.1067E-02	.1142E-02	.9836E-03	.4259E-03	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
.2210E-02	.3508E-02	.4732E-02	.5480E-02	.4855E-02	.5969E-02	.6935E-02	.7322E-02
.6077E-02	.7810E-02	.9519E-02	.1052E-01	.6586E-02	.8610E-02	.1070E-01	.1204E-01
.6077E-02	.7810E-02	.9519E-02	.1052E-01	.4855E-02	.5969E-02	.6935E-02	.7322E-02

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 .2204E-02 .3501E-02 .4724E-02 .5476E-02 .1432E-01 .2384E-01 .1830E-01 .1413E-01


 .2241E-01 .1281E-01 .7764E-02 .8636E-02 .4378E-02 .1428E-01 .2381E-01 .1830E-01
 .7773E-02 .8656E-02 .4392E-02 .1417E-01 .2253E-01 .1290E-01 .5918E-02 .1465E-01
 .1469E-01 .5944E-02 .1658E-01 .2147E-01 .2150E-01 .1661E-01 .2454E-01 .3394E-01
 .3295E-01 .1418E-01 .1977E+00
 .1925E-02 .2072E-02 .1827E-02 .8241E-03 .2596E-02 .3279E-02 .3519E-02 .1932E-02
 .3725E-02 .5350E-02 .6912E-02 .4739E-02 .4108E-02 .6140E-02 .8435E-02 .6257E-02
 .3363E-02 .4644E-02 .5658E-02 .3604E-02 .2191E-02 .2626E-02 .2632E-02 .1342E-02
 .1278E-02 .1338E-02 .1141E-02 .4984E-030.         0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .2256E-02 .3395E-02 .4322E-02 .4725E-02 .4869E-02 .5581E-02 .5969E-02 .5768E-02
 .5984E-02 .7082E-02 .7809E-02 .7733E-02 .6440E-02 .7715E-02 .8610E-02 .8608E-02
 .5984E-02 .7082E-02 .7809E-02 .7733E-02 .4869E-02 .5581E-02 .5969E-02 .5768E-02
 .2249E-02 .3388E-02 .4314E-02 .4721E-02 .1291E-01 .2448E-01 .2364E-01 .1134E-01
 .1930E-01 .1288E-01 .5668E-02 .6367E-02 .3400E-02 .1288E-01 .2447E-01 .2367E-01
 .5670E-02 .6375E-02 .3407E-02 .1136E-01 .1939E-01 .1297E-01 .7391E-02 .3220E-01
 .3236E-01 .7438E-02 .1543E-01 .1978E-01 .1979E-01 .1545E-01 .2450E-01 .3435E-01
 .5885E-01 .1097E-01 .2250E+00
 .1855E-02 .1924E-02 .1643E-02 .7294E-03 .2236E-02 .2597E-02 .2536E-02 .1284E-02
 .2957E-02 .3724E-02 .4047E-02 .2308E-02 .3185E-02 .4108E-02 .4613E-02 .2733E-02
 .2735E-02 .3363E-02 .3538E-02 .1944E-02 .1954E-02 .2191E-02 .2048E-02 .9914E-03
 .1257E-02 .1278E-02 .1066E-02 .4623E-030.         0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .2146E-02 .3073E-02 .3722E-02 .3889E-02 .4532E-02 .4868E-02 .4854E-02 .4384E-02
 .5452E-02 .5983E-02 .6076E-02 .5554E-02 .5821E-02 .6439E-02 .6585E-02 .6046E-02
 .5452E-02 .5983E-02 .6076E-02 .5554E-02 .4532E-02 .4868E-02 .4854E-02 .4384E-02
 .2139E-02 .3067E-02 .3715E-02 .3886E-02 .1072E-01 .2198E-01 .2618E-01 .8504E-02
 .1469E-01 .1085E-01 .3947E-02 .4355E-02 .2363E-02 .1071E-01 .2199E-01 .2625E-01
 .3944E-02 .4355E-02 .2366E-02 .8510E-02 .1473E-01 .1092E-01 .4636E-02 .8027E-01
 .8112E-01 .4676E-02 .1351E-01 .1703E-01 .1704E-01 .1353E-01 .2020E-01 .2868E-01
 .9543E-01 .7135E-02 .2101E+00
 .3647E-03 .3551E-03 .2745E-03 .1079E-03 .6377E-03 .7477E-03 .7005E-03 .3181E-03
 .1351E-02 .2078E-02 .2835E-02 .1907E-02 .2374E-02 .4961E-02 .1233E-01 .3586E-01
 .2711E-02 .6173E-02 .1854E-01 .6789E-01 .1869E-02 .3389E-02 .6235E-02 .6828E-02
 .9439E-03 .1253E-02 .1372E-02 .7191E-030.         0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .1328E-02 .2066E-02 .2756E-02 .3197E-02 .3112E-02 .3814E-02 .4466E-02 .4829E-02
 .4386E-02 .5768E-02 .7323E-02 .8611E-02 .5555E-02 .7733E-02 .1052E-01 .1335E-01
 .6048E-02 .8608E-02 .1204E-01 .1578E-01 .5555E-02 .7733E-02 .1052E-01 .1335E-01
 .2741E-02 .4963E-02 .7780E-02 .1054E-01 .1180E-01 .1405E-01 .8072E-02 .1184E-01
 .1330E-01 .5602E-02 .6557E-02 .5855E-02 .2426E-02 .1573E-01 .2745E-01 .1907E-01
 .1467E-01 .2081E-01 .1219E-01 .2042E-01 .3965E-01 .2378E-01 .2203E-02 .5028E-02
 .8129E-02 .6793E-02 .1222E-01 .1828E-01 .2224E-01 .2065E-01 .1353E-01 .4324E-01
 .1732E-01 .1505E-01 .1425E+00
 .8900E-03 .8700E-03 .6831E-03 .2746E-03 .1409E-02 .1618E-02 .1509E-02 .6998E-03
 .2641E-02 .3724E-02 .4571E-02 .2833E-02 .4138E-02 .7145E-02 .1230E-01 .1233E-01
 .4586E-02 .8356E-02 .1588E-01 .1854E-01 .3429E-02 .5404E-02 .7928E-02 .6230E-02
 .1967E-02 .2488E-02 .2623E-02 .1371E-020.         0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .1509E-02 .2259E-02 .2883E-02 .3190E-02 .3497E-02 .4066E-02 .4457E-02 .4466E-02
 .4855E-02 .5969E-02 .6934E-02 .7322E-02 .6077E-02 .7809E-02 .9519E-02 .1052E-01
 .6586E-02 .8609E-02 .1070E-01 .1204E-01 .6077E-02 .7809E-02 .9519E-02 .1052E-01
 .3020E-02 .5117E-02 .7373E-02 .9054E-02 .1161E-01 .1547E-01 .1018E-01 .1063E-01
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 .1302E-01 .6127E-02 .5454E-02 .5069E-02 .2229E-02 .1521E-01 .3344E-01 .3217E-01


 .1042E-01 .1541E-01 .1033E-01 .1698E-01 .3934E-01 .3219E-01 .2551E-02 .7846E-02
 .1637E-01 .1229E-01 .1217E-01 .1816E-01 .2207E-01 .2052E-01 .1383E-01 .5355E-01
 .2966E-01 .1331E-01 .1742E+00
 .1137E-02 .1104E-02 .8699E-03 .3551E-03 .1614E-02 .1784E-02 .1618E-02 .7469E-03
 .2681E-02 .3421E-02 .3723E-02 .2077E-02 .3787E-02 .5474E-02 .7144E-02 .4961E-02
 .4090E-02 .6100E-02 .8355E-02 .6174E-02 .3283E-02 .4494E-02 .5403E-02 .3397E-02
 .2122E-02 .2516E-02 .2488E-02 .1252E-020.         0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .1579E-02 .2270E-02 .2777E-02 .2949E-02 .3591E-02 .3951E-02 .4066E-02 .3813E-02
 .4869E-02 .5581E-02 .5969E-02 .5767E-02 .5984E-02 .7081E-02 .7809E-02 .7732E-02
 .6440E-02 .7714E-02 .8609E-02 .8607E-02 .5984E-02 .7081E-02 .7809E-02 .7732E-02
 .3010E-02 .4765E-02 .6352E-02 .7207E-02 .1069E-01 .1565E-01 .1189E-01 .8967E-02
 .1164E-01 .6057E-02 .4297E-02 .4078E-02 .1872E-02 .1325E-01 .3495E-01 .4982E-01
 .6794E-02 .9776E-02 .6868E-02 .1267E-01 .3179E-01 .3409E-01 .2395E-02 .1133E-01
 .3936E-01 .2342E-01 .1143E-01 .1683E-01 .2030E-01 .1894E-01 .1261E-01 .6123E-01
 .5268E-01 .1030E-01 .1948E+00
 .1187E-02 .1136E-02 .8893E-03 .3645E-03 .1524E-02 .1614E-02 .1409E-02 .6373E-03
 .2293E-02 .2681E-02 .2641E-02 .1350E-02 .2994E-02 .3786E-02 .4137E-02 .2374E-02
 .3174E-02 .4089E-02 .4584E-02 .2711E-02 .2684E-02 .3283E-02 .3428E-02 .1868E-02
 .1905E-02 .2121E-02 .1965E-02 .9433E-030.         0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .1547E-02 .2142E-02 .2524E-02 .2592E-02 .3439E-02 .3589E-02 .3495E-02 .3109E-02
 .4530E-02 .4866E-02 .4852E-02 .4383E-02 .5450E-02 .5981E-02 .6073E-02 .5551E-02
 .5818E-02 .6436E-02 .6582E-02 .6044E-02 .5450E-02 .5981E-02 .6073E-02 .5551E-02
 .2781E-02 .4136E-02 .5169E-02 .5528E-02 .9232E-02 .1440E-01 .1248E-01 .7161E-02
 .9559E-02 .5362E-02 .3247E-02 .3091E-02 .1455E-02 .1040E-01 .3004E-01 .6220E-01
 .4203E-02 .5651E-02 .3860E-02 .8680E-02 .2125E-01 .2627E-01 .1114E-02 .8715E-02
 .1255E+00 .3386E-01 .1018E-01 .1464E-01 .1744E-01 .1635E-01 .9629E-02 .5846E-01
 .8600E-01 .6704E-02 .1794E+00
 .1928E-03 .1713E-03 .1219E-03 .4531E-04 .3155E-03 .3148E-03 .2485E-03 .9892E-04
 .6737E-03 .8020E-03 .7652E-03 .3532E-03 .1418E-02 .2232E-02 .3162E-02 .2235E-02
 .2437E-02 .5176E-02 .1334E-01 .4322E-01 .2682E-02 .6064E-02 .1793E-01 .8148E-01
 .1800E-02 .3188E-02 .5607E-02 .5615E-020.         0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .8697E-03 .1278E-02 .1614E-02 .1787E-02 .2083E-02 .2387E-02 .2601E-02 .2624E-02
 .3112E-02 .3814E-02 .4466E-02 .4229E-02 .4386E-02 .5768E-02 .7323E-02 .8611E-02
 .5555E-02 .7733E-02 .1052E-01 .1335E-01 .6048E-02 .8608E-02 .1204E-01 .1578E-01
 .3393E-02 .6594E-02 .1126E-01 .1672E-01 .8972E-02 .9350E-02 .5067E-02 .8432E-02
 .8128E-02 .3169E-02 .4395E-02 .3519E-02 .1367E-02 .1304E-01 .2742E-01 .2118E-01
 .1860E-01 .4218E-01 .4157E-01 .2047E-01 .5963E-01 .5220E-01 .1151E-02 .2748E-02
 .5992E-02 .8284E-02 .8455E-02 .1382E-01 .1975E-01 .2239E-01 .8067E-02 .5021E-01
 .1327E-01 .1272E-01 .1076E+00
 .4968E-03 .4458E-03 .3225E-03 .1220E-03 .7595E-03 .7595E-03 .6088E-03 .2483E-03
 .1477E-02 .1717E-02 .1626E-02 .7649E-03 .2748E-02 .3936E-02 .4949E-02 .3159E-02
 .4223E-02 .7367E-02 .1292E-01 .1334E-01 .4547E-02 .8250E-02 .1555E-01 .1793E-01
 .3330E-02 .5168E-02 .7391E-02 .5605E-020.         0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .1002E-02 .1431E-02 .1750E-02 .1874E-02 .2376E-02 .2616E-02 .2718E-02 .2601E-02
 .3497E-02 .4066E-02 .4457E-02 .4466E-02 .4855E-02 .5969E-02 .6934E-02 .7322E-02
 .6077E-02 .7809E-02 .9519E-02 .1052E-01 .6586E-02 .8609E-02 .1070E-01 .1204E-01
 .3697E-02 .6635E-02 .1019E-01 .1330E-01 .8833E-02 .9978E-02 .5938E-02 .7738E-02
 .7949E-02 .3341E-02 .3811E-02 .3155E-02 .1279E-02 .1205E-01 .3446E-01 .4313E-01
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 .1137E-01 .2581E-01 .3233E-01 .1572E-01 .5903E-01 .9450E-01 .1151E-02 .3397E-02


 .1022E-01 .1685E-01 .8426E-02 .1374E-01 .1960E-01 .2222E-01 .7743E-02 .6529E-01
 .2150E-01 .1119E-01 .1249E+00
 .6767E-03 .6095E-03 .4458E-03 .1714E-03 .9544E-03 .9456E-03 .7594E-03 .3145E-03
 .1678E-02 .1872E-02 .1717E-02 .8015E-03 .2766E-02 .3565E-02 .3935E-02 .2230E-02
 .3845E-02 .5592E-02 .7366E-02 .5176E-02 .4064E-02 .6047E-02 .8249E-02 .6064E-02
 .3213E-02 .4356E-02 .5167E-02 .3188E-020.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .1072E-02 .1485E-02 .1760E-02 .1830E-02 .2499E-02 .2638E-02 .2616E-02 .2387E-02
 .3591E-02 .3951E-02 .4066E-02 .3813E-02 .4869E-02 .5581E-02 .5968E-02 .5767E-02
 .5984E-02 .7081E-02 .7809E-02 .7732E-02 .6440E-02 .7714E-02 .8609E-02 .8607E-02
 .3621E-02 .5993E-02 .8357E-02 .9856E-02 .8258E-02 .9998E-02 .6551E-02 .6762E-02
 .7288E-02 .3284E-02 .3166E-02 .2679E-02 .1124E-02 .9735E-02 .3539E-01 .8762E-01
 .6249E-02 .1249E-01 .1491E-01 .1046E-01 .4216E-01 .1187E+00 .9205E-03 .3452E-02
 .1760E-01 .4124E-01 .7997E-02 .1285E-01 .1810E-01 .2043E-01 .6675E-02 .8039E-01
 .3597E-01 .8653E-02 .1315E+00
 .7528E-03 .6763E-03 .4964E-03 .1927E-03 .9803E-03 .9547E-03 .7596E-03 .3154E-03
 .1574E-02 .1678E-02 .1477E-02 .6732E-03 .2350E-02 .2765E-02 .2747E-02 .1417E-02
 .3029E-02 .3844E-02 .4221E-02 .2436E-02 .3159E-02 .4064E-02 .4547E-02 .2682E-02
 .2643E-02 .3212E-02 .3328E-02 .1799E-020.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .1081E-02 .1455E-02 .1678E-02 .1701E-02 .2468E-02 .2501E-02 .2378E-02 .2084E-02
 .3444E-02 .3595E-02 .3501E-02 .3114E-02 .4537E-02 .4873E-02 .4859E-02 .4389E-02
 .5458E-02 .5990E-02 .6083E-02 .5560E-02 .5827E-02 .6446E-02 .6592E-02 .6053E-02
 .3285E-02 .5050E-02 .6511E-02 .7137E-02 .7346E-02 .9369E-02 .6712E-02 .5663E-02
 .6290E-C2 .3000E-02 .2542E-02 .2176E-02 .9354E-03 .6851E-02 .2735E-01 .1469E+00
 .3216E-02 .5440E-02 .5280E-02 .6189E-02 .2241E-01 .8273E-01 .3754E-03 .1726E-02
 .2003E-01 .1326E+00 .7262E-02 .1138E-01 .1569E-01 .1757E-01 .4919E-02 .8524E-01
 .5621E-01 .5667E-02 .1145E+00
 .9766E-04 .8151E-04 .5507E-04 .1985E-04 .1468E-03 .1315E-03 .9416E-04 .3516E-04
 .2946E-03 .2929E-03 .2309E-03 .9207E-04 .6282E-03 .7446E-03 .7098E-03 .3288E-03
 .1324E-02 .2067E-02 .2928E-02 .2113E-02 .2300E-02 .4812E-02 .1213E-01 .3952E-01
 .2626E-02 .5944E-02 .1765E-01 .8413E-010.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .5335E-03 .7475E-03 .9042E-03 .9671E-03 .1277E-02 .1375E-02 .1408E-02 .1343E-02
 .1948E-02 .2216E-02 .2397E-02 .2401E-02 .2922E-02 .3549E-02 .4117E-02 .4412E-02
 .4158E-02 .5417E-02 .6806E-02 .7319E-02 .5360E-02 .7409E-02 .9993E-02 .1257E-01
 .3519E-02 .7130E-02 .1290E-01 .2065E-01 .6374E-02 .5950E-02 .3082E-02 .5735E-02
 .4915E-02 .1815E-02 .2872E-02 .2124E-02 .7901E-03 .4964E-02 .1110E-01 .8849E-02
 .1143E-01 .4816E-01 .2725E+00 .9441E-02 .3797E-01 .5275E-01 .5728E-03 .1300F-02
 .3111E-02 .6432E-02 .5367E-02 .9160E-02 .1473E-01 .2036E-01 .4521E-02 .4259E-01
 .7930E-02 .9308E-02 .6589E-01
 .2822E-03 .2388E-03 .1640E-03 .5971E-04 .4077E-03 .3708E-03 .2711E-03 .1031E-03
 .7725E-03 .7763E-03 .6256E-03 .2561E-03 .1504E-02 .1763E-02 .1686E-02 .8004E-03
 .2789E-02 .4034E-02 .5156E-02 .3362E-02 .4244E-02 .7452E-02 .1321E-01 .1385E-01
 .4535E-02 .8233E-02 .1555E-01 .1805E-010.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .6528E-03 .8978E-03 .1064E-02 .1114E-02 .1552E-02 .1629E-02 .1619E-02 .1494E-02
 .2337E-02 .2570E-02 .2668E-02 .2551E-02 .3445E-02 .3999E-02 .4379E-02 .4384E-02
 .4795E-02 .5889E-02 .6835E-02 .7212E-02 .6030E-02 .7748E-02 .9443E-02 .1044E-01
 .3875E-02 .7211E-02 .1159E-01 .1592E-01 .6508E-02 .6498E-02 .3608E-02 .5562E-02
 .5043E-02 .1971E-02 .2676E-02 .2044E-02 .7870E-03 .4374E-02 .1386E-01 .1745E-01
 .5907E-02 .2153E-01 .2090E+00 .6731E-02 .3677E-01 .1790E+00 .5551E-03 .1451E-02
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 .4435E-02 .1242E-01 .5609E-02 .9543E-02 .1521E-01 .2067E-01 .4394E-02 .5528E-01


 .1206E-01 .8453E-02 .7478E-01
 .4268E-03 .3654E-03 .2548E-03 .9434E-04 .5848E-03 .5369E-03 .3991E-03 .1550E-03
 .1031E-02 .1035E-02 .8429E-03 .3527E-03 .1811E-02 .2058E-02 .1928E-02 .9167E-03
 .2947E-02 .3880E-02 .4404E-02 .2570E-02 .3978E-02 .5873E-02 .7905E-02 .5700E-02
 .4045E-02 .6007E-02 .8172E-02 .5987E-020.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .7474E-03 .1008E-02 .1169E-02 .1199E-02 .1753E-02 .1790E-02 .1725E-02 .1541E-02
 .2584E-02 .2737E-02 .2723E-02 .2491E-02 .3706E-02 .4093E-02 .4229E-02 .3979E-02
 .5000E-02 .5756E-02 .6182E-02 .5995E-02 .6095E-02 .7240E-02 .8015E-02 .7965E-02
 .3826E-02 .6519E-02 .9396E-02 .1146E-01 .6396E-02 .6808E-02 .4074E-02 .5191E-02
 .4949E-02 .2048E-02 .2406E-02 .1889E-02 .7503E-03 .3267E-02 .1361E-01 .4778E-01
 .2703E-02 .7302E-02 .2250E-01 .3993E-02 .2259E-01 .3861E+00 .4418E-03 .1339E-02
 .5625E-02 .2815E-01 .5647E-02 .9462E-02 .1475E-01 .1951E-01 .3918E-02 .6839E-01
 .1874E-01 .6839E-02 .7765E-01
 .5235E-03 .4515E-03 .3184E-03 .1195E-03 .6766E-03 .6224E-03 .4668E-03 .1839E-03
 .1108E-02 .1101E-02 .8937E-03 .3774E-03 .1766E-02 .1930E-02 .1746E-02 .8164E-03
 .2575E-02 .3109E-02 .3186E-02 .1697E-02 .3176E-02 .4095E-02 .4593E-02 .2714E-02
 .3134E-02 .4019E-02 .4476E-02 .2627E-020.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
 .8083E-03 .1068E-02 .1215E-02 .1223E-02 .1861E-02 .1847E-02 .1727E-02 .1498E-02
 .2667E-02 .2720E-02 .2600E-02 .2287E-02 .3697E-02 .3887E-02 .3808E-02 .3402E-02
 .4810E-02 .5202E-02 .5220E-02 .4736E-02 .5672E-02 .6259E-02 .6389E-02 .5863E-02
 .3483E-02 .5474E-02 .7224E-02 .8092E-02 .6024E-02 .6786E-02 .4378E-02 .4658E-02
 .4626E-02 .2019E-02 .2088E-02 .1674E-02 .6833E-03 .2006E-02 .9237E-02 .1453E+00
 .1121E-C2 .2276E-02 .3188E-02 .1990E-02 .9329E-02 .3144E+00 .1929E-03 .6609E-03
 .3840E-02 .9321E-01 .5466E-02 .8921E-02 .1345E-01 .1719E-01 .3058E-02 .7434E-01
 .2751E-01 .4732E-02 .6839E-01
 .3653E-02 .6180E-02 .5516E-02 .4285E-02 .2412E-02 .4197E-02 .3830E-02 .3019E-02
 .1331E-02 .2619E-02 .2670E-02 .2288E-02 .6198E-03 .1380E-02 .1590E-02 .1507E-02
 .2903E-03 .7069E-03 .8982E-03 .9317E-03 .1453E-03 .3753E-03 .5115E-03 .5688E-03
 .7863E-04 .2111E-03 .3022E-03 .3539E-03 .8038E-02 .7181E-02 .5443E-02 .3467E-02
 .5814E-02 .6335E-02 .6206E-02 .5630E-02 .4696E-02 .5175E-02 .5157E-02 .4765E-02
 .3373E-02 .3775E-02 .3853E-02 .3665E-02 .2267E-02 .2578E-02 .2697E-02 .2642E-02
 .1485E-02 .1712E-02 .1831E-02 .1847E-02 .1212E-02 .1203E-02 .1061E-02 .8055E-03
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.         .1478E+00 .9485E-02 .2061E-02 .3153E+00
 .9466E-02 .2022E-02 .3239E-02 .2316E-02 .1141E-02 .4349E-02 .6740E-02 .5980E-02
 .6785E-03 .1662E-02 .2072E-02 .2010E-02 .4603E-02 .4631E-02 .1707E-01 .1335E-01
 .8872E-02 .5434E-02 .9181E-01 .3838E-02 .6592E-03 .1921E-03 .5924E-01 .4225E-02
 .4842E-02 .3005E-01 .7845E-01
 .8315E-02 .1126E-01 .8222E-02 .5516E-02 .4572E-02 .6754E-02 .5269E-02 .3682E-02
 .1790E-02 .3329E-02 .3147E-02 .2519E-02 .6445E-03 .1429E-02 .1614E-02 .1490E-02
 .2598E-03 .6405E-03 .8162E-03 .8424E-03 .1194E-03 .3131E-03 .4311E-03 .4815E-03
 .6146E-04 .1673E-03 .2422E-03 .2859E-03 .1143E-01 .9378E-02 .6507E-02 .3824E-02
 .7930E-02 .7980E-02 .7207E-02 .6074E-02 .5967E-02 .6153E-02 .5729E-02 .4973E-02
 .3960E-02 .4209E-02 .4074E-02 .3687E-02 .2479E-02 .2710E-02 .2724E-02 .2570E-02
 .1534E-02 .1716E-02 .1781E-02 .1746E-02 .1193E-02 .1163E-02 .1005E-02 .7478E-03
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.         .4911E-01 .1401E-01 .3364E-02 .3853E+00
 .2275E-01 .4029E-02 .2257E-01 .7362E-02 .2728E-02 .4059E-02 .6783E-02 .6368E-02
 .7481E-03 .1883E-02 .2397E-02 .2047E-02 .4943E-02 .5181E-02 .1944E-01 .1470E-01
 .9443E-02 .5634E-02 .2815E-01 .5631E-02 .1340E-02 .4413E-03 .5431E-01 .5418E-02
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 .7033E-02 .2022E-01 .8793E-01


 .2465E-01 .2119E-01 .1118E-01 .6150E-02 .9004E-02 .1004E-01 .6275E-02 .3783E-02
 .1959E-02 .3455E-02 .3037E-02 .2272E-02 .5182E-03 .1166E-02 .1309E-02 .1188E-02
 .1816E-03 .4578E-03 .5915E-03 .6130E-03 .7786E-04 .2083E-03 .2916E-03 .3292E-03
 .3862E-04 .106[illegible]E-03 .1570E-03 .1875E-03 .1593E-01 .1161E-01 .7225E-02 .3887E-02
 .1043E-01 .9435E-02 .7741E-02 .6031E-02 .7204E-02 .6827E-02 .5883E-02 .4787E-02
 .4378E-02 .4374E-02 .3994E-02 .3440E-02 .2547E-02 .2664E-02 .2567E-02 .2333E-02
 .1492E-02 .1617E-02 .1627E-02 .1551E-02 .1112E-02 .1061E-02 .8987E-03 .6554E-03
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .2006E-01 .1430E-01 .4515E-02 .1789E+00
 .3694E-01 .6773E-02 .2076E+00 .2161E-01 .5939E-02 .3606E-02 .6494E-02 .6501E-02
 .7877E-03 .2046E-02 .2677E-02 .1977E-02 .5056E-02 .5573E-02 .2067E-01 .1522E-01
 .9559E-02 .5616E-02 .1245E-01 .4448E-02 .1456E-02 .5563E-03 .4375E-01 .6075E-02
 .8730E-02 .1286E-01 .8355E-01
 .1114E+00 .2349E-01 .7968E-02 .3532E-02 .1340E-01 .7829E-02 .3755E-02 .1965E-02
 .9946E-03 .1718E-02 .1441E-02 .1028E-02 .2000E-03 .4628E-03 .5277E-03 .4788E-03
 .6379E-04 .1646E-03 .2176E-03 .2285E-03 .2630E-04 .7142E-04 .1020E-03 .1169E-03
 .1280E-04 .3572E-04 .5332E-04 .6455E-04 .2068E-01 .1294E-01 .7150E-02 .3533E-02
 .1257E-01 .9992E-02 .7408E-02 .5365E-02 .7916E-02 .6803E-02 .5416E-02 .4154E-02
 .4410E-02 .4114E-02 .3547E-02 .2920E-02 .2400E-02 .2395E-02 .2214E-02 .1946E-02
 .1342E-02 .1407E-02 .1374E-02 .1277E-02 .9660E-03 .9027E-03 .7488E-03 .5360E-03
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .9144E-02 .1148E-01 .5132E-02 .5284E-01
 .3811E-01 .9483E-02 .2711E+00 .4822E-01 .1147E-01 .3082E-02 .5951E-02 .6372E-02
 .7921E-03 .2129E-02 .2879E-02 .1823E-02 .4935E-02 .5756E-02 .2039E-01 .1476E-01
 .9188E-C2 .5381E-02 .6446E-02 .3121E-02 .1305E-02 .5747E-03 .3357E-01 .6230E-02
 .9619E-02 .8363E-02 .7262E-01
 .2680E-02 .4845E-02 .4586E-02 .3723E-02 .2754E-02 .4642E-02 .4127E-02 .3195E-02
 .2094E-02 .3751E-02 .3516E-02 .2830E-02 .1102E-02 .2235E-02 .2350E-02 .2066E-02
 .5131E-03 .1168E-02 .1379E-02 .1338E-02 .2445E-03 .6037E-03 .7809E-03 .8246E-03
 .1253E-03 .3263E-03 .4503E-03 .5075E-03 .7142E-02 .6521E-02 .5059E-02 .3294E-02
 .6049E-02 .6587E-02 .6440E-02 .5828E-02 .5556E-02 .6077E-02 .5984E-02 .5450E-02
 .4386E-02 .4855E-02 .4869E-02 .4532E-02 .3112E-02 .3497E-02 .3591E-02 .3439E-02
 .2083E-02 .2376E-02 .2499E-02 .2468E-02 .1699E-02 .1675E-02 .1458E-02 .1086E-02
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .1469E+00 .2757E-01 .6917E-02 .8180E-01
 .2248E-01 .6226E-02 .5302E-02 .5473E-02 .3239E-02 .6726E-02 .9383E-02 .7350E-02
 .9366E-03 .2178E-02 .2543E-02 .3013E-02 .6311E-02 .5675E-02 .1757E-01 .1570E-01
 .1140E-01 .7278E-02 .1324E+00 .2036E-01 .1740E-02 .3773E-03 .6524E-01 .6900E-02
 .5802E-02 .6007E-01 .1288E+00
 .5083E-02 .7839E-02 .6368E-02 .4590E-02 .6340E-02 .8517E-02 .6181E-02 .4126E-02
 .4054E-02 .6169E-02 .4939E-02 .3517E-02 .1554E-02 .2960E-02 .2876E-02 .2350E-02
 .5677E-03 .1278E-02 .1470E-02 .1379E-02 .2335E-03 .5801E-03 .7479E-03 .7810E-03
 .1096E-03 .2883E-03 .3999E-03 .4505E-03 .9873E-02 .8377E-02 .6009E-02 .3635E-02
 .8610E-02 .8611E-02 .7715E-02 .6447E-02 .7734E-02 .7810E-02 .7082E-02 .5981E-02
 .5768E-02 .5969E-02 .5581E-02 .4868E-02 .3814E-02 .4066E-02 .3951E-02 .3589E-02
 .2387E-02 .2616E-02 .2638E-02 .2501E-02 .1830E-02 .1759E-02 .1488E-02 .1078E-02
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .8803E-01 .3569E-C1 .9836E-02 .1173E+00
 .4213E-01 .1049E-01 .1488E-01 .1251E-01 .6271E-02 .6559E-02 .1001E-01 .8257E-02
 .1126E-02 .2683E-02 .3169E-02 .3299E-02 .7315E-02 .6779E-02 .2043E-01 .1811E-01
 .1288E-01 .8014E-02 .4122E-01 .1771E-01 .3475E-02 .9246E-03 .6157E-01 .9332E-02
 .8864E-02 .3810E-01 .1455E+00
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 .1051E-01 .1213E-01 .7841E-02 .4850E-02 .1950E-01 .1639E-01 .8518E-02 .4642E-02


 .8535E-02 .9738E-02 .6170E-02 .3752E-02 .1852E-02 .3320E-02 .2961E-02 .2236E-02
 .4987E-03 .1129E-02 .1278E-02 .1168E-02 .1770E-03 .4471E-03 .5802E-03 .6038E-03
 .7683E-04 .2054E-03 .2883E-03 .3265E-03 .1332E-01 .1021E-01 .6652E-02 .3711E-02
 .1204E-01 .1070E-01 .8610E-02 .6593E-02 .1052E-01 .9519E-02 .7809E-02 .6073E-02
 .7323E-02 .6935E-02 .5969E-02 .4854E-02 .4466E-02 .4457E-02 .4066E-02 .3495E-02
 .2601E-02 .2718E-02 .2616E-02 .2378E-02 .1873E-02 .1748E-02 .1434E-02 .1008E-02
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0.         0.         0.         0.          .4347E-01 .3479E-01 .1218E-01 .9362E-01
 .5887E-01 .1574E-01 .3213E-01 .2577E-01 .1139E-01 .5941E-02 .9980E-02 .8828E-02
 .1282E-02 .3161E-02 .3817E-02 .3358E-02 .7982E-02 .7762E-02 .2222E-01 .1962E-01
 .1377E-01 .8445E-02 .1685E-01 .1026E-01 .3415E-02 .1156E-02 .5002E-01 .1077E-01
 .1146E-01 .2253E-01 .1360E+00
 .1773E-01 .1051E-01 .5081E-02 .2681E-02 .1009E+00 .1951E-01 .6342E-02 .2754E-02
 .1304E-01 .8540E-02 .4055E-02 .2095E-02 .1062E-02 .1854E-02 .1555E-02 .1102E-02
 .2151E-03 .4989E-03 .5681E-03 .5134E-03 .6850E-04 .1770E-03 .2336E-03 .2447E-03
 .2826E-04 .7681E-04 .1095E-03 .1254E-03 .1675E-01 .1128E-01 .6610E-02 .3405E-02
 .1578E-01 .1204E-01 .8608E-02 .6054E-02 .1335E-01 .1052E-01 .7733E-02 .5551E-02
 .8611E-02 .7322E-02 .5768E-02 .4384E-02 .4829E-02 .4466E-02 .3813E-02 .3109E-02
 .2624E-02 .2601E-02 .2387E-02 .2084E-02 .1786E-02 .1613E-02 .1281E-02 .8742E-03
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         C.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .2139E-01 .2770E-01 .1319E-01 .5185E-01
 .5943E-01 .2046E-01 .4128E-01 .4203E-01 .1858E-01 .5066E-02 .9346E-02 .8962E-02
 .1371E-02 .3527E-02 .4404E-02 .3185E-02 .8164E-02 .8461E-02 .2239E-01 .1977E-01
 .1385E-01 .8475E-02 .8283E-02 .6006E-02 .2759E-02 .1155E-02 .3847E-01 .1115E-01
 .1301E-C1 .1378E-01 .1156E+00
 .1477E-02 .2989E-02 .3140E-02 .2765E-02 .2238E-02 .3953E-02 .3659E-02 .2916E-02
 .2748E-02 .4632E-02 .4121E-02 .3192E-02 .2019E-02 .3645E-02 .3440E-02 .2783E-02
 .1045E-02 .2140E-02 .2269E-02 .2010E-02 .4861E-03 .1114E-02 .1325E-02 .1295E-02
 .2335E-03 .5788E-03 .7528E-03 .7995E-03 .5540E-02 .5184E-02 .4149E-02 .2793E-02
 .5556E-02 .6078E-02 .5984E-02 .5459E-02 .6048E-02 .6586E-02 .6440E-02 .5818E-02
 .5555E-02 .6077E-02 .5984E-02 .5452E-02 .4386E-02 .4855E-02 .4869E-02 .4530E-02
 .3112E-02 .3497E-02 .3591E-02 .3444E-02 .2592E-02 .2523E-02 .2148E-02 .1556E-02
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .6202E-01 .3008E-01 .1044E-01 .2606E-01
 .2121E-01 .8688E-02 .3859E-02 .5658E-02 .4213E-02 .1251E-01 .1442E-01 .9228E-02
 .1457E-02 .3092E-02 .3246E-02 .5388E-02 .9589E-02 .7171E-02 .1634E-01 .1743E-01
 .1466E-01 .1020E-01 .3324E-01 .1260E+00 .8818E-02 .1120E-02 .4204E-01 .1362E-01
 .6786E-02 .8810E-01 .1097E+00
 .2104E-02 .3975E-02 .3846E-02 .3143E-02 .4510E-02 .6671E-02 .5218E-02 .3658E-02
 .6314E-02 .8489E-02 .6167E-02 .4121E-02 .3827E-02 .5914E-02 .4793E-02 .3441E-02
 .1444E-02 .2792E-02 .2749E-02 .2270E-02 .5308E-03 .1206E-02 .1400E-02 .1325E-02
 .2212E-03 .5521E-03 .7163E-03 .7532E-03 .7218E-02 .6366E-02 .4776E-02 .3021E-02
 .7734E-02 .7810E-02 .7082E-02 .5990E-02 .8609E-02 .8610E-02 .7715E-02 .6436E-02
 .7733E-02 .7810E-02 .7082E-02 .5983E-02 .5768E-02 .5969E-02 .5581E-02 .4866E-02
 .3814E-02 .4066E-02 .3951E-02 .3595E-02 .2948E-02 .2775E-02 .2276E-02 .1587E-02
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
0.         0.         0.         0.          .4980E-01 .3503E-01 .1331E-01 .3378E-01
 .3166E-01 .1266E-01 .6850E-02 .9769E-02 .6799E-02 .1191E-01 .1565E-01 .1068E-01
 .1876E-02 .4083E-02 .4300E-02 .6090E-02 .1169E-01 .8988E-02 .1892E-01 .2030E-01
 .1686E-01 .1145E-01 .2329E-01 .3943E-01 .1142E-01 .2408E-02 .4470E-01 .1771E-01
 .1043E-01 .5398E-01 .2049E+00
 .2578E-02 .4516E-02 .3976E-02 .2991E-02 .1035E-01 .1102E-01 .6672E-02 .3952E-02
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.1935E-01	.1630E-01	.8490E-02	.4634E-02	.7705E-02	.9115E-02	.5915E-02	.3646E-02
.1672E-02	.3066E-02	.2792E-02	.2141E-02	.4597E-03	.1052E-02	.1206E-02	.1114E-02
.1664E-03	.4225E-03	.5522E-03	.5792E-03	.9068E-02	.7388E-02	.5130E-02	.3031E-02
.1052E-01	.9520E-02	.7810E-02	.6083E-02	.1204E-01	.1070E-01	.8610E-02	.6582E-02
.1052E-01	.9519E-02	.7809E-02	.6076E-02	.7323E-02	.6934E-02	.5969E-02	.4852E-02
.4466E-02	.4457E-02	.4066E-02	.3501E-02	.3188E-02	.2880E-02	.2264E-02	.1517E-02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	.3223E-01	.3355E-01	.1529E-01	.3191E-01
.3914E-01	.1695E-01	.1028E-01	.1537E-01	.1041E-01	.1018E-01	.1546E-01	.1159E-01
.2235E-02	.5080E-02	.5461E-02	.6163E-02	.1308E-01	.1066E-01	.2050E-01	.2207E-01
.1819E-01	.1219E-01	.1225E-01	.1638E-01	.7884E-02	.2562E-02	.3957E-01	.1925E-01
.1348E-01	.3033E-01	.1820E+00					
.1544E-02	.2579E-02	.2104E-02	.1477E-02	.2242E-01	.1036E-01	.4513E-02	.2239E-02
.9807E-01	.1934E-01	.6313E-02	.2748E-02	.1041E-01	.7710E-02	.3828E-02	.2020E-02
.9277E-03	.1673E-02	.1445E-02	.1046E-02	.1961E-03	.4600E-03	.5312E-03	.4864E-03
.6411E-04	.1664E-03	.2212E-03	.2336E-03	.1055E-01	.7796E-02	.4974E-02	.2750E-02
.1335E-01	.1052E-01	.7733E-02	.5561E-02	.1578E-01	.1204E-01	.8608E-02	.6044E-02
.1335E-01	.1052E-01	.7733E-02	.5554E-02	.8611E-02	.7322E-02	.5767E-02	.4383E-02
.4829E-02	.4466E-02	.3813E-02	.3114E-02	.3195E-02	.2753E-02	.2071E-02	.1335E-02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	.1914E-01	.2758E-01	.1582E-01	.2360E-01
.3944E-01	.2038E-01	.1213E-01	.2074E-01	.1464E-01	.8065E-02	.1404E-01	.1178E-01
.2434E-02	.5871E-02	.6571E-02	.5633E-02	.1336E-01	.1188E-01	.2063E-01	.2224E-01
.1831E-01	.1224E-01	.6779E-02	.8131E-02	.5046E-02	.2210E-02	.3222E-01	.1866E-01
.1523E-01	.1764E-01	.1479E+00					
.7294E-C3	.1643E-02	.1324E-02	.1855E-02	.1284E-02	.2536E-02	.2597E-02	.2236E-02
.2308E-02	.4047E-02	.3724E-02	.2957E-02	.2733E-02	.4613E-02	.4108E-02	.3185E-02
.1944E-02	.3538E-02	.3363E-02	.2735E-02	.9914E-03	.2048E-02	.2191E-02	.1954E-02
.4622E-03	.1066E-02	.1278E-02	.1257E-02	.3893E-02	.3724E-02	.3075E-02	.2147E-02
.4386E-02	.4856E-02	.4869E-02	.4538E-02	.5556E-02	.6077E-02	.5984E-02	.5450E-02
.6048E-02	.6586E-02	.6440E-02	.5821E-02	.5555E-02	.6077E-02	.5984E-02	.5450E-02
.4386E-02	.4855E-02	.4869E-02	.4537E-02	.3887E-02	.3718E-02	.3081E-02	.2157E-02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	.2618E-01	.2198E-01	.1072E-01	.1085E-01
.1469E-01	.8503E-02	.2363E-02	.4354E-02	.3947E-02	.2624E-01	.2199E-01	.1070E-01
.2365E-02	.4354E-02	.3943E-02	.1092E-01	.1473E-01	.8509E-02	.1351E-01	.1703E-01
.1704E-01	.1352E-01	.4635E-02	.8027E-01	.8111E-01	.4676E-02	.2020E-01	.2867E-01
.7134E-02	.9542E-01	.2101E+00					
.8241E-03	.1827E-02	.2072E-02	.1925E-02	.1932E-02	.3519E-02	.3279E-02	.2596E-02
.4739E-02	.6912E-02	.5350E-02	.3725E-02	.6257E-02	.8435E-02	.6140E-02	.4108E-02
.3604E-02	.5658E-02	.4644E-02	.3363E-02	.1342E-02	.2632E-02	.2626E-02	.2191E-02
.4984E-03	.1141E-02	.1338E-02	.1278E-02	.4728E-02	.4323E-02	.3396E-02	.2257E-02
.5769E-02	.5970E-02	.5581E-02	.4874E-02	.7734E-02	.7810E-02	.7082E-02	.5981E-02
.8609E-02	.8610E-02	.7715E-02	.6439E-02	.7733E-02	.7809E-02	.7081E-02	.5981E-02
.5768E-02	.5969E-02	.5581E-02	.4873E-02	.4722E-02	.4317E-02	.3403E-02	.2268E-02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	.2364E-01	.2448E-01	.1291E-01	.1288E-01
.1930E-01	.1134E-01	.3399E-02	.6367E-02	.5668E-02	.2367E-01	.2447E-01	.1288E-01
.3407E-02	.6375E-02	.5669E-02	.1297E-01	.1938E-01	.1136E-01	.1543E-01	.1977E-01
.1979E-01	.1545E-01	.7391E-02	.3220E-01	.3235E-01	.7438E-02	.2450E-01	.3435E-01
.1097E-01	.5884E-01	.2250E+00					
.7434E-03	.1648E-02	.1828E-02	.1645E-02	.2542E-02	.4221E-02	.3520E-02	.2536E-02
.1133E-01	.1166E-01	.6913E-02	.4048E-02	.1902E-01	.1613E-01	.8436E-02	.4614E-02

.6936E-02	.8510E-02	.5659E-02	.3539E-02	.1510E-02	.2831E-02	.2632E-02	.2049E-02
.4259E-03	.9836E-03	.1142E-02	.1067E-02	.5485E-02	.4733E-02	.3509E-02	.2211E-02
.7324E-02	.6935E-02	.5969E-02	.4860E-02	.1052E-01	.9519E-02	.7809E-02	.6073E-02
.1204E-01	.1070E-01	.8610E-02	.6585E-02	.1052E-01	.9519E-02	.7809E-02	.6073E-02
.7323E-02	.6934E-02	.5968E-02	.4859E-02	.5477E-02	.4727E-02	.3516E-02	.2222E-02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	.1830E-01	.2383E-01	.1431E-01	.1281E-01
.2241E-01	.1413E-01	.4377E-02	.8635E-02	.7763E-02	.1829E-01	.2381E-01	.1427E-01
.4392E-02	.8656E-02	.7773E-02	.1290E-01	.2253E-01	.1416E-01	.1658E-01	.2147E-01
.2149E-01	.1661E-01	.5918E-02	.1465E-01	.1469E-01	.5944E-02	.2453E-01	.3394E-01
.1418E-01	.3294E-01	.1977E+00					
.3284E-03	.7433E-03	.8241E-03	.7298E-03	.1634E-02	.2545E-02	.1934E-02	.1285E-02
.2886E-01	.1134E-01	.4739E-02	.2309E-02	.9352E-01	.1901E-01	.6256E-02	.2733E-02
.8394E-02	.6941E-02	.3606E-02	.1945E-02	.8139E-03	.1511E-02	.1343E-02	.9920E-03
.1798E-03	.4259E-03	.4985E-03	.4625E-03	.5878E-02	.4738E-02	.3301E-02	.1976E-02
.8612E-02	.7323E-02	.5768E-02	.4390E-02	.1335E-01	.1052E-01	.7733E-02	.5551E-02
.1578E-01	.1204E-01	.8608E-02	.6046E-02	.1335E-01	.1052E-01	.7732E-02	.5551E-02
.8611E-02	.7322E-02	.5767E-02	.4389E-02	.5870E-02	.4732E-02	.3308E-02	.1985E-02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	C.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	.1292E-01	.2071E-01	.1461E-01	.1092E-01
.2279E-01	.1622E-01	.4907E-02	.1055E-01	.9932E-02	.1289E-01	.2067E-01	.1456E-01
.4927E-02	.1059E-01	.9953E-02	.1099E-01	.2291E-01	.1627E-01	.1667E-01	.2163E-01
.2165E-01	.1670E-01	.4137E-02	.7585E-02	.7600E-02	.4150E-02	.2201E-01	.3010E-01
.1600E-01	.1899E-01	.1588E+00					
.3645E-03	.8893E-03	.1136E-02	.1187E-02	.6373E-03	.1409E-02	.1614E-02	.1524E-02
.1350E-C2	.2641E-02	.2C81E-02	.2293E-02	.2374E-02	.4137E-02	.3786E-02	.2994E-02
.2711E-02	.4584E-02	.4089E-02	.3174E-02	.1868E-02	.3428E-02	.3283E-02	.2684E-02
.9433E-03	.1965E-02	.2121E-02	.1906E-02	.2596E-02	.2526E-02	.2144E-02	.1549E-02
.3112E-02	.3498E-02	.3592E-02	.3444E-02	.4386E-02	.4855E-02	.4869E-02	.4531E-02
.5555E-02	.6077E-02	.5984E-02	.5452E-02	.6048E-02	.6586E-02	.6440E-02	.5818E-02
.5555E-02	.6077E-02	.5984E-02	.5458E-02	.5532E-02	.5176E-02	.4157E-02	.2806E-02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	.1248E-01	.1440E-01	.9230E-02	.5361E-02
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.1744E-01	.1635E-01	.1113E-02	.8714E-02	.1255E+00	.3385E-01	.9627E-02	.5845E-01
.6703E-02	.8598E-01	.1794E+00					
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.2077E-02	.3723E-02	.3421E-02	.2681E-02	.4961E-02	.7144E-02	.5474E-02	.3787E-02
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.7733E-02	.7810E-02	.7082E-02	.5983E-02	.8608E-02	.8609E-02	.7714E-02	.6436E-02
.7733E-02	.7809E-02	.7081E-02	.5990E-02	.7208E-02	.6357E-02	.4786E-02	.3036E-02
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0.	0.	0.	0.	0.	0.	0.	0.
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.6868E-02	.9775E-02	.6793E-02	.3408E-01	.3179E-01	.1267E-01	.1143E-01	.1683E-01
.2030E-01	.1893E-01	.2395E-02	.1133E-01	.3936E-01	.2342E-01	.1261E-01	.6123E-01
.1030E-01	.5267E-01	.1947E+00					
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.1907E-02	.2835E-02	.2078E-02	.1351E-02	.3586E-01	.1233E-01	.4961E-02	.2374E-02
.8789E-01	.1854E-01	.6173E-02	.2711E-02	.6828E-02	.6235E-02	.3389E-02	.1869E-02
.7190E-03	.1372E-02	.1253E-02	.9440E-03	.3199E-02	.2757E-02	.2067E-02	.1328E-02
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.2224E-01	.2065E-01	.2203E-02	.5028E-02	.8128E-02	.6792E-02	.1353E-01	.4323E-01
.1504E-01	.1731E-01	.1425E+00					
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.6732E-03	.1477E-02	.1678E-02	.1574E-02	.1417E-02	.2747E-02	.2765E-02	.2350E-02
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.1799E-02	.3328E-02	.3212E-02	.2643E-02	.1701E-02	.1677E-02	.1455E-02	.1081E-02
.2083E-02	.2377E-02	.2499E-02	.2468E-02	.3112E-02	.3498E-02	.3592E-02	.3439E-02
.4386E-02	.4855E-02	.4869E-02	.4532E-02	.5555E-02	.6077E-02	.5984E-02	.5450E-02
.6048E-02	.6586E-02	.6440E-02	.5827E-02	.7131E-02	.6510E-02	.5068E-02	.3310E-02
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.6290E-02	.5664E-02	.9354E-03	.2176E-02	.2542E-02	.1470E+00	.2735E-01	.6851E-02
.5281E-02	.5440E-02	.3216E-02	.8273E-01	.2241E-01	.6189E-02	.7262E-02	.1138E-01
.1569E-01	.1757E-01	.3754E-03	.1726E-02	.2003E-01	.1326E+00	.4919E-02	.8525E-01
.5667E-02	.5621E-01	.1145E+00					
.1714E-03	.4458E-03	.6095E-03	.6767E-03	.3145E-03	.7594E-03	.9456E-03	.9544E-03
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.1491E-01	.1249E-01	.6248E-02	.1187E+00	.4215E-01	.1045E-01	.7996E-02	.1285E-01
.1810E-01	.2043E-01	.9204E-03	.3452E-02	.1760E-01	.4123E-01	.6675E-02	.8038E-01
.8652E-02	.3597E-01	.1314E+00					
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.7649E-03	.1626E-02	.1717E-02	.1477E-02	.3159E-02	.4949E-02	.3936E-02	.2748E-02
.1334E-01	.1292E-01	.7367E-02	.4223E-02	.1793E-01	.1555E-01	.8250E-02	.4547E-02
.5604E-02	.7391E-02	.5168E-02	.3331E-02	.1876E-02	.1750E-02	.1431E-02	.1003E-02

.2602E-02	.2719E-02	.2616E-02	.2379E-02	.4467E-02	.4458E-02	.4066E-02	.3495E-02
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.1204E-01	.1070E-01	.8609E-02	.6592E-02	.1330E-01	.1019E-01	.6665E-02	.3728E-02
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0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
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.3233E-01	.2580E-01	.1137E-01	.9448E-01	.5903E-01	.1572E-01	.8425E-02	.1374E-01
.1960E-01	.2221E-01	.1151E-02	.3396E-02	.1022E-01	.1685E-01	.7742E-02	.6528E-01
.1119E-01	.2150E-01	.1249E+00					
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[illegible]	.7652E-03	.8020E-03	.6737E-03	.2235E-02	.3162E-02	.2232E-02	.1418E-02
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0.	0.	0.	0.	0.	0.	0.	0.
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.1272E-01	.1327E-01	.1076E+00					
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.3774E-03	.8937E-03	.1101E-02	.1108E-02	.8164E-03	.1746E-02	.1930E-02	.1766E-02
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.6843E-02	.1875E-01	.7769E-01					
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.2561E-03	.6256E-03	.7763E-03	.7725E-03	.8004E-03	.1686E-02	.1763E-02	.1504E-02
.3362E-02	.5156E-02	.4034E-02	.2789E-02	.1385E-01	.1321E-01	.7452E-02	.4244E-02
.1804E-01	.1555E-01	.8233E-02	.4535E-02	.1114E-02	.1063E-02	.8973E-03	.6525E-03
.1493E-02	.1618E-02	.1628E-02	.1552E-02	.2549E-02	.2666E-02	.2568E-02	.2334E-02

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 .1257E-01 .9993E-02 .7408E-02 .5365E-02 .2065E-01 .1291E-01 .7162E-02 .3549E-02
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 .2252E-02 .2127E-02 .1935E-02 .1704E-02 .2349E-02 .1679E-02 .9637E-03 .4146E-03
 .4535E-02 .4186E-02 .3381E-02 .2377E-02 .5438E-02 .5255E-02 .4574E-02 .3588E-02
 .5021E-02 .4920E-02 .4436E-02 .3685E-02 .4057E-02 .3990E-02 .3676E-02 .3173E-02
 .3084E-02 .3036E-02 .2838E-02 .2525E-02 .2915E-02 .2414E-02 .1828E-02 .1208E-02
 .2974E-01 .1407E-01 .7461E-02 .4186E-02 .5048E-01 .3025E-01 .1494E-01 .7352E-02
 .2132E-01 .1711E-01 .1108E-01 .6580E-02 .8998E-02 .8124E-02 .6290E-02 .4440E-02
 .4290E-02 .4087E-02 .3499E-02 .2774E-02 .2307E-02 .2252E-02 .2041E-02 .1742E-02
 .8788E-03 .1165E-02 .1339E-02 .1409E-020.         0.         0.         0.
0.         0.         0.         0.         0.          .1832E-01 .1583E-01 .9994E-02
 .7858E-02 .7040E-02 .5727E-02 .1553E-01 .1378E-01 .9229E-02 .3926E-02 .8119E-02
 .7560E-02 .5578E-02 .1410E+00 .2721E-01 .8036E-02 .3229E-02 .8095E-01 .3570E-02
 .1594E-02 .3066E-01 .6370E-01
 .6321E-02 .7582E-02 .7582E-02 .6321E-02 .1115E-01 .1323E-01 .1323E-01 .1115E-01
 .1073E-01 .1231E-01 .1231E-01 .1073E-01 .7740E-02 .8573E-02 .8573E-02 .7740E-02
 .5070E-02 .5464E-02 .5464E-02 .5070E-02 .3284E-02 .3471E-02 .3471E-02 .3284E-02
 .2181E-02 .2273E-02 .2273E-02 .2181E-02 .5147E-02 .5209E-02 .3931E-02 .1869E-02
 .9329E-02 .1172E-01 .1202E-01 .9282E-02 .9286E-02 .1130E-01 .1180E-01 .101[illegible]-01
 .6975E-02 .8026E-02 .8242E-02 .7402E-02 .4732E-02 .5208E-02 .5269E-02 .4849E-02
 .3148E-02 .3360E-02 .3367E-02 .3155E-02 .2665E-02 .2362E-02 .1906E-02 .1333E-02
 .1870E-02 .3931E-02 .5209E-02 .5147E-02 .9283E-02 .1202E-01 .1172E-01 .9329E-02
 .1013E-01 .1179E-01 .1130E-01 .9286E-02 .7401E-02 .8242E-02 .8026E-02 .6975E-02
 .4849E-02 .5268E-02 .5207E-02 .4731E-02 .3155E-02 .3366E-02 .3359E-02 .3148E-02
 .1334E-02 .1907E-02 .2362E-02 .2665E-020.         0.         0.         0.
0.         0.         0.         0.         0.          .1551E-01 .1869E-01 .1551E-01
 .7467E-02 .7912E-02 .7467E-02 .1347E-01 .1589E-01 .1347E-01 .1647E-01 .2055E-01
 .1186E-01 .6406E-02 .1647E-01 .2055E-01 .1186E-01 .6406E-02 .1099E+00 .4277E-02
 .6714E-02 .6714E-02 .1016E+00
 .2425E-02 .3775E-02 .5504E-02 .7107E-02 .4534E-02 .6914E-02 .9855E-02 .1248E-01
 .5122E-02 .7308E-02 .9766E-02 .1179E-01 .4393E-02 .5809E-02 .7244E-02 .8326E-02
 .3314E-02 .4105E-02 .4840E-02 .5357E-02 .2381E-02 .2807E-02 .3176E-02 .3423E-02
 .1704E-02 .1935E-02 .2127E-02 .2252E-02 .4186E-02 .7461E-02 .1407E-01 .2970E-01
 .7352E-02 .1494E-01 .3026E-01 .5047E-01 .6580E-02 .1108E-01 .1712E-01 .2132E-01
 .4440E-02 .6290E-02 .8124E-02 .8999E-02 .2774E-02 .3499E-02 .4087E-02 .4291E-02
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 .1742E-02 .2041E-02 .2252E-02 .2307E-02 .1409E-02 .1339E-02 .1164E-02 .8779E-03


 .4147E-03 .9637E-03 .1679E-02 .2349E-02 .2377E-02 .3381E-02 .4186E-02 .4535E-02
 .3587E-02 .4574E-02 .5255E-02 .5438E-02 .3684E-02 .4436E-02 .4920E-02 .5021E-02
 .3172E-02 .3675E-02 .3990E-02 .4056E-02 .2525E-02 .2838E-02 .3036E-02 .3083E-02
 .1209E-02 .1829E-02 .2415E-02 .2914E-020.         0.         0.         0.
0.         0.         0.         0.         0.          .9995E-02 .1583E-01 .1832E-01
 .5728E-02 .7041E-02 .7859E-02 .9230E-02 .1379E-01 .1553E-01 .1410E+00 .2721E-01
 .8037E-02 .3229E-02 .3926E-02 .8120E-02 .7560E-02 .5578E-02 .8096E-01 .3571E-02
 .3066E-01 .1594E-02 .6371E-01
 .2749E-01 .1687E-01 .8134E-02 .3795E-02 .2621E-01 .1816E-01 .1043E-01 .5604E-02
 .1428E-01 .1120E-01 .7689E-02 .4908E-02 .7227E-02 .6154E-02 .4773E-02 .3473E-02
 .3877E-02 .3474E-02 .2910E-02 .2315E-02 .2246E-02 .2077E-02 .1827E-02 .1543E-02
 .1399E-02 .1320E-02 .1200E-02 .1055E-02 .4066E-02 .2359E-02 .1081E-02 .3811E-03
 .6587E-02 .5066E-02 .3376E-02 .2004E-02 .6560E-02 .5457E-02 .4077E-02 .2797E-02
 .5221E-02 .4549E-02 .3651E-02 .2738E-02 .3810E-02 .3423E-02 .2887E-02 .2305E-02
 .2715E-02 .2491E-02 .2177E-02 .1823E-02 .2457E-02 .1933E-02 .1390E-02 .8750E-03
 .5944E-01 .1034E+00 .6230E-01 .2266E-01 .2634E-01 .3777E-01 .3014E-01 .1669E-01
 .8389E-02 .1087E-01 .1027E-01 .7599E-02 .3493E-02 .4147E-02 .4125E-02 .3516E-02
 .1726E-02 .1950E-02 .1973E-02 .1803E-02 .9659E-03 .1057E-02 .1076E-02 .1020E-02
 .3797E-03 .5485E-03 .6850E-03 .7773E-030.         0.         0.         0.
0.         0.         0.         0.         0.          .1453E-01 .1287E-01 .8639E-02
 .8424E-02 .7594E-02 .6245E-02 .1450E-01 .1305E-01 .9068E-02 .3522E-02 .6966E-02
 .6491E-02 .4910E-02 .4014E-01 .1916E-01 .7761E-02 .3694E-02 .1151E-01 .6751E-02
 .3161E-02 .1607E-01 .5994E-01
 .1945E-01 .2899E-01 .2899E-01 .1945E-01 .2075E-01 .2771E-01 .2771E-01 .2075E-01
 .1242E-01 .1494E-01 .1494E-01 .1242E-01 .6632E-02 .7471E-02 .7471E-02 .6632E-02
 .3665E-02 .3971E-02 .3971E-02 .3665E-02 .2160E-02 .2287E-02 .2287E-02 .2160E-02
 .1361E-02 .1419E-02 .1419E-02 .1361E-02 .1600E-01 .1260E-01 .5979E-02 .1747E-02
 .1873E-01 .1856E-01 .1328E-01 .7085E-02 .1243E-01 .1234E-01 .9982E-02 .6686E-02
 .7185E-02 .7066E-02 .6085E-02 .4630E-02 .4191E-02 .4104E-02 .3671E-02 .3013E-02
 .2562E-02 .2506E-02 .2297E-02 .1983E-02 .2061E-02 .1716E-02 .1297E-02 .8509E-03
 .1747E-02 .5979E-02 .1260E-01 .1600E-01 .7086E-02 .1328E-01 .1856E-01 .1873E-01
 .6685E-02 .9982E-02 .1234E-01 .1243E-01 .4629E-02 .6084E-02 .7065E-02 .7185E-02
 .3013E-02 .3670E-02 .4103E-02 .4191E-02 .1983E-02 .2297E-02 .2505E-02 .2562E-02
 .8518E-03 .1298E-02 .1716E-02 .2061E-020.         0.         0.         0.
0.         0.         0.         0.         0.          .1261E-01 .1483E-01 .1261E-01
 .8005E-02 .8454E-02 .8005E-02 .1275E-01 .1480E-01 .1275E-01 .1145E-01 .1490E-01
 .9512E-02 .5603E-02 .1145E-01 .1490E-01 .9512E-02 .5603E-02 .1751E-01 .7723E-02
 .8356E-02 .8356E-02 .8256E-01
 .3795E-02 .8134E-02 .1687E-01 .2749E-01 .5604E-02 .1043E-01 .1816E-01 .2621E-01
 .4908E-02 .7689E-02 .1120E-01 .1428E-01 .3473E-02 .4773E-02 .6154E-02 .7227E-02
 .2315E-02 .2910E-02 .3474E-02 .3877E-02 .1543E-02 .1827E-02 .2077E-02 .2246E-02
 .1055E-02 .1200E-02 .1320E-02 .1399E-02 .2266E-01 .6230E-01 .1034E+00 .5942E-01
 .1669E-01 .3014E-01 .3777E-01 .2633E-01 .7599E-02 .1027E-01 .1088E-01 .8391E-02
 .3516E-02 .4125E-02 .4147E-02 .3494E-02 .1803E-02 .1973E-02 .1950E-02 .1726E-02
 .1020E-02 .1076E-02 .1057E-02 .9659E-03 .7774E-03 .6850E-03 .5482E-03 .3793E-03
 .3812E-03 .1081E-02 .2359E-02 .4067E-02 .2005E-02 .3376E-02 .5066E-02 .6587E-02
 .2797E-02 .4077E-02 .5457E-02 .6560E-02 .2738E-02 .3650E-02 .4549E-02 .5221E-02
 .2305E-02 .2887E-02 .3423E-02 .3810E-02 .1823E-02 .2177E-02 .2491E-02 .2714E-02
 .8759E-03 .1390E-02 .1933E-02 .2456E-020.         0.         0.         0.
0.         0.         0.         0.         0.          .8638E-02 .1287E-01 .1453E-01
 .6244E-02 .7593E-02 .8423E-02 .9067E-02 .1305E-01 .1450E-01 .4019E-01 .1915E-01
 .7760E-02 .3694E-02 .3521E-02 .6965E-02 .6491E-02 .4909E-02 .1151E-01 .6750E-02
 .1607E-01 .3160E-02 .5993E-01
 .2000E+00 .8482E-01 .1429E-01 .4069E-02 .2350E-01 .1664E-01 .8557E-02 .3986E-02
 .6834E-02 .5729E-02 .4015E-02 .2535E-02 .2702E-02 .2441E-02 .1975E-02 .1473E-02
 .1310E-02 .1228E-02 .1070E-02 .8774E-03 .7272E-03 .6957E-03 .6318E-03 .5485E-03
 .4452E-03 .4309E-03 .4015E-03 .3616E-03 .6825E-02 .2872E-02 .1016E-02 .2986E-03
 .8306E-02 .5089E-02 .2803E-02 .1447E-02 .6545E-02 .4653E-02 .3039E-02 .1883E-02
 .4439E-02 .3470E-02 .2533E-02 .1764E-02 .2931E-02 .2437E-02 .1920E-02 .1451E-02
 .1964E-02 .1703E-02 .1415E-02 .1136E-02 .1708E-02 .1291E-02 .8939E-03 .5444E-03
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 .8475E-03 .8408E-02 .1004E+00 .1614E+00 .2369E-02 .6649E-02 .1436E-01 .1845E-01


 .1724E-02 .3062E-02 .4596E-02 .5420E-02 .1056E-02 .1519E-02 .1956E-02 .2193E-02
 .6503E-03 .8365E-03 .9959E-03 .1084E-02 .4181E-03 .5023E-03 .5714E-03 .6109E-03
 .1784E-03 .2790E-03 .3797E-03 .4697E-030.        0.        0.        0.
0.        0.        0.        0.        0.        .1024E-01 .9930E-02 .7461E-02
 .7980E-02 .7546E-02 .6523E-02 .1174E-01 .1142E-01 .8701E-02 .2994E-02 .5714E-02
 .5306E-02 .4073E-02 .8007E-02 .9539E-02 .6059E-02 .3658E-02 .4344E-02 .6964E-02
 .3585E-02 .7626E-02 .4056E-01
 .3959E-01 .1657E+00 .1657E+00 .3959E-01 .1463E-01 .2270E-01 .2270E-01 .1463E-01
 .5408E-02 .6735E-02 .6735E-02 .5408E-02 .2364E-02 .2682E-02 .2682E-02 .2364E-02
 .1204E-02 .1305E-02 .1305E-02 .1204E-02 .6865E-03 .7255E-03 .7255E-03 .6865E-03
 .4271E-03 .4444E-03 .4444E-03 .4271E-03 .2882E-01 .1050E-01 .2754E-02 .6084E-03
 .1887E-01 .1157E-01 .5616E-02 .2456E-02 .9308E-02 .6899E-02 .4385E-02 .2540E-02
 .4736E-02 .3876E-02 .2858E-02 .1954E-02 .2628E-02 .2275E-02 .1830E-02 .1387E-02
 .1579E-02 .1416E-02 .1202E-02 .9764E-03 .1268E-02 .9905E-03 .7048E-03 .4383E-03
 .6086E-03 .2754E-02 .1050E-01 .2882E-01 .2457E-02 .5615E-02 .1157E-01 .1887E-01
 .2539E-02 .4385E-02 .6898E-02 .9308E-02 .1954E-02 .2857E-02 .3876E-02 .4736E-02
 .1387E-02 .1830E-02 .2275E-02 .2627E-02 .9765E-03 .1202E-02 .1416E-02 .1579E-02
 .4388E-03 .7052E-03 .9905E-03 .1268E-020.        0.        0.        0.
0.        0.        0.        0.        0.        .9178E-02 .1053E-01 .9178E-02
 .7551E-02 .7930E-02 .7551E-02 .1059E-01 .1206E-01 .1059E-01 .5243E-02 .8185E-02
 .6312E-02 .4257E-02 .5243E-02 .8185E-02 .6312E-02 .4257E-02 .5036E-02 .7359E-02
 .5623E-02 .5623E-02 .4523E-01
 .4069E-02 .1429E-01 .8482E-01 .2000E+00 .3986E-02 .8557E-02 .1664E-01 .2350E-01
 .2535E-02 .4015E-02 .5729E-02 .6834E-02 .1473E-02 .1975E-02 .2441E-02 .2702E-02
 .8774E-03 .1070E-02 .1228E-02 .1310E-02 .5485E-03 .6318E-03 .6957E-03 .7272E-03
 .3616E-03 .4015E-03 .4309E-03 .4452E-03 .1614E+00 .1004E+00 .8408E-02 .8472E-03
 .1845E-01 .1436E-01 .6649E-02 .2369E-02 .5420E-02 .4596E-02 .3062E-02 .1725E-02
 .2193E-02 .1956E-02 .1519E-02 .1056E-02 .1084E-02 .9960E-03 .8366E-03 .6504E-03
 .6110E-C3 .5715E-03 .5023E-03 .4180E-03 .4698E-03 .3797E-03 .2788E-03 .1782E-03
 .2987E-03 .1016E-02 .2872E-02 .6825E-02 .1448E-02 .2803E-02 .5089E-02 .8306E-02
 .1883E-02 .3039E-02 .4653E-02 .6545E-02 .1764E-02 .2533E-02 .3469E-02 .4439E-02
 .1451E-02 .1920E-02 .2437E-02 .2930E-02 .1136E-02 .1415E-02 .1703E-02 .1964E-02
 .5449E-03 .8944E-03 .1291E-02 .1708E-020.        0.        0.        0.
0.        0.        0.        0.        0.        .7462E-02 .9931E-02 .1024E-01
 .6524E-02 .7547E-02 .7980E-02 .8701E-02 .1142E-01 .1174E-01 .8008E-02 .9539E-02
 .6059E-02 .3658E-02 .2994E-02 .5715E-02 .5306E-02 .4073E-02 .4345E-02 .6965E-02
 .7626E-02 .3585E-02 .4056E-01
 .3296E-02 .3102E-02 .2806E-02 .2454E-02 .4005E-02 .3687E-02 .3215E-02 .2683E-02
 .6285E-02 .5610E-02 .4672E-02 .3691E-02 .9575E-02 .8193E-02 .6416E-02 .4725E-02
 .1257E-01 .1022E-01 .7456E-02 .5090E-02 .1102E-01 .8598E-02 .5942E-02 .3842E-02
 .3647E-02 .2830E-02 .1946E-02 .1254E-02 .2923E-02 .2423E-02 .1828E-02 .1205E-02
 .3087E-02 .3041E-02 .2844E-02 .2531E-02 .4057E-02 .3993E-02 .3680E-02 .3179E-02
 .5015E-02 .4917E-02 .4436E-02 .3687E-02 .5416E-02 .5238E-02 .4563E-02 .3582E-02
 .4492E-02 .4149E-02 .3353E-02 .2360E-02 .2275E-02 .1626E-02 .9356E-03 .4032E-03
 .8772E-03 .1165E-02 .1344E-02 .1414E-02 .2317E-02 .2259E-02 .2046E-02 .1745E-02
 .4309E-02 .4101E-02 .3508E-02 .2778E-02 .9039E-02 .8151E-02 .6301E-02 .4441E-02
 .2142E-01 .1716E-01 .1108E-01 .6567E-02 .5061E-01 .3018E-01 .1485E-01 .7294E-02
 .2923E-01 .1369E-01 .7232E-02 .4054E-02 .1836E-01 .1586E-01 .1002E-01 .1555E-01
 .1377E-01 .9241E-02 .7890E-02 .7043E-02 .5751E-020.        0.        0.
 .6384E-04 .1294E-04 .1478E-04 .5296E-04 .9052E-04 .7592E-06 .5587E-02 .7570E-02
 .8137E-02 .3933E-02 .3235E-02 .8046E-02 .2727E-01 .1412E+00 .2603E-02 .9646E-01
 .1603E-02 .2765E-01 .5375E-01
 .3186E-02 .3329E-02 .3329E-02 .3186E-02 .3826E-02 .4070E-02 .4070E-02 .3826E-02
 .5914E-02 .6430E-02 .6430E-02 .5914E-02 .8835E-02 .9903E-02 .9903E-02 .8835E-02
 .1136E-01 .1320E-01 .1320E-01 .1136E-01 .9812E-02 .1173E-01 .1173E-01 .9812E-02
 .3247E-02 .3890E-02 .3890E-02 .3247E-02 .2674E-02 .2371E-02 .1908E-02 .1331E-02
 .3154E-02 .3368E-02 .3376E-02 .3166E-02 .4737E-02 .5218E-02 .5283E-02 .4865E-02
 .6974E-02 .8034E-02 .8257E-02 .7421E-02 .9262E-02 .1128E-01 .1179E-01 .1014E-01
 .9251E-02 .1163E-01 .1194E-01 .9228E-02 .4985E-02 .5047E-02 .3818E-02 .1819E-02
 .1332E-02 .1908E-02 .2371E-02 .2674E-02 .3166E-02 .3376E-02 .3368E-02 .3154E-02
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 .4864E-02 .5282E-02 .5217E-02 .4737E-02 .7420E-02 .8257E-02 .8033E-02 .6974E-02


 .1013E-01 .1179E-01 .1128E-01 .9262E-02 .9229E-02 .1194E-01 .1163E-01 .9250E-02
 .1820E-02 .3820E-02 .5047E-02 .4985E-02 .1554E-01 .1873E-01 .1554E-01 .1349E-01
 .1587E-01 .1349E-01 .7497E-02 .7914E-02 .7498E-020.        0.        0.
 .2019E-04 .6468E-04 .2019E-04 .9978E-04 .1205E-03 .9978E-04 .6414E-02 .1187E-01
 .2059E-01 .1650E-01 .6414E-02 .1187E-01 .2059E-01 .1650E-01 .3098E-02 .1315E+00
 .6525E-02 .6525E-02 .8349E-01
 .2454E-02 .2806E-02 .3102E-02 .3296E-02 .2683E-02 .3215E-02 .3687E-02 .4005E-02
 .3691E-02 .4672E-02 .5610E-02 .6285E-02 .4725E-02 .6416E-02 .8193E-02 .9575E-02
 .5090E-02 .7456E-02 .1022E-01 .1257E-01 .3842E-02 .5942E-02 .8598E-02 .1102E-01
 .1254E-02 .1946E-02 .2830E-02 .3647E-02 .1414E-02 .1344E-02 .1165E-02 .8768E-03
 .1745E-02 .2046E-02 .2259E-02 .2317E-02 .2778E-02 .3508E-02 .4101E-02 .4309E-02
 .4442E-02 .6302E-02 .8152E-02 .9040E-02 .6567E-02 .1108E-01 .1716E-01 .2142E-01
 .7295E-02 .1485E-01 .3018E-01 .5061E-01 .4055E-02 .7232E-02 .1368E-01 .2921E-01
 .1206E-02 .1828E-02 .2423E-02 .2923E-02 .2531E-02 .2844E-02 .3040E-02 .3087E-02
 .3178E-02 .3680E-02 .3993E-02 .4057E-02 .3687E-02 .4436E-02 .4917E-02 .5014E-02
 .3582E-02 .4562E-02 .5238E-02 .5416E-02 .2360E-02 .3353E-02 .4149E-02 .4492E-02
 .4036E-03 .9361E-03 .1626E-02 .2274E-02 .1002E-01 .1586E-01 .1836E-01 .9242E-02
 .1377E-01 .1554E-01 .5750E-02 .7043E-02 .7891E-020.        0.        0.
 .1478E-04 .1294E-04 .6385E-04 .7593E-06 .9053E-04 .5296E-04 .3235E-02 .8046E-02
 .2727E-01 .1412E+00 .5587E-02 .7570E-02 .8137E-02 .3933E-02 .2603E-02 .9646E-01
 .2765E-01 .1603E-02 .5376E-01
 .6596E-03 .6369E-03 .5906E-03 .5283E-03 .8855E-03 .8424E-03 .7555E-03 .6444E-03
 .1665E-02 .1545E-02 .1317E-02 .1050E-02 .3658E-02 .3238E-02 .2516E-02 .1788E-02
 .1020E-01 .8174E-02 .5271E-02 .3045E-02 .3973E-01 .2539E-01 .1079E-01 .4313E-02
 .1794E+00 .7240E-01 .9746E-02 .2492E-02 .1711E-02 .1293E-02 .8920E-03 .5414E-03
 .1966E-02 .1704E-02 .1415E-02 .1135E-02 .2933E-02 .2438E-02 .1920E-02 .1449E-02
 .4443E-02 .3470E-02 .2531E-02 .1760E-02 .6550E-02 .4651E-02 .3033E-02 .1876E-02
 .8303E-02 .5077E-02 .2789E-02 .1435E-02 .6791E-02 .2847E-02 .1003E-02 .2919E-03
 .1774E-C3 .2783E-03 .3005E-03 .4710E-03 .4181E-03 .5026E-03 .5722E-03 .6120E-03
 .6503E-03 .8373E-03 .9975E-03 .1087E-02 .1056E-02 .1521E-02 .1961E-02 .2199E-02
 .1723E-02 .3066E-02 .4611E-02 .5441E-02 .2357E-02 .6655E-02 .1443E-01 .1856E-01
 .8312E-03 .8355E-02 .1007E+00 .1618E+00 .1021E-01 .9900E-02 .7440E-02 .1168E-01
 .1134E-01 .8658E-02 .7971E-02 .7510E-02 .6517E-02 .8275E-04 .2671E-04 .1915E-04
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 .5631E-02 .2931E-02 .3609E-02 .5972E-02 .9396E-02 .7833E-02 .5102E-02 .6595E-02
 .3552E-02 .7458E-02 .3923E-01
 .6309E-03 .6582E-03 .6582E-03 .6309E-03 .8294E-03 .8833E-03 .8833E-03 .8294E-03
 .1509E-02 .1657E-02 .1657E-02 .1509E-02 .3115E-02 .3624E-02 .3624E-02 .3115E-02
 .7588E-02 .1000E-01 .1000E-01 .7588E-02 .2111E-01 .3775E-01 .3775E-01 .2111E-01
 .2969E-01 .1462E+00 .1462E+00 .2969E-C1 .1271E-02 .9925E-03 .7035E-03 .4361E-03
 .1581E-02 .1417E-02 .1203E-02 .9761E-03 .2632E-02 .2278E-02 .1831E-02 .1387E-02
 .4746E-02 .3881E-02 .2858E-02 .1752E-02 .9331E-02 .6907E-02 .4383E-02 .2533E-02
 .1891E-01 .1157E-01 .5599E-02 .2439E-02 .2873E-01 .1042E-01 .2722E-02 .5953E-03
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 .1386E-02 .1831E-02 .2277E-02 .2632E-02 .1952E-02 .2858E-02 .3880E-02 .4746E-02
 .2533E-02 .4382E-02 .6907E-02 .9331E-02 .2439E-02 .5598E-02 .1157E-01 .1891E-01
 .5958E-03 .2724E-02 .1042E-01 .2872E-01 .9183E-02 .1053E-01 .9184E-02 .1057E-01
 .1202E-01 .1057E-01 .7570E-02 .7921E-02 .7570E-02 .1684E-04 .8594E-04 .1684E-04
0.        0.        0.        .1714E-03 .2246E-03 .1714E-03 .4209E-02 .6234E-02
 .8079E-02 .5140E-02 .4209E-02 .6234E-02 .8079E-02 .5140E-02 .5392E-02 .7637E-02
 .5540E-02 .5540E-02 .4364E-01
 .5283E-03 .5906E-03 .6369E-03 .6596E-03 .6444E-03 .7555E-03 .8424E-03 .8855E-03
 .1050E-02 .1317E-02 .1545E-02 .1665E-02 .1788E-02 .2516E-02 .3238E-02 .3658E-02
 .3045E-02 .5271E-02 .8174E-02 .1020E-01 .4313E-02 .1079E-01 .2539E-01 .3973E-01
 .2492E-02 .9746E-02 .7240E-01 .1794E+00 .4710E-03 .3805E-03 .2783E-03 .1773E-03
 .6120E-03 .5722E-03 .5027E-03 .4181E-03 .1087E-02 .9976E-03 .8373E-03 .6504E-03
 .2199E-02 .1961E-02 .1521E-02 .1056E-02 .5442E-02 .4611E-02 .3066E-02 .1723E-02
 .1856E-01 .1443E-01 .6656E-02 .2357E-02 .1618E+00 .1007E+00 .8350E-02 .8304E-03
 .5416E-03 .8920E-03 .1293E-02 .1712E-02 .1135E-02 .1415E-02 .1704E-02 .1966E-02
 .1449E-02 .1920E-02 .2438E-02 .2933E-02 .1760E-02 .2531E-02 .3470E-02 .4443E-02
```

.1876E-02	.3033E-02	.4650E-02	.6549E-02	.1436E-02	.2789E-02	.5077E-02	.8302E-02

.2922E-03	.1004E-02	.2847E-02	.6790E-02	.7439E-02	.9900E-02	.1021E-01	.8659E-02
.1134E-01	.1168E-01	.6516E-02	.7510E-02	.7971E-02	.1915E-04	.2671E-04	.8275E-04
0.	0.	0.	.3451E-05	.7027E-04	.1771E-03	.3608E-02	.5970E-02
.9393E-02	.7831E-02	.4018E-02	.5230E-02	.5630E-02	.2930E-02	.5100E-02	.6594E-02
.7456E-02	.3551E-02	.3922E-01					
.2071E-02	.1946E-02	.1757E-02	.1534E-02	.2709E-02	.2482E-02	.2151E-02	.1782E-02
.4809E-02	.4242E-02	.3471E-02	.2685E-02	.9202E-02	.7640E-02	.5707E-02	.3983E-02
.1819E-01	.1371E-01	.8882E-02	.5348E-02	.2959E-01	.1950E-01	.1042E-01	.5267E-02
.1635E-01	.9859E-02	.4634E-02	.2122E-02	.2466E-02	.1940E-02	.1389E-02	.8719E-03
.2722E-02	.2497E-02	.2181E-02	.1825E-02	.3820E-02	.3430E-02	.2891E-02	.2307E-02
.5233E-02	.4557E-02	.3654E-02	.2737E-02	.6570E-02	.5461E-02	.4075E-02	.2792E-02
.6584E-02	.5057E-02	.3363E-02	.1991E-02	.4040E-02	.2337E-02	.1068E-02	.3735E-03
.3787E-03	.5487E-03	.6882E-03	.7811E-03	.9693E-03	.1061E-02	.1080E-02	.1024E-02
.1733E-02	.1959E-02	.1982E-02	.1812E-02	.3512E-02	.4172E-02	.4151E-02	.3536E-02
.8448E-02	.1096E-01	.1035E-01	.7648E-02	.2661E-01	.3817E-01	.3039E-01	.1679E-01
.5907E-01	.1033E+00	.6215E-01	.2257E-01	.1453E-01	.1287E-01	.8639E-02	.1449E-01
.1301E-01	.9059E-02	.8451E-02	.7589E-02	.6263E-02	.4946E-04	.9512E-04	.7091E-06
.1276E-03	.1230E-03	.2486E-05	0.	0.	0.	.4887E-02	.6456E-02
.6925E-02	.3481E-02	.3679E-02	.7724E-02	.1907E-01	.3973E-01	.4937E-02	.1689E-01
.3153E-02	.1548E-01	.5611E-01					
.2010E-02	.2101E-02	.2101E-02	.2010E-02	.2593E-02	.2765E-02	.2765E-02	.2593E-02
.4507E-02	.4941E-02	.4941E-02	.4507E-02	.8315E-02	.9553E-02	.9553E-02	.8315E-02
.1539E-01	.1912E-01	.1912E-01	.1539E-01	.2243E-01	.3131E-01	.3131E-01	.2243E-01
.1135E-01	.1721E-01	.1721E-01	.1135E-01	.2070E-02	.1723E-02	.1298E-02	.8486E-03
.2572E-02	.2514E-02	.2304E-02	.1988E-02	.4208E-02	.4119E-02	.3683E-02	.3021E-02
.7217E-02	.7095E-02	.6106E-02	.4640E-02	.1249E-01	.1239E-01	.1001E-01	.6694E-02
.1878E-01	.1859E-01	.1328E-01	.7058E-02	.1591E-01	.1250E-01	.5916E-02	.1715E-02
.8489E-03	.1298E-02	.1723E-02	.2071E-02	.1988E-02	.2304E-02	.2514E-02	.2572E-02
.3020E-C2	.3683E-02	.4119E-02	.4208E-02	.4640E-02	.6105E-02	.7095E-02	.7217E-02
.6693E-02	.1001E-01	.1239E-01	.1249E-01	.7058E-02	.1328E-01	.1859E-01	.1878E-01
.1716E-02	.5920E-02	.1250E-01	.1591E-01	.1263E-01	.1486E-01	.1263E-01	.1277E-01
.1479E-01	.1276E-01	.8046E-02	.8466E-02	.8046E-02	.8278E-04	.1124E-03	.8279E-04
.4959E-04	.1578E-03	.4958E-04	0.	0.	0.	.5579E-02	.9464E-02
.1482E-01	.1132E-01	.5579E-02	.9464E-02	.1482E-01	.1132E-01	.5624E-02	.2544E-01
.8176E-02	.8176E-02	.7598E-01					
.1534E-02	.1757E-02	.1946E-02	.2071E-02	.1782E-02	.2151E-02	.2482E-02	.2709E-02
.2685E-02	.3471E-02	.4242E-02	.4809E-02	.3983E-02	.5707E-02	.7640E-02	.9202E-02
.5348E-02	.8882E-02	.1371E-01	.1819E-01	.5267E-02	.1042E-01	.1950E-01	.2959E-01
.2122E-02	.4634E-02	.9859E-02	.1635E-01	.7810E-03	.6882E-03	.5487E-03	.3785E-03
.1024E-02	.1080E-02	.1061E-02	.9692E-03	.1812E-02	.1982E-02	.1959E-02	.1733E-02
.3537E-02	.4151E-02	.4173E-02	.3512E-02	.7649E-02	.1036E-01	.1097E-01	.8450E-02
.1679E-01	.3040E-01	.3818E-01	.2661E-01	.2258E-01	.6215E-01	.1033E+00	.5901E-01
.8722E-03	.1389E-02	.1940E-02	.2466E-02	.1826E-02	.2181E-02	.2497E-02	.2722E-02
.2307E-02	.2891E-02	.3430E-02	.3820E-02	.2737E-02	.3654E-02	.4556E-02	.5233E-02
.2791E-02	.4075E-02	.5460E-02	.6569E-02	.1991E-02	.3363E-02	.5056E-02	.6583E-02
.3739E-03	.1069E-02	.2337E-02	.4040E-02	.8638E-02	.1287E-01	.1454E-01	.9060E-02
.1301E-01	.1449E-01	.6262E-02	.7589E-02	.8452E-02	.7091E-06	.9512E-04	.4946E-04
.2487E-05	.1230E-03	.1276E-03	0.	0.	0.	.3681E-02	.7728E-02
.1908E-01	.3976E-01	.4889E-02	.6459E-02	.6929E-02	.3483E-02	.4939E-02	.1690E-01
.1548E-01	.3155E-02	.5614E-01					
.8087E-02	.1081E-01	.1398E-01	.1676E-01	.6693E-02	.9180E-02	.1222E-01	.1508E-01
.6007E-02	.8020E-02	.1033E-01	.1229E-01	.4585E-02	.57[illegible]5E-02	.6950E-02	.7694E-02
.3138E-02	.3690E-02	.4120E-02	.4235E-02	.2033E-02	.2245E-02	.2350E-02	.2277E-02
.1303E-02	.1366E-02	.1361E-02	.1264E-02	.3396E-02	.5326E-02	.9282E-02	.2136E-01
.3276E-02	.6665E-02	.1630E-01	.5236E-01	.2681E-02	.4845E-02	.9213E-02	.1315E-01
.1637E-02	.2341E-02	.2924E-02	.1834E-02	.8713E-03	.1009E-02	.9474E-03	.4405E-03
.4552E-03	.4553E-03	.3641E-03	.1485E-03	.3015E-03	.2370E-03	.1453E-03	.4453E-04
.3953E-02	.6408E-02	.8847E-02	.1074E-01	.6951E-02	.8081E-02	.8788E-02	.8856E-02
.6463E-02	.7484E-02	.8109E-02	.8162E-02	.5342E-02	.6102E-02	.6559E-02	.6594E-02
.4027E-02	.4522E-02	.4812E-02	.4833E-02	.2872E-02	.3163E-02	.3332E-02	.3344E-02

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 .1263E-02 .1858E-02 .2395E-02 .2824E-02 .4518E-02 .1935E-01 .1623E+00 .4327E-02


 .1437E-01 .4938E-01 .2650E-02 .4621E-02 .7087E-02 .6416E-02 .7518E-02 .3715E-02
 .3561E-02 .3714E-02 .3197E-02 .6009E-02 .7006E-02 .4526E-020.         0.
0.         0.        .1620E-01 .1426E-01 .1009E-01 .6257E-02 .3895E-01 .1745E-02
 .4360E-01 .2015E-02 .5006E-01
 .5638E-02 .6990E-02 .8288E-02 .9065E-02 .5881E-02 .7831E-02 .1006E-01 .1196E-01
 .6682E-02 .9159E-02 .1219E-01 .1505E-01 .6298E-02 .8509E-02 .1112E-01 .1346E-01
 .4996E-02 .6410E-02 .7886E-02 .8941E-02 .3498E-02 .4193E-02 .4782E-02 .5020E-02
 .2296E-02 .2577E-02 .2743E-02 .2701E-02 .1644E-02 .1904E-02 .1857E-02 .8886E-03
 .2376E-02 .4059E-02 .7007E-02 .8052E-02 .3217E-02 .6481E-02 .1560E-01 .4986E-01
 .3001E-02 .5795E-02 .1274E-01 .3175E-01 .1989E-02 .3103E-02 .4482E-02 .3447E-02
 .1087E-02 .1344E-02 .1366E-02 .6827E-03 .6841E-03 .6197E-03 .4404E-03 .1525E-03
 .3093E-02 .4846E-02 .6513E-02 .7777E-02 .6211E-02 .7165E-02 .7760E-02 .7820E-02
 .6896E-02 .8029E-02 .8730E-02 .8798E-02 .6735E-02 .7822E-02 .8494E-02 .8557E-02
 .5789E-02 .6656E-02 .7183E-02 .7231E-02 .4501E-02 .5082E-02 .5435E-02 .5466E-02
 .2061E-02 .3114E-02 .4075E-02 .4820E-02 .9344E-02 .2414E-01 .3132E-01 .8559E-02
 .1869E-01 .2353E-01 .5058E-02 .7214E-02 .8443E-02 .8693E-02 .1392E-01 .9241E-02
 .4635E-02 .5501E-02 .5290E-02 .7938E-02 .1189E-01 .9503E-020.         0.
0.         0.        .1415E-01 .1609E-01 .1416E-01 .1000E-01 .1168E-01 .4812E-02
 .6591E-01 .2477E-02 .9129E-01
 .3377E-02 .3841E-02 .4148E-02 .4141E-02 .4016E-02 .4938E-02 .5786E-02 .6238E-02
 .5523E-02 .7241E-02 .9135E-02 .1064E-01 .6573E-02 .8971E-02 .1187E-01 .1457E-01
 .6518E-02 .8882E-02 .1174E-01 .1439E-01 .5394E-02 .7045E-02 .8852E-02 .1027E-01
 .3898E-02 .4764E-02 .5556E-02 .5971E-02 .6875E-03 .6230E-03 .4416E-03 .1526E-03
 .1091E-02 .1350E-02 .1374E-02 .6880E-03 .1995E-02 .3118E-02 .4514E-02 .3487E-02
 .3005E-02 .5809E-02 .1279E-01 .3208E-01 .3214E-02 .6473E-02 .1556E-01 .4962E-01
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 .2054E-02 .3112E-02 .4090E-02 .4839E-02 .4509E-02 .5093E-02 .5446E-02 .5478E-02
 .5796E-02 .6665E-02 .7193E-02 .7241E-02 .6739E-02 .7826E-02 .8499E-02 .8562E-02
 .6894E-02 .8026E-02 .8726E-02 .8795E-02 .6204E-02 .7156E-02 .7749E-02 .7809E-02
 .3105E-02 .4851E-02 .6492E-02 .7750E-02 .8697E-02 .1393E-01 .9246E-02 .7973E-02
 .1193E-01 .9531E-02 .4695E-02 .5561E-02 .5361E-02 .9341E-02 .2412E-01 .3130E-01
 .4988E-02 .7126E-02 .8320E-02 .8513E-02 .1861E-01 .2346E-010.         0.
0.         0.        .1001E-01 .1416E-01 .1610E-01 .1415E-01 .3373E-02 .1702E-01
 .6542E-01 .2455E-02 .8799E-01
 .1922E-02 .2036E-02 .2048E-02 .1919E-02 .2382E-02 .2688E-02 .2875E-02 .2838E-02
 .3627E-02 .4371E-02 .5009E-02 .5282E-02 .5130E-02 .6613E-02 .8172E-02 .9300E-02
 .6376E-02 .8634E-02 .1131E-01 .1372E-01 .6651E-02 .9109E-02 .1211E-01 .1494E-01
 .5787E-02 .7673E-02 .9826E-02 .1165E-01 .3028E-03 .2381E-03 .1455E-03 .4446E-04
 .4568E-03 .4571E-03 .3658E-03 .1492E-03 .8744E-03 .1014E-02 .9525E-03 .4432E-03
 .1642E-02 .2351E-02 .2942E-02 .1850E-02 .2687E-02 .4861E-02 .9265E-02 .1339E-01
 .3277E-02 .6666E-02 .1631E-01 .5243E-01 .3385E-02 .5305E-02 .9257E-02 .2151E-01
 .1258E-02 .1857E-02 .2404E-02 .2035E-02 .2879E-02 .3170E-02 .3340E-02 .3352E-02
 .4034E-02 .4531E-02 .4822E-02 .4843E-02 .5350E-02 .6111E-02 .6569E-02 .6604E-02
 .6468E-02 .7490E-02 .8115E-02 .8168E-02 .6951E-02 .8080E-02 .8787E-02 .8854E-02
 .3972E-02 .6420E-02 .8825E-02 .1071E-01 .6419E-02 .7525E-02 .3717E-02 .6032E-02
 .7030E-02 .4538E-02 .3605E-02 .3752E-02 .3238E-02 .4517E-02 .1934E-01 .1622E+00
 .2597E-02 .4535E-02 .6939E-02 .4280E-02 .1422E-01 .4889E-010.         0.
0.         0.        .6251E-02 .1008E-01 .1425E-01 .1619E-01 .1242E-02 .5097E-01
 .3999E-01 .1961E-02 .4232E-01
 .1676E-01 .1398E-01 .1081E-01 .8087E-02 .1508E-01 .1222E-01 .9180E-02 .6693E-02
 .1229E-01 .1033E-01 .8020E-02 .6007E-02 .7694E-02 .6950E-02 .5775E-02 .4585E-02
 .4235E-02 .4120E-02 .3690E-02 .3138E-02 .2277E-02 .2350E-02 .2245E-02 .2033E-02
 .1264E-02 .1361E-02 .1366E-02 .1303E-02 .1074E-01 .8847E-02 .6408E-02 .3952E-02
 .8856E-02 .8788E-02 .8081E-02 .6951E-02 .8162E-02 .8109E-02 .7485E-02 .6464E-02
 .6594E-02 .6559E-02 .6102E-02 .5343E-02 .4834E-02 .4813E-02 .4522E-02 .4027E-02
 .3345E-02 .3333E-02 .3163E-02 .2872E-02 .2824E-02 .2395E-02 .1857E-02 .1262E-02
 .2126E-01 .9282E-02 .5326E-02 .3396E-02 .5236E-01 .1630E-01 .6665E-02 .3276E-02
 .1315E-01 .9212E-02 .4845E-02 .2681E-02 .1834E-02 .2924E-02 .2341E-02 .1636E-02
 .4404E-03 .9473E-03 .1009E-02 .8712E-03 .1485E-03 .3641E-03 .4552E-03 .4552E-03
 .4457E-04 .1454E-03 .2370E-03 .3014E-03 .1623E+00 .1935E-01 .4518E-02 .4931E-01
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 .1437E-01 .4326E-02 .7087E-02 .4621E-02 .2650E-02 .3715E-02 .7518E-02 .6417E-02


 .3198E-02 .3714E-02 .3560E-02 .4523E-02 .7006E-02 .6012E-02 .1620E-01 .1415E-01
 .1001E-01 .6251E-020.         0.         0.                  .3905E-01 .1750E-02
 .2020E-02 .4372E-01 .5020E-01
 .9065E-02 .8288E-02 .6990E-02 .5638E-02 .1196E-01 .1006E-01 .7831E-02 .5881E-02
 .1505E-01 .1219E-01 .9159E-02 .6682E-02 .1346E-01 .1112E-01 .8509E-02 .6298E-02
 .8941E-02 .7886E-02 .6410E-02 .4996E-02 .5020E-02 .4782E-02 .4193E-02 .3498E-02
 .2701E-02 .2743E-02 .2577E-02 .2296E-02 .7777E-02 .6513E-02 .4846E-02 .3092E-02
 .7820E-02 .7760E-02 .7165E-02 .6210E-02 .8798E-02 .8730E-02 .8029E-02 .6897E-02
 .8557E-02 .8494E-02 .7822E-02 .6736E-02 .7231E-02 .7183E-02 .6656E-02 .5790E-02
 .5466E-02 .5435E-02 .5083E-02 .4501E-02 .4821E-02 .4075E-02 .3112E-02 .2059E-02
 .8889E-03 .1857E-02 .1904E-02 .1645E-02 .8053E-02 .7007E-02 .4059E-02 .2376E-02
 .4985E-01 .1560E-01 .6481E-02 .3216E-02 .3175E-01 .1274E-01 .5795E-02 .3000E-02
 .3447E-02 .4481E-02 .3103E-02 .1989E-02 .6827E-03 .1365E-02 .1343E-02 .1087E-02
 .1527E-03 .4407E-03 .6197E-03 .6840E-03 .3131E-01 .2414E-01 .9345E-02 .2354E-01
 .1869E-01 .8558E-02 .8442E-02 .7214E-02 .5058E-02 .9240E-02 .1392E-01 .8694E-02
 .5292E-02 .5501E-02 .4634E-02 .9498E-02 .1189E-01 .7943E-02 .1426E-01 .1609E-01
 .1416E-01 .1008E-010.         0.         0.                  .1167E-01 .4807E-02
 .2475E-02 .6585E-01 .9120E-01
 .4141E-02 .4148E-02 .3841E-02 .3377E-02 .6238E-02 .5786E-02 .4938E-02 .4016E-02
 .1064E-01 .9135E-02 .7241E-02 .5523E-02 .1457E-01 .1187E-01 .8971E-02 .6573E-02
 .1439E-01 .1174E-01 .8882E-02 .6518E-02 .1027E-01 .8852E-02 .7045E-02 .5394E-02
 .5971E-02 .5556E-02 .4764E-02 .3898E-02 .4839E-02 .4090E-02 .3112E-02 .2053E-02
 .5478E-02 .5446E-02 .5093E-02 .4509E-02 .7242E-02 .7194E-02 .6665E-02 .5797E-02
 .8562E-02 .8499E-02 .7827E-02 .6739E-02 .8795E-02 .8727E-02 .8027E-02 .6895E-02
 .7810E-02 .7750E-02 .7157E-02 .6203E-02 .7751E-02 .6492E-02 .4848E-02 .3102E-02
 .1526E-03 .4416E-03 .6230E-03 .6875E-03 .6880E-03 .1374E-02 .1350E-02 .1091E-02
 .3487E-02 .4514E-02 .3117E-02 .1995E-02 .3207E-01 .1279E-01 .5808E-02 .3005E-02
 .4961E-01 .1556E-01 .6473E-02 .3214E-02 .7922E-02 .6958E-02 .4042E-02 .2369E-02
 .8869E-03 .1850E-02 .1093E-02 .1637E-02 .9245E-02 .1393E-01 .8698E-02 .9532E-02
 .1193E-01 .7972E-02 .5361E-02 .5561E-02 .4695E-02 .3130E-01 .2412E-01 .9342E-02
 .8322E-02 .7126E-02 .4987E-02 .2344E-01 .1861E-01 .8518E-02 .1009E-01 .1415E-01
 .1610E-01 .1425E-010.         0.         0.                  .3370E-02 .1701E-01
 .2453E-02 .6536E-01 .8792E-01
 .1919E-02 .2048E-02 .2036E-02 .1922E-02 .2838E-02 .2875E-02 .2688E-02 .2382E-02
 .5282E-02 .5009E-02 .4371E-02 .3627E-02 .9300E-02 .8172E-02 .6613E-02 .5130E-02
 .1372E-01 .1131E-01 .8634E-02 .6376E-02 .1494E-01 .1211E-01 .9109E-02 .6651E-02
 .1165E-01 .9826E-02 .7673E-02 .5788E-02 .2835E-02 .2404E-02 .1857E-02 .1258E-02
 .3352E-02 .3341E-02 .3170E-02 .2878E-02 .4844E-02 .4823E-02 .4531E-02 .4034E-02
 .6604E-02 .6569E-02 .6111E-02 .5350E-02 .8169E-02 .8116E-02 .7491E-02 .6469E-02
 .8855E-02 .8787E-02 .8081E-02 .6950E-02 .1071E-01 .8825E-02 .6416E-02 .3968E-02
 .4448E-04 .1455E-03 .2381E-03 .3028E-03 .1492E-03 .3657E-03 .4571E-03 .4568E-03
 .4431E-03 .9524E-03 .1014E-02 .8743E-03 .1850E-02 .2942E-02 .2351E-02 .1642E-02
 .1339E-01 .9264E-02 .4860E-02 .2687E-02 .5244E-01 .1631E-01 .6665E-02 .3276E-02
 .2153E-01 .9263E-02 .5305E-02 .3384E-02 .3716E-02 .7525E-02 .6420E-02 .4539E-02
 .7030E-02 .6031E-02 .3237E-02 .3752E-02 .3605E-02 .1622E+00 .1934E-01 .4517E-02
 .6941E-02 .4535E-02 .2596E-02 .4886E-01 .1422E-01 .4282E-02 .6257E-02 .1000E-01
 .1416E-01 .1619E-010.         0.         0.                  .1244E-02 .5103E-01
 .1964E-02 .4004E-01 .4238E-01
 .1635E-01 .1772E-01 .1772E-01 .1635E-01 .1384E-01 .1507E-01 .1507E-01 .1384E-01
 .1139E-01 .1234E-01 .1234E-01 .1139E-01 .7543E-02 .8098E-02 .8098E-02 .7543E-02
 .4478E-02 .4751E-02 .4751E-02 .4478E-02 .2587E-02 .2714E-02 .2714E-02 .2587E-02
 .1524E-02 .1583E-02 .1583E-02 .1524E-02 .1212E-01 .1283E-01 .1226E-01 .9395E-02
 .1042E-01 .1355E-01 .1668E-01 .1767E-01 .8731E-02 .1072E-01 .1211E-01 .1139E-01
 .5963E-02 .6648E-02 .6640E-02 .5474E-02 .3665E-02 .3746E-02 .3416E-02 .2609E-02
 .2186E-02 .2098E-02 .1809E-02 .1333E-02 .1630E-02 .1205E-02 .8826E-03 .4835E-03
 .9399E-02 .1226E-01 .1283E-01 .1212E-01 .1768E-01 .1668E-01 .1355E-01 .1042E-01
 .1139E-01 .1211E-01 .1072E-01 .8731E-02 .5473E-02 .6639E-02 .6648E-02 .5963E-02
 .2609E-02 .3415E-02 .3746E-02 .3665E-02 .1333E-02 .1808E-02 .2098E-02 .2186E-02
 .4839E-03 .8831E-03 .1205E-02 .1629E-02 .6382E-01 .8847E-01 .6382E-01 .9685E-02
 .1505E-01 .9683E-02 .2634E-02 .3040E-02 .2634E-02 .2047E-02 .2487E-02 .2048E-02
```

```
 .3096E-02 .3259E-02 .3096E-02 .4158E-02 .4838E-02 .4161E-02 .2668E-01 .8004E-02


 .2311E-02 .8509E-03 .2675E-01 .7995E-02 .2309E-02 .8520E-030.          0.
0.         0.         0.
 .2403E-02 .2503E-02 .2503E-02 .2403E-02 .3316E-02 .3498E-02 .3498E-02 .3316E-02
 .5710E-02 .6092E-02 .6092E-02 .5710E-02 .9253E-02 .9983E-02 .9983E-02 .9253E-02
 .1281E-01 .1392E-01 .1392E-01 .1281E-01 .1375E-01 .1496E-01 .1496E-01 .1375E-01
 .1121E-01 .1212E-01 .1212E-01 .1121E-01 .1722E-02 .1364E-02 .9370E-03 .5131E-03
 .2313E-02 .2234E-02 .1936E-02 .1432E-02 .3873E-02 .3995E-02 .3675E-02 .2826E-02
 .6247E-02 .7043E-02 .7127E-02 .5950E-02 .8971E-02 .1111E-01 .1271E-01 .1213E-01
 .1042E-01 .1355E-01 .1668E-01 .1769E-01 .1176E-01 .1238E-01 .1180E-01 .9000E-02
 .5133E-03 .9370E-03 .1364E-02 .1722E-02 .1432E-02 .1936E-02 .2234E-02 .2313E-02
 .2825E-02 .3675E-02 .3995E-02 .3872E-02 .5950E-02 .7127E-02 .7042E-02 .6246E-02
 .1213E-01 .1270E-01 .1111E-01 .8970E-02 .1769E-01 .1668E-01 .1354E-01 .1042E-01
 .9009E-02 .1181E-01 .1238E-01 .1176E-01 .2155E-02 .2636E-02 .2156E-02 .4351E-02
 .5083E-02 .4350E-02 .3233E-02 .3402E-02 .3234E-02 .5811E-01 .8088E-01 .5811E-01
 .3066E-02 .3535E-02 .3065E-02 .1090E-01 .1676E-01 .1090E-01 .9155E-03 .2524E-02
 .8932E-02 .2674E-01 .9180E-03 .2522E-02 .8925E-02 .2677E-010.          0.
0.         0.         0.
 .4428E-02 .5862E-02 .7442E-02 .8835E-02 .4618E-02 .6392E-02 .8449E-02 .1033E-01
 .5464E-02 .7717E-02 .1039E-01 .1288E-01 .5667E-02 .8037E-02 .1086E-01 .1349E-01
 .5144E-02 .7213E-02 .9649E-02 .1191E-01 .4112E-02 .5607E-02 .7313E-02 .8858E-02
 .2965E-02 .3875E-02 .4860E-02 .5716E-02 .3889E-02 .4856E-02 .5885E-02 .6140E-02
 .4812E-02 .7865E-02 .1330E-01 .2097E-01 .6160E-02 .1059E-01 .1885E-01 .3076E-01
 .6629E-02 .1150E-01 .2055E-01 .3332E-01 .6045E-02 .1036E-01 .1839E-01 .3003E-01
 .4635E-02 .7507E-02 .1256E-01 .1963E-01 .3684E-02 .4545E-02 .5441E-02 .5604E-02
 .9898E-03 .2047E-02 .3298E-02 .4473E-02 .2026E-02 .3095E-02 .4001E-02 .4544E-02
 .2369E-02 .3642E-02 .4706E-02 .5317E-02 .2491E-02 .3831E-02 .4950E-02 .5585E-02
 .2340E-02 .3596E-02 .4647E-02 .5252E-02 .1979E-02 .3021E-02 .3906E-02 .4439E-02
 .9650E-03 .1986E-02 .3186E-02 .4323E-02 .1620E-02 .6962E-02 .3114E-01 .3428E-02
 .9255E-C2 .1743E-01 .2000E-02 .4374E-02 .5958E-02 .1625E-02 .6752E-02 .2803E-01
 .2778E-02 .4315E-02 .5831E-02 .3422E-02 .9063E-02 .1681E-01 .3849E-01 .5818E-01
 .5776E-01 .3530E-01 .1783E-02 .2184E-02 .2166E-02 .1734E-020.          0.
0.         0.         0.
 .8835E-02 .7442E-02 .5862E-02 .4428E-02 .1033E-01 .8449E-02 .6392E-02 .4618E-02
 .1288E-01 .1039E-01 .7717E-02 .5464E-02 .1349E-01 .1086E-01 .8037E-02 .5667E-02
 .1191E-01 .9649E-02 .7213E-02 .5144E-02 .8858E-02 .7313E-02 .5607E-02 .4112E-02
 .5716E-02 .4860E-02 .3875E-02 .2966E-02 .4473E-02 .3298E-02 .2047E-02 .9894E-03
 .4544E-02 .4002E-02 .3095E-02 .2025E-02 .5317E-02 .4706E-02 .3642E-02 .2370E-02
 .5585E-02 .4951E-02 .3832E-02 .2491E-02 .5253E-02 .4647E-02 .3596E-02 .2341E-02
 .4440E-02 .3907E-02 .3021E-02 .1978E-02 .4324E-02 .3186E-02 .1985E-02 .9641E-03
 .5142E-02 .5885E-02 .4856E-02 .3889E-02 .2097E-01 .1330E-01 .7865E-02 .4812E-02
 .3076E-01 .1885E-01 .1059E-01 .6160E-02 .3332E-01 .2054E-01 .1150E-01 .6629E-02
 .3002E-01 .1839E-01 .1036E-01 .6045E-02 .1963E-01 .1256E-01 .7506E-02 .4634E-02
 .5609E-02 .5444E-02 .4545E-02 .3683E-02 .3114E-01 .6962E-02 .1620E-02 .1743E-01
 .9255E-02 .3427E-02 .5957E-02 .4374E-02 .2801E-02 .2802E-01 .6752E-02 .1625E-02
 .5833E-02 .4315E-02 .2777E-02 .1680E-01 .9063E-02 .3424E-02 .1778E-02 .2186E-02
 .2168E-02 .1731E-02 .3859E-01 .5812E-01 .5771E-01 .3534E-010.          0.
0.         0.         0.
 .7936E-02 .8534E-02 .8534E-02 .7936E-02 .9506E-02 .1036E-01 .1036E-01 .9506E-02
 .1210E-01 .1325E-01 .1325E-01 .1210E-01 .1266E-01 .1388E-01 .1388E-01 .1266E-01
 .1085E-01 .1186E-01 .1186E-01 .1085E-01 .7747E-02 .8395E-02 .8395E-02 .7747E-02
 .4860E-02 .5201E-02 .5201E-02 .4860E-02 .5870E-02 .5486E-02 .4448E-02 .2787E-02
 .7016E-02 .8255E-02 .8830E-02 .7817E-02 .8976E-02 .1105E-01 .1243E-01 .1152E-01
 .9639E-02 .1200E-01 .1366E-01 .1275E-01 .8646E-02 .1057E-01 .1182E-01 .1089E-01
 .6531E-02 .7580E-02 .7979E-02 .6950E-02 .5321E-02 .4899E-02 .3918E-02 .2422E-02
 .2788E-02 .4448E-02 .5486E-02 .5870E-02 .7818E-02 .8830E-02 .8254E-02 .7016E-02
 .1151E-01 .1243E-01 .1105E-01 .8976E-02 .1275E-01 .1366E-01 .1200E-01 .9638E-02
 .1089E-01 .1182E-01 .1057E-01 .8645E-02 .6950E-02 .7978E-02 .7579E-02 .6531E-02
 .2424E-02 .3921E-02 .4899E-02 .5320E-02 .1125E-01 .1832E-01 .1125E-01 .1130E-01
 .1590E-01 .1130E-01 .5508E-02 .6116E-02 .5508E-02 .9472E-02 .1502E-01 .9473E-02
 .5334E-02 .5907E-02 .5333E-02 .1059E-01 .1464E-01 .1059E-01 .7681E-02 .1401E-01
```

```
 .1351E-01 .6493E-02 .7702E-02 .1399E-01 .1349E-01 .6502E-020.          0.


0.         0.         0.
    1
0.          .1000E+04
    3
0.
 .1000E+00
 .4000E+00
 .1000E+01
    1    4    3
    5   28    2
   29   32    3
   33   56    2
   57   60    3
   61   84    2
   85  114    3
  115  115    1
    1     40.
    5    5 .5640E+02
    6    6 .6620E+02
    7    7 .6710E+02
    8    8 .6340E+02
    9    9 .2477E+03
   10   10 .2844E+03
   11   11 .2807E+03
   12   12 .2620E+03
   13   13 .3557E+03
   14   14 .3909E+03
   15   15 .3944E+03
   16   16 .3615E+03
   17   17 .1500E+03
   18   18 .1567E+03
   19   19 .1543E+03
   20   20 .1417E+03
   21   21 .3640E+02
   22   22 .3680E+02
   23   23 .3630E+02
   24   24 .2640E+02
   25   25 .4200E+01
   26   26 .3900E+01
   27   27 .3600E+01
   28   28 .2300E+01
   29    320.
   33   33 .3720E+02
   34   34 .2720E+02
   35   35 .1470E+02
   36   36 .2800E+01
   37   37 .1823E+03
   38   38 .1609E+03
   39   39 .8990E+02
   40   40 .2060E+02
   41   41 .3006E+03
   42   42 .2945E+03
   43   43 .1510E+03
   44   44 .3310E+02
   45   45 .1591E+03
   46   46 .1626E+03
   47   47 .7000E+02
   48   48 .1130E+02
   49   49 .2440E+02
   50   50 .2440E+02
```

```
 51    51 .3100E+01


 52    52 .5000E+00
 53    53 .1900E+01
 54    54 .1200E+01
 55    600.
 61    61 .2400E+01
 62    62 .1060E+02
 63    63 .2420E+02
 64    64 .3490E+02
 65    65 .1970E+02
 66    66 .8400E+02
 67    67 .1468E+03
 68    68 .1699E+03
 69    69 .3220E+02
 70    70 .1418E+03
 71    71 .2729E+03
 72    72 .3020E+03
 73    73 .1410E+02
 74    74 .7630E+02
 75    75 .1662E+03
 76    76 .1904E+03
 77    77 .5000E+00
 78    78 .8100E+01
 79    79 .3230E+02
 80    80 .4630E+02
 81    810.
 82    82 .3000E+00
 83    83 .1800E+01
 84    84 .5100E+01
 85   1150.
  1     4      20.
  5    28      3 .5980E+03
 29    32      20.
 33    56      3 .5980E+03
 57    60      20.
 61    84      3 .5980E+03
 85   114      20.
115   115      10.
```

```
      PROGRAM RADSOLV(INPUT,OUTPUT,TAPE1,TAPE2,TAPE3,TAPE4,TAPE5,TAPE6, 000100
     1  TAPE7=INPUT)                                                    000110
C                                                                       000111
C        THIS PROGRAM HAS WRITTEN BY                                    000120
C               M. ABRAMS                                               000130
C        THERMAL SCIENCES DIVISION                                      000140
C        SANDIA NATIONAL LABORATORIES                                   000150
C        LIVERMORE, CALIFORNIA 94550                                    000160
C                                                                       000161
      COMMON/PROP/XLAM(4),REFL(3,3),PHI(3),IREFL(120),GDRECT(120),IBC(12000170
     1            0),NBUS,NSET,RADNET(120),TEMP(120),POCTIN,QTOTL(120,2)000180
     2            ,EMP(120,3),IQROW(120),N                              000190
      COMMON/GEOM/KIND(120),X(120,4),W(120,120),NZB,NZC,NZT,NFIC,NZONE,N000200
     1            Q,B(120),IN(120),BB(120)                              000210
C                                                                       000211
C             TAPE ALLOCATIONS% TAPE1% CONFIGURATION FACTOR MATRIX STORED000230
C                            BY SUCCESSIVE ROWS                         000240
C                            TAPES 2--4% RESPECTIVELY, THE MATRIX       000250
C                            "R-INVERSE" FOR THE K-TH BAND. THE PROGRAM 000260
C                            IS DIMENSIONED FOR 3 BANDS, I.E., K=1 TO 3. 000270
C                            STORAGE IS BY SUCCESSIVE COLUMNS.          000271
C                            THE A-MATRIX FOR K-TH BAND IS ALSO STORED  000280
C                            ON THESE TAPES BUT BY SUCCESIVE ROWS.      000290
C                            (R-MATRIX DEFINED BY EQN(9))               000300
C                            (A-MATRIX DEFINED BY EQN(16))              000310
C                            TAPES 5,6% IRRADIATION DISTRIBUTIONS,      000320
C                            RESPECTIVELY, FOR IOPT=1,2                 000330
C                                                                       000340
C                                                                       000350
C                                                                       000360
C             SPECIFY TYPE OF ENCLOSURE GEOMETRY BEING CONSIDERED       000370
C             IGEOM=0 FOR CYLINDRICAL ENCLOSURE GEOMETRY                000380
C             IGEOM .NE. 0 FOR GENERAL ENCLOSURE GEOMETRY               000390
C                                                                       000391
      READ(7,500) IGEOM                                                 000400
  500 FORMAT(I5)                                                        000410
      IF(IGEOM.EQ.0) GO TO 100                                          000420
C                                                                       000430
C             FOR NON-CYLINDRICAL ENCLOSURES READ THE NO. OF ZONES AND  000440
C             THE ZONAL AREAS (UNITS% METER**2)                         000450
C                                                                       000451
      READ(7,500) NZONE                                                 000460
      READ(7,505) (X(I,4),I=1,NZONE)                                    000470
  505 FORMAT(8E10.4)                                                    000480
C                                                                       000490
C             ALSO, FOR NON-CYLINDRICAL ENCLOSURES, READ THE CONFIGUR-  000500
C             ATION FACTOR MATRIX [F-IJ] INTO THE WORK ARRAY W(I,J)     000510
C             ALSO, WE WRITE [F-IJ] TO TAPE 1 FOR STORAGE               000511
C                                                                       000512
      DO 50 I=1,NZONE                                                   000520
      READ(7,505) (W(I,J),J=1,NZONE)                                    000530
      WRITE(1) (W(I,J),J=1,NZONE)                                       000540
   50 CONTINUE                                                          000550
      REWIND 1                                                          000551
      GO TO 200                                                         000560
C                                                                       000561
  100 CALL CYLINDR                                                      000570
```



```
      CALL ENCLOSE                                                      000580
  200 CALL PROP                                                         000600
      CALL RADIST(1)                                                    000610
      CALL THERMAL(0)                                                   000620
      CALL RADIST(2)                                                    000630
      END                                                               000640
```

```
     SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
20444  RADSOLV        1

VARIABLES       SN  TYPE            RELOCATION
35236  B            REAL        ARRAY    GEOM        REFS        13
35616  BB           REAL        ARRAY    GEOM        REFS        13
 1533  EMP          REAL        ARRAY    PROP        REFS        10
  210  GDRECT       REAL        ARRAY    PROP        REFS        10
20620  I            INTEGER                          REFS        42     51      52    DEFINED     43      50
  400  IBC          INTEGER     ARRAY    PROP        REFS        10
20617  IGEOM        INTEGER                          REFS        37   DEFINED   35
35426  IN           INTEGER     ARRAY    GEOM        REFS        13
 2303  IQROW        INTEGER     ARRAY    PROP        REFS        10
   20  IREFL        INTEGER     ARRAY    PROP        REFS        10
20621  J            INTEGER                          REFS        51     52    DEFINED     51      52
    0  KIND         INTEGER     ARRAY    GEOM        REFS        13
 2473  N            INTEGER              PROP        REFS        10
  570  NBUS         INTEGER              PROP        REFS        10
35233  NFIC         INTEGER              GEOM        REFS        13
35235  NQ           INTEGER              GEOM        REFS        13
  571  NSET         INTEGER              PROP        REFS        10
35230  NZB          INTEGER              GEOM        REFS        13
35231  NZC          INTEGER              GEOM        REFS        13
35234  NZONE        INTEGER              GEOM        REFS        13     43      50      51      52
                                                  DEFINED        42
35232  NZT          INTEGER              GEOM        REFS        13
 1152  POCTIN       REAL                 PROP        REFS        10
   15  PHI          REAL        ARRAY    PROP        REFS        10
 1153  QTOTL        REAL        ARRAY    PROP        REFS        10
  572  RADNET       REAL        ARRAY    PROP        REFS        10
    4  REFL         REAL        ARRAY    PROP        REFS        10
  762  TEMP         REAL        ARRAY    PROP        REFS        10
 1130  W            REAL        ARRAY    GEOM        REFS        13     52    DEFINED     51
  170  X            REAL        ARRAY    GEOM        REFS        13   DEFINED   43
    0  XLAM         REAL        ARRAY    PROP        REFS        10

FILE NAMES          MODE
    0  INPUT
 2043  OUTPUT
 4106  TAPE1        UNFMT                    WRITES      52      MOTION      54
 6151  TAPE2
10214  TAPE3
12257  TAPE4
14322  TAPE5
```

```
FILE NAMES       MODE
16365  TAPE6
    0  TAPE7      FMT                 READS      35        42        43        51

EXTERNALS           TYPE   ARGS         REFERENCES
       CYLINDR               0             57
       ENCLOSE               0             58
       PROP                  0             59
       RADIST                1             60        62
       THERMAL               1             61

STATEMENT LABELS              DEF LINE   REFERENCES
    0  50                        53         50
20526  100                       57         37
20533  200                       59         55
20560  500      FMT              36         35        42
20574  505      FMT              44         43        51

LOOPS  LABEL    INDEX     FROM-TO     LENGTH     PROPERTIES
20463  50      * I         50 53       37B                   EXT REFS  NOT INNER
20466          * J         51 51       11B                   EXT REFS
20504          * J         52 52       11B                   EXT REFS

COMMON BLOCKS   LENGTH
       PROP       1340
       GEOM      15366

STATISTICS
  PROGRAM LENGTH                 172B      122
  BUFFER LENGTH                20430B     8472
  CM LABELED COMMON LENGTH     40502B    16706
```



```
      SUBROUTINE CONFIG (ITYP,F12,PARAM)                                000650
C                                                                       000660
C     THIS PROGRAM WAS WRITTEN BY                                       000670
C           M. ABRAMS                                                   000680
C     THERMAL SCIENCES DIVISION                                         000690
C     SANDIA NATIONAL LABORATORIES                                      000700
C     LIVERMORE, CALIFORNIA 94550                                       000710
C                                                                       000720
C                                                                       000730
C          THIS SUBROUTINE DETERMINES THE CONFIGURATION FACTOR BETWEEN  000740
C          TWO FINITE-SIZED DIFFUSE SURFACES FROM ANALYTICAL            000750
C          SOLUTIONS.                                                   000751
C             F12..............CONFIGURATION FACTOR BETWEEN SURFACES    000760
C             ITYP.............INDEX SPECIFYING THE CONFIGURATION OF    000770
C                              THE SURFACES WITH RESPECT TO EACH OTHER  000780
C             ITYP=1...........1-ST SURFACE%  SEGMENT OF CYLINDER       000790
C                              2-ND SURFACE%  SEGMENT OF CYLINDER       000900
C             ITYP=2...........SPECIAL CASE OF ITYP=1.  A SEGMENT OF A  000810
C                              CYLINDER WHICH VIEWS ITSELF              000820
C             ITYP=3...........1-ST SURFACE% SEGMENT OF CYLINDER        000830
C                              2-ND SURFACE% RING IN END OF CYLINDER    000840
C             ITYP=4...........1-ST SURFACE% SEGMENT OF CYLINDER        000850
C                              2-ND SURFACE%  ENTIRE END OF CYLINDER    000860
C             ITYP=5...........1-ST SURFACE% RING IN END OF CYLINDER    000870
C                              2-ND SURFACE% RING IN OPPOSITE END       000880
C             ITYP=6...........1-ST SURFACE% DISC                       000890
C                              2-ND SURFACE% CO-AXIAL DISC              000900
C                              (THE DISCS LIE IN OPPOSITE ENDS OF A CYL 000910
C                              INDER)                                   000920
C             ITYP=7...........1-ST SURFACE% RING IN END OF CYLINDER    000930
C                              2-ND SURFACE% SEGMENT OF CYLINDER        000940
C                              (INVERSE OF ITYP=3)                      000950
C             ITYP=8...........1-ST SURFACE% END OF CYLINDER            000960
C                              2-ND SURFACE% SEGMENT OF CYLINDER        000970
C                              (INVERSE OF ITYP=4)                      000980
C             ITYP=9...........1-ST SURFACE% RING IN END OF CYLINDER    000990
C                              2-ND SURFACE% CO-AXIAL DISC IN OPPOSITE  001000
C                              END                                      001010
C             ITYP=10..........1-ST SURFACE% DISC IN END OF CYLINDER    001020
C                              2-ND SURFACE% CO-AXIAL RING IN OPPOSITE  001030
C                              END. (INVERSE OF ITYP=9)                 001040
C             PARAM............ARRAY OF GEOMETRICAL PARAMETERS. THESE   001050
C                              ARE DEFINED BELOW.                       001060
C                                                                       001061
      DIMENSION PARAM(10)                                               001070
      GO TO (10,20,30,30,50,50,30,30,50,50),ITYP                        001080
C                                                                       001081
   10 CONTINUE                                                          001090
C                                                                       001091
C        CONFIGURATION 1 (SEGMENT-TO-SEGMENT)                           001100
C             PARAM(1)....THE DIAMETER-TO-LENGTH RATIO OF CYLINDER (D/L) 001110
C             PARAM(2)....RATIO H1/L WHERE H1 IS THE HEIGHT OF 1-ST SEG- 001120
C                         MENT                                          001130
C             PARAM(3)....RATIO W/L WHERE W IS THE SEPARATION BETWEEN THE001140
C                         1-ST AND 2-ND SEGMENTS                        001150
C             PARAM(4)....RATIO H2/L WHERE H2 IS THE HEIGHT OF 2-ND SEG- 001160
C                         MENT                                          001170
```

```
      D=PARAM(1)                                                        001180
      H1=PARAM(2)                                                       001190
      W=PARAM(3)                                                        001200
      H2=PARAM(4)                                                       001210
      WH12=(W+H1)**2                                                    001220
      WH22=(W+H2)**2                                                    001230
      W2=W**2                                                           001240
      D2=D**2                                                           001250
      WH1H22=(W+H1+H2)**2                                               001260
      QUANT=0.                                                          001270
      IF(W.GT.0.) QUANT=W2*SQRT(1.+D2/W2)                               001280
      F12=(.5/(D*H1))*(WH12*SQRT(1.+D2/WH12) +2.*H1*H2                  001290
     1                  -QUANT            -WH1H22*SQRT(1.+D2/WH1H22)    001300
     2                  +WH22* SQRT(1.+D2/WH22))                        001310
      RETURN                                                            001320
C                                                                       001321
   20 CONTINUE                                                          001330
C        CONFIGURATION 2 (SEGMENT TO ITSELF)                            001340
C           PARAM(1).....THE DIAMETER-TO-LENGTH RATIO OF CYLINDER (D/L) 001350
C           PARAM(2).....THE RATIO H/L WHERE H IS HEIGHT OF SEGMENT     001360
      D=PARAM(1)                                                        001370
      H=PARAM(2)                                                        001380
      F12=(1.+H/D)-SQRT(1.+(H/D)**2)                                    001390
      RETURN                                                            001400
C                                                                       001401
   30 CONTINUE                                                          001410
C        CONFIGURATION 3  (SEGMENT-TO-RING)                             001420
C              PARAM(1).......THE DIAMETER-TO-LENGTH RATIO OF CYLINDER  001430
C                             (D/L)                                     001440
C              PARAM(2).......THE RATIO  H/L WHERE H IS HEIGHT OF SEG-  001450
C                             MENT                                      001460
C              PARAM(3).......RATIO W/L WHERE W IS DISTANCE BETWEEN     001470
C                             BOTTOM EDGE OF SEGMENT AND BASE OF        001480
C                             CYLINDER                                  001490
C              PARAM(4).......RATIO R2/A WHERE R2 IS RADIUS OF INSIDE OF001500
C                             RING.    A IS RADIUS OF CYLINDER          001510
C              PARAM(5).......RATIO R1/A WHERE R1 IS RADIUS OF OUTSIDE  001520
C                             OF RING                                   001530
      D=PARAM(1)                                                        001540
      H=PARAM(2)                                                        001550
      W=PARAM(3)                                                        001560
      W2=W**2                                                           001570
      D2=D**2                                                           001580
      WPH2=(W+H)**2                                                     001590
      IF((ITYP.EQ.4).OR.(ITYP.EQ.8))GO TO 40                            001600
      R2=PARAM(4)                                                       001610
      R1=PARAM(5)                                                       001620
      W4=W2**2                                                          001630
      D4=D2**2                                                          001640
      WPH4=WPH2**2                                                      001650
      OPR1SQ=1.+R1**2                                                   001660
      OMR1SQ=1.-R1**2                                                   001670
      OPR2SQ=1.+R2**2                                                   001680
      OMR2SQ=1.-R2**2                                                   001690
      F12=(.5/(D*H))*(SQRT(WPH4+.5*D2*WPH2*OPR1SQ+D4*OMR1SQ**2/16.)     001700
     1                -SQRT(WPH4+.5*D2*WPH2*OPR2SQ+D4*OMR2SQ**2/16.)    001710
     2              +SQRT(W4+.5*D2*W2*OPR2SQ+D4*OMR2SQ**2/16.)          001720
```



```
     3                -SQRT(W4+.5*D2*W2*OPR1SQ+D4*OMR1SQ**2/16.) )      001730
      IF(ITYP.EQ.7) GO TO 70                                            001740
      RETURN                                                            001750
C                                                                       001751
   40 CONTINUE                                                          001760
C        IN CONFIGURATION 4 (SEGMENT-TO-BASE)                           001770
C           PARAM(1,2,3)...DEFINED FOLLOWING STATEMENT 30               001780
C           PARAM(4,5).....NOT USED                                     001790
      QUANT=0.                                                          001800
      IF(W.GT.0.)QUANT=W2*SQRT(1.+D2/W2)                                001810
      F12=(.5/(D*H))*( WPH2 *SQRT(1.+D2/WPH2)-2.*W*H -H**2              001820
     1                  -QUANT     )                                    001830
      IF(ITYP.EQ.8) GO TO 80                                            001840
      RETURN                                                            001850
C                                                                       001851
   50 CONTINUE                                                          001860
C        CONFIGURATION 5  (RING-TO-RING)                                001870
C             PARAM(1)......DIAMETER-TO-LENGTH RATIO OF CYLINDER        001880
C             PARAM(2)......RATIO R2/A...R2 IS OUTER RADIUS OF 1-ST     001890
C                           RING.     A IS RADIUS OF CYLINDER.          001900
C             PARAM(3)......RATIO R1/A...R1 IS INNER RADIUS OF 1-ST     001910
C                           RING                                        001920
C             PARAM(4)......RATIO R3/A...R3 IS INNER RADIUS OF 2-ND     001930
C                           RING                                        001940
C             PARAM(5)......RATIO R4/A...R4 IS OUTER RADIUS OF 2-ND     001950
C                           RING                                        001960
      D=PARAM(1)                                                        001970
      D2=D**2                                                           001980
      R2=PARAM(2)                                                       001990
      R2SQ=R2**2                                                        002000
      R4=PARAM(5)                                                       002010
      R4SQ=R4**2                                                        002020
      IF(ITYP.EQ.6)GO TO 60                                             002030
      R1=PARAM(3)                                                       002040
      R1SQ=R1**2                                                        002050
      IF((ITYP.EQ.9).OR.(ITYP.EQ.10)) GO TO 90                          002060
      R3=PARAM(4)                                                       002070
      R3SQ=R3**2                                                        002080
      F12=(2./(D2*(R2SQ-R1SQ)))*(                                       002090
     1SQRT((.25*D2*R2SQ+.25*D2*R3SQ+1.)**2-(.5*D2*R3*R2)**2 )  -        002100
     2SQRT((.25*D2*R2SQ+.25*D2*R4SQ+1.)**2-(.5*D2*R2*R4)**2 )  +        002110
     3SQRT((.25*D2*R1SQ+.25*D2*R4SQ+1.)**2-(.5*D2*R1*R4)**2 )  -        002120
     4SQRT((.25*D2*R1SQ+.25*D2*R3SQ+1.)**2-(.5*D2*R1*R3)**2 )   )       002130
      RETURN                                                            002140
C                                                                       002141
   60 CONTINUE                                                          002150
C        IN CONFIGURATION 6 (DISC-TO-DISC)                              002160
C           PARAM(1).......DEFINED FOLLOWING STATEMENT 50               002170
C           PARAM(2).......RATIO R2/A. R2 IS RADIUS OF FIRST DISC       002180
C           PARAM(3).......NOT USED                                     002190
C           PARAM(4).......NOT USED                                     002200
C           PARAM(5).......RATIO R4/A. R4 IS RADIUS OF SECOND DISC      002210
      QUANT=R2SQ+R4SQ+4./D2                                             002220
      F12=(.5/R2SQ)*(QUANT-SQRT(QUANT**2-4.*R2SQ*R4SQ))                 002230
      RETURN                                                            002240
C                                                                       002241
   70 CONTINUE                                                          002250
```

```
      C        CONFIGURATION 7 (RING-TO-SEGMENT.                               002260
      C        DEFINITION OF PARAMETERS GIVEN FOLLOWING STATEMENT 30           002270
            F12=F12*4.*H/(D*(R1**2-R2**2))                                     002280
            RETURN                                                             002290
      C                                                                        002291
         80 CONTINUE                                                           002300
      C        CONFIGURATION 8 (BASE-TO-SEGMENT)                               002310
      C        DEFINITION OF PARAMETERS GIVEN FOLLOWING STATEMENTS 30 AND 40   002320
            F12=F12*4.*H /D                                                    002330
            RETURN                                                             002340
      CC                                                                       002341
      C        IN CONFIGURATIONS 9 AND 10                                      002350
      C            PARAM(1)......DEFINED FOLLOWING STATEMENT 50                002360
      C            PARAM(2)......RATIO R2/A. R2 IS OUTER RADIUS OF RING        002370
      C            PARAM(3)......RATIO R1/A. R1 IS INNER RADIUS OF RING        002380
      C            PARAM(4)......NOT USED                                      002390
      C            PARAM(5)......RATIO R4/A. R4 IS RADIUS OF DISC              002400
      C                                                                        002401
         90 CONTINUE                                                           002410
            F12=(.5/(R2SQ-R1SQ))*((R2SQ-R1SQ)                                  002420
           1-SQRT((R2SQ+R4SQ+4./D2)**2-(2.*R2*R4)**2)                          002430
           2+SQRT((R1SQ+R4SQ+4./D2)**2-(2.*R1*R4)**2))                         002440
            IF(ITYP.EQ.10) GO TO 100                                           002450
            RETURN                                                             002460
      C                                                                        002461
        100 F12=F12*((R2SQ-R1SQ)/R4SQ)                                         002470
            RETURN                                                             002480
            END                                                                002490
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS    DEF LINE    REFERENCES
   4  CONFIG         1        72       81      117      128      158      169      175      181      195      198

VARIABLES       SN  TYPE          RELOCATION
  604  D            REAL                        REFS      65       69     2*80      100      112      125      142
                                                 174      180  DEFINED       58       78       96      141
  613  D2           REAL                        REFS      68     3*69      106    4*112      124      125   13*153
                                                 167    2*191  DEFINED       65      100      142
  623  D4           REAL                        REFS   4*112  DEFINED      106
    0  F12          REAL               F.P.     REFS     174      180      197  DEFINED        1       69       80
                                                 112      125      153      168      174      180      191      197
  616  H            REAL                        REFS    2*80      101      112    3*125      174      180
                                             DEFINED      79       97
  605  H1           REAL                        REFS      62       66     2*69  DEFINED       59
  607  H2           REAL                        REFS      63       66       69  DEFINED       61
    0  ITYP         INTEGER            F.P.     REFS      46    2*102      116      127      147    2*150      194
                                             DEFINED       1
  626  OMR1SQ       REAL                        REFS   2*112  DEFINED      109
  630  OMR2SQ       REAL                        REFS   2*112  DEFINED      111
  625  OPR1SQ       REAL                        REFS   2*112  DEFINED      108
  627  OPR2SQ       REAL                        REFS   2*112  DEFINED      110
    0  PARAM        REAL       ARRAY   F.P.     REFS      45       58       59       60       61       78       79
```



```
VARIABLES       SN  TYPE          RELOCATION
                                                  96       97  [illegible]   103      104      141      143      145
                                                 148      151  DEFINED        1
  615  QUANT        REAL                        REFS      69      125    2*168  DEFINED       67       68      123
                                                 124      167
  621  R1           REAL                        REFS     108      109      149    2*153      174      191
                                             DEFINED     104      148
  634  R1SQ         REAL                        REFS   3*153    3*191      197  DEFINED      149
  620  R2           REAL                        REFS     110      111      144    2*153      174      191
                                             DEFINED     103      143
  631  R2SQ         REAL                        REFS   3*153      167    2*168    3*191      197
                                             DEFINED     144
  635  R3           REAL                        REFS     152    2*153  DEFINED      151
  636  R3SQ         REAL                        REFS   2*153  DEFINED      152
  632  R4           REAL                        REFS     146    2*153    2*191  DEFINED      145
  633  R4SQ         REAL                        REFS   2*153      167      168    2*191      197
                                             DEFINED     146
  606  W            REAL                        REFS      62       63       64       66       68       99      101
                                                 124      125  DEFINED       60       98
  614  WH1H22       REAL                        REFS    2*69  DEFINED       66
  610  WH12         REAL                        REFS    2*69  DEFINED       62
  611  WH22         REAL                        REFS    2*69  DEFINED       63
  617  WPH2         REAL                        REFS     107    2*112    2*125  DEFINED      101
  624  WPH4         REAL                        REFS   2*112  DEFINED      107
  612  W2           REAL                        REFS    2*68      105    2*112    2*124  DEFINED       64       99
  622  W4           REAL                        REFS   2*112  DEFINED      105

EXTERNALS           TYPE    ARGS        REFERENCES
      SQRT          REAL      1 LIBRARY     68     3*69       80    4*112      124      125    4*153      168    2*191

STATEMENT LABELS           DEF LINE   REFERENCES
   26  10                      48        46
  125  20                      74        46
  145  30                      83      4*46
  300  40                     119       102
  334  50                     130      4*46
  456  60                     160       147
  477  70                     171       116
  507  80                     177       127
  515  90                     130       150
  551  100                    197       194

STATISTICS
  PROGRAM LENGTH               637B       415
```

```
      SUBROUTINE CYLINDR                                                002500
C                                                                       002510
C        THIS PROGRAM WAS WRITTEN BY                                    002520
C             M. ABRAMS                                                 002530
C        THERMAL SCIENCES DIVISION                                      002540
C        SANDIA NATIONAL LABORATORIES                                   002550
C        LIVERMORE, CALIFORNIA 94550                                    002560
C                                                                       002570
C        THIS SUBROUTINE READS IN THE GEOMETRICAL DATA FOR THE ZONES OF 002580
C        A CYLINDRICAL ENCLOSURE, DETERMINES THE ,,KIND,, OF EACH ZONE, 002590
C        AND THEN DETERM,NES THE GEOMETRICAL PARAMETERS OF              002600
C        EACH ZONE NECESSARY TO CALCULATE THE CONFIGURATION             002610
C        FACTOR MATRIX  USING SUBROUTINE CONFIG. THE REQURED            002620
C        PARAMETERS ARE STORED IN THE ARRAY X(I,J). THE DEFINITIONS     002630
C        OF  X(I,J) AND "KIND" ARE GIVEN IN SUBROUTINE ENCLOSE.         002640
C                                                                       002650
      COMMON/GEOM/KIND(120),X(120,4),W(120,120),NZB,NZC,NZT,NFIC,NZONE,N002660
     1         Q,B(120),IN(120),BB(120)                                 002670
C             D..............DIAMETER OF CYLINDER (METERS)              002760
C             L..............LENGTH OF CYLINDER (METERS)                002770
C             NZB............NO. OF ZONES IN BASE OF CYLINDER           002780
C             NZC............NO. OF ZONES IN CYLINDRICAL SURFACE        002790
C             NZT............NO. OF ZONES IN TOP OF CYLINDER            002800
C             NZONE..........TOTAL NO. OF ZONES IN CYLINDRICAL ENCLOSURE 002830
C                                                                       002840
      TYPE REAL L                                                       002850
      DIMENSION R(61),Z(61)                                             002860
      DATA PI/3.141592654/                                              002870
C                                                                       002871
      PRINT 601                                                         002880
601   FORMAT(//39X,*GEOMETRICAL DATA THAT HAVE BEEN INPUT (DIMENSIONS IN002890
     1 METERS)*//)                                                      002900
C                                                                       002901
      READ(7,500) D,L                                                   002910
  500 FORMAT(8E10.4)                                                    002920
      PRINT 600,D,L                                                     002930
  600 FORMAT(//5X,*DIAMETER OF CYLINDER*,F10.4/5X,*LENGTH OF CYLINDER*, 002940
     1F10.4)                                                            002950
      DOL=D/L                                                           002960
C                                                                       002961
      READ(7,505) NZB,NZC,NZT                                           002970
  505 FORMAT(5I5)                                                       002980
      NZONE=NZB+NZC+NZT                                                 002990
      PRINT 605,NZB,NZC,NZT                                             003000
  605 FORMAT(//10X,*NO. ZONES IN BASE*,I5,5X,*NO. OF ZONES IN CYLINDER*,003010
     1I5,5X,*NO. ZONES IN TOP*,I5)                                      003020
C                                                                       003030
C        READ AND PRINT RADII OF ZONES IN BASE OF CYLINDER.             003040
C        THE "BASE" IS DEFINED AS THE END WITH THE APERTURE.            003050
C        THE ZONES ARE NUMBERED SUCH THAT ZONE NO. 1 IS A DISC IN THE   003060
C        CENTER OF THE BASE, AND ZONE NO. NZB IS AN ANNULAR RING WHOSE  003070
C        OUTER RADIUS IS THE RADIUS OF THE CYLINDER.                    003080
C                                                                       003090
      N=NZB+1                                                           003100
      READ(7,500) (R(I),I=1,N)                                          003110
      PRINT 510,(R(I),I=1,N)                                            003120
  510 FORMAT(//10X,*RADII OF ZONES IN BASE OF CYLINDER*/15X,8F10.4/15X, 003130
```



```
     1         8F10.4/15X,8F10.4)                                       003140
C                                                                       003150
C          HERE WE SET THE KIND AND THE GEOMETRICAL PARAMETERS OF EACH  003160
C          ZONE IN THE BASE OF THE CYLINDER. KIND IS AN INDEX WHICH     003170
C          SPECIFIES THE GEOMETRICAL SHAPE OF THE I-TH ZONE. KIND AND THE003180
C          ARRAY X  ARE DEFINED IN THE SUBROUTINE ENCLOSE.              003190
C                                                                       003200
      DO 10 I=1,NZB                                                     003210
      KIND(I)=3                                                         003220
      IF(I.EQ.1)KIND(I)=1                                               003230
      X(I,1)=R(I+1)/(D/2.)                                              003240
      X(I,2)=R(I)/(D/2.)                                                003250
      X(I,3)=DOL                                                        003260
      X(I,4)=PI*(R(I+1)**2-R(I)**2)                                     003270
   10 CONTINUE                                                          003280
C                                                                       003290
C C      READ AND PRINT THE ELEVATIONS OF PLANES WHICH DIVIDE THE CYLINDR003300
C        INTO SEGMENTS. THE ELEVATIONS ARE NUMBERED SUCH THAT THE FIRST 003310
C        PLANE LIES IN THE LOWER END OF CYLINDER, AND THE ELEVATION NZC+1003320
C        LIES IN THE UPPER END OF THE CYLINDER.                         003330
C                                                                       003340
      N=NZC+1                                                           003350
      READ(7,500) (Z(I),I=1,N)                                          003360
      PRINT 515,(Z(I),I=1,N)                                            003370
  515 FORMAT(//10X,*ELEVATIONS OF PLANES WHICH DIVIDE THE CYLINDRICAL SU003380
     :RFACE INTO SEGMENTS*/15X,8F10.4/15X,8F10.4/15X,8F10.4)            003390
C                                                                       003400
C        HERE WE SET THE KIND AND GEOMETRICAL PARAMETERS OF EACH ZONE   003410
C        ON CYLINDER.                                                   003420
C                                                                       003430
      DO 20 II=1,NZC                                                    003440
      I=II+NZB                                                          003450
      KIND(I)=5                                                         003460
      X(I,1)=Z(II)/L                                                    003470
      X(I,2)=(Z(II+1)-Z(II))/L                                          003480
      X(I,3)=DOL                                                        003490
      X(I,4)=PI*D*L*X(I,2)                                              003500
   20 CONTINUE                                                          003510
C                                                                       003520
C        READ AND PRINT RADII OF ZONES IN UPPER END-PLANE OF CYLINDER   003530
C                                                                       003540
      N=NZT+1                                                           003550
      READ(7,500) (R(I),I=1,N)                                          003560
      PRINT 520,(R(I),I=1,N)                                            003570
  520 FORMAT(//10X,*RADII OF ZONES IN UPPER END-PLANE OF CYLINDER*/     003580
     1         15X,8F10.4/15X,8F10.4/15X,8F10.4)                        003590
C                                                                       003600
C        HERE WE SET KIND AND GEOMETRICAL PARAMETERS OF EACH ZONE ON    003610
C        UPPER END PLANE ON CYLINDER.                                   003620
C                                                                       003630
      DO 30 II=1,NZT                                                    003640
      I=II+NZB+NZC                                                      003650
      KIND(I)=4                                                         003660
      IF(II.EQ.NZT)KIND(I)=2                                            003670
      X(I,1)=R(NZT+2-II)/(D/2.)                                         003680
      X(I,2)=R(NZT+1-II)/(D/2.)                                         003690
      X(I,3)=DOL                                                        003700
```

```
              X(I,4)=.25*PI*D**2*(X(I,1)**2-X(I,2)**2)                  003710
           30 CONTINUE                                                  003720
        C                                                               003740
        C      NOW WE DRAW THE ZONES OF THE ENCLOSURE IF THE PLOT OPTION HAS   003750
        C      BEEN SELECTED.                                           003760
        C      THE SNLL VERSION OF RADSOLVER INCLUDES PLOTTING PACKAGE HERE.  003770
        C                                                               003780
              RETURN                                                    003790
              END                                                       003800
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    2  CYLINDR        1           122

VARIABLES        SN  TYPE             RELOCATION
35236  B             REAL       ARRAY    GEOM        REFS       17
35616  BB            REAL       ARRAY    GEOM        REFS       17
  421  D             REAL                            REFS       36       39       68       69       94      112      113
                                                      115  DEFINED       34
  422  DOL           REAL                            REFS       70       93      114  DEFINED       39
  424  I             INTEGCR                         REFS       55       56       66     2*67     2*68     2*69       70
                                                     3*71       80       81       90       91       92       93     2*94
                                                      100      101      110      111      112      113      114    3*115
                                                  DEFINED       55       56       65       80       81       89      100
                                                      101      109
  425  II            INTEGER                         REFS       89       91     2*92      109      111      112      113
                                                  DEFINED       88      108
35426  IN            INTEGER    ARRAY    GEOM        REFS       17
    0  KIND          INTEGER    ARRAY    GEOM        REFS       17  DEFINED       66       67       90      110      111
  420  L             REAL                            REFS       26       36       39       91       92       94
                                                  DEFINED       34
  423  N             INTEGER                         REFS       55       56       80       81      100      101
                                                  DEFINED       54       79       99
35233  NFIC          INTEGER             GEOM        REFS       17
35235  NQ            INTEGER             GEOM        REFS       17
35230  NZB           INTEGER             GEOM        REFS       17       43       44       54       65       89      109
                                                  DEFINED       41
35231  NZC           INTEGER             GEOM        REFS       17       43       44       79       88      109
                                                  DEFINED       41
35234  NZONE         INTEGER             GEOM        REFS       17  DEFINED       43
35232  NZT           INTEGER             GEOM        REFS       17       43       44       99      108      111      112
                                                      113  DEFINED       41
  227  PI            REAL                            REFS       71       94      115  DEFINED       28
  426  R             REAL       ARRAY                REFS       27       56       68       69     2*71      101      112
                                                      113  DEFINED       55      100
 1130  W             REAL       ARRAY    GEOM        REFS       17
  170  X             REAL       ARRAY    GEOM        REFS       17       94    2*115  DEFINED       68       69       70
                                                       71       91       92       93       94      112      113      114
                                                      115
  523  Z             REAL       ARRAY                REFS       27       81       91     2*92  DEFINED       80
```



```
FILE NAMES         MODE
       OUTPUT     FMT                      WRITES      30       36       44       56       81      101
       TAPE7      FMT                       READS      34       41       55       80      100

STATEMENT LABELS               DEF LINE    REFERENCES
    0  10                         72          65
    0  20                         95          88
    0  30                        116         108
  252  500       FMT              35          34          55       80      100
  300  505       FMT              42          41
  333  510       FMT              57          56
  355  515       FMT              82          81
  403  520       FMT             102         101
  261  600       FMT              37          36
  233  601       FMT              31          30
  310  605       FMT              45          44

LOOPS  LABEL    INDEX      FROM-TO      LENGTH     PROPERTIES
   44  10       I           65 72        30B          OPT
  115  20       II          88 95        31B          OPT
  167  30       II         108 116       37B          OPT

COMMON BLOCKS   LENGTH
       GEOM     15366

STATISTICS
  PROGRAM LENGTH                 620B      400
  CM LABELED COMMON LENGTH     36006B    15366
```

```
      SUBROUTINE ENCLOSE                                                003810
C                                                                       003820
C     THIS PROGRAM WAS WRITTEN BY                                       003830
C             M. ABRAMS                                                 003840
C     THERMAL SCIENCES DIVISION                                         003850
C     SANDIA NATIONAL LABORATORIES                                      003860
C     LIVERMORE, CALIFORNIA 94550                                       003870
C                                                                       003880
C       THIS SUBROUTINE TAKES THE GEOMETRICAL DATA (THE ARRAYS KIND AND 003890
C       X) FROM THE SUBROUTINE CYLINDR AND THEN COMPUTES (BY CALLING THE003900
C       SUBROUTINE CONFIG) THE CONFIGURATION FACTOR BETWEEN EACH PAIR OF003910
C       ZONES.                                                          003920
C                                                                       003930
C       W(I,J).........UPON COMPETION OF THIS SUBROUTINE W(I,J)         003940
C                      CONTAINS THE CONFIGURATION FACTOR MATRIX.        003950
C                      THE 2-D ARRAY W(I,J)   IS THEN WRITTEN TO TAPE1 003960
C       KIND(I)........INDEX WHICH DESIGNATES THE TYPE OF THE I-TH ZONE003970
C                            =1....DISC WHICH LIES IN LOWER END-PLANE   003980
C                                  OF CYLINDER. DISC AND CYLINDER ARE   003990
C                                  CO-AXIAL.                            004000
C                            =2....DISC WHICH LIES IN UPPER END PLANE OF004010
C                                  CYLINDER.                            004020
C                            =3....ANNULAR RING WHICH LIES IN LOWER END-004030
C                                  PLANE OF CYLINDER                    004040
C                            =4....ANNULAR RING WHICH LIES IN UPPER END-004050
C                                  PLANE OF CYLINDER                    004060
C                            =5....SEGMENT OF CYLINDER                  004070
C                                                                       004071
C          X(I,J).........COORDINATES OF I-TH ZONE DEFINED AS FOLLOWS% 004080
C              KIND(I) .       X(I,1)     X(I,2)     X(I,3)     X(I,4)  004090
C              =======================================================004100
C              1 OR 2  .       R/A        0.         D/L        AREA    004110
C              3 OR 4  .       RO/A       RI/A       D/L        AREA    004120
C              5       .       W/L        H/L        D/L        AREA    004130
C                                WHERE                                  004140
C                                  R.....RADIUS OF DISC                 004150
C                                  RO....OUTER RADIUS OF ANNULAR RING   004160
C                                  RI....INNER RADIUS OF ANNULAR RING   004170
C                                  A.....RADIUS OF CYLINDER             004180
C                                  W.....DISTANCE FROM BOTTOM EDGE OF   004190
C                                        SEGMENT TO BASE OF CYLINDER    004200
C                                  L.....LENGTH OF CYLINDER             004210
C                                  H.....HEIGHT OF SEGMENT              004220
C                                  AREA..AREA OF ZONE                   004230
C                                  (ALL DIMENSIONS ARE IN METERS)       004240
C                                                                       004241
      COMMON/GEOM/KIND(120),X(120,4),W(120,120),NZB,NZC,NZT,NFIC,NZONE,N004250
     1          Q,B(120),IN(120),BB(120)                                004260
C                                                                       004341
      DIMENSION PARAM(10)                                               004350
      DO 100 I=1,NZONE                                                  004360
      JMIN=I                                                            004370
C                                                                       004371
C        IN THIS LOOP WE DETERMINE THE ARRAY "PARAM" WHICH IS USED      004380
C        IN THE COMPUTATION OF THE CONFIGURATION FACTOR IN SUBROUTINE   004381
C        CONFIG. HERE "PARAM" IS FOUND FOR ZONES I AND J WHERE J > OR = I004382
C        THE CONFIGURATION FACTORS FOR THE CASE J<I IS                  004383
```



```
C        DETERMINED IN THE NEXT LOOP BY RECIPROCITY.                    004384
C                                                                       004421
      DO  90 J=JMIN,NZONE                                               004430
      IF((KIND(J).EQ.1).OR.(KIND(J).EQ.3).OR.(KIND(I).EQ.4).OR.         004440
     1     (KIND(I).EQ.2)) GO TO 51                                     004450
      IF(((KIND(I).EQ.1).OR.(KIND(I).EQ.3)).AND.(KIND(J).EQ.5)) GO TO 37004460
      IF(((KIND(I).EQ.1).OR.(KIND(I).EQ.3)).AND.((KIND(J).EQ.2).OR.     004470
     1     (KIND(J).EQ.4))) GO TO 35                                    004480
      IF((KIND(I).EQ.5).AND.(J.EQ.I)) GO TO 32                          004490
      IF((KIND(I).EQ.5).AND.(KIND(J).EQ.5)) GO TO 31                    004500
      IF((KIND(I).EQ.5).AND.((KIND(J).EQ.4).OR.(KIND(J).EQ.2)))GO TO 33 004510
C         DISC (OR RING)-TO-SEGMENT                                     004520
   37 ITYP=7                                                            004530
      PARAM(1)=X(J,3)                                                   004540
      PARAM(2)=X(J,2)                                                   004550
      PARAM(3)=X(J,1)                                                   004560
      PARAM(4)=X(I,2)                                                   004570
      PARAM(5)=X(I,1)                                                   004580
      GO TO 45                                                          004590
C         DISC (OR RING)-TO-DISC (OR RING)                              004600
   35 ITYP=5                                                            004610
      PARAM(1)=X(I,3)                                                   004620
      PARAM(2)=X(I,1)                                                   004630
      PARAM(3)=X(I,2)                                                   004640
      PARAM(4)=X(J,2)                                                   004650
      PARAM(5)=X(J,1)                                                   004660
      GO TO 45                                                          004670
C         SEGMENT TO ITSELF                                             004680
   32 ITYP=2                                                            004690
      PARAM(1)=X(I,3)                                                   004700
      PARAM(2)=X(I,2)                                                   004710
      GO TO 45                                                          004720
C         SEGMENT-TO-SEGMENT                                            004730
   31 ITYP=1                                                            004740
      PARAM(1)=X(I,3)                                                   004750
      PARAM(2)=X(I,2)                                                   004760
      PARAM(3)=X(J,1)-X(I,1)-X(I,2)                                     004770
      PARAM(4)=X(J,2)                                                   004780
      GO TO 45                                                          004790
C         SEGMENT-TO-DISC (OR RING)                                     004800
   33 ITYP=3                                                            004810
      PARAM(1)=X(I,3)                                                   004820
      PARAM(2)=X(I,2)                                                   004830
      PARAM (3)=1.-X(I,1)-X(I,2)                                        004840
      PARAM(4)=X(J,2)                                                   004850
      PARAM(5)=X(J,1)                                                   004860
   45 CALL CONFIG(ITYP,FIG,PARAM)                                       004870
      W(I,J)  =FIG                                                      004880
      GO TO 90                                                          004890
 51   W(I,J)  =0.                                                       004900
   90 CONTINUE                                                          004910
  100 CONTINUE                                                          004920
C                                                                       004921
      DO 200 I=2,NZONE                                                  004930
C                                                                       004931
C         IN THIS LOOP WE DETERMINE BY RECIPROCITY  THE CONFIGURATION   004940
C         FACTOR BETWEEN ZONES I AND J WHERE J.LT.I                     004950
```

```
115   C                                                                      004951
            JMAX=I-1                                                         004960
            DO 190 J=1,JMAX                                                  004970
            IF(W(J,I)   .EQ.0.) GO TO 151                                    004980
            IF((KIND(I).EQ.5).AND.((KIND(J).EQ.1).OR.(KIND(J).EQ.3))GO TO 130004990
120         IF((KIND(I).EQ.5).AND.(KIND(J).EQ.5))GO TO 140                   005000
            IF(((KIND(I).EQ.4).OR.(KIND(I).EQ.2)).AND.(KIND(J).EQ.5))GO TO 120005010
            IF(((KIND(I).EQ.4).OR.(KIND(I).EQ.2)).AND.((KIND(J).EQ.1).OR.    005020
           1 (KIND(J).EQ.3))) GO TO 110                                      005030
      C        DISC (OR RING)-TO-DISC (OR RING)                              005040
125   110   W(I,J)  =(X(J,1)**2-X(J,2)**2)*W(J,I)  /(X(I,1)**2-X(I,2)**2)    005050
            GO TO 190                                                        005060
      C        RING (OR DISC)-TO-SEGMENT                                     005070
      120   W(I,J)  =4.*X(J,2)*W(J,I)  /(X(J,3)*(X(I,1)**2-X(I,2)**2))       005080
            GO TO 190                                                        005090
130   C        SEGMENT-TO-SEGMENT                                            005100
      140   W(I,J)  =X(J,2)/X(I,2)*W(J,I)                                    005110
            GO TO 190                                                        005120
      C        SEGMENT-TO-RING (OR DISC)                                     005130
      130   W(I,J)  =.25*X(I,3)*W(J,I)  *(X(J,1)**2-X(J,2)**2)/X(I,2)        005140
135         GO TO 190                                                        005150
      151   W(I,J)  =0.                                                      005160
        190 CONTINUE                                                         005170
        200 CONTINUE                                                         005180
      C                                                                      005181
140         PRINT 600                                                        005190
      600   FORMAT(////28X,*CONFIGURATION F CTOR MATRIX FOR CYLINDRICAL ENCLOS005200
           1URE CALCULATED BY THIS PROGRAM*//)                               005210
            DO 401 I=1,NZONE                                                 005220
            PRINT 650,(W(I,J)  ,J=1,NZONE)                                   005230
145     650 FORMAT( /7(4X,8F16.12/))                                         005240
        401 CONTINUE                                                         005250
            DO 402 I=1,NZONE                                                 005260
            WRITE(1) (W(I,J)  ,J=1,NZONE)                                    005270
      402   CONTINUE                                                         005280
150         REWIND 1                                                         005290
            RETURN                                                           005300
            END                                                              005310
```

```
CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

    122      I       110       THIS IF DEGENERATES INTO A SIMPLE TRANSFER TO THE LABEL INDICATED.
```

```
        SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
    2  ENCLOSE        1          151
```

```
VARIABLES       SN  TYPE            RELOCATION
35236  B            REAL        ARRAY     GEOM        REFS         47
35616  BB           REAL        ARRAY     GEOM        REFS         47
  505  FIG          REAL                              REFS        104        105
  501  I            INTEGER                           REFS         52       2*61       2*63       2*64       2*66         67         68
                                                        74         75         79         80         81         87         88         92
                                                        93       2*94         99        100      2*101        105        107        116
                                                       118        119        120      2*121      2*122      4*125      4*128      3*131
                                                     4*134        136        144        148    DEFINED         51        111        143
                                                       147
35426  IN           INTEGER     ARRAY     GEOM        REFS         47
  504  ITYP         INTEGER                           REFS        104    DEFINED         70         78         86         91         98
  503  J            INTEGER                           REFS       2*61         63       2*64         66         67       2*68         71
                                                        72         73         82         83         94         95        102        103
                                                       105        107        118      2*119        120        121      2*122      4*125
                                                     4*128      3*131      4*134        136        144        148
                                                   DEFINED         60        117        144        148
  506  JMAX         INTEGER                           REFS        117    DEFINED        116
  502  JMIN         INTEGER                           REFS         60    DEFINED         52
    0  KIND         INTEGER     ARRAY     GEOM        REFS         47       4*61       3*63       4*64         66       2*67       3*68
                                                     3*119      2*120      3*121      4*122
35233  NFIC         INTEGER               GEOM        REFS         47
35235  NQ           INTEGER               GEOM        REFS         47
35230  NZB          INTEGER               GEOM        REFS         47
35231  NZC          INTEGER               GEOM        REFS         47
35234  NZONE        INTEGER               GEOM        REFS         47         51         60        111        143        144        147
                                                       148
35232  NZT          INTEGER               GEOM        REFS         47
  507  PARAM        REAL        ARRAY                 REFS         50        104    DEFINED         71         72         73         74
                                                        75         79         80         81         82         83         87         88
                                                        92         93         94         95         99        100        101        102
                                                       103
 1130  W            REAL        ARRAY     GEOM        REFS         47        118        125        128        131        134        144
                                                       148    DEFINED        105        107        125        128        131        134
                                                       136
  170  X            REAL        ARRAY     GEOM        REFS         47         71         72         73         74         75         79
                                                        80         81         82         83         87         88         92         93
                                                      3*94         95         99        100      2*101        102        103      4*125
                                                     4*128      2*131      4*134

FILE NAMES         MODE
       OUTPUT     FMT                      WRITES      140        1A4
       TAPE1      UNFMT                    WRITES      148     MOTION        150

EXTERNALS            TYPE    ARGS          REFERENCES
       CONFIG                  3               104

STATEMENT LABELS                DEF LINE   REFERENCES
  145  31                          91         67
  134  32                          86         66
  166  33                          98         68
  112  35                          78         64
   70  37                          70         63
  210  45                         104         76         84         89         96
  220  51                         107         61
  224  90                         108         60        106
    0  100                        109         51
```



```
STATEMENT LABELS                DEF LINE   REFERENCES
    0  110            INACTIVE    125        122
  307  120                        128        121
  334  130                        134        119
  323  140                        131        120
  350  151                        136        118
  354  190                        137        117        126        129        132        135
    0  200                        138        111
    0  401                        146        143
    0  402                        149        147
  444  600      FMT               141        140
  465  650      FMT               145        144

LOOPS  LABEL      INDEX     FROM-TO     LENGTH     PROPERTIES
    5  100      * I          51 109      225B                EXT REFS  NOT INNER
   11  90       * J          60 108      216B                EXT REFS
  234  200      * I         111 138      126B                NOT INNER
  241  190        J         117 137      116B         OPT
  366  401      * I         143 146       21B                EXT REFS  NOT INNER
  371           * J         144 144       11B                EXT REFS
  411  402      * I         147 149       21B                EXT REFS  NOT INNER
  414           * J         148 148       11B                EXT REFS

COMMON BLOCKS    LENGTH
       GEOM       15366

STATISTICS
  PROGRAM LENGTH                   521B      337
  CM LABELED COMMON LENGTH       36006B    15366
```

```
      SUBROUTINE PROP                                                   005320
C                                                                       005330
C       THIS PROGRAM WAS WRITTEN BY                                     005340
C            M. ABRAMS                                                  005350
C       THERMAL SCIENCES DIVISION                                       005360
C       SANDIA NATIONAL LABORATORIES                                    005370
C       LIVERMORE, CALIFORNIA 94550                                     005380
C                                                                       005390
C         THIS SUBROUTINE READS AND PRINTS THE NON-GEOMETRICAL DATA     005400
C        NEEDED IN THE SOLUTION OF ENCLOSURE PROBLEMS.  THESE DATA ARE%005410
C           NBDS............NO. OF BANDS IN THE BAND MODEL              005420
C           NSET............NO. OF SEPARATE REFLECTANCE-VERSUS-         005430
C                           WAVELENGTH CHARACTERISTICS                  005431
C           XLAM(K).........ARRAY OF WAVELENGTHS (MICRONS) SEPARATING   005440
C                           ADJACENT BANDS. THE K-TH BAND IS BOUNDED    005450
C                           BY WAVELENGTHS XLAM(K) AND XLAM(K+1)        005460
C           REFL(I,K).......REFLECTANCE OF THE K-TH BAND OF THE I-TH    005470
C                           REFLECTANCE-VERSUS-WAVELENGTH               005480
C                           CHARACTERISTIC                              005481
C           PHI(K)..........FRACTION OF THE SOLAR IRRADIATION WHICH     005490
C                           LIES IN THE K-TH BAND. THIS FRACTION IS     005500
C                           REGARDED AS BEING INDEPENDENT OF POSITION   005510
C                           ON THE ENCLOSURE SURFACE.                   005520
C           IREFL(I)........INDEX WHICH ASSIGNS THE "IREFL(I)"          005530
C                           REFLECTANCE-VERSUS-WAVELENGTH CHARACTERIS-  005531
C                           TIC TO THE I-TH ZONE                        005532
C           GDRECT(I).......SOLAR IRRADIATION AT I-TH ZONE              005550
C           IBC(I)..........THE TYPE OF RADIATIVE BOUNDARY CONDITION AT005560
C                           THE I-TH ZONE                               005570
C                                   IBC(I)=1  I-TH ZONE LIES IN AN APER-005580
C                                             TURE                      005581
C                                   IBC(I)=2  THE HEAT FLUX IS SPECI-   005620
C                                             FIED AT THE I-TH ZONE     005621
C                                   IBC(I)=3  THE TEMPERATURE OF THE    005650
C                                             I-TH ZONE IS SPECIFIED    005660
C           RADNET(I).......THE HEAT FLUX AT THOSE ZONES HAVING THE     005670
C                           IBC(I)=2 TYPE BOUNDARY CONDITION            005671
C           TEMP(I).........THE TEMPERATURE AT THOSE ZONES HAVING       005700
C                           THE TYPE IBC(I)=3 BOUNDARY CONDITION        005710
C           NOTE THAT THE ABOVE DATA NEED BE SPECIFIED FOR ALL          005730
C           ENCLOSURE GEOMETRIES.                                       005731
C                                                                       005741
      COMMON/PROP/XLAM(4),REFL(3,3),PHI(3),IREFL(120),GDRECT(120),IBC(12005750
     1             0),NBDS,NSET,RADNET(120),TEMP(120),POCTIN,QTOTL(120,2)005760
     2             ,EMP(120,3),IQROW(120),N                             005770
      COMMON/GEOM/KIND(120),X(120,4),W(120,120),NZB,NZC,NZT,NFIC,NZONE,N005780
     1             Q,B(120),IN(120),BB(120)                             005790
C                                                                       005880
      READ(7,500) NBDS                                                  005890
  500 FORMAT(10I5)                                                      005900
      N=NBDS+1                                                          005910
C                                                                       005911
      READ(7,510) (XLAM(K),K=1,N)                                       005930
  510 FORMAT(8E10.4)                                                    005940
C                                                                       005941
      PRINT 600                                                         005950
  600 FORMAT(////60X,*REFLECTANCE DATA*//25X,*BAND 1*,14X,*BAND 2*,14X, 005960
```



```
     1*BAND 3*,14X,*BAND 4*,14X,*BAND 5*)                               005970
      PRINT 601,(XLAM(K),XLAM(K+1),K=1,NBDS)                            005980
  601 FORMAT(1X,*MICRONS*,10X,5(F8.3,* -- *,F8.3))                      005990
C                                                                       005991
      READ(7,500) NSET                                                  006010
C                                                                       006011
C          READ IN REFLECTANCE-VERSUS-WAVELENGTH CHARACTERISTICS        006012
      DO 10 I=1,NSET                                                    006020
      READ(7,510) (REFL(I,K),K=1,NBDS)                                  006040
      PRINT 602,I,(REFL(I,K),K=1,NBDS)                                  006050
  602 FORMAT( 1X,*CHRTISTC*,I2,7X,5(6X,F8.5,6X))                        006060
   10 CONTINUE                                                          006070
C                                                                       006071
      READ(7,510) (PHI(K),K=1,NBDS)                                     006090
      PRINT 603,(PHI(K),K=1,NBDS)                                       006100
  603 FORMAT(/1X,*FRACTION OF SOLAR RAD.*/1X,*IN THIS BAND*,5X,5(6X,F8. 006110
     15,6X))                                                            006120
C                                                                       006121
C          ASSIGNMENT OF REFLECTANCE CHARACTERISTICS TO INDIVIDUAL  ZONES006130
25    READ(7,500) IZMIN,IZMAX,ISPEC                                     006150
      DO 30 I=IZMIN,IZMAX                                               006160
      IREFL(I)=ISPEC                                                    006170
   30 CONTINUE                                                          006180
      IF(IZMAX.LT.NZONE)GO TO 25                                        006190
C                                                                       006191
C          ASSIGNMENT OF SOLAR IRRADIATION TO INDIVIDUAL ZONES          006200
35    READ(7,515) IZMIN,IZMAX,FLUX                                      006220
  515 FORMAT(2I5,E10.4)                                                 006230
      DO 40 I=IZMIN,IZMAX                                               006240
      GDRECT(I) =FLUX                                                   006250
   40 CONTINUE                                                          006260
      IF(IZMAX.EQ.NZONE)GO TO 41                                        006270
      GO TO 35                                                          006280
   41 CONTINUE                                                          006290
C                                                                       006291
C          ASSIGNMENT OF TYPE OF RADIATIVE BOUNDARY AT EACH ZONE        006300
C          AND EITHER THE HEAT FLUX OR THE TEMPERATURE (DEPENDING       006301
C          ON THE TYPE OF BOUNDARY CONDITION ASSIGNED)                  006302
45    READ(7,501) IZMIN,IZMAX,INT,VALUE                                 006320
501   FORMAT(3I5,E10.4)                                                 006330
      DO 50 I=IZMIN,IZMAX                                               006340
      IBC(I)=INT                                                        006350
      IF(INT.EQ.2)RADNET(I)=VALUE                                       006360
      IF((INT.EQ.3).OR.(INT.EQ.1))TEMP(I)=VALUE                         006370
   50 CONTINUE                                                          006380
      IF(IZMAX.LT.NZONE)GO TO 45                                        006390
C                                                                       006391
  611 FORMAT(//24X,*NOTE THAT B. C. TYPE 1... CORRESPONDS TO ZONE IN APE006400
     1RTURE PLANE*/40X,                                            *TYPE006401
     2 2... HEAT FLUX IS SPECIFIED  */                                  006410
     340X,*TYPE 3... TEMPERATURE OF ZONE IS SPECIFIED*)                 006420
C                                                                       006421
      PRINT 612                                                         006430
  612 FORMAT(////36X,*SUMMARY OF THE NON-GEOMETRICAL ZONAL DATA WHICH HA006440
     1VE BEEN INPUT*)                                                   006450
C                                                                       006451
      PRINT 613                                                         006460
```

```
115          613   FORMAT(/24X,*ZONE*,6X,*REFLEC-*,7X,*TYPE*,8X,*DIRECT SOLAR*,8X,    006470
                  1 *  HEAT FLUX *,8X,*TEMPERATURE*)                                006480
             C                                                                      006481
                   PRINT 614                                                        006490
             614   FORMAT(34X,*TANCE*,10X,*OF*,9X,*IRRADIATION*,6X,*  IF SPECIFIED  006500
120               1*,8X,*IF SPECIFIED*)                                             006510
             C                                                                      006511
                   PRINT 615                                                        006520
             615   FORMAT(34X,*CHRTISTC*,6X,*B. C.*,7X,*(KW/METER-SQ)*,7X,*(KW/METER-006530
                  1SQ)*,9X,*(DEG-K)*)                                               006540
125          C                                                                      006541
                   DO 70 I=1,NZONE                                                  006550
                   IF(IBC(I).EQ.1) PRINT 623,I,IREFL(I),IBC(I),GDRECT(I),TEMP(I)    006560
                   IF(IBC(I).EQ.2) PRINT 622,I,IREFL(I),IBC(I),GDRECT(I),RADNET(I)  006570
             622   FORMAT(25X,I3,8X,I2,11X,I1,10X,E13.6,6X,E13.6)                   006580
130                IF(IBC(I).EQ.3)PRINT 623,I,IREFL(I),IBC(I),GDRECT(I),TEMP(I)     006590
             623   FORMAT(25X,I3,8X,I2,11X,I1,10X,E13.6,27X,E12.5)                  006600
                70 CONTINUE                                                         006610
             C                                                                      006611
                   PRINT 611                                                        006620
135          C                                                                      006621
             C          CALCULATION OF THE SOLAR POWER INTO ENCLOSURE               006630
                   PDCTIN=0.                                                        006640
                   DO 60 I=1,NZONE                                                  006650
                   PDCTIN=PDCTIN+X(I,4)*GDRECT(I)                                   006660
140             60 CONTINUE                                                         006670
                   PRINT 610,PDCTIN                                                 006680
               610 FORMAT(////41X,* SOLAR POWER INTO ENCLOSURE (KW)*,E16.5)         006690
                   RETURN                                                           006700
                   END                                                              006710
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS      DEF LINE      REFERENCES
    2  PROP            1           1:3

VARIABLES       SN  TYPE              RELOCATION
35236  B            REAL      ARRAY     GEOM      REFS      46
35616  BB           REAL      ARRAY     GEOM      REFS      46
 1533  EMP          REAL      ARRAY     PROP      REFS      43
  650  FLUX         REAL                          REFS      87    DEFINED      84
  210  GDRECT       REAL      ARRAY     PROP      REFS      43        127     128      130       139
                                               DEFINED      87
  644  I            INTEGER                       REFS      66       2*67      79       87        99     100     101
                                                 6*127   6*128      6*130   2*139  DEFINED       65      78      86
                                                    98     126        138
  400  IBC          INTEGER   ARRAY     PROP      REFS      43      2*127   2*128    2*130   DEFINED      99
35426  IN           INTEGER   ARRAY     GEOM      REFS      46
  651  INT          INTEGER                       REFS      99        100   2*101  DEFINED        96
 2303  IQROW        INTEGER   ARRAY     PROP      REFS      43
   20  IREFL        INTEGER   ARRAY     PROP      REFS      43        127     128      130   DEFINED      79
  647  ISPEC        INTEGER                       REFS      79    DEFINED      77
  646  IZMAX        INTEGER                       REFS      78         81      86       89        98     103
```



```
VARIABLES       SN  TYPE              RELOCATION
                                               DEFINED      77         84      96
  645  IZMIN        INTEGER                       REFS      78         86      98  DEFINED        77      84      96
  643  K            INTEGER                       REFS      53       2*59      66       67        71      72
                                               DEFINED      53         59      66       67        71      72
    0  KIND         INTEGER   ARRAY     GEOM      REFS      46
 2473  N            INTEGER             PROP      :EFS      43         53 DEFINED       51
  570  NBDS         INTEGER             PROP      REFS      43         51      59       66        67      71      72
                                               DEFINED      49
35233  NFIC         INTEGER             GEOM      REFS      46
35235  NQ           INTEGER             GEOM      REFS      46
  571  NSET         INTEGER             PROP      REFS      43         65 DEFINED       62
35230  NZB          INTEGER             GEOM      REFS      46
35231  NZC          INTEGER             GEOM      REFS      46
35234  NZONE        INTEGER             GEOM      REFS      46         81      89      103       126     138
35232  NZT          INTEGER             GEOM      REFS      46
 1152  PDCTIN       REAL                PROP      REFS      43        139     141  DEFINED       137     139
   15  PHI          REAL      ARRAY     PROP      REFS      43         72 DEFINED       71
 1153  QTOTL        REAL      ARRAY     PROP      REFS      43
  572  RADNET       REAL      ARRAY     PROP      REFS      43        126 DEFINED      100
    4  REFL         REAL      ARRAT     PROP      REFS      43         67 DEFINED       66
  762  TEMP         REAL      ARRAY     PROP      REFS      43        127     130  DEFINED       101
  652  VALUE        REAL                          REFS     100        101 DEFINED       96
 1130  W            REAL      ARRAY     GEOM      REFS      46
  170  X            REAL      ARRAY     GEOM      REFS      46        139
    0  XLAM         REAL      ARRAY     PROP      REFS      43       2*59 DEFINED       53

FILE NAMES         MODE
       OUTPUT      FMT                 WRITES      56      59      67      72     110     114     118     122
                                          127     128     130     134     141
       TAPE7       FMT                  READS      49      53      62      66      71      77      84      96

STATEMENT LABELS              DEF LINE   REFERENCES
    0  10                         69         65
  115  25                         77         81
    0  30                         80         78
  133  35                         84         90
    0  40                         88         86
  152  41                         91         89
  153  45                         :6        103
    0  50                        102         98
    0  60                        140        138
    0  70                        132        126
  310  500        FMT             50         49         62         77
  455  501        FMT             97         96
  317  510        FMT             54         53         66         71
  442  515        FMT             85         84
  324  600        FMT             57         56
  346  601        FMT             60         59
  376  602        FMT             68         67
  414  603        FMT             73         72
  635  610        FMT            142        141
  460  611        FMT            105        134
  505  612        FMT            111        110
  521  613        FMT            115        114
  536  614        FMT            119        118
  553  615        FMT            123        122
  604  622        FMT            129        128
```

```
STATEMENT LABELS             DEF LINE   REFERENCES
  621  623     FMT              131        127        130

LOOPS  LABEL     INDEX      FROM-TO     LENGTH    PROPERTIES
   23            * K         59 59        10B                 EXT REFS
   41   10       * I         65 69        37B                 EXT REFS  NOT INNER
   44            * K         66 66        11B                 EXT REFS
   62            * K         67 67        11B                 EXT REFS
  121   30         I         78 80         6B       INSTACK
  137   40         I         86 88         6B       INSTACK
  157   50         I         98 102       22B         OPT
  216   70       * I        126 132       45B                 EXT REFS
  271   60         I        138 140        7B       INSTACK

COMMON BLOCKS   LENGTH
       PROP       1340
       GEOM      15366

STATISTICS
  PROGRAM LENGTH                  653B     427
  CM LABELED COMMON LENGTH      40502B   16706
```



```
      SUBROUTINE RADIST(IOPT)                                           006720
C                                                                       006730
C     THIS PROGRAM WAS WRITTEN BY                                       006740
C             M. ABRAMS                                                 006750
C     THERMAL SCIENCES DIVISION                                         006760
C     SANDIA NATIONAL LABORATORIES                                      006770
C     LIVERMORE, CALIFORNIA 94550                                       006780
C                                                                       006790
C             THIS SUBROUTINE CALCULATES THE RADIOSITY AND IRRADIATION  006800
C             AT THE ZONES OF AN ENCLOSURE.                             006810
C             THESE RADIATIVE HEAT FLUXES ARE CALCU-                    006820
C             LATED FOR EACH WAVELENGTH BAND IN A BAND MODEL CONSISTING 006830
C             OF NBDS NO. OF BANDS.  WITH THE RADIOSITIES AND IRRADI-   006840
C             ATIONS KNOWN AT EACH ZONE, WE THEN CALCULATE%             006841
C             A) THE HEAT TRANSFER TO EACH ZONE DUE TO                  006860
C                RADIATIVE TRANSPORT IN THE K-THE WAVE-                 006861
C                LENGTH BAND                                            006862
C             B) THE TOTAL HEAT TRANSFER TO EACH ZONE, I. E., THE SUM OF 006880
C                THE HEAT TRANSFERS IN THE INDIVIDUAL BANDS             006881
C             C) THE POWER LEAVING THE ENCLOSURE THROUGH THE APERTURE(S) 006890
C                                                                       006891
C             D) THE EFFECTIVE ENCLOSURE ABSORPTANCE FOR IOPT=1,        006910
C                I. E., THE FRACTION OF THE INCOMING SOLAR POWER RETAINED006911
C                BY THE ENCLOSURE                                       006912
C             E) THE TOTAL HEAT TRANSFER TO EACH ZONE                   006920
C                FOR THE CASE IN WHICH THE SITUATIONS IOPT=1 AND IOPT=2 006930
C                ARE SUPERIMPOSED                                       006940
C                IOPT..........IF.EQ.1 THE RADIOSITY AND IRRADIATION    006950
C                              ARE CALCULATED FOR THE CASE OF AN        006960
C                              ENCLOSURE AT 0-DEG ABSOLUTE WITH INCOMING 006970
C                              EXTERNAL RADIATION                       006980
C                              IF.EQ.2 THE RADIOSITY AND IRRADIATION ARE 006990
C                              DETERMINED FOR THE CASE OF AN ENCLOSURE  006991
C                              HAVING KNOWN (OR CALCULATED) TEMPERATURES 006992
C                              AT EACH ZONE WITH NO INCOMING EXTERNAL   006993
C                              (SOLAR) RADIATION.                       006994
C                              THE CASE IOPT=1 MUST BE EXERCISED        007020
C                              BEFORE IOPT=2. A REAL ENCLOSURE IS THE   007030
C                              SUPERPOSITION OF THESE 2 CASES.          007040
C                RADST(I,K)....THE RADIOSITY AT THE I-TH ZONE IN BAND K 007050
C                XIRRA(I,K)....THE IRRADIATION AT THE I-TH ZONE IN BAND K007060
C                QBAND(I,K)....THE HEAT TRANSFER TO ZONE I DUE TO       007070
C                              RADIATIVE TRANSPORT IN THE K-TH WAVELENGTH007071
C                              BAND.                                    007072
C                QTOTL(I,IOPT).. THE TOTAL HEAT TRANSFER TO I-TH ZONE.  007080
C                              UPON COMPLETION OF THIS PROGRAM WITH IOPT=007090
C                              2,  QTOTL(I,IOPT) IS THE  TOTAL HEAT     007100
C                              FLUX AT ZONE I FOR THE COMBINED CASES OF 007110
C                              A) EXTERNAL RADIATION ENTERING A 0-DEG ABS007120
C                              CAVITY        AND B) NO EXTERNAL RADIATION 007130
C                              ENTERING A CAVITY HAVING NON-ZERO TEM-   007140
C                              PERATURES. ALSO INCLUDED IN QTOTL(I,2) IS 007150
C                              THE DIRECT SOLAR RADIATION.              007151
C                PLEAV(IOPT)...THE POWER LEAVING THE ENCLOSURE THROUGH  007160
C                              APERTURES                                007170
C                ABEFD.........THE EFFECTIVE ABSORPTANCE OF THE ENCLOSURE007180
C                              FOR DIRECT IRRADIATION FROM THE SURROUND- 007190
```

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      C                           INGS (I. E. WHEN THE ENCLOSURE IS AT 0 DEG007200
      C                           ABSOLUTE)                                 007210
      C               CAVEFF........CAVITY EFFICIENCY                       007220
      C                                                                     007221
       COMMON/PROP/XLAM(4),REFL(3,3),PHI(3),IREFL(120),GORECT(120),IBC(12007230
      1            0),NBDS,NSET,RADNET(120),TEMP(120),PDCTIN,QTOTL(120,2)007240
      2            ,EMP(120,3),IQROW(120),N                              007250
       COMMON/GEOM/KIND(120),X(120,4),W(120,120),NZB,NZC,NZT,NFIC,NZONE,N007260
      1         Q,B(120),IN(120),BB(120)                                 007270
       DIMENSION RADST(120,3),XIRRA(120,3),QBAND(120,3),PLEAV(2)         007360
      C                                                                  007361
       DO 100 K=1,NBDS                                                   007370
      C                                                                  007371
      C          WE FORM EITHER THE VECTOR H-K OR THE VECTOR E-K.        007380
      C          H-K IS DETERMINED IF IOPT=1; E-K IS DETERMINED IF IOPT=2.  007381
      C          WE ALSO CALCULATE THE I-TH ROW OF THE [R-IJ] MATRIX     007382
       DO 30 I=1,NZONE                                                   007390
       ISET=IREFL(I)                                                     007400
       RHO=REFL(ISET,K)                                                  007410
       IF(IOPT.EQ.2) GO TO 21                                            007420
       B(I)=RHO*GORECT(I)*PHI(K)                                         007430
       GO TO 22                                                          007440
    21 B(I)=EMP(I,K)                                                     007450
      C                                                                  007451
      C          HERE WE FORM THE I-TH ROW OF THE [R-IJ] MATRIX          007460
   22  CONTINUE                                                          007470
       READ(1) (BB(J),J=1,NZONE)                                         007480
       DO 40 J=1,NZONE                                                   007490
       W(I,J)  =-RHO*BB(J)                                               007500
       IF(J.EQ.I) W(I,J)  =W(I,J)  +1.                                   007510
      C          THE [R-IJ] MATRIX (SEE ANALYSIS) IS STORED TEMPORARILY IN W007520
    40 CONTINUE                                                          007530
    30 CONTINUE                                                          007540
       REWIND 1                                                          007550
      C                                                                  007551
      C          HERE WE DETERMINE THE RADIOSITY DISTRIBUTION IN THE K-TH   007560
      C          BAND BY CALLING THE SMPL SUBROUTINE SAXB.               007570
      C          THIS CORRESPONDS TO THE SOLUTION OF EQN. (12)           007571
      C          WITH EITHER THE VECTOR E-K OR H-K SET = 0               007572
       INIT=0                                                            007580
       CALL SAXB(120,NZONE,1,W,B,INIT,IN,KER)                            007590
       IF(KER.EQ.0)GO TO 50                                              007600
      C                                                                  007601
       PRINT 605,IOPT,KER,K                                              007610
   605 FORMAT(//5X,*ERROR DETECTED IN SAXB CALLED FROM RADIST   IOPT=*,I5007620
      1,10X,*KER=*,I5,10X,*K=*,I5)                                       007630
      C                                                                  007631
   50  DO 55 I=1,NZONE                                                   007650
       RADST(I,K)=B(I)                                                   007660
    55 CONTINUE                                                          007670
      C                                                                  007671
       IF(IOPT.EQ.2)GO TO 100                                            007680
      C                                                                  007681
      C          HERE COMPUTE THE INVERSE OF THE R MATRIX, THE INVERSE IS   007690
      C          IS USED IN SUBROUTINE THERMAL. IT IS EFFICIENT TO DO THIS  007700
      C          COMPUTATION HERE BECAUSE OF THE INFORMATION AVAILABLE   007710
      C          AFTER ABOVE USE OF SAXB.                                007720
```



```
       INIT=1                                                            007730
       DO 57 ICOL=1,NZONE                                                007740
       DO 56 I=1,NZONE                                                   007750
       B(I)=0.                                                           007760
    56 CONTINUE                                                          007770
       B(ICOL)=1.                                                        007780
       CALL SAXB(120,NZONE,1,W,B,INIT,IN,KER)                            007790
       IF(KER.EQ.0)GO TO 59                                              007800
      C                                                                  007801
       PRINT 613,KER,K,ICOL                                              007810
   613 FORMAT(//5X,*ERROR DETECTED IN SAXB CALLED FROM RADIST DURING MATR007820
      1IX INVERSION (KER,K,ICOL)*,3I5)                                   007830
       CALL EXIT                                                         007840
      C                                                                  007841
   59  CONTINUE                                                          007850
       ITAPE=K+1                                                         007860
       WRITE(ITAPE)  (B(I),I=1,NZONE)                                    007870
    57 CONTINUE                                                          007880
      C                                                                  007881
   100 CONTINUE                                                          007890
      C                                                                  007891
      C                                                                  007892
       DO 101 ITAPE=2,N                                                  007900
       REWIND ITAPE                                                      007910
  101  CONTINUE                                                          007920
      C                                                                  007921
       IF(IOPT.EQ.1)PRINT 608                                            007930
   608 FORMAT(1H1                                                        007931
      1/2X,*THE FOLLOWING FLUX DISTRIBUTIONS ARE FOR AN ENCLOSURE*       007940
      2/  2X,     *WHOSE SURFACES ARE AT 0-DEG ABSOLUTE, AND INTO WHICH*/007950
      3   2X,     *THE FOREGOING DIRECT SOLAR RADIATION ENTERS*)         007960
      C                                                                  007961
       IF(IOPT.EQ.2) PRINT 609                                           007970
   609 FORMAT(1H1                                                        007979
      1/2X,*THE FOLLOWING FLUX DISTRIBUTIONS ARE FOR AN ENCLOSURE*       007980
      2/  2X,     *INTO WHICH NO EXTERNAL RADIATION ENTERS, AND WHICH HAS007990
      3*/ 2X,     *THE TEMPERATURES LISTED ABOVE AND/OR THOSE CAL-*/     008000
      4   2X,     *CULATED BY THE SUBROUTINE THERMAL *)                  008010
      C                                                                  008011
       PRINT 606                                                         008020
   606 FORMAT(///57X,*RADIOSITY DISTRIBUTION*//18X,*ZONE*,8X,*TOTAL*,11X,008030
      1*BAND 1*,10X,*BAND 2*,10X,*BAND 3*,10X,*BAND 4*,10X,*BAND 5*/)   008040
       PRINT 614                                                         008050
   614 FORMAT(25X,6(2X,*(KW/METER-SQ)*,1X)/)                             008060
      C                                                                  008061
      C           LIST THE RADIOSITIES IN EACH WAVELENGTH BAND           008062
       DO 110 I=1,NZONE                                                  008070
       TOT=0.                                                            008080
       DO 105 K=1,NBDS                                                   008090
       TOT=TOT+RADST(I,K)                                                008100
   105 CONTINUE                                                          008110
       PRINT 607,I       ,TOT,(RADST(I,K),K=1,NBDS)                      008120
  607  FORMAT(19X,I3,4X,6E16.5)                                          008130
   110 CONTINUE                                                          008140
      C                                                                  008150
      C           HERE WE COMPUTE THE IRRADIATION AT THE I-TH ZONE       008160
      C           IN THE K-TH WAVELENGTH BAND. WE USE EQN. (2)           008161
```

```
C              NOTE, HOWEVER, THAT IN THE CASE IOPT=1, THE DIRECT            008162
C              SOLAR IRRADIATION IS INCLUDED.                                008163
      DO 210 K=1,NBDS                                                        008180
      DO 200 I=1,NZONE                                                       008190
      READ(1) (BB(J),J=1,NZONE)                                              008200
      XIRRA(I,K)=0.                                                          008210
      IF(IOPT.EQ.1)XIRRA(I,K)=GDRECT(I)*PHI(K)                               008220
      DO 190 J=1,NZONE                                                       008230
      XIRRA(I,K)=XIRRA(I,K)+RADST(J,K)*BB(J)                                 008240
  190 CONTINUE                                                               008250
  200 CONTINUE                                                               008260
      REWIND 1                                                               008270
  210 CONTINUE                                                               008280
C                                                                            008281
      PRINT 620                                                              008290
  620 FORMAT(///56X,*IRRADIATION DISTRIBUTION*// 18X,*ZONE*,8X,*TOTAL*,1008300
     11X,*BAND 1*,10X,*BAND 2*,10X,*BAND 3*,10X,*BAND 4*,10X,*BAND 5*/) 008310
      PRINT 614                                                              008320
C                                                                            008321
C              LIST THE IRRADIATIONS IN EACH WAVELENGTH BAND                 008322
      DO 220 I=1,NZONE                                                       008330
      TOT=0.                                                                 008340
      DO 230 K=1,NBDS                                                        008350
      TOT=TOT+XIRRA(I,K)                                                     008360
  230 CONTINUE                                                               008370
      PRINT 607,I,TOT,(XIRRA(I,K),K=1,NBDS)                                  008380
      ITAPE=IOPT+4                                                           008390
      WRITE(ITAPE) TOT                                                       008400
  220 CONTINUE                                                               008410
      REWIND ITAPE                                                           008420
C                                                                            008421
C               AT EACH ZONE, CALCULATE THE HEAT TRANSFER DUE TO             008422
C               RADIATIVE TRANSPORT IN EACH BAND: ALSO CALCULATE             008423
C               THE TOTAL HEAT TRANSFER, I. E., THE SUM OF THE HEAT          008424
C               TRANSFERS IN EACH BAND.                                      008425
      PRINT 630                                                              008460
  630 FORMAT(///54X,*DISTRIBUTION OF  HEAT FLUX*//18X,*ZONE*,8X,*TOTAL  008470
     1 *,11X,*BAND 1*,10X,*BAND 2*,10X,*BAND 3*,10X,*BAND 4*,10X,*BAND 5008480
     2*/)                                                                    008490
      PRINT 614                                                              008500
C                                                                            008501
      DO 250 I=1,NZONE                                                       008510
      QTOTL(I,IOPT)=0.                                                       008520
      DO 260 K=1,NBDS                                                        008530
      QBAND(I,K)=XIRRA(I,K)-RADST(I,K)                                       008540
      QTOTL(I,IOPT)=QBAND(I,K)+QTOTL(I,IOPT)                                 008550
  260 CONTINUE                                                               008560
      PRINT 607,I,QTOTL(I,IOPT),(QBAND(I,K),K=1,NBDS)                        008570
  250 CONTINUE                                                               008580
C                                                                            008581
C              HERE WE COMPUTE POWER LEAVING THROUGH THE APERTURE(S)          008590
      PLEAV(IOPT)=0.                                                         008600
      DO 270 I=1,NZONE                                                       008610
      IF(IBC(I).NE.1)GO TO 270                                               008620
      TOT=0.                                                                 008630
      DO 265 K=1,NBDS                                                        008640
      TOT=TOT+XIRRA(I,K)                                                     008650
```



```
  265 CONTINUE                                                               008660
      POWI=TOT*X(I,4)                                                        008670
      PLEAV(IOPT)=PLEAV(IOPT)+POWI                                           008680
  270 CONTINUE                                                               008690
C                                                                            008691
      PRINT 653,IOPT,PLEAV(IOPT)                                             008700
  653 FORMAT(//37X,*TOTAL POWER LEAVING ENCLOSURE APERTURE (IOPT=*,I1,*)008710
     1*,E15.5,* KW*)                                                         008720
C                                                                            008721
      IF(IOPT.EQ.2)PRINT 656                                                 008730
656   FORMAT(37X,*THIS IS THE SO-CALLED RERADIATION LOSS*)                   008740
C                                                                            008741
      IF(IOPT.EQ.2) GO TO 300                                                008750
C                                                                            008751
C                                                                            008760
C              HERE WE CALCULATE THE FRACTION OF THE INCOMING SOLAR POWER008770
C              RETAINED BY THE ENCLOSURE. THIS FRACTION IS THE SO-CALLED 008771
C              ENCLOSURE ABSORPTANCE.                                        008772
      TOT=0.                                                                 008780
      DO 280 I=1,NZONE                                                       008790
      IF(IBC(I).EQ.1)GO TO 280                                               008800
      TOT=TOT+QTOTL(I,1)*X(I,4)                                              008810
  280 CONTINUE                                                               008820
      ABEFO=TOT/PDCTIN                                                       008830
      PRINT 650                                                              008840
  650 FORMAT(///54X,*ENERGY BALANCE OF ENCLOSURE (FOR IOPT=1) (KW)*/)        008850
      PRINT 651,PDCTIN                                                       008860
      PRINT 652,TOT                                                          008870
      PRINT 654,ABEFO                                                        008880
  651 FORMAT(37X,*SOLAR POWER INPUT TO ENCLOSURE*,5(*...*),E16.5)            008890
  652 FORMAT(37X,*SOLAR POWER ABSORBED IN ENCLOSURE*,12(*.*),E16.5)          008900
  654 FORMAT(37X,*EFFECTIVE ABSORPTANCE OF ENCLOSURE*,11(*.*),F8.5)          008910
      RETURN                                                                 008920
C                                                                            008921
  300 CONTINUE                                                               008930
C                                                                            008931
C               HERE WE COMPUTE THE  HEAT TRANSFER TO EACH                   008940
C               ZONE FOR THE CASES IOPT = 1 AND 2 OCCURRING SIMULTANSLY      008950
      PRINT 610                                                              008960
610   FORMAT( ///31X,*THE HEAT TRANSFER TO EACH ZONE FOR THE COMBINED C 008970
     1ASES OF*/                   35X,*A)ENCLOSURE AT O-DEG ABSOLUTE WITH 008971
     2INCOMING SOLAR RADIATION*/40X,*PLUS*/35X,*B) ENCLOSURE WITH SPECI 008990
     3FIED (AND/OR CALCULATED) SURFACE TEMPERATURES AND NO INCOMING*     009000
     4/38X,*SOLAR RADIATION*/)                                               009010
C                                                                            009011
      PRINT 611                                                              009020
611   FORMAT(//49X,*ZONE*,4X,*HEAT TRANSFER*,6X,*IRRADIATION*/51X    ,       009030
     12(6X,*(KW/METER-SQ)*)/)                                                009040
C                                                                            009041
      DO 310 I=1,NZONE                                                       009050
      QTOTL(I,2)=QTOTL(I,2)+QTOTL(I,1)                                       009060
      READ(5) G1                                                             009070
      READ(6) G2                                                             009080
      TOT=G1+G2                                                              009090
      PRINT 612,I,QTOTL(I,2),TOT                                             009100
612   FORMAT(49X,I3,2(6X,E16.8))                                             009110
  310 CONTINUE                                                               009120
```

```
          C                                                                 009121
          C               HERE WE PRINT THE TEMPERATURES OF ZONES HAVING THE TYPE 2  009130
          C               BOUNDARY CONDITION (IF THERE ARE SUCH ZONES IN THIS PROB)  009140
                IF(NQ.EQ.0) GO TO 315                                       009150
  290           PRINT 615                                                   009160
          615   FORMAT(//48X,*TEMPERATURES OF ZONES HAVING TYPE 2 B. C.*//  009170
               153X,*   ZONE         TEMPERATURE*)                          009180
                DO 314 I=1,NQ                                               009190
                IRFS=IQROW(I)                                               009200
  295           PRINT 616       ,IRFS,TEMP(IRFS)                            009210
          616   FORMAT(56X,I5, 6X,E11.5)                                    009220
          314   CONTINUE                                                    009230
          C                                                                 009231
          315   CONTINUE                                                    009240
  300     C                                                                 009241
          C               CALCULATION OF CAVITY EFFICIENCY                  009250
                ELEAV=PLEAV(1)+PLEAV(2)                                     009260
                IF(PDCTIN.GT.0.) GO TO 311                                  009270
                CAVEFF=-10.                                                 009280
  305           GO TO 312                                                   009290
          311   CAVEFF=1.-ELEAV/PDCTIN                                      009300
          312   PRINT 655,ELEAV,CAVEFF                                      009310
             655 FORMAT(///60X,*PROBLEM SUMMARY*/32X,*POWER (KW) LEAVING CAVITY APE009320
               1RTURE DUE TO ALL RADIATIVE MECHANISMS*,E15.5/32X,           009330
  310          2 *CAVITY EFFICIENCY*,45X,F10.5)                             009340
                REWIND 5                                                    009350
                REWIND 6                                                    009360
                RETURN                                                      009370
                END                                                         009380


      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE     REFERENCES
    4  RADIST         1          261      313

VARIABLES      SN  TYPE            RELOCATION
  1472  ABEFD       REAL                                  REFS      257    DEFINED     252
 35236  B           REAL        ARRAY     GEOM            REFS       65       98       106       121       131
                                                       DEFINED       78       80       118       120
 35616  BB          REAL        ARRAY     GEOM            REFS       65       86       180   DEFINED        84       176
  1477  CAVEFF      REAL                                  REFS      307    DEFINED     304       306
  1476  ELEAV       REAL                                  REFS      306      307   DEFINED       302
  1533  EMP         REAL        ARRAY     PROP            REFS       62       80
   210  GDRECT      REAL        ARRAY     PROP            REFS       62       78       178
  1473  G1          REAL                                  REFS      282    DEFINED     280
  1474  G2          REAL                                  REFS      282    DEFINED     281
  1460  I           INTEGER                               REFS       75     2*78      2*80        86      3*87     2*106       118
                                                           131      164    2*166       177     2*178     2*180       195     2*197
                                                           214    3*216    3*217     3*219       225       226       230       249
                                                         2*250    3*279    2*283       294   DEFINED        74       105       117
                                                           131      161      175       192       213       224       248       278
                                                           293
   400  IBC         INTEGER     ARRAY     PROP            REFS       62      225       249
```



```
VARIABLES      SN  TYPE            RELOCATION
  1466  ICOL        INTEGER                               REFS      120      124   DEFINED       116
 35426  IN          INTEGER     ARRAY     GEOM            REFS       65       98       121
  1464  INIT        INTEGER                               REFS       98      121   DEFINED        97       115
     0  IOPT        INTEGER               F.P.            REFS       77      101       109       141       147       178       198
                                                           214    2*217      219       223     2*231     2*234       238       241
                                                       DEFINED        1
  2303  IQROW       INTEGER     ARRAY     PROP            REFS       62      294
    20  IREFL       INTEGER     ARRAY     PROP            REFS       62       75
  1475  IRFS        INTEGER                               REFS    2*295    DEFINED       294
  1461  ISET        INTEGER                               REFS       76    DEFINED        75
  1467  ITAPE       INTEGER                            DEFINED      130      137       198  I/O REFS       131       138       199
                                                           201
  1463  J           INTEGER                               REFS       84     2*86      3*87       176     2*180
                                                       DEFINED       84       85       176       179
  1457  K           INTEGER                               REFS       76       78        80       101       106       124       130
                                                           164      166       177     2*178     3*180       195       197     3*216
                                                           217      219       228   DEFINED        69       163       166       174
                                                           194      197       215       219       227
  1465  KER         INTEGER                               REFS       98       99       101       121       122       124
     0  KIND        INTEGER     ARRAY     GEOM            REFS       65
  2473  N           INTEGER               PROP            REFS       62      137
   570  NBDS        INTEGER               PROP            REFS       62       69       163       166       174       194       197
                                                           215      219       227
 35233  NFIC        INTEGER               GEOM            REFS       65
 35235  NQ          INTEGER               GEOM            REFS       65      289       293
   571  NSET        INTEGER               PROP            REFS       62
 35230  NZB         INTEGER               GEOM            REFS       65
 35231  NZC         INTEGER               GEOM            REFS       65
 35234  NZONE       INTEGER               GEOM            REFS       65       74        84        85        98       105       116
                                                           117      121       131       161       175       176       179       192
                                                           213      224       248       278
 35232  NZT         INTEGER               GEOM            REFS       65
  1152  PDCTIN      REAL                  PROP            REFS       62      252       255       303       306
    15  PHI         REAL        ARRAY     PROP            REFS       62       78       178
  3570  PLEAV       REAL        ARRAY                     REFS       67      231       234     2*302   DEFINED       223       231
  1471  POWI        REAL                                  REFS      231    DEFINED     230
  3020  QBAND       REAL        ARRAY                     REFS       67      217       219   DEFINED       216
  1153  QTOTL       REAL        ARRAY     PROP            REFS       62      217       219       250     2*279       283
                                                       DEFINED      214      217       279
   572  RADNET      REAL        ARRAY     PROP            REFS       62
  1500  RADST       REAL        ARRAY                     REFS       67      164       166       180       216
                                                       DEFINED      106
     4  REFL        REAL        ARRAY     PROP            REFS       62       76
  1462  RHO         REAL                                  REFS       78       86   DEFINED        76
   762  TEMP        REAL        ARRAY     PROP            REFS       62      295
  1470  TOT         REAL                                  REFS      164      166       195       197       199       228       230
                                                           250      252       256       283   DEFINED       162       164       193
                                                           195      226       228       247       250       282
  1130  W           REAL        ARRAY     GEOM            REFS       65       87        98       121   DEFINED        86        87
   170  X           REAL        ARRAY     GEOM            REFS       65      230       250
  2250  XIRRA       REAL        ARRAY                     REFS       67      180       195       197       216       228
                                                       DEFINED      177      178       180
     0  XLAM        REAL        ARRAY     PROP            REFS       62

FILE NAMES        MODE
      OUTPUT      FMT                       WRITES      101       124       141       147       154       157       166       186
                                               189      197       207       211       219       234       238       253       255
```

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       SUBROUTINE RADIST     74/74    OPT=0 TRACE                      FTN 4.6+439        07/22/81  14.56.32        PAGE     8

FILE NAMES          MODE
                                               256        257        267        274        283        290        295        307
       TAPE1       UNFMT                      READS        84        176       MOTION       91        183
       TAPE5       UNFMT                      READS       280       MOTION      311
       TAPE6       UNFMT                      READS       281       MOTION      312
       VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS             TYPE    ARGS         REFERENCES
       EXIT                    0               127
       SAXB                    B                98        121

STATEMENT LABELS                DEF LINE   HEFERENCES
   43  21                          80          77
   50  22                          83          79
    0  30                          90          74
    0  40                          89          85
  114  50                         105          99
    0  55                         107         105
    0  56                         119         117
    0  57                         132         116
  156  59                         129         122
  173  100                        134          69        109
    0  101                        139         137
    0  105                        165         163
    0  110                        168         161
    0  190                        181         179
    0  200                        182         175
    0  210                        184         174
    0  220                        200         192
    0  230                        196         194
    0  250                        220         213
    0  260                        218         215
    0  265                        229         227
  515  270                        232         224        225
  550  280                        251         248        249
  570  300                        263         241
    0  310                        285         278
  653  311                        306         303
  657  312                        307         305
    0  314                        297         293
  642  315                        299         289
  712  605      FMT               102         101
 1035  606      FMT               155         154
 1072  607      FMT               167         166        197        219
  754  608      FMT               142         141
 1002  609      FMT               148         147
 1304  610      FMT               268         267
 1343  611      FMT               275         274
 1372  612      FMT               284         283
  732  613      FMT               125         124
 1056  614      FMT               158         157        189        211
 1400  615      FMT               291         290
 1417  616      FMT               296         295
 1105  620      FMT               187         186
 1145  630      FMT               208         207
 1231  650      FMT               254         253
 1254  651      FMT               258         255
 1263  652      FMT               259         256
```

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STATEMENT LABELS                DEF LINE   REFERENCES
  1204  653     FMT                235        234
  1272  654     FMT                260        257
  1427  655     FMT                308        307
  1220  656     FMT                239        238

LOOPS  LABEL    INDEX       FROM-TO    LENGTH    PROPERTIES
   20  100    * K            69 134     156B              EXT REFS  NOT INNER
   22  30     * I            74 90      57B               EXT REFS  NOT INNER
   60  40       J            85 89      16B        OPT
  115  55       I           105 107     7B       INSTACK
  133  57     * ICOL        116 132     37B               EXT REFS  NOT INNER
  135  56       I           117 119     5B       INSTACK
  200  101    * ITAPE       137 139     5B                EXT REFS
  223  110    * I           161 168     35B               EXT REFS  NOT INNER
  227  105      K           163 165     10B        OPT
  242         * K           166 166     11B               EXT REFS
  262  210    * K           174 184     46B               EXT REFS  NOT INNER
  264  200    * I           175 182     37B               EXT REFS  NOT INNER
  307  190      J           179 181     11B        OPT
  336  220    * I           192 200     42B               EXT REFS  NOT INNER
  342  230      K           194 196     10B        OPT
  355         * K           197 197     11B               EXT REFS
  410  250    * I           213 220     53B               EXT REFS  NOT INNER
  416  260      K           215 218     17B        OPT
  445         * K           219 219     11B               EXT REFS
  467  270    * I           224 232     31B               NOT INNER
  476  265      K           227 229     10B        OPT
  540  280      I           248 251     13B        OPT
  576  310    * I           278 285     22B               EXT REFS
  626  314    * I           293 297     13B               EXT REFS

COMMON BLOCKS   LENGTH
       PROP       1340
       GEOM      15366

STATISTICS
  PROGRAM LENGTH                 3603B    1923
  CM LABELED COMMON LENGTH      40502B   16706
```



```
      SUBROUTINE THERMAL(ICHECK)                                        009390
C                                                                       009400
C     THIS PROGRAM WAS WRITTEN BY                                       009410
C           M. ABRAMS                                                   009420
C     THERMAL SCIENCES DIVISION                                         009430
C     SANDIA NATIONAL LABORATORIES                                      009440
C     LIVERMORE, CALIFORNIA 94550                                       009450
C                                                                       009460
C             THIS SUBROUTINE DETERMINES THE EMISSIVE POWERS OF ALL     009470
C             ZONES IN EACH WAVELENGTH BAND (CF. EQN. (6)). IF THE ENCLO-009471
C             SURE CONTAINS ZONES WITH THE TYPE 2 BOUNDARY CONDITION    009472
C             (I.E., WHERE THE TEMPERATURE HAS NOT BEEN INITIALLY       009473
C             SPECIFIED), SUBROUTINE THERMAL ALSO DETERMINES THE        009474
C             TEMPERATURES OF SUCH ZONES.                               009475
C                ICHECK.......DIAGNOSTIC PRINTOUT IF .NE. 0             009520
C                NQ...........NO. OF ZONES WHICH HAVE THE IBC(I)=2      009530
C                             BOUNDARY CONDITION (COUNTED HEREIN)       009540
C                EMP(I,K).....EMISSIVE POWER AT THE ZONE I IN THE BAND K 009690
C                Q(I).........THE COLUMN VECTOR RADNET(I)-QTOTL(I,1)    009700
C                             (DEFINED IN EQN(17))                      009701
C                TGES(I)......APPROXIMATE TEMPERATURES USED AS INPUT TO 009830
C                             THE EXACT SOLUTION PROCEDURE IN THE CASE  009840
C                             OF A NON-GRAY ENCLOSURE                   009841
C                                                                       009842
      EXTERNAL FUNC                                                     009850
      COMMON/PROP/XLAM(4),REFL(3,3),PHI(3),IREFL(120),GDRECT(120),IBC(12009860
     1           0),NBDS,NSET,RADNET(120),TEMP(120),PDCTIN,QTOTL(120,2)009870
     2           ,EMP(120,3),IQROW(120),N                               009880
      COMMON/GEOM/KIND(120),X(120,4),W(120,120),NZB,NZC,NZT,NFIC,NZONE,N009890
     1          Q,B(120),IN(120),RR(120)                                009900
      DIMENSION Q(120),TGES(120),WA(7600)                               009990
C                                                                       009991
      DATA SIGMA,NTIM/5.6693E-11,0/                                     010000
      DATA EPS,NSIG,ITMAX,NQ/1.E-4,4,10,0/                              010010
      NTIM=NTIM+1                                                       010020
C                                                                       010021
C             AS A PRELIMINARY STEP WE DETERMINE THE EMISSIVE POWERS OF 010030
C             THOSE ZONES HAVING THE TYPE 1 OR TYPE 3 BOUNDARY CONDITION 010031
C             (THE TEMPERATURES OF THESE ZONES ARE KNOWN A PRIORI)      010032
C                                                                       010040
                 IF(ICHECK.NE.0)PRINT 619                               010050
  619 FORMAT(///35X,*EMISSIVE POWER AT ZONES WHICH HAVE IBC=1 AND 3  BOU010060
     1NDARY CONDITION*//26X,*ZONE*,8X,*BAND 1*,10X,*BAND 2*,10X,*BAND 3*010070
     2,10X,*BAND 4*,10X,*BAND 5*/34X,5(2X,*(KW/METER-SQ)*,1X)/)         010080
C                                                                       010081
      DO 40 I=1,NZONE                                                   010090
      IF(IBC(I).EQ.2)GO TO 40                                           010100
      ISET=IREFL(I)                                                     010110
      DO 30 K=1,NBDS                                                    010120
      RHO=REFL(ISET,K)                                                  010130
      EMP(I,K)=(1.-RHO)*EMISS(TEMP(I),XLAM(K),XLAM(K+1))                010140
   30 CONTINUE                                                          010150
C                                                                       010151
             IF(ICHECK.NE.0)PRINT 620,I,(EMP(I,K),K=1,NBDS)             010160
  620 FORMAT(28X,I3,4X,5(2X,E12.6,2X))                                  010170
   40 CONTINUE                                                          010180
C                                                                       010181
```

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      C               HERE WE TALLY THE NUMBER OF ZONES HAVING THE IBC(I)=2    010190
      C               BOUNDARY CONDITION. IF THIS NUMBER IS ZERO WE RETURN TO  010200
      C               THE CALLING PROGRAM.                                     010210
         4 NQ=0                                                                 010220
           DO 1 I=1,NZONE                                                       010230
           IF(IBC(I).EQ.2)NQ=NQ+1                                               010240
         1 CONTINUE                                                             010250
           IF(NQ.EQ.0)RETURN                                                    010260
      C                                                                         010269
      C          HERE WE FORMULATE THE VECTOR IQROW(I).                         010270
      C          THE SIGNIFICANCE OF THIS VECTOR IS AS FOLLOWS% WE HAVE         010271
      C          DETERMINED ABOVE THAT THE NUMBER OF UNKNOWN TEMPERATURES       010272
      C          IS NQ. IQROW(I) IS THE ROW NUMBER OF THE A-MATRIX COR-         010273
      C          RESPONDING TO THE I-TH UNKNOWN TEMPERATURE                     010274
      C                                                                         010275
             IF(ICHECK.NE.0)  PRINT 499                                         010280
      499    FORMAT(///50X,*ROW NO. IN Q      CORRESPONDING*/50X,*MATRIX*,13X,  010290
            1*ROW IN R-MATRIX*/)                                                010300
      C                                                                         010301
           NLIM=0                                                               010310
           DO 20 I=1,NQ                                                         010320
      25   IRF=I+NLIM                                                           010330
           IF(IBC(IRF).EQ.2)GO TO 27                                            010340
           NLIM=NLIM+1                                                          010350
           GO TO 25                                                             010360
      27   IQROW(I)=IRF                                                         010370
           IF(ICHECK.NE.0) PRINT 500,I,IQROW(I)                                 010380
      500  FORMAT(54X,I4,17X,I4)                                                010390
        20 CONTINUE                                                             010400
      C                                                                         010401
      C              HERE WE FORM A-MATRIX FOR BAND K.  THE A-MATRIX            010410
      C               IS THE MATRIX PRODUCT [F-I] X [RI] (CF. EQN(16))          010420
           DO 11 K=1,NBDS                                                       010430
           ITAPE=K+1                                                            010440
      C                                                                         010441
           DO 10 J=1,NZONE                                                      010450
           READ(ITAPE) (B(L),L=1,NZONE)                                         010460
      C    THE B-VECTOR NOW CONTAINS THE J-TH COLUMN OF THE VECTOR R-INVERSE 010470
           DO 5 I=1,NZONE                                                       010480
           W(I,J)  =0.                                                          010490
           READ(1) (BB(L),L=1,NZONE)                                            010500
           DO 8 L=1,NZONE                                                       010510
           IF(L.EQ.I)BB(L)=BB(L)-1.                                             010520
           W(I,J)  =W(I,J)+BB(L)*B(L)                                           010530
      8    CONTINUE                                                             010540
      5    CONTINUE                                                             010550
           REWIND 1                                                             010560
      10   CONTINUE                                                             010570
      C                                                                         010571
      C              NOW THAT A-MATRIX FOR BAND K HAS BEEN FORMED WE WE PRINT IT010580
      C              (IF THE DIAGNOSTIC PRINT OPTION HAS BEEN SELECTED) AND THEN010590
      C              WE WRITE IT TO TAPE "ITAPE". THE INFORMATION NOW THERE     010591
      C              (R-INVERSE) IS NOT NEEDED HENCEFORTH.                      010600
           REWIND ITAPE                                                         010610
           DO 18 I=1,NZONE                                                      010620
           WRITE(ITAPE) (W(I,J),J=1,NZONE)                                      010630
      18   CONTINUE                                                             010640
```



```
                IF(ICHECK.EQ.0) GO TO 11                                        010650
           PRINT 623                                                            010660
       623 FORMAT(///66X,*THE A-MATRICES*///)                                   010670
           PRINT 624,K                                                          010680
       624 FORMAT(/65X,*BAND*,I2/)                                              010690
           DO 14 I=1,NZONE                                                      010700
           PRINT 622,(W(I,J)   ,J=1,NZONE)                                      010710
      622  FORMAT(/3(6(4X,E16.6)/))                                             010720
        14 CONTINUE                                                             010730
      11   CONTINUE                                                             010740
      C                                                                         010741
           DO 17 ITAPE=2,N                                                      010750
           REWIND ITAPE                                                         010760
      17   CONTINUE                                                             010770
      C                                                                         010771
      C        WE DETERMINE THE BAND "IBAND" WHOSE PROPERTIES ARE USED IN       010777
      C        OBTAINING THE INITIAL GUESS OF TEMPERATURES INPUT TO ZSYSTM      010778
      C        IF THE ENCLOSURE IS NON-GRAY                                     010779
      16   DO 35 K=1,NBDS                                                       010780
           KK=K+1                                                               010790
           IF(XLAM(KK).GT.3.3)GO TO 36                                          010800
        35 CONTINUE                                                             010810
        36 IBAND=KK-1                                                           010820
      C                                                                         010821
                      IF(ICHECK.NE.0) PRINT 625                                 010830
       625 FORMAT(///56X,*THE COLUMN VECTOR Q(I)*/51X,*ELEMENT*,3X,*ZONE*       010840
          1 ,7X,*Q(I)*/)                                                        010850
      C                                                                         010851
      C         HERE WE DETERMINE THE VECTOR Q(I). THIS VECTOR                  010852
      C         IS THE SET OF THE NQ KNOWN ELEMENTS OF THE B-VECTOR             010853
      C         WHICH IS EQUIVALENT TO EQN. (17)                                010854
           DO 110 I=1,NQ                                                        010860
           IRF=IQROW(I)                                                         010870
           Q(I)=RADNET(IRF)-QTOTL(IRF,1)                                        010880
                     IF(ICHECK.EQ.0) GO TO 110                                  010890
           PRINT 626,I,IRF,Q(I)                                                 010900
      626  FORMAT(54X,I3,8X,I3,6X,E12.6)                                        010910
       110 CONTINUE                                                             010920
      C                                                                         010921
      C          WITH THE B-VECTOR KNOWN, WE CAN NOW CALCULATE THE NQ           010930
      C          ELEMENTS IN THE R. H. S. OF EQN. (20)                          010931
      C          THIS IS DONE IN THE NEXT "DO LOOP"                             010932
        47 CONTINUE                                                             010940
                     IF(ICHECK.NE.0) PRINT 627                                  010950
       627 FORMAT(///56X,* R.H.S. EQN (20)*/60X,*I*,8X,*R.H.S. EQN (20)*/)      010960
      C                                                                         010961
           DO 200 I=1,NQ                                                        010970
           IRFS=IQROW(I)                                                        010980
           LL=1                                                                 010990
           LU=NBDS                                                              011000
           IF(NTIM.GT.1) GO TO 46                                               011010
      C            IF NTIM.GT.1 TEMPERATURE ESTIMATES (PRESUMABLY RELIABLE      011020
      C             ONES) ALREADY EXIST FOR THOSE ZONES HAVING THE IBC(I)=2     011030
      C             BOUNDARY CONDITION. THEREFORE WE CAN GO TO 46 WHERE WE      011040
      C             BEGIN THE EXACT CALCULATION FOR R.H.S. OF EQN. (20).        011050
      C             ON THE OTHER HAND, IF NTIM=1 NO SUCH ESTIMATES YET EXIST,   011060
      C             AND WE  DETERMINE TEMPERATURES BY ASSUMING THAT THE         011070
```

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      C           ENCLOSURE IS GRAY.    IN THIS CASE WE CALCULATE AN        011080
      C           APPROXIMATE R.H.S. OF EQ.(20) CORRESPONDING TO A GRAY     011090
      C           ENCLOSURE. THE PROPERTIES OF THE "IBAND-TH" BAND ARE USED. 011091
            LL=IBAND                                                        011100
            LU=IBAND                                                        011110
         46 SUM=0.                                                          011120
      C                                                                     011121
      C         WE READ THE A-MATRIX FOR THE K-TH BAND INTO WORK ARRAY W(I,J)C11122
            DO 48 K=LL,LU                                                   011130
            ITAPE = K+1                                                     011140
            DO 49 L=1,NZONE                                                 011150
            READ(ITAPE) (W(L,J),J=1,NZONE)                                  011160
      49    CONTINUE                                                        011170
            REWIND ITAPE                                                    011180
      C                                                                     011181
      C           WE NOW PERFORM THE "J" SUMMATIONS INDICATED ON THE R.H.S. 011182
      C           OF EQN (20)                                               011183
            DO 140 J=1,NZONE                                                011190
            IF(IBC(J).EQ.2) GO TO 140                                       011200
            XMUL=EMP(J,K)                                                   011210
            IF((NTIM.GT.1).OR.(NBDS.EQ.1))GO TO 55                          011220
      C                                                                     011221
      C        WE EXECUTE THE FOLLOWING 3 STATEMENTS ONLY IF R.H.S. OF EQ. 20011230
      C        CORRESPONDING TO A GRAY ENCLOSURE IS BEING CALCULATED        011240
      C        FOR THE PURPOSE OF OBTAINING TEMPERATURE ESTIMATES WHICH     011250
      C        CAN BE INPUT TO THE SOLUTION PROCEDURE FOR THE NON-GRAY      011260
      C        PROBLEM                                                      011270
            ISET=IREFL(J)                                                   011280
            RHO=REFL(ISET,IBAND)                                            011290
            XMUL=(1.-RHO)*SIGMA*TEMP(J)**4                                  011300
      55    SUM=SUM+W(IRFS,J)   *XMUL                                       011310
        140 CONTINUE                                                        011320
      C                                                                     011321
         48 CONTINUE                                                        011330
      C                                                                     011331
            B(I)=Q(I)-SUM                                                   011340
      C                                                                     011341
                IF(ICHECK.NE.0) PRINT 628,I,B(I)                            011350
      C            THE B-VECTOR NOW CONTAINS THE R.H.S. OF EQ (20)          011360
      628   FORMAT(59X,I3,6X,E12.6)                                         011370
      C                                                                     011371
        200 CONTINUE                                                        011380
      C                                                                     011381
            IF((NTIM.GT.1).AND.(NBDS.GT.1))GO TO 170                        011390
      C                                                                     011391
      C           HERE WE DETERMINE                                         011399
      C           THE COEFFICIENT MATRIX (I.E., THE A-MATRIX IN EQ (20))    011400
      C           USED IN THE SOLUTION OF THE GRAY ENCLOSURE PROBLEM.       011410
      C           WE THEN DETERMINE TEMPERATURES BY SOLVING A SET OF LINEAR 011420
      C           ALGEBRAIC EQUATIONS. THIS DETERMINATION IS MADE ONLY IF   011430
      C               A) THE ENCLOSURE INTERIOR IS ACTUALLY GRAY OR         011440
      C               B) THE ENCLOSURE IS NON-GRAY AND NTIM =1 IN WHICH CASE 011450
      C                  WE NEED THE FIRST ESTIMATES OF TEMPERATURE AT THE  011460
      C                  IBC(I)=2 ZONES                                     011470
            ITAPE=IBAND+1                                                   011480
            DO 128 L=1,NZONE                                                011490
            READ(ITAPE) (W(L,J),J=1,NZONE)                                  011500
```



```
      128   CONTINUE                                                        011510
            REWIND ITAPE                                                    011520
      C                                                                     011521
                          IF(ICHECK.NE.0) PRINT 629                         011540
        629 FORMAT(///62X,*THE A-MATRIX (CF. EQ. 20)*/)                     011550
            DO 130 I=1,NQ                                                   011560
            IRFS=IQROW(I)                                                   011570
            DO 125 J=1,NQ                                                   011580
            JRFS=IQROW(J)                                                   011590
            W(I,J)   =W(IRFS,JRFS)                                          011600
        125 CONTINUE                                                        011610
                IF(ICHECK.NE.0) PRINT 622,(W(I,J)   ,J=1,NQ)                011620
        130 CONTINUE                                                        011630
      C                                                                     011631
            INIT=0                                                          011632
            CALL SAXB(120,NQ,1,W,B,INIT,IN,KER)                             011640
      C                                                                     011641
            IF(KER.EQ.0) GO TO 131                                          011650
            PRINT 630,KER                                                   011660
        630 FORMAT(//5X,*ERROR DETECTED IN SAXB CALLED FROM THERMAL  KER=*,I5)011670
            CALL EXIT                                                       011680
      C                                                                     011681
        131 IF(ICHECK.EQ.0) GO TO 132                                       011690
      C                                                                     011691
            PRINT 631                                                       011700
        631 FORMAT(///25X,*ESTIMATES OF TEMPERATURES AT ZONES WITH IBC(I)=2 B.011710
           1 C.,S (XACT TEMPS IF GRAY PROBLEM)*/47X,*ZONE NO.*,4X,*TEMPERATURE011720
           2*,3X,*EMISSIVE POWER*/)                                         011730
      C                                                                     011731
        132 DO 135 I=1,NQ                                                   011740
            IRFS=IQROW(I)                                                   011750
            ISET=IREFL(IRFS)                                                011760
            RHO=REFL(ISET,IBAND)                                            011770
            TGES(I)=(B(I)/((1.-RHO)*SIGMA))**.25                            011780
            TEMP(IRFS)=TGES(I)                                              011790
            EMP(IRFS,IBAND)=B(I)                                            011800
            IF(ICHECK.NE.0)PRINT 632,IRFS,TGES(I),B(I)                      011810
      632   FORMAT(50X,I3,6X,E12.6,4X,E12.6)                                011820
        135 CONTINUE                                                        011830
      C                                                                     011831
            IF(NBDS.EQ.1)RETURN                                             011840
      C                                                                     011841
            NTIM=NTIM+1                                                     011850
            GO TO 47                                                        011860
      C           WE GO BACK TO 47 WHERE WE COMPUTE THE EXACT VALUE         011870
      C           OF R.H.S. EQ. (20) FOR THE MULTI-BAND PROBLEM             011880
        170 CONTINUE                                                        011890
      C                                                                     011899
      C           HERE WE USE  THE SOLUTION PROCEDURE  FOR SOLVING          011900
      C           EQUATION (20) FOR NO. OF BANDS > 1                        011910
      C                                                                     011911
            ITMAXX=ITMAX                                                    011920
            CALL ZSYSTM(FUNC,EPS,NSIG,NQ,TGES,ITMAXX,WA,PAR,IER)            011930
      C                                                                     011931
            IF(ICHECK.NE.0) PRINT 633,ITMAXX                                011940
        633 FORMAT(//5X,*NO. OF ITERATIONS IN SOLVING SET OF NON-LINEAR EQUAT 011950
           1IONS*, I5)                                                      011960
```

```
      SUBROUTINE THERMAL     74/74    OPT=0 TRACE                       FTN 4.6+439         07/22/81  14.56.32        PAGE      6

                C                                                                011961
                     IF(ICHECK.NE.0) PRINT 634                                   011970
                 634 FORMAT(///45X,*EXACT TEMPERATURES AT ZONES WITH IBC(I)=2 B.C.*/     011980
                    153X,*ZONE*,3X,*    TEMPERATURE*/)                           011990
                C                                                                011991
                     DO 146 I=1,NQ                                               012000
                     IRFS=IQROW(I)                                               012010
                     ISET=IREFL(IRFS)                                            012020
                     TEMP(IRFS)=TGES(I)                                          012030
                C                                                                012031
                     IF(ICHECK.NE.0)PRINT 635,IRFS,TEMP(IRFS)                    012040
                 635 FORMAT(55X,I2,6X,E16.10)                                    012050
                C                                                                012051
                     DO 145 K=1,NBDS                                             012060
                     RHO=REFL(ISET,K)                                            012070
                     EMP(IRFS,K)=EMISS(TGES(I),XLAM(K),XLAM(K+1))*(1.-RHO)       012080
                 145 CONTINUE                                                    012090
                C                                                                012091
                 146 CONTINUE                                                    012100
                C                                                                012101
                     RETURN                                                      012110
                     END                                                         012120
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    4  THERMAL         1           65        269        306

VARIABLES       SN  TYPE             RELOCATION
35236  B            REAL       ARRAY    GEOM        REFS        29        101        209        244        262        264        265
                                                DEFINED        94        207
35616  BB           REAL       ARRAY    GEOM        REFS        29        100        101    DEFINED         98        100
 1533  EMP          REAL       ARRAY    PROP        REFS        26         54        191    DEFINED         51        264        301
 1061  EPS          REAL                            REFS       281    DEFINED         34
  210  GDRECT       REAL       ARRA:    PROP        REFS        26
 1445  I            INTEGER                         REFS        47         48       2*51       2*54         63         79         83
                                                   2*84        97        100      2*101        113        121        147        148
                                                  2*150       162      2*207      2*209        235        238        240        259
                                                  2*262       263        264      2*265        292        294        301
                                                DEFINED        46         62         78         96        112        120        146
                                                    161       234        258        291
 1457  IBAND        INTEGER                         REFS       175        176        200        226        261        264
                                                DEFINED       137
  400  IBC          INTEGER    ARRAY    PROP        REFS        26         47         63         80        190
    0  ICHECK       INTEGER               F.P.      REFS        41         54         73         84        115        139        149
                                                    158       209        232        240        251        265        283        287
                                                    296   DEFINED          1
 1472  IER        * INTEGER                         REFS       281
35426  IN           INTEGER    ARRAY    GEOM        REFS        29        244
 1466  INIT         INTEGER                         REFS       244    DEFINED        243
 2303  IQROW        INTEGER    ARRAY    PROP        REFS        26         84        147        162        235        237        259
                                                    292   DEFINED         83
   20  IREFL        INTEGER    ARRAY    PROP        REFS        26         48        199        260        293
```

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      SUBROUTINE THERMAL     74/74    OPT=0 TRACE                       FTN 4.6+439         07/22/81  14.56.32        PAGE      7

VARIABLES       SN  TYPE             RELOCATION
 1452  IRF          INTEGER                         REFS        80         83      2*148        150    DEFINED         79        147
 1460  IRFS         INTEGER                         REFS       202        238        260        263        264        265        293
                                                    294     2*296        301    DEFINED        162        235         25        292
 1446  ISET         INTEGER                         REFS        50        200        261        300    DEFINED         46        199
                                                    260       293
 1453  ITAPE        INTEGER                      DEFINED        91        126        181        226   I/O REFS         94        111
                                                    113       127        183        185        228        230
 1063  ITMAX        INTEGER                         REFS       280    DEFINED         34
 1470  ITMAXX       INTEGER                         REFS       281        283    DEFINED        280
 1454  J            INTEGER                         REFS        97      2*101        113        121        183        190        191
                                                    199       201        202        228        237        238        240
                                                DEFINED        93        113        121        183        189        228        236
                                                    240
 1465  JRFS         INTEGER                         REFS       238    DEFINED        237
 1447  K            INTEGER                         REFS        50       3*51         54         91        118        134        181
                                                    191       300      3*301    DEFINED         49         54         90        133
                                                    180       299
 1467  KER          INTEGER                         REFS       244        246        247
    0  KIND         INTEGER    ARRAY    GEOM        REFS        29
 1456  KK           INTEGER                         REFS       135        137    DEFINED        134
 1455  L            INTEGER                         REFS        94         98      3*103      2*101        183        228
                                                DEFINED        94         98         99        182        227
 1461  LL           INTEGER                         REFS       180    DEFINED        163        175
 1462  LU           INTEGER                         REFS       180    DEFINED        164        176
 2473  N            INTEGER             PROP        REFS        26        126
  570  NBDS         INTEGER             PROP        REFS        26         49         54         90        133        164        192
                                                    215       269        299
35233  NFIC         INTEGER             GEOM        REFS        29
 1451  NLIM         INTEGER                         REFS        79         81    DEFINED         77         81
35235  NQ           INTEGER             GEOM        REFS        29         63         65         78        146        161        234
                                                    236       240        244        258        281        291
                                                DEFINED        34         61         63
  571  NSET         INTEGER             PROP        REFS        26
 1062  NSIG         INTEGER                         REFS       281    DEFINED         34
 1060  NTIM         INTEGER                         REFS        35        165        192        215        271
                                                DEFINED        33         35        271
35230  NZB          INTEGER             GEOM        REFS        29
35231  NZC          INTEGER             GEOM        REFS        29
35234  NZONE        INTEGER             GEOM        REFS        29         46         62         93         94         96         98
                                                     99       112        113        120        121        182        183        189
                                                    227       228
35232  NZT          INTEGER             GEOM        REFS        29
 1471  PAR        * REAL                            REFS       281
 1152  PDCTIN       REAL                PROP        REFS        26
   15  PHI          REAL       ARRAY    PROP        REFS        26
 1473  Q            REAL       ARRAY                REFS        31        150        207    DEFINED        148
 1153  QTOTL        REAL       ARRAY    PROP        REFS        26        148
  572  RADNET       REAL       ARRAY    PROP        REFS        26        148
    4  REFL         REAL       ARRAY    PROP        REFS        26         50        200        261        300
 1450  RHO          REAL                            REFS        51        201        262        301    DEFINED         50        200
                                                    261       300
 1057  SIGMA        REAL                            REFS       201        262    DEFINED         33
 1463  SUM          REAL                            REFS       202        207    DEFINED        177        202
  762  TEMP         REAL       ARRAY    PROP        REFS        26         51        201        296    DEFINED        263        294
 1663  TGES         REAL       ARRAY                REFS        31        263        265        281        294        301
                                                DEFINED       262
 1130  W            REAL       ARRAY    GEOM        REFS        29        101        113        121        202        238        240
```

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      SUBROUTINE THERMAL    74/74   OPT=0 TRACE                       FTN 4.6+439        07/22/81  14.56.32        PAGE      8

VARIABLES       SN  TYPE            RELOCATION
                                                           244     DEFINED       97         101         183        228        238
  2053  WA            REAL       ARRAY                     REFS        31       281
   170  X             REAL       ARRAY    GEOM             REFS        29
     0  XLAM          REAL       ARRAY    PROP             REFS        26       2*51        135        2*301
  1464  XMUL          REAL                                 REFS       202     DEFINED       191         201

FILE NAMES         MODE
       OUTPUT     FMT                      WRITES           41        54        73          84         116        118        121        139
                                              150          158       209       232         240         247        253        265        283
                                              287          296
       TAPE1      UNFMT                     HEADS           98     MOTION      104
       VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS            TYPE   ARGS        REFERENCES
       EMISS      REAL       3              51        301
       EXIT                  0             249
       FUNC                  0              25        281
       SAXB                  8             244
       ZSYSTM                9             281

STATEMENT LABELS               DEF LINE    REFERENCES
     0  1                           64         62
     0  4            INACTIVE       61
     0  5                          103         96
     0  8                          102         99
     0  10                         105         93
   314  11                         124         90        115
     0  14                         123        120
     0  16           INACTIVE      133
     0  17                         128        126
     0  18                         114        112
     0  20                          86         78
   130  25                          79         82
   141  27                          83         80
     0  30                          52         49
     0  35                         136        133
   342  36                         137        135
    77  40                          56         46         47
   420  46                         177        165
   374  47                         157        272
     0  48                         205        180
     0  49                         184        182
   506  55                         202        192
   370  110                        152        146        149
     0  125                        239        236
     0  128                        229        227
     0  130                        241        234
   656  131                        251        246
   662  132                        258        251
     0  135                        267        258
   514  140                        203        189        190
     0  145                        302        299
     0  146                        304        291
   735  170                        275        215
     0  200                        213        161
  1131  499       FMT               74         73
  1147  500       FMT               85         84
```

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      SUBROUTINE THERMAL    74/74   OPT=0 TRACE                       FTN 4.6+439        07/22/81  14.56.32        PAGE      9

STATEMENT LABELS               DEF LINE    REFERENCES
  1067  619      FMT                42         41
  1122  620      FMT                55         54
  1215  622      FMT               122        121        240
  1174  623      FMT               117        116
  1204  624      FMT               119        118
  1224  625      FMT               140        139
  1242  626      FMT               151        150
  1250  627      FMT               159        158
  1273  628      FMT               211        209
  1310  629      FMT               233        232
  1327  630      FMT               248        247
  1341  631      FMT               254        253
  1370  632      FMT               266        265
  1400  633      FMT               284        283
  1413  634      FMT               288        287
  1433  635      FMT               297        296

LOOPS   LABEL     INDEX       FROM-TO      LENGTH     PROPERTIES
    25  40       * I          46 56         55B                 EXT REFS  NOT INNER
    35  30       * K          49 52         22B                 EXT REFS
    63           * K          54 54         11B                 EXT REFS
   106  1          I          62 64         10B          OPT
   127  20       * I          78 86         25B                 EXT REFS
   156  11       * K          90 124       141B                 EXT REFS  NOT INNER
   163  10       * J          93 105        52B                 EXT REFS  NOT INNER
   173  5        * I          96 103        35B                 EXT REFS  NOT INNER
   207  8          L          99 102        16B          OPT
   241  18       * I         112 114        21B                 EXT REFS  NOT INNER
   244           * J         113 113        11B                 EXT REFS
   272  14       * I         120 123        21B                 EXT REFS  NOT INNER
   275           * J         121 121        11B                 EXT REFS
   321  17       * ITAPE     126 128         5B                 EXT REFS
   330  35       * K         133 136        11B          OPT      EXITS
   351  110      * I         146 152        22B                 EXT REFS
   401  200      * I         161 213       135B                 EXT REFS  NOT INNER
   423  48       * K         180 205        77B                 EXT REFS  NOT INNER
   430  49       * L         182 184        21B                 EXT REFS  NOT INNER
   433           * J         183 183        11B                 EXT REFS
   455  140        J         189 203        42B          OPT
   547  128      * L         227 229        21B                 EXT REFS  NOT INNER
   552           * J         228 228        11B                 EXT REFS
   577  130      * I         234 241        44B                 EXT REFS  NOT INNER
   604  125        J         236 239        15B          OPT
   625           * J         240 240        11B                 EXT REFS
   663  135      * I         258 267        43B                 EXT REFS
   751  146      * I         291 304        46B                 EXT REFS  NOT INNER
   772  145      * K         299 302        22B                 EXT REFS

COMMON BLOCKS    LENGTH
        PROP        1340
        GEOM       15366

STATISTICS
  PROGRAM LENGTH                207744B     8676
  CM LABELED COMMON LENGTH      40502B     16706
```

FUNCTION FUNC 74/74 OPT=0 TRACE FTN 4.6+439 07/22/81 14.56.32 PAGE 1

```
              FUNCTION FUNC(TGES,I,PAR)                                        012130
        C                                                                      012140
        C     THIS PROGRAM WAS WRITTEN BY                                      012150
        C             M. ABRAMS                                                012160
        C     THERMAL SCIENCES DIVISION                                        012170
        C     SANDIA NATIONAL LABORATORIES                                     012180
        C     LIVERMORE, CALIFORNIA 94550                                      012190
        C                                                                      012200
        C             THIS FUNCTION COMPUTES THE DIFFERENCE BETWEEN THE RIGHT  012210
        C             AND LEFT HAND SIDES OF EQUATION 20. THIS DIFFERENCE IS   012220
        C             EXPRESSED BY EQN (23).                                   012221
        C             FUNC IS OPERATED UPON BY "ZSYSTM".                       012222
        C                                                                      012223
              COMMON/GEOM/KIND(120),X(120,4),W(120,120),NZB,NZC,NZT,NFIC,NZONE,N012230
             1          Q,B(120),IN(120),BB(120)                               012240
              COMMON/PROP/XLAM(4),REFL(3,3),PHI(3),IREFL(120),GDRECT(120),IBC(12012330
             1          0),NBDS,NSET,RADNET(120),TEMP(120),PDCTIN,QTOTL(120,2)012340
             2          ,EMP(120,3),IQROW(120),N                               012350
              DIMENSION TGES(120)                                              012360
        C                                                                      012361
        C     PRINT 500,(TGES(L),L=1,NQ)                                       012370
        C 500 FORMAT(/1X,*(TGES(L),L=1,NQ)*,7E16.9/3(17X,7E16.9/))             012380
        C                                                                      012381
              IRFS=IQROW(I)                                                    012390
              SUM=0.                                                           012400
        C                                                                      012401
              DO 100 K=1,NBDS                                                  012410
              ITAPE=K+1                                                        012420
        C                                                                      012421
              DO 10 L=1,NZONE                                                  012430
              READ(ITAPE) (W(L,J),J=1,NZONE)                                   012440
        10    CONTINUE                                                         012450
              REWIND ITAPE                                                     012460
        C                                                                      012461
              DO 80 J=1,NQ                                                     012470
              ICFS=IQROW(J)                                                    012480
              ISET=IREFL(ICFS)                                                 012490
              RHO=REFL(ISET,K)                                                 012500
              SUM=SUM+W(IRFS,ICFS)  *EMISS(TGES(J),XLAM(K),XLAM(K+1))*(1.-RHO) 012510
           80 CONTINUE                                                         012520
        C                                                                      012521
          100 CONTINUE                                                         012530
        C                                                                      012531
        C     (NOTE THAT B(I) HERE REPRESENTS THE R. H. S. OF EQ. 20)          012532
              FUNC=B(I)-SUM                                                    012540
        C                                                                      012541
        C     PRINT 499,I,FUNC                                                 012550
        C 499 FORMAT(17X,*(I,FUNC)*,I5,E16.10)                                 012560
        C                                                                      012561
              RETURN                                                           012570
              END                                                              012580
```

FUNCTION FUNC 74/74 OPT=0 TRACE FTN 4.6+439 07/22/81 14.56.32 PAGE 2

```
       SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    5  FUNC           1            50

VARIABLES       SN  TYPE           RELOCATION
35236  B            REAL       ARRAY    GEOM          REFS      14      45
35616  BB           REAL       ARRAY    GEOM          REFS      14
 1533  EMP          REAL       ARRAY    PROP          REFS      16
  136  FUNC         REAL                           DEFINED      45
  210  GDRECT       REAL       ARRAY    PROP          REFS      16
    0  I            INTEGER              F.P.         REFS      24      45   DEFINED     1
  400  IBC          INTEGER    ARRAY    PROP          REFS      16
  145  ICFS         INTEGER                           REFS      37      39   DEFINED    36
35426  IN           INTEGER    ARRAY    GEOM          REFS      14
 2303  IQROW        INTEGER    ARRAY    PROP          REFS      16      24       36
   20  IREFL        INTEGER    ARRAY    PROP          REFS      16      37
  137  IRFS         INTEGER                           REFS      39   DEFINED     24
  146  ISET         INTEGER                           REFS      38   DEFINED     37
  142  ITAPE        INTEGER                        DEFINED      28   I/O REFS    31       33
  144  J            INTEGER                           REFS      31      36       39   DEFINED       31       35
  141  K            INTEGER                           REFS      28      38     2*39   DEFINED       27
    0  KIND         INTEGER    ARRAY    GEOM          REFS      14
  143  L            INTEGER                           REFS      31   DEFINED     30
 2473  N            INTEGER             PROP          REFS      16
  570  NBDS         INTEGER             PROP          REFS      16      27
35233  NFIC         INTEGER             GEOM          REFS      14
35235  NQ           INTEGER             GEOM          REFS      14      35
  571  NSET         INTEGER             PROP          REFS      16
35230  NZB          INTEGER             GEOM          REFS      14
35231  NZC          INTEGER             GEOM          REFS      14
35234  NZONE        INTEGER             GEOM          REFS      14      30       31
35232  NZT          INTEGER             GEOM          REFS      14
    0  PAR          REAL      *UNUSED    F.P.      DEFINED       1
 1152  PDCTIN       REAL                PROP          REFS      16
   15  PHI          REAL       ARRAY    PROP          REFS      16
 1153  QTOTL        REAL       ARRAY    PROP          REFS      16
  572  RADNET       REAL       ARRAY    PROP          REFS      16
    4  REFL         REAL       ARRA:    PROP          REFS      16      38
  147  RHO          REAL                              REFS      39   DEFINED     38
  140  SUM          REAL                              REFS      39      45   DEFINED       25       39
  762  TEMP         REAL       ARRAY    PROP          REFS      16
    0  TGES         REAL       ARRAY     F.P.         REFS      19      39   DEFINED        1
 1130  W            REAL       ARRAY    GEOM          REFS      14      39   DEFINED       31
  170  X            REAL       ARRAY    GEOM          REFS      14
    0  XLAM         REAL       ARRAY    PROP          REFS      16    2*39
       VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS          TYPE   ARGS        REFERENCES
       EMISS      REAL      3             39

STATEMENT LABELS              DEF LINE   REFERENCES
    0  10                        32          30
    0  80                        40          35
    0  100                       42          27
```

```
LOOPS  LABEL    INDEX      FROM-TO    LENGTH    PROPERTIES
   26  100      * K          27 42      66B              EXT REFS  NOT INNER
   33  10       * L          30 32      21B              EXT REFS  NOT INNER
   36           * J          31 31      11B              EXT REFS
   60  80       * J          35 40      31B              EXT REFS

COMMON BLOCKS   LENGTH
      GEOM       15366
      PROP        1340

STATISTICS
  PROGRAM LENGTH                   156B      110
  CM LABELED COMMON LENGTH      40502B    16706
```



```
            FUNCTION EMISS(T,W1,W2)                                      012590
      C                                                                  012600
      C     THIS PROGRAM WAS WRITTEN BY                                  012610
      C            M. ABRAMS                                             012620
      C     THERMAL SCIENCES DIVISION                                    012630
      C     SANDIA NATIONAL LABORATORIES                                 012640
      C     LVERMORE, CALIFORNIA 94550                                   012650
      C                                                                  012660
      C            COMPUTES THE EMISSIVE POWER OF A BLACK BODY OVER THE  012670
      C            WAVELENGTH RANGE W1 TO W2.                            012680
      C               T............ABSOLUTE TEMPERATURE OF BLACK BODY (DEG-K) 012690
      C               W1,W2.......LOWER AND UPPER WAVELENGTHS (MICRONS)  012700
      C               UNITS OF EMISSIVE POWER% KW/METER**2               012710
      C                                                                  012711
            DIMENSION W(2),R(2),B(10)                                    012720
      C                                                                  012721
            DATA PI415,(B(I),I=1,10) /6.493939405,                       012730
           1      .1666666667,     -.03333333333,      .02380952381,     012740
           2     -.03333333333,    .07575757576,      -.2531135531,      012750
           3     1.166666667,      -7.092156863,       54.97117794,      012760
           4    -529.1242424 /                                           012770
            DATA THIRD,C2,SIGMA/.3333333333333,14388.,5.6693E-11/        012780
      C                                                                  012781
            W(1)=W1                                                      012790
            W(2)=W2                                                      012800
            DO 50 I=1,2                                                  012810
            R(I)=PI415                                                   012820
            WIT=W(I)*T                                                   012830
            IF(WIT.LE.1.E-4)GO TO 50                                     012840
            R(I)=0.                                                      012850
            IF(WIT.GE.1.E+9)GO TO 50                                     012860
            X1=C2/WIT                                                    012870
            X2=X1*X1                                                     012880
            X3=X2*X1                                                     012890
            SUM=1.E-50                                                   012900
            IF(X1.GE.2.)GO TO 20                                         012910
      C                                                                  012911
      C     BEGINNING OF EQN 27.1.1 IN HMF                               012920
            FAC=1.                                                       012930
            TOP=1.                                                       012940
            DO  10  J= 1,10                                              012950
            J2=2*J                                                       012960
            FAC=FAC*J2*(J2-1)                                            012970
            TOP=TOP*X2                                                   012980
            ADD=B(J)*TOP/((J2+3)*FAC)                                    012990
            SUM= SUM+ADD                                                 013000
            IF(ABS(ADD/SUM).LT.1.E-6) GO TO 15                           013010
         10 CONTINUE                                                     013020
         15 R(I)=X3 *(THIRD-.125*X1  +SUM)                               013030
            GO TO 50                                                     013040
      C                                                                  013041
      C     BEGINNING OF EQN 27.1.2 IN HMF                               013050
         20 DO  30  J=1,10                                               013060
            Z=J*X1                                                       013070
            IF(Z.GT.670.)33,34                                           013080
         33 ADD=0.                                                       013090
            GO TO 32                                                     013100
```

```
            34 EX=EXP(-Z)                                           013110
               J1=J                                                 013120
               J2=J1*J                                              013130
               J3=J2*J                                              013140
               J4=J3*J                                              013150
               ADD=EX*(X3/J1+3.*X2/J2+6.*X1/J3 +6./J4)              013160
            32 SUM=SUM+ADD                                          013170
               IF(ABS(ADD/SUM).LT.1.E-6) GO TO 35                   013180
            30 CONTINUE                                             013190
            35 R(I)=(PI415-SUM)                                     013200
            50 CONTINUE                                             013210
               EMISS=(SIGMA/PI415)*(T**4)*(R(1)-R(2))               013220
               RETURN                                               013230
               END                                                  013240


      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
   5  EMISS           1            70

VARIABLES      SN  TYPE            RELOCATION
   262  ADD        REAL                              REFS      46      47      64      65   DEFINED      45      56
                                                                63
   274  B          REAL       ARRAY                  REFS      15      45 DEFINED      17
   233  C2         REAL                              REFS      32 DEFINED      22
   247  EMISS      REAL                           DEFINED      69
   264  EX         REAL                              REFS      63 DEFINED      58
   256  FAC        REAL                              REFS      43      45 DEFINED      39      43
   250  I          INTEGER                           REFS      27      28      30      49      67
                                                  DEFINED      26
   260  J          INTEGER                           REFS      42      45      54      59      60      61      62
                                                  DEFINED      41      53
   265  J1         INTEGER                           REFS      60      63 DEFINED      59
   261  J2         INTEGER                           REFS    2*43      45      61      63 DEFINED      42      60
   266  J3         INTEGER                           REFS      62      63 DEFINED      61
   267  J4         INTEGER                           REFS      63 DEFINED      62
   231  PI415      REAL                              REFS      27      67      69 DEFINED      17
   272  R          REAL       ARRAY                  REFS      15    2*69 DEFINED      27      30      49      67
   234  SIGMA      REAL                              REFS      69 DEFINED      22
   255  SUM        REAL                              REFS      46      47      49      64      65      67
                                                  DEFINED      35      46      64
     0  T          REAL                 F.P.         REFS      28      69 DEFINED       1
   232  THIRD      REAL                              REFS      49 DEFINED      22
   257  TOP        REAL                              REFS      44      45 DEFINED      40      44
   270  W          REAL       ARRAY                  REFS      15      28 DEFINED      24      25
   251  WIT        REAL                              REFS      29      31      32 DEFINED      28
     0  W1         REAL                 F.P.         REFS      24 DEFINED       1
     0  W2         REAL                 F.P.         REFS      25 DEFINED       1
   252  X1         REAL                              REFS    2*33      34      36      49      54      63
                                                  DEFINED      32
   253  X2         REAL                              REFS      34      44      63 DEFINED      33
   254  X3         REAL                              REFS      49      63 DEFINED      34
   263  Z          REAL                              REFS      55      58 DEFINED      54
```

```
         FUNCTION EMISS       74/74   OPT=0 TRACE                     FTN 4.6+439        07/22/81  14.56.32       PAGE     3

EXTERNALS            TYPE    ARGS       REFERENCES
        EXP         REAL        1 LIBRARY     58

INLINE FUNCTIONS     TYPE    ARGS            DEF LINE  REFERENCES
        ABS         REAL        1   INTRIN                   47          65

STATEMENT LABELS                  DEF LINE    REFERENCES
     0  10                           48          41
   117  15                           49          47
   126  20                           53          36
     0  30                           66          53
   175  32                           64          57
     0  33             INACTIVE      56          55
   141  34                           58          55
   207  35                           67          65
   213  50                           68          26          29          31          50

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   25  50      * I           26 68       171B                EXT REFS  NOT INNER
   66  10      * J           41 48       30B          OPT       EXITS
  127  30      * J           53 66       57B                 EXT REFS     EXITS

STATISTICS
  PROGRAM LENGTH                   314B      204
```

```
                              74/74   OPT=0 TRACE                     FTN 4.6+439        07/22/81  14.56.32       PAGE     1

                      SUBROUTINE FDUMP
                C
                C     SANDIA MATHEMATICAL PROGRAM LIBRARY
                C     APPLIED MATHEMATICS DIVISION 2646
                C     SANDIA LABORATORIES
                C     ALBUQUERQUE, NEW MEXICO  87185
                C     CONTROL DATA 6600/7600  VERSION 8.1  AUGUST 1980
                C                   *************************
                C                   *       ISSUED BY       *
                C                   *  SANDIA LABORATORIES, *
                C                   *   A PRIME CONTRACTOR  *
                C                   ********     TO THE     *
                C                           *  UNITED STATES *
                C                           *   DEPARTMENT   *
                C                           *       OF       *
                C                           *     ENERGY     *
                C      *********************  ---NOTICE---  *********************
                C      *THIS REPORT WAS PREPARED AS AN ACCOUNT OF WORK SPONSORED*
                C      *  BY THE UNITED STATES GOVERNMENT.  NEITHER THE UNITED  *
                C      *   STATES NOR THE UNITED STATES DEPARTMENT OF ENERGY,   *
                C      *               NOR ANY OF THEIR EMPLOYEES,              *
                C      * NOR ANY OF THEIR CONTRACTORS, SUBCONTRACTORS, OR THEIR *
                C      * EMPLOYEES, MAKES ANY WARRANTY, EXPRESS OR IMPLIED, OR  *
                C      * ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE  *
                C      *         **********    ACCURACY,   **********          *
                C      *         *         *  COMPLETENESS  *        *          *
                C      *         *         *  OR USEFULNESS *        *          *
                C      *         *         *     OF ANY     *        *          *
                C      *         *         *  INFORMATION,  *        *          *
                C      *         *         *   APPARATUS,   *        *          *
                C      *      ****         *    PRODUCT     *        ****       *
                C      *      *            *   OR PROCESS   *           *       *
                C      *      *            *   DISCLOSED,   *           *       *
                C      *      *            *  OR REPRESENTS *           *       *
                C      *      *           **    THAT ITS    **          *       *
                C      *      *           **  USE WOULD NOT **          *       *
                C      ********           **    INFRINGE    **          ********
                C                         **    PRIVATELY   **
                C                         **      OWNED     **
                C                         **     RIGHTS.    **
                C                         **                **
                C                         **                **
                C                         **                **
                C                         ********************
                C
                C     ABSTRACT
                C         ***NOTE*** MACHINE DEPENDENT ROUTINE
                C         FDUMP IS INTENDED TO BE REPLACED BY A LOCALLY WRITTEN
                C         VERSION WHICH PRODUCES A SYMBOLIC DUMP.  FAILING THIS,
                C         IT SHOULD BE REPLACED BY A VERSION WHICH PRINTS THE
                C         SUBPROGRAM NESTING LIST.  NOTE THAT THIS DUMP MUST BE
                C         PRINTED ON EACH OF UP TO FIVE FILES, AS INDICATED BY THE
                C         XGETUA ROUTINE.  SEE XSETUA AND XGETUA FOR DETAILS.
                C
                C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
                C     LATEST REVISION ---  23 MAY 1979
                C
```

```
                RETURN
                END
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS      DEF LINE      REFERENCES
   2  FDUMP           1            58

STATISTICS
  PROGRAM LENGTH                   4B        4
```



```
                SUBROUTINE XERABT(MESSG,NMESSG)
          C
          C     ABSTRACT
          C        ***NOTE*** MACHINE DEPENDENT ROUTINE
          C        XERABT ABORTS THE EXECUTION OF THE PROGRAM.
          C        THE ERROR MESSAGE CAUSING THE ABORT IS GIVEN IN THE CALLING
          C        SEQUENCE IN CASE ONE NEEDS IT FOR PRINTING ON A DAYFILE,
          C        FOR EXAMPLE.
          C
          C     DESCRIPTION OF PARAMETERS
          C        MESSG AND NMESSG ARE AS IN XERROR, EXCEPT THAT NMESSG MAY
          C        BE ZERO, IN WHICH CASE NO MESSAGE IS BEING SUPPLIED.
          C
          C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
          C     LATEST REVISION ---  7 JUNE 1978
          C
                DIMENSION MESSG(NMESSG)
                STOP
                END
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS      DEF LINE      REFERENCES
   4  XERABT          1

VARIABLES      SN  TYPE              RELOCATION
    0  MESSG       INTEGER    ARRAY     F.P.         REFS       17     DEFINED        1
    0  NMESSG      INTEGER              F.P.         REFS       17     DEFINED        1

STATISTICS
  PROGRAM LENGTH                   11B       9
```

```
1        FUNCTION J4SAVE(IWHICH,IVALUE,ISET)
2  C
3  C     ABSTRACT
4  C        J4SAVE SAVES AND RECALLS SEVERAL GLOBAL VARIABLES NEEDED
5  C        BY THE LIBRARY ERROR HANDLING ROUTINES.
6  C
7  C     DESCRIPTION OF PARAMETERS
8  C      --INPUT--
9  C        IWHICH - INDEX OF ITEM DESIRED.
10 C                 = 1 REFERS TO CURRENT ERROR NUMBER.
11 C                 = 2 REFERS TO CURRENT ERROR CONTROL FLAG.
12 C                 = 3 REFERS TO CURRENT UNIT NUMBER TO WHICH ERROR
13 C                     MESSAGES ARE TO BE SENT.  (0 MEANS USE STANDARD.)
14 C                 = 4 REFERS TO THE MAXIMUM NUMBER OF TIMES ANY
15 C                     MESSAGE IS TO BE PRINTED (AS SET BY XERMAX).
16 C                 = 5 REFERS TO THE TOTAL NUMBER OF UNITS TO WHICH
17 C                     EACH ERROR MESSAGE IS TO BE WRITTEN.
18 C                 = 6 REFERS TO THE 2ND UNIT FOR ERROR MESSAGES
19 C                 = 7 REFERS TO THE 3RD UNIT FOR ERROR MESSAGES
20 C                 = 8 REFERS TO THE 4TH UNIT FOR ERROR MESSAGES
21 C                 = 9 REFERS TO THE 5TH UNIT FOR ERROR MESSAGES
22 C        IVALUE - THE VALUE TO BE SET FOR THE IWHICH-TH PARAMETER,
23 C                 IF ISET IS .TRUE. .
24 C        ISET   - IF ISET=.TRUE., THE IWHICH-TH PARAMETER WILL BE
25 C                 GIVEN THE VALUE, IVALUE.  IF ISET=.FALSE., THE
26 C                 IWHICH-TH PARAMETER WILL BE UNCHANGED, AND IVALUE
27 C                 IS A DUMMY PARAMETER.
28 C      --OUTPUT--
29 C        THE (OLD) VALUE OF THE IWHICH-TH PARAMETER WILL BE RETURNED
30 C        IN THE FUNCTION VALUE, J4SAVE.
31 C
32 C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
33 C     ADAPTED FROM BELL LABORATORIES PORT LIBRARY ERROR HANDLER
34 C     LATEST REVISION ---  23 MAY 1979
35 C
36       LOGICAL ISET
37       INTEGER IPARAM(9)
38       DATA IPARAM(1),IPARAM(2),IPARAM(3),IPARAM(4)/0,2,0,10/
39       DATA IPARAM(5)/1/
40       DATA IPARAM(6),IPARAM(7),IPARAM(8),IPARAM(9)/0,0,0,0/
41       J4SAVE = IPARAM(IWHICH)
42       IF (ISET) IPARAM(IWHICH) = IVALUE
43       RETURN
44       END
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS     DEF LINE     REFERENCES
   5  J4SAVE         1            43

VARIABLES      SN  TYPE            RELOCATION
  20  IPARAM       INTEGER    ARRAY               REFS     37     41   DEFINED   4*38    39    4*40    42
   0  ISET         LOGICAL            F.P.        REFS     36     42   DEFINED     1
```



```
VARIABLES      SN  TYPE            RELOCATION
   0  IVALUE       INTEGER            F.P.        REFS     42   DEFINED     1
   0  IWHICH       INTEGER            F.P.        REFS     41     42   DEFINED     1
  17  J4SAVE       INTEGER                     DEFINED     41

STATISTICS
  PROGRAM LENGTH                31B     25
```

```
      FUNCTION NUMXER      74/74    OPT=0 TRACE                    FTN 4.6+439        07/22/81  14.56.32        PAGE     1

                     FUNCTION NUMXER(NERR)
              C
              C      ABSTRACT
              C         NUMXER RETURNS THE MOST RECENT ERROR NUMBER,
              C         IN BOTH NUMXER AND THE PARAMETER NERR.
              C
              C      WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
              C      LATEST REVISION ---  7 JUNE 1978
              C
                     NERR = J4SAVE(1,0,.FALSE.)
                     NUMXER = NERR
                     RETURN
                     END


      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    5  NUMXER         1            12

VARIABLES      SN  TYPE             RELOCATION
    0  NERR        INTEGER                 F.P.          REFS        11     DEFINED         1          10
   23  NUMXER      INTEGER                            DEFINED        11

EXTERNALS           TYPE   ARGS         REFERENCES
        J4SAVE      INTEGER    3              10

STATISTICS
  PROGRAM LENGTH                   24B      20
```

```
      SUBROUTINE S88FMT     74/74    OPT=0 TRACE                   FTN 4.6+439        07/22/81  14.56.32        PAGE     1

                     SUBROUTINE S88FMT(N,IVALUE,IFMT)
              C
              C      ABSTRACT
              C          S88FMT REPLACES IFMT(1), ... ,IFMT(N) WITH THE
              C          CHARACTERS CORRESPONDING TO THE N LEAST SIGNIFICANT
              C          DIGITS OF IVALUE.
              C
              C      TAKEN FROM THE BELL LABORATORIES PORT LIBRARY ERROR HANDLER
              C      LATEST REVISION ---  7 JUNE 1978
              C
                     DIMENSION IFMT(N),IDIGIT(10)
                     DATA IDIGIT(1),IDIGIT(2),IDIGIT(3),IDIGIT(4),IDIGIT(5),
                    1     IDIGIT(6),IDIGIT(7),IDIGIT(8),IDIGIT(9),IDIGIT(10)
                    2     /1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9/
                     NT = N
                     IT = IVALUE
                  10    IF (NT .EQ. 0) RETURN
                        INDEX = MOD(IT,10)
                        IFMT(NT) = IDIGIT(INDEX+1)
                        IT = IT/10
                        NT = NT - 1
                        GO TO 10
                     END


      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    4  S88FMT         1            17

VARIABLES      SN  TYPE             RELOCATION
   36  IDIGIT      INTEGER    ARRAY                      REFS        11          19    DEFINED      10*12
    0  IFMT        INTEGER    ARRAY     F.P.             REFS        11     DEFINED         1          19
   35  INDEX       INTEGER                               REFS        19     DEFINED        18
   34  IT          INTEGER                               REFS        18          20    DEFINED        16          20
    0  IVALUE      INTEGER              F.P.             REFS        16     DEFINED         1
    0  N           INTEGER              F.P.             REFS        11          15    DEFINED         1
   33  NT          INTEGER                               REFS        17          19         21    DEFINED        15          21

INLINE FUNCTIONS    TYPE    ARGS          DEF LINE  REFERENCES
       MOD          INTEGER    2  INTRIN                   18

STATEMENT LABELS                DEF LINE    REFERENCES
   13  10                           17           22

STATISTICS
  PROGRAM LENGTH                   50B      40
```

```
      SUBROUTINE XERCLR
C
C     ABSTRACT
C        THIS ROUTINE SIMPLY RESETS THE CURRENT ERROR NUMBER TO ZERO.
C        THIS MAY BE NECESSARY TO DO IN ORDER TO DETERMINE THAT
C        A CERTAIN ERROR HAS OCCURRED AGAIN SINCE THE LAST TIME
C        NUMXER WAS REFERENCED.
C
C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C     LATEST REVISION ---  7 JUNE 1978
C
      JUNK = J4SAVE(1,0,.TRUE.)
      RETURN
      END
```

```
SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
    2  XERCLR         1           13

VARIABLES      SN  TYPE            RELOCATION
   16  JUNK     *  INTEGER                        DEFINED       12

EXTERNALS           TYPE    ARGS        REFERENCES
        J4SAVE    INTEGER     3             12

STATISTICS
  PROGRAM LENGTH                   17B       15
```



```
      SUBROUTINE XERCTL(MESSG1,NMESSG,NERR,LEVEL,KONTRL)
C
C     ABSTRACT
C        ALLOWS USER CONTROL OVER HANDLING OF INDIVIDUAL ERRORS.
C        JUST AFTER EACH MESSAGE IS RECORDED, BUT BEFORE IT IS
C        PROCESSED ANY FURTHER (I.E., BEFORE IT IS PRINTED OR
C        A DECISION TO ABORT IS MADE) A CALL IS MADE TO XERCTL.
C        IF THE USER HAS PROVIDED HIS OWN VERSION OF XERCTL, HE
C        CAN THEN OVERRIDE THE VALUE OF KONTROL USED IN PROCESSING
C        THIS MESSAGE BY REDEFINING ITS VALUE.
C        KONTRL MAY BE SET TO ANY VALUE FROM -2 TO 2.
C        THE MEANINGS FOR KONTRL ARE THE SAME AS IN XSETF, EXCEPT
C        THAT THE VALUE OF KONTRL CHANGES ONLY FOR THIS MESSAGE.
C        IF KONTRL IS SET TO A VALUE OUTSIDE THE RANGE FROM -2 TO 2,
C        IT WILL BE MOVED BACK INTO THAT RANGE.
C
C     DESCRIPTION OF PARAMETERS
C
C      --INPUT--
C        MESSG1 - THE FIRST WORD (ONLY) OF THE ERROR MESSAGE.
C        NMESSG - SAME AS IN THE CALL TO XERROR OR XERRWV.
C        NERR   - SAME AS IN THE CALL TO XERROR OR XERRWV.
C        LEVEL  - SAME AS IN THE CALL TO XERROR OR XERRWV.
C        KONTRL - THE CURRENT VALUE OF THE CONTROL FLAG AS SET
C                 BY A CALL TO XSETF.
C
C      --OUTPUT--
C        KONTRL - THE NEW VALUE OF KONTRL.  IF KONTRL IS NOT
C                 DEFINED, IT WILL REMAIN AT ITS ORIGINAL VALUE.
C                 THIS CHANGED VALUE OF CONTROL AFFECTS ONLY
C                 THE CURRENT OCCURRENCE OF THE CURRENT MESSAGE.
C
      RETURN
      END
```

```
SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
    4  XERCTL         1           33

VARIABLES      SN  TYPE            RELOCATION
    0  KONTRL      INTEGER    *UNUSED    F.P.      DEFINED        1
    0  LEVEL       INTEGER    *UNUSED    F.P.      DEFINED        1
    0  MESSG1      INTEGER    *UNUSED    F.P.      DEFINED        1
    0  NERR        INTEGER    *UNUSED    F.P.      DEFINED        1
    0  NMESSG      INTEGER    *UNUSED    F.P.      DEFINED        1

STATISTICS
  PROGRAM LENGTH                   7B        7
```

```
      SUBROUTINE XEROMP
C
C     ABSTRACT
C        XEROMP PRINTS AN ERROR TABLE SHOWING ALL ERRORS WHICH
C        HAVE OCCURRED DURING THE CURRENT EXECUTION, OR SINCE XEROMP
C        HAS LAST CALLED.  AFTER PRINTING, THE ERROR TABLE IS CLEARED,
C        AND IF PROGRAM EXECUTION IS CONTINUED ACCUMULATION OF THE
C        ERROR TABLE BEGINS AT ZERO.
C
C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C     LATEST REVISION ---  7 JUNE 1978
C
      CALL XERSAV(1H ,0,0,0,KOUNT)
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
   2  XEROMP         1             14

VARIABLES      SN  TYPE              RELOCATION
   15  KOUNT    *  INTEGER                             REFS        13

EXTERNALS            TYPE   ARGS        REFERENCES
       XERSAV                 5             13

STATISTICS
  PROGRAM LENGTH                   20B       16
```



```
      SUBROUTINE XERMAX(MAX)
C
C     ABSTRACT
C        XERMAX SETS THE MAXIMUM NUMBER OF TIMES ANY MESSAGE
C        IS TO BE PRINTED.  THAT IS, NON-FATAL MESSAGES ARE
C        NOT TO BE PRINTED AFTER THEY HAVE OCCURED MAX TIMES.
C        SUCH NON-FATAL MESSAGES MAY BE PRINTED LESS THAN
C        MAX TIMES EVEN IF THEY OCCUR MAX TIMES, IF ERROR
C        SUPPRESSION MODE (KONTRL=0) IS EVER IN EFFECT.
C
C        THE DEFAULT VALUE FOR MAX IS 10.
C
C     DESCRIPTION OF PARAMETER
C      --INPUT--
C        MAX - THE MAXIMUM NUMBER OF TIMES ANY ONE MESSAGE
C              IS TO BE PRINTED.
C
C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C     LATEST REVISION ---  7 JUNE 1978
C
      JUNK = J4SAVE(4,MAX,.TRUE.)
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
   4  XERMAX         1             22

VARIABLES      SN  TYPE              RELOCATION
   21  JUNK     *  INTEGER                     DEFINED       21
    0  MAX         INTEGER               F.P.     REFS       21     DEFINED        1

EXTERNALS            TYPE   ARGS        REFERENCES
       J4SAVE    INTEGER     3             21

STATISTICS
  PROGRAM LENGTH                   22B       18
```

```
  1              SUBROUTINE XERPRT(MESSG,NMESSG)
           C
           C     ABSTRACT
           C        PRINT THE HOLLERITH MESSAGE IN MESSG, OF LENGTH MESSG,
  5        C        ON EACH FILE INDICATED BY XGETUA.
           C        THIS VERSION PRINTS EXACTLY THE RIGHT NUMBER OF CHARACTERS,
           C        NOT A NUMBER OF WORDS, AND THUS SHOULD WORK ON MACHINES
           C        WHICH DO NOT BLANK FILL THE LAST WORD OF THE HOLLERITH.
           C
 10        C     RON JONES, JUNE 1980
           C
                 INTEGER F(10),G(14),LUN(5)
                 DIMENSION MESSG(NMESSG)
                 DATA F(1),F(2),F(3),F(4),F(5),F(6),F(7),F(8),F(9),F(10)
 15             1   / 1H( ,1H1 ,1HX ,1H. ,1H  ,1H  ,1HA ,1H  ,1H  ,1H) /
                 DATA G(1),G(2),G(3),G(4),G(5),G(6),G(7),G(8),G(9),G(10)
                1   / 1H( ,1H1 ,1HX ,1H  ,1H  ,1H  ,1H  ,1H  ,1H  ,1H  /
                 DATA G(11),G(12),G(13),G(14)
                1   / 1H   ,1H   ,1H   ,1H)  /
 20              DATA LA/1HA/,LCOM/1H,/,LBLANK/1H /
           C     PREPARE FORMAT FOR WHOLE LINES
                 NCHAR = I1MACH(6)
                 NFIELD = 72/NCHAR
                 CALL S88FMT(2,NFIELD,F(5))
 25              CALL S88FMT(2,NCHAR,F(8))
           C     PREPARE FORMAT FOR LAST, PARTIAL LINE, IF NEEDED
                 NCHARL = NFIELD*NCHAR
                 NLINES = NMESSG/NCHARL
                 NWORD  = NLINES*NFIELD
 30              NCHREM = NMESSG - NLINES*NCHARL
                 IF (NCHREM.LE.0) GO TO 40
                    DO 10 I=4,13
           10          G(I) = LBLANK
                    NFIELD = NCHREM/NCHAR
 35                 IF (NFIELD.LE.0) GO TO 20
           C        PREPARE WHOLE WORD FIELDS
                       G(4) = LCOM
                       CALL S88FMT(2,NFIELD,G(5))
                       G(7. = LA
 40                    CALL S88FMT(2,NCHAR,G(8))
           20       CONTINUE
                    NCHLST = MOD(NCHREM,NCHAR)
                    IF (NCHLST.LE.0) GO TO 30
           C        PREPARE PARTIAL WORD FIELD
 45                    G(10) = LCOM
                       G(11) = LA
                       CALL S88FMT(2,NCHLST,G(12))
           30       CONTINUE
           40    CONTINUE
 50        C     PRINT THE MESSAGE
                 NWORD1 = NWORD+1
                 NWORD2 = (NMESSG+NCHAR-1)/NCHAR
                 CALL XGETUA(LUN,NUNIT)
                 DO 50 KUNIT = 1,NUNIT
 55                 IUNIT = LUN(KUNIT)
                    IF (IUNIT.EQ.0) IUNIT = I1MACH(4)
                    IF (NWORD.GT.0) WRITE (IUNIT,F) (MESSG(I),I=1,NWORD)
```



```
                    IF (NCHREM.GT.0) WRITE (IUNIT,G) (MESSG(I),I=NWORD1,NWORD2)
           50    CONTINUE
 60              RETURN
                 END
```

```
       SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    4  XERPRT          1           60

VARIABLES       SN  TYPE            RELOCATION
  254  F            INTEGER    ARRAY                REFS        12        24        25        57    DEFINED      10*14
  266  G            INTEGER    ARRAY                REFS        12        38        40        47       58
                                                 DEFINED     10*16      4*18        33        37       39          45         46
  245  I            INTEGER                         REFS        33        57        58   DEFINED       32          57         58
  253  IUNIT        INTEGER                         REFS        56   DEFINED        55        56    I/O REFS       57         58
  252  KUNIT        INTEGER                         REFS        55   DEFINED        54
  221  LA           INTEGER                         REFS        39        46   DEFINED        20
  223  LBLANK       INTEGER                         REFS        33   DEFINED        20
  222  LCOM         INTEGER                         REFS        37        45   DEFINED        20
  304  LUN          INTEGER    ARRAY                REFS        12        53        55
    0  MESSG        INTEGER    ARRAY      F.P.      REFS        13        57        58   DEFINED        1
  237  NCHAR        INTEGER                         REFS        23        25        27        34       40          42       2*52
                                                 DEFINED        22
  241  NCHARL       INTEGER                         REFS        28        30   DEFINED        27
  246  NCHLST       INTEGER                         REFS        43        47   DEFINED        42
  244  NCHREM       INTEGER                         REFS        31        34        42        58    DEFINED       30
  240  NFIELD       INTEGER                         REFS        24        27        29        35       38
                                                 DEFINED        23        34
  242  NLINES       INTEGER                         REFS        29        30   DEFINED        28
    0  NMESSG       INTEGER               F.P.      REFS        13        28        30        52    DEFINED        1
  251  NUNIT        INTEGER                         REFS        53        54
  243  NWORD        INTEGER                         REFS        51      2*57   DEFINED        29
  247  NWORD1       INTEGER                         REFS        58   DEFINED        51
  250  NWORD2       INTEGER                         REFS        58   DEFINED        52
       VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS           TYPE    ARGS        REFERENCES
       I1MACH      INTEGER    1              22        56
       S88FMT                 3              24        25        38        40        47
       XGETUA                 2              53

INLINE FUNCTIONS    TYPE    ARGS        DEF LINE  REFERENCES
       MOD         INTEGER    2  INTRIN                 42

STATEMENT LABELS                DEF LINE    REFERENCES
    0  10                          33          32
   76  20                          41          35
  113  30                          48          43
  114  40                          49          31
    0  50                          59          54
```

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
53	10	I	32 33	4B	INSTACK
130	50	* KUNIT	54 59	33B	EXT REFS

STATISTICS

PROGRAM LENGTH	322B	210

```
      SUBROUTINE XERROR(MESSG,NMESSG,NERR,LEVEL)
C
C     ABSTRACT
C        XERROR PROCESSES A DIAGNOSTIC MESSAGE, IN A MANNER
C        DETERMINED BY THE VALUE OF LEVEL AND THE CURRENT VALUE
C        OF THE LIBRARY ERROR CONTROL FLAG, KONTRL.
C        (SEE SUBROUTINE XSETF FOR DETAILS.)
C
C     DESCRIPTION OF PARAMETERS
C      --INPUT--
C        MESSG - THE HOLLERITH MESSAGE TO BE PROCESSED, CONTAINING
C                NO MORE THAN 72 CHARACTERS.
C        NMESSG- THE ACTUAL NUMBER OF CHARACTERS IN MESSG.
C        NERR  - THE ERROR NUMBER ASSOCIATED WITH THIS MESSAGE.
C                NERR MUST NOT BE ZERO.
C        LEVEL - ERROR CATEGORY.
C                =2 MEANS THIS IS AN UNCONDITIONALLY FATAL ERROR.
C                =1 MEANS THIS IS A RECOVERABLE ERROR.  (I.E., IT IS
C                   NON-FATAL IF XSETF HAS BEEN APPROPRIATELY CALLED.)
C                =0 MEANS THIS IS A WARNING MESSAGE ONLY.
C                =-1 MEANS THIS IS A WARNING MESSAGE WHICH IS TO BE
C                   PRINTED AT MOST ONCE, REGARDLESS OF HOW MANY
C                   TIMES THIS CALL IS EXECUTED.
C
C     EXAMPLES
C        CALL XERROR(23HSMOOTH -- NUM WAS ZERO.,23,1,2)
C        CALL XERROR(43HINTEG  -- LESS THAN FULL ACCURACY ACHIEVED.,
C                    43,2,1)
C        CALL XERROR(65HROOTER -- ACTUAL ZERO OF F FOUND BEFORE INTERVAL
C    1 FULLY COLLAPSED.,65,3,0)
C        CALL XERROR(39HEXP    -- UNDERFLOWS BEING SET TO ZERO.,39,1,-1)
C
C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C     REVISED BY K HASKELL TO CHECK INPUT ARGS, 2/18/80
C
      DIMENSION MESSG(NMESSG)
C     CHECK FOR VALID INPUT
      LKNTRL = J4SAVE (2,0,.FALSE.)
      IF (NMESSG.GT.0) GO TO 10
      IF (LKNTRL.GT.0) CALL XERPRT(17HFATAL ERROR IN...,17)
      CALL XERPRT (33HXERROR -- NMESSG MUST BE POSITIVE,33)
      IF (LKNTRL.GT.0) CALL FDUMP
      IF (LKNTRL.GT.0) CALL XERPRT(29HJOB ABORT DUE TO FATAL ERROR.,
     1 29)
      IF (LKNTRL.GT.0) CALL XERSAV (1H ,0,0,0,KDUMMY)
      CALL XERABT (23HXERROR -- INVALID INPUT,23)
      RETURN
   10 CONTINUE
      IF (NERR.NE.0) GO TO 15
      IF (LKNTRL.GT.0) CALL XERPRT(17HFATAL ERROR IN...,17)
      CALL XERPRT (28HXERROR -- NERR=0 IS AN ERROR,28)
      IF (LKNTRL.GT.0) CALL FDUMP
      IF (LKNTRL.GT.0) CALL XERPRT(29HJOB ABORT DUE TO FATAL ERROR.,
     1 29)
      IF (LKNTRL.GT.0) CALL XERSAV (1H ,0,0,0,KDUMMY)
      CALL XERABT (23HXERROR -- INVALID INPUT,23)
      RETURN
```



```
   15 CONTINUE
      IF ((LEVEL.GE.(-1)).AND.(LEVEL.LE.2)) GO TO 20
      IF (LKNTRL.GT.0) CALL XERPRT(17HFATAL ERROR IN...,17)
      CALL XERPRT (32HXERROR -- INVALID VALUE OF LEVEL,32)
      IF (LKNTRL.GT.0) CALL FDUMP
      IF (LKNTRL.GT.0) CALL XERPRT(29HJOB ABORT DUE TO FATAL ERROR.,
     1 29)
      IF (LKNTRL.GT.0) CALL XERSAV (1H ,0,0,0,KDUMMY)
      CALL XERABT (23HXERROR -- INVALID INPUT,23)
      RETURN
   20 CONTINUE
      CALL XERRWV(MESSG,NMESSG,NERR,LEVEL,0,0,0,0,0.,0.)
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    4  XERROR         1          47        57        67        70

VARIABLES      SN  TYPE             RELOCATION
  255  KDUMMY      INTEGER                           REFS       45        55       65
    0  LEVEL       INTEGER                 F.P.      REFS       2*59      69       DEFINED      1
  254  LKNTRL      INTEGER                           REFS       40        42       43           45        50        52        53
                                                     55         60        62       63           65        DEFINED   38
    0  MESSG       INTEGER      ARRAY      F.P.      REFS       36        69       DEFINED      1
    0  NERR        INTEGER                 F.P.      REFS       49        69       DEFINED      1
    0  NMESSG      INTEGER                 F.P.      REFS       36        39       69           DEFINED   1

EXTERNALS            TYPE    ARGS        REFERENCES
       FDUMP                  0            42        52        62
       J4SAVE      INTEGER    3            38
       XERABT                 2            46        56        66
       XERPRT                 2            40        41        43        50        51        53        60        61        63
       XERRWV                10            69
       XERSAV                 5            45        55        65

STATEMENT LABELS              DEF LINE    REFERENCES
   42  10                       48          39
   72  15                       58          49
  124  20                       68          59

STATISTICS
  PROGRAM LENGTH               343B      227
```

```
      SUBROUTINE XERRWV(MESSG,NMESSG,NERR,LEVEL,NI,I1,I2,NR,R1,R2)
C
C     ABSTRACT
C        XERRWV PROCESSES A DIAGNOSTIC MESSAGE, IN A MANNER
C        DETERMINED BY THE VALUE OF LEVEL AND THE CURRENT VALUE
C        OF THE LIBRARY ERROR CONTROL FLAG, KONTRL.
C        (SEE SUBROUTINE XSETF FOR DETAILS.)
C        IN ADDITION, UP TO TWO INTEGER VALUES AND TWO REAL
C        VALUES MAY BE PRINTED ALONG WITH THE MESSAGE.
C
C     DESCRIPTION OF PARAMETERS
C      --INPUT--
C        MESSG - THE HOLLERITH MESSAGE TO BE PROCESSED.
C        NMESSG- THE ACTUAL NUMBER OF CHARACTERS IN MESSG.
C        NERR  - THE ERROR NUMBER ASSOCIATED WITH THIS MESSAGE.
C                NERR MUST NOT BE ZERO.
C        LEVEL - ERROR CATEGORY.
C                =2 MEANS THIS IS AN UNCONDITIONALLY FATAL ERROR.
C                =1 MEANS THIS IS A RECOVERABLE ERROR.  (I.E., IT IS
C                   NON-FATAL IF XSETF HAS BEEN APPROPRIATELY CALLED.)
C                =0 MEANS THIS IS A WARNING MESSAGE ONLY.
C                =-1 MEANS THIS IS A WARNING MESSAGE WHICH IS TO BE
C                    PRINTED AT MOST ONCE, REGARDLESS OF HOW MANY
C                    TIMES THIS CALL IS EXECUTED.
C        NI    - NUMBER OF INTEGER VALUES TO BE PRINTED. (0 TO 2)
C        I1    - FIRST INTEGER VALUE.
C        I2    - SECOND INTEGER VALUE.
C        NR    - NUMBER OF REAL VALUES TO BE PRINTED. (0 TO 2)
C        R1    - FIRST REAL VALUE.
C        R2    - SECOND REAL VALUE.
C
C     EXAMPLES
C        CALL XERRWV(29HSMOOTH -- NUM (=I1) WAS ZERO.,29,1,2,
C    1   1,NUM,0,0,0.,0.)
C        CALL XERRWV(54HQUADXY -- REQUESTED ERROR (R1) LESS THAN MINIMUM
C    1 (R2).,54,77,1,0,0,0,2,ERRREQ,ERRMIN)
C
C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C     LATEST REVISION ---  19 MAR 1980
C     REVISED BY K HASKELL TO CHECK INPUT ARGS, 2/18/80
C
      DIMENSION MESSG(NMESSG),LUN(5)
C     GET FLAGS
      LKNTRL = J4SAVE(2,0,.FALSE.)
      MAXMES = J4SAVE(4,0,.FALSE.)
C     CHECK FOR VALID INPUT
      IF (NMESSG.GT.0) GO TO 2
         IF (LKNTRL.GT.0) CALL XERPRT(17HFATAL ERROR IN...,17)
      CALL XERPRT (33HXERRWV -- NMESSG MUST BE POSITIVE,33)
      IF (LKNTRL.GT.0) CALL FDUMP
      IF (LKNTRL.GT.0) CALL XERPRT(29HJOB ABORT DUE TO FATAL ERROR.,
     1 29)
      IF (LKNTRL.GT.0) CALL XERSAV(1H ,0,0,0,KDUMMY)
      CALL XERABT (23HXERRWV -- INVALID INPUT,23)
      RETURN
    2 CONTINUE
      IF (NERR.NE.0) GO TO 4
```



```
      IF (LKNTRL.GT.0) CALL XERPRT(17HFATAL ERROR IN...,17)
      CALL XERPRT (28HXERRWV -- NERR=0 IS AN ERROR,28)
      IF (LKNTRL.GT.0) CALL FDUMP
      IF (LKNTRL.GT.0) CALL XERPRT(29HJOB ABORT DUE TO FATAL ERROR.,
     1 29)
      IF (LKNTRL.GT.0) CALL XERSAV(1H ,0,0,0,KDUMMY)
      CALL XERABT (23HXERRWV -- INVALID INPUT,23)
      RETURN
    4 CONTINUE
      IF ((LEVEL.GE.(-1)).AND.(LEVEL.LE.2)) GO TO 10
      IF (LKNTRL.GT.0) CALL XERPRT(17HFATAL ERROR IN...,17)
      CALL XERPRT (32HXERRWV -- INVALID VALUE OF LEVEL,32)
         IF (LKNTRL.GT.0) CALL FDUMP
         IF (LKNTRL.GT.0) CALL XERPRT(29HJOB ABORT DUE TO FATAL ERROR.,
     1   29)
         IF (LKNTRL.GT.0) CALL XERSAV(1H ,0,0,0,KDUMMY)
         CALL XERABT(23HXERROR -- INVALID INPUT,23)
         RETURN
   10 CONTINUE
C     RECORD MESSAGE
      JUNK = J4SAVE(1,NERR,.TRUE.)
      CALL XERSAV(MESSG,NMESSG,NERR,LEVEL,KOUNT)
C     LET USER OVERRIDE
      LFIRST = MESSG(1)
      LMESSG = NMESSG
      LERR = NERR
      LLEVEL = LEVEL
      CALL XERCTL(LFIRST,LMESSG,LERR,LLEVEL,LKNTRL)
C     RESET TO ORIGINAL VALUES
      LMESSG = NMESSG
      LERR = NERR
      LLEVEL = LEVEL
      LKNTRL = MAX0(-2,MIN0(2,LKNTRL))
      MKNTRL = IABS(LKNTRL)
C     DECIDE WHETHER TO PRINT MESSAGE
      IF ((LLEVEL.LT.2).AND.(LKNTRL.EQ.0)) GO TO 100
      IF (((LLEVEL.EQ.(-1)).AND.(KOUNT.GT.MIN0(1,MAXMES)))
     1.OR.((LLEVEL.EQ.0)   .AND.(KOUNT.GT.MAXMES))
     2.OR.((LLEVEL.EQ.1)   .AND.(KOUNT.GT.MAXMES).AND.(MKNTRL.EQ.1))
     3.OR.((LLEVEL.EQ.2)   .AND.(KOUNT.GT.MAX0(1,MAXMES)))) GO TO 100
         IF (LKNTRL.LE.0) GO TO 20
            CALL XERPRT(1H ,1)
C           INTRODUCTION
            IF (LLEVEL.EQ.(-1)) CALL XERPRT
     1(57HWARNING MESSAGE...THIS MESSAGE WILL ONLY BE PRINTED ONCE.,57)
            IF (LLEVEL.EQ.0) CALL XERPRT(13HWARNING IN...,13)
            IF (LLEVEL.EQ.1) CALL XERPRT
     1      (23HRECOVERABLE ERROR IN...,23)
            IF (LLEVEL.EQ.2) CALL XERPRT(17HFATAL ERROR IN...,17)
   20    CONTINUE
C        MESSAGE
         CALL XERPRT(MESSG,LMESSG)
         CALL XGETUA(LUN,NUNIT)
         DO 50 KUNIT=1,NUNIT
            IUNIT = LUN(KUNIT)
            IF (IUNIT.EQ.0) IUNIT = I1MACH(4)
            IF (NI.GE.1) WRITE (IUNIT,22) I1
```

```
                     IF (NI.GE.2) WRITE (IUNIT,23) I2
                     IF (NR.GE.1) WRITE (IUNIT,24) R1
                     IF (NR.GE.2) WRITE (IUNIT,25) R2
          22         FORMAT (11X,21HIN ABOVE MESSAGE, I1=,I10)
          23         FORMAT (11X,21HIN ABOVE MESSAGE, I2=,I10)
          24         FORMAT (11X,21HIN ABOVE MESSAGE, R1=,E20.10)
          25         FORMAT (11X,21HIN ABOVE MESSAGE, R2=,E20.10)
                     IF (LKNTRL.LE.0) GO TO 40
      C                 ERROR NUMBER
                        WRITE (IUNIT,30) LERR
          30            FORMAT (15H ERROR NUMBER =,I10)
          40         CONTINUE
          50      CONTINUE
      C           TRACE-BACK
                  CALL FDUMP
         100 CONTINUE
             IFATAL = 0
             IF ((LLEVEL.EQ.2).OR.((LLEVEL.EQ.1).AND.(MKNTRL.EQ.2)))
            1IFATAL = 1
      C      QUIT HERE IF MESSAGE IS NOT FATAL
             IF (IFATAL.LE.0) RETURN
             IF (LKNTRL.LE.0) GO TO 120
      C         PRINT REASON FOR ABORT
                IF (LLEVEL.EQ.1) CALL XERPRT
            1   (35HJOB ABORT DUE TO UNRECOVERED ERROR.,35)
                IF (LLEVEL.EQ.2) CALL XERPRT
            1   (29HJOB ABORT DUE TO FATAL ERROR.,29)
      C         PRINT ERROR SUMMARY
                CALL XERSAV(1H ,0,0,0,KDUMMY)
         120 CONTINUE
      C      ABORT
             IF ((LLEVEL.EQ.2).AND.(KOUNT.GT.MAX0(1,MAXMES))) LMESSG = 0
             CALL XERABT(MESSG,LMESSG)
             RETURN
             END
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS       DEF LINE      REFERENCES
    4  XERRWV          1           55         65         75        135        148

VARIABLES       SN  TYPE            RELOCATION
  663  IFATAL       INTEGER                         REFS       135    DEFINED       131       132
  662  IUNIT        INTEGER                         REFS       113    DEFINED       112       113     I/O REFS      114        115
                                                     116       117        124
    0  I1           INTEGER                F.P.     REFS       114    DEFINED         1
    0  I2           INTEGER                F.P.     REFS       115    DEFINED         1
  651  JUNK      *  INTEGER                      DEFINED        78
  650  KDUMMY       INTEGER                         REFS        53         63        73       143
  652  KOUNT        INTEGER                         REFS        79       4*94       146
  661  KUNIT        INTEGER                         REFS       112    DEFINED       111
  655  LERR         INTEGER                         REFS        85        124   DEFINED        83        88
    0  LEVEL        INTEGER                F.P.     REFS      2*67         79        84        89   DEFINED         1
```



```
VARIABLES       SN  TYPE            RELOCATION
  653  LFIRST       INTEGER                         REFS        85    DEFINED        81
  646  LKNTRL       INTEGER                         REFS        48         50        51        53        58        60        61
                                                      63        68         70        71        73        85        90        91
                                                      93        98        122       136   DEFINED        44        90
  656  LLEVEL       INTEGER                         REFS        85         93      4*94       101       103       104       106
                                                   2*132       138        140       146   DEFINED        84        89
  654  LMESSG       INTEGER                         REFS        85        109       147   DEFINED        82        87       146
  664  LUN          INTEGER    ARRAY                REFS        42        110       112
  647  MAXMES       INTEGER                         REFS      4*94        146   DEFINED        45
    0  MESSG        INTEGER    ARRAY       F.P.     REFS        42         79        81       109       147
                                                 DEFINED         1
  657  MKNTRL       INTEGER                         REFS        94        132   DEFINED        91
    0  NERR         INTEGER                F.P.     REFS        57         78        79        83        88
                                                 DEFINED         1
    0  NI           INTEGER                F.P.     REFS       114        115   DEFINED         1
    0  NMESSG       INTEGER                F.P.     REFS        42         47        79        82        87
                                                 DEFINED         1
    0  NR           INTEGER                F.P.     REFS       116        117   DEFINED         1
  660  NUNIT        INTEGER                         REFS       110        111
    0  R1           REAL                   F.P.     REFS       116    DEFINED         1
    0  R2           REAL                   F.P.     REFS       117    DEFINED         1
       VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS           TYPE    ARGS          REFERENCES
       FDUMP                  0              50         60        70       129
       I1MACH       INTEGER   1             113
       J4SAVE       INTEGER   3              44         45        78
       XERABT                 2              54         64        74       147
       XERCTL                 5              85
       XERPRT                 2              48         49        51        58        59        61        68        69        71
                                             99        101       103       104       106       109       138       140
       XERSAV                 5              53         63        73        79       143
       XGETUA                 2             110

INLINE FUNCTIONS    TYPE    ARGS         DEF LINE   REFERENCES
       IABS         INTEGER   1  INTRIN               91
       MAX0         INTEGER   0  INTRIN               90         94       146
       MIN0         INTEGER   0  INTRIN               90         94

STATEMENT LABELS                DEF LINE    REFERENCES
   55  2                           56          47
  105  4                           66          57
  137  10                          76          67
  253  20                         107          98
  572  22         FMT             118         114
  577  23         FMT             119         115
  604  24         FMT             120         116
  611  25         FMT             121         117
  622  30         FMT             125         124
  316  40                         126         122
    0  50                         127         111
  324  100                        130          93         94
  354  120                        144         136

LOOPS  LABEL     INDEX       FROM-TO     LENGTH     PROPERTIES
  262  50      * KUNIT       111 127       378                  EXT REFS
```

```
STATISTICS
  PROGRAM LENGTH              1042B     546
```



```
      SUBROUTINE XERSAV(MESSG,NMESSG,NERR,LEVEL,ICOUNT)
C
C     ABSTRACT
C        RECORD THAT THIS ERROR OCCURRED.
C
C     DESCRIPTION OF PARAMETERS
C     --INPUT--
C       MESSG, NMESSG, NERR, LEVEL ARE AS IN XERROR,
C       EXCEPT THAT WHEN NMESSG=0 THE TABLES WILL BE
C       DUMPED AND CLEARED, AND WHEN NMESSG IS LESS THAN ZERO THE
C       TABLES WILL BE DUMPED AND NOT CLEARED.
C     --OUTPUT--
C       ICOUNT WILL BE THE NUMBER OF TIMES THIS MESSAGE HAS
C       BEEN SEEN, OR ZERO IF THE TABLE HAS OVERFLOWED AND
C       DOES NOT CONTAIN THIS MESSAGE SPECIFICALLY.
C       WHEN NMESSG=0, ICOUNT WILL NOT BE ALTERED.
C
C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C
      INTEGER F(17),LUN(5)
      DIMENSION MESSG(1)
      DIMENSION MESTAB(10),NERTAB(10),LEVTAB(10),KOUNT(10)
C     NEXT THREE DATA STATEMENTS ARE NEEDED MERELY TO SATISFY
C     CERTAIN CONVENTIONS FOR COMPILERS WHICH DYNAMICALLY
C     ALLOCATE STORAGE.
      DATA MESTAB(1),MESTAB(2),MESTAB(3),MESTAB(4),MESTAB(5),
     1     MESTAB(6),MESTAB(7),MESTAB(8),MESTAB(9),MESTAB(10)
     2     /0,0,0,0,0,0,0,0,0,0/
      DATA NERTAB(1),NERTAB(2),NERTAB(3),NERTAB(4),NERTAB(5),
     1     NERTAB(6),NERTAB(7),NERTAB(8),NERTAB(9),NERTAB(10)
     2     /0,0,0,0,0,0,0,0,0,0/
      DATA LEVTAB(1),LEVTAB(2),LEVTAB(3),LEVTAB(4),LEVTAB(5),
     1     LEVTAB(6),LEVTAB(7),LEVTAB(8),LEVTAB(9),LEVTAB(10)
     2     /0,0,0,0,0,0,0,0,0,0/
C     NEXT TWO DATA STATEMENTS ARE NECESSARY TO PROVIDE A BLANK
C     ERROR TABLE INITIALLY
      DATA KOUNT(1),KOUNT(2),KOUNT(3),KOUNT(4),KOUNT(5),
     1     KOUNT(6),KOUNT(7),KOUNT(8),KOUNT(9),KOUNT(10)
     2     /0,0,0,0,0,0,0,0,0,0/
      DATA KOUNTX/0/
C     NEXT DATA STATEMENT SETS UP OUTPUT FORMAT
      DATA F(1),F(2),F(3),F(4),F(5),F(6),F(7),F(8),F(9),F(10),
     1     F(11),F(12),F(13),F(14),F(15),F(16),F(17)
     2     /1H( ,1H1 ,1HX ,1H, ,1HA ,1H  ,1H  ,1H, ,1HI ,1H  ,
     3      1H  ,1H, ,1H2 ,1HI ,1H1 ,1H0 ,1H) /
      IF (NMESSG.GT.0) GO TO 80
C     DUMP THE TABLE
         IF (KOUNT(1).EQ.0) RETURN
C        PREPARE FORMAT
         NCHAR = I1MACH(6)
         CALL S88FMT(2,NCHAR,F(6))
         NCOL = 20 - NCHAR
         CALL S88FMT(2,NCOL,F(10))
C        PRINT TO EACH UNIT
         CALL XGETUA(LUN,NUNIT)
         DO 60 KUNIT=1,NUNIT
            IUNIT = LUN(KUNIT)
```

```
                IF (IUNIT.EQ.0) IUNIT = I1MACH(4)
C               PRINT TABLE HEADER
                WRITE (IUNIT,10)
   10           FORMAT (32H0          ERROR MESSAGE SUMMARY/
     1            41H FIRST WORD      NERR     LEVEL     COUNT)
C               PRINT BODY OF TABLE
                DO 20 I=1,10
                   IF (KOUNT(I).EQ.0) GO TO 30
                   WRITE (IUNIT,F) MESTAB(I),NERTAB(I),LEVTAB(I),KOUNT(I)
   20           CONTINUE
   30           CONTINUE
C               PRINT NUMBER OF OTHER ERRORS
                IF (KOUNTX.NE.0) WRITE (IUNIT,40) KOUNTX
   40           FORMAT (41HOOTHER ERRORS NOT INDIVIDUALLY TABULATED=,I10)
                WRITE (IUNIT,50)
   50           FORMAT (1X)
   60        CONTINUE
             IF (NMESSG.LT.0) RETURN
C            CLEAR THE ERROR TABLES
             DO 70 I=1,10
   70           KOUNT(I) = 0
             KOUNTX = 0
             RETURN
   80 CONTINUE
C     PROCESS A MESSAGE...
C     SEARCH FOR THIS MESSG, OR ELSE AN EMPTY SLOT FOR THIS MESSG,
C     OR ELSE DETERMINE THAT THE ERROR TABLE IS FULL.
      DO 90 I=1,10
         II = I
         IF (KOUNT(I).EQ.0) GO TO 110
         IF (MESSG(1).NE.MESTAB(I)) GO TO 90
         IF (NERR.NE.NERTAB(I)) GO TO 9C
         IF (LEVEL.NE.LEVTAB(I)) GO TO 90
         GO TO 100
   90 CONTINUE
C     THREE POSSIBLE CASES...
C     TABLE IS FULL
         KOUNTX = KOUNTX+1
         ICOUNT = 1
         RETURN
C     MESSAGE FOUND IN TABLE
  100    KOUNT(II) = KOUNT(II) + 1
         ICOUNT = KOUNT(II)
         RETURN
C     EMPTY SLOT FOUND FOR NEW MESSAGE
  110    MESTAB(II) = MESSG(1)
         NERTAB(II) = NERR
         LEVTAB(II) = LEVEL
         KOUNT(II)  = 1
         ICOUNT = 1
         RETURN
      END
```



```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
   4  XERSAV          1         48        75        80        97        101       108

VARIABLES        SN  TYPE              RELOCATION
  274  F             INTEGER   ARRAY                   REFS        20        51        53        66   DEFINED   17*42
  272  I             INTEGER                           REFS        65      4*66        78        86        87        88        89
                                                         90   DEFINED      64        77        85
    0  ICOUNT        INTEGER             F.P.       DEFINED         1        96       100       107
  273  II            INTEGER                           REFS      2*99       100       103       104       105       106
                                                    DEFINED        86
  271  IUNIT         INTEGER                           REFS        58   DEFINED        57        58  I/O REFS        60        66
                                                         70        72
  360  KOUNT         INTEGER   ARRAY                   REFS        22        48        65        66        87        99       100
                                                    DEFINED     10*37        78        99       106
  216  KOUNTX        INTEGER                           REFS      2*70        95   DEFINED        40        79        95
  270  KUNIT         INTEGER                           REFS        57   DEFINED        56
    0  LEVEL         INTEGER             F.P.          REFS        90       105   DEFINED         1
  346  LEVTAB        INTEGER   ARRAY                   REFS        22        66        90   DEFINED     10*32       105
  315  LUN           INTEGER   ARRAT                   REFS        20        55        57
    0  MESSG         INTEGER   ARRAY     F.P.          REFS        21        88       103   DEFINED         1
  322  MESTAB        INTEGER   ARRAY                   REFS        22        66        88   DEFINED     10*26       103
  265  NCHAR         INTEGER                           REFS        51        52   DEFINED        50
  266  NCOL          INTEGER                           REFS        53   DEFINED        52
    0  NERR          INTEGER             F.P.          REFS        89       104   DEFINED         1
  334  NERTAB        INTEGER   ARRAY                   REFS        22        66        89   DEFINED     10*29       104
    0  NMESSG        INTEGER             F.P.          REFS        46        75   DEFINED         1
  267  NUNIT         INTEGER                           REFS        55        56
       VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS            TYPE    ARGS        REFERENCES
       I1MACH        INTEGER   1              50        58
       S88FMT                  3              51        53
       XGETUA                  2              55

STATEMENT LABELS              DEF LINE   REFERENCES
  222  10        FMT             61         60
    0  20                        67         64
   73  30                        68         65
  247  40        FMT             71         70
  260  50        FMT             73         72
    0  60                        74         56
    0  70                        78         77
  120  80                        81         46
  141  90                        92         85        88        89        90
  152  100                       99         91
  161  110                      103         87

LOOPS  LABEL     INDEX       FROM-TO     LENGTH     PROPERTIES
   41  60       * KUNIT       56 74        42B                EXT REFS  NOT INNER
   54  20       * I           64 67        16B                EXT REFS    EXITS
  110  70         I           77 78         4B       INSTACK
  122  90       * I           85 92        22B          OPT      EXITS
```

```
STATISTICS
  PROGRAM LENGTH                404B     260
```



```
                  SUBROUTINE XGETF(KONTRL)
            C
            C     ABSTRACT
            C        XGETF RETURNS THE CURRENT VALUE OF THE ERROR CONTROL FLAG
            C        IN KONTRL.  SEE SUBROUTINE XSETF FOR FLAG VALUE MEANINGS.
            C        (KONTRL IS AN OUTPUT PARAMETER ONLY.)
            C
            C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
            C     LATEST REVISION ---  7 JUNE 1978
            C
                  KONTRL = J4SAVE(2,0,.FALSE.)
                  RETURN
                  END
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    4  XGETF          1             12

VARIABLES      SN  TYPE              RELOCATION
    0  KONTRL      INTEGER               F.P.      DEFINED        1         11

EXTERNALS            TYPE    ARGS          REFERENCES
        J4SAVE      INTEGER     3                11

STATISTICS
  PROGRAM LENGTH                  20B       16
```

```
  1              SUBROUTINE XGETUA(IUNIT,N)
           C
           C     ABSTRACT
           C        XGETUA MAY BE CALLED TO DETERMINE THE UNIT NUMBER OR NUMBERS
  5        C        TO WHICH ERROR MESSAGES ARE BEING SENT.
           C        THESE UNIT NUMBERS MAY HAVE BEEN SET BY A CALL TO XSETUN,
           C        OR A CALL TO XSETUA, OR MAY BE A DEFAULT VALUE.
           C
           C     DESCRIPTION OF PARAMETERS
 10        C      --OUTPUT--
           C        IUNIT - AN ARRAY OF ONE TO FIVE UNIT NUMBERS, DEPENDING
           C                ON THE VALUE OF N.  A VALUE OF ZERO REFERS TO THE
           C                DEFAULT UNIT, AS DEFINED BY THE I1MACH MACHINE
           C                CONSTANT ROUTINE.  ONLY IUNIT(1),...,IUNIT(N) ARE
 15        C                DEFINED BY XGETUA.  THE VALUES OF IUNIT(N+1),...,
           C                IUNIT(5) ARE NOT DEFINED (FOR N.LT.5) OR ALTERED
           C                IN ANY WAY BY XGETUA.
           C        N     - THE NUMBER OF UNITS TO WHICH COPIES OF THE
           C                ERROR MESSAGES ARE BEING SENT.  N WILL BE IN THE
 20        C                RANGE FROM 1 TO 5.
           C
           C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
           C
                 DIMENSION IUNIT(5)
 25              N = J4SAVE(5,0,.FALSE.)
                 DO 30 I=1,N
                    INDEX = I+4
                    IF (I.EQ.1) INDEX = 3
                    IUNIT(I) = J4SAVE(INDEX,0,.FALSE.)
 30           30 CONTINUE
                 RETURN
                 END
```

```
     SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
    4  XGETUA        1            31

VARIABLES       SN  TYPE            RELOCATION
   53  I            INTEGER                                REFS       27        28        29    DEFINED        26
   54  INDEX        INTEGER                                REFS       29    DEFINED       27         28
    0  IUNIT        INTEGER      ARRAY       F.P.          REFS       24    DEFINED        1         29
    0  N            INTEGER                  F.P.          REFS       26    DEFINED        1         25

EXTERNALS           TYPE     ARGS         REFERENCES
       J4SAVE       INTEGER    3              25         29

STATEMENT LABELS               DEF LINE   REFERENCES
    0  30                          30         26

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   23  30      * I           26 30       15B                 EXT REFS
```



```
STATISTICS
  PROGRAM LENGTH                61B       49
```

```
              SUBROUTINE XGETUN(IUNIT)
C
C             ABSTRACT
C                XGETUN GETS THE (FIRST) OUTPUT FILE TO WHICH ERROR MESSAGES
C                ARE BEING SENT.  TO FIND OUT IF MORE THAN ONE FILE IS BEING
C                USED, ONE MUST USE THE XGETUA ROUTINE.
C
C             DESCRIPTION OF PARAMETER
C              --OUTPUT--
C                IUNIT - THE LOGICAL UNIT NUMBER OF THE  (FIRST) UNIT TO
C                        WHICH ERROR MESSAGES ARE BEING SENT.
C                        A VALUE OF ZERO MEANS THAT THE DEFAULT FILE, AS
C                        DEFINED BY THE I1MACH ROUTINE, IS BEING USED.
C
C             WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C             LATEST REVISION --- 23 MAY 1979
C
              IUNIT = J4SAVE(3,0,.FALSE.)
              RETURN
              END
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS      DEF LINE      REFERENCES
    4  XGETUN         1             19

VARIABLES      SN  TYPE             RELOCATION
    0  IUNIT       INTEGER              F.P.      DEFINED        1        18

EXTERNALS            TYPE   ARGS          REFERENCES
        J4SAVE     INTEGER    3                18

STATISTICS
  PROGRAM LENGTH                     20B       16
```

```
      SUBROUTINE XSETF(KONTRL)
C
C     ABSTRACT
C        XSETF SETS THE ERROR CONTROL FLAG VALUE TO KONTRL.
C        (KONTRL IS AN INPUT PARAMETER ONLY.)
C        THE FOLLOWING TABLE SHOWS HOW EACH MESSAGE IS TREATED,
C        DEPENDING ON THE VALUES OF KONTRL AND LEVEL.  (SEE XERROR
C        FOR DESCRIPTION OF LEVEL.)
C
C        IF KONTRL IS ZERO OR NEGATIVE, NO INFORMATION OTHER THAN THE
C        MESSAGE ITSELF (INCLUDING NUMERIC VALUES, IF ANY) WILL BE
C        PRINTED.  IF KONTRL IS POSITIVE, INTRODUCTORY MESSAGES,
C        TRACE-BACKS, ETC., WILL BE PRINTED IN ADDITION TO THE MESSAGE.
C
C              IABS(KONTRL)
C        LEVEL        0              1              2
C        VALUE
C          2        FATAL          FATAL          FATAL
C
C          1     NOT PRINTED      PRINTED         FATAL
C
C          0     NOT PRINTED      PRINTED        PRINTED
C
C         -1     NOT PRINTED      PRINTED        PRINTED
C                                  ONLY           ONLY
C                                  ONCE           ONCE
C
C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C     LATEST REVISION ---  23 MAY 1979
C
      IF ((KONTRL.GE.(-2)).AND.(KONTRL.LE.2)) GO TO 10
         CALL XERRWV(39HXSETF  -- INVALID VALUE OF KONTRL (I1).,33,1,2,
     1   KONTRL,0,0,0.,0.)
         RETURN
   10 JUNK = J4SAVE(2,KONTRL,.TRUE.)
      RETURN
      END
```

```
       SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE     REFERENCES
    4  XSETF          1           34          36

VARIABLES       SN  TYPE               RELOCATION
   50  JUNK      *  INTEGER                          DEFINED       35
    0  KONTRL       INTEGER                 F.P.       REFS       2*31        32          35    DEFINED          1

EXTERNALS           TYPE    ARGS          REFERENCES
        J4SAVE    INTEGER     3               35
        XERRWV               10               32
```



```
STATEMENT LABELS            DEF LINE   REFERENCES
   17  10                      35          31

STATISTICS
  PROGRAM LENGTH               56B        46
```

```
      SUBROUTINE XSETUA(IUNIT,N)
C
C     ABSTRACT
C        XSETUA MAY BE CALLED TO DECLARE A LIST OF UP TO FIVE
C        LOGICAL UNITS, EACH OF WHICH IS TO RECEIVE A COPY OF
C        EACH ERROR MESSAGE PROCESSED BY THIS PACKAGE.
C        THE PURPOSE OF XSETUA IS TO ALLOW SIMULTANEOUS PRINTING
C        OF EACH ERROR MESSAGE ON, SAY, A MAIN OUTPUT FILE,
C        AN INTERACTIVE TERMINAL, AND OTHER FILES SUCH AS GRAPHICS
C        COMMUNICATION FILES.
C
C     DESCRIPTION OF PARAMETERS
C      --INPUT--
C        IUNIT - AN ARRAY OF UP TO FIVE UNIT NUMBERS.
C                NORMALLY THESE NUMBERS SHOULD ALL BE DIFFERENT.
C                (BUT DUPLICATES ARE NOT PROHIBITED.)
C        N     - THE NUMBER OF UNIT NUMBERS PROVIDED IN IUNIT.
C                MUST HAVE 1 .LE. N .LE. 5.
C
C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C     LATEST REVISION --- 23 MAY 1979
C
      DIMENSION IUNIT(5)
      IF ((N.GE.1).AND.(N.LE.5)) GO TO 10
         CALL XERRWV(34HXSETUA -- INVALID VALUE OF N (I1).,34,1,2,
     1   1,N,0,0,0.,0.)
         RETURN
   10 CONTINUE
      DO 20 I=1,N
         INDEX = I+4
         IF (I.EQ.1) INDEX = 3
         JUNK = J4SAVE(INDEX,IUNIT(I),.TRUE.)
   20 CONTINUE
      JUNK = J4SAVE(5,N,.TRUE.)
      RETURN
      END
```

```
       SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    4  XSETUA          1            27         35

VARIABLES       SN  TYPE              RELOCATION
  110  I            INTEGER                               REFS        30        31        32   DEFINED       29
  111  INDEX        INTEGER                               REFS        32   DEFINED        30        31
    0  IUNIT        INTEGER     ARRAY       F.P.          REFS        23        32   DEFINED         1
  112  JUNK         INTEGER                            DEFINED        32        34
    0  N            INTEGER                 F.P.          REFS      2*24        25        29        34   DEFINED        1

EXTERNALS             TYPE    ARGS           REFERENCES
       J4SAVE       INTEGER     3                32        34
       XERRWV                  10                25
```



```
STATEMENT LABELS              DEF LINE   REFERENCES
   30  10                        28          24
    0  20                        33          29

LOOPS  LABEL     INDEX       FROM-TO     LENGTH     PROPERTIES
   32  20      * I            29 33        17B                EXT REFS

STATISTICS
  PROGRAM LENGTH                 124B        84
```

```
      SUBROUTINE XSETUN(IUNIT)
C
C     ABSTRACT
C        XSETUN SETS THE OUTPUT FILE TO WHICH ERROR MESSAGES ARE TO
C        BE SENT.  ONLY ONE FILE WILL BE USED.  SEE XSETUA FOR
C        HOW TO DECLARE MORE THAN ONE FILE.
C
C     DESCRIPTION OF PARAMETER
C      --INPUT--
C        IUNIT - AN INPUT PARAMETER GIVING THE LOGICAL UNIT NUMBER
C                TO WHICH ERROR MESSAGES ARE TO BE SENT.
C
C     WRITTEN BY RON JONES, WITH SLATEC COMMON MATH LIBRARY SUBCOMMITTEE
C     LATEST REVISION ---  7 JUNE 1978
C
      JUNK = J4SAVE(3,IUNIT,.TRUE.)
      JUNK = J4SAVE(5,1,.TRUE.)
      RETURN
      END
```

```
     SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    4  XSETUN          1            18

VARIABLES      SN  TYPE                RELOCATION
    0  IUNIT       INTEGER                  F.P.          REFS         16    DEFINED          1
   32  JUNK        INTEGER                             DEFINED        16         17

EXTERNALS            TYPE    ARGS          REFERENCES
       J4SAVE      INTEGER     3                16           17

STATISTICS
  PROGRAM LENGTH                       33B       27
```



```
      INTEGER FUNCTION I1MACH(I)
C
C     SANDIA MATHEMATICAL PROGRAM LIBRARY
C     APPLIED MATHEMATICS DIVISION 2646
C     SANDIA LABORATORIES
C     ALBUQUERQUE, NEW MEXICO  87185
C     CONTROL DATA 6600/7600  VERSION 8.1  AUGUST 1980
C                   *************************
C                   *       ISSUED BY       *
C                   *  SANDIA LABORATORIES, *
C                   *   A PRIME CONTRACTOR  *
C                   ********     TO THE     *
C                          *  UNITED STATES *
C                          *   DEPARTMENT   *
C                          *       OF       *
C                          *     ENERGY     *
C      *********************  ---NOTICE---  *********************
C      *THIS REPORT WAS PREPARED AS AN ACCOUNT OF WORK SPONSORED*
C      *  BY THE UNITED STATES GOVERNMENT.  NEITHER THE UNITED  *
C      *   STATES NOR THE UNITED STATES DEPARTMENT OF ENERGY,   *
C      *               NOR ANY OF THEIR EMPLOYEES,              *
C      * NOR ANY OF THEIR CONTRACTORS, SUBCONTRACTORS, OR THEIR *
C      * EMPLOYEES, MAKES ANY WARRANTY, EXPRESS OR IMPLIED, OR  *
C      * ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE  *
C      *         **********    ACCURACY,    **********          *
C      *         *        *  COMPLETENESS  *         *          *
C      *         *        *  OR USEFULNESS *         *          *
C      *         *        *     OF ANY     *         *          *
C      *         *        *  INFORMATION,  *         *          *
C      *         *        *   APPARATUS,   *         *          *
C      *      ****        *     PRODUCT    *         ****       *
C      *      *           *   OR PROCESS   *            *       *
C      *      *           *   DISCLOSED,   *            *       *
C      *      *           *  OR REPRESENTS *            *       *
C      *      *          **    THAT ITS    **           *       *
C      *      *          **  USE WOULD NOT **           *       *
C      ********          **    INFRINGE    **           ********
C                        **    PRIVATELY   **
C                        **      OWNED     **
C                        **     RIGHTS.    **
C                        **                **
C                        **                **
C                        **                **
C                        ********************
C
C
C     I1MACH CAN BE USED TO OBTAIN MACHINE-DEPENDENT PARAMETERS
C     FOR THE LOCAL MACHINE ENVIRONMENT.  IT IS A FUNCTION
C     SUBROUTINE WITH ONE (INPUT) ARGUMENT, AND CAN BE CALLED
C     AS FOLLOWS, FOR EXAMPLE
C
C          K = I1MACH(I)
C
C     WHERE I=1,...,16.  THE (OUTPUT) VALUE OF K ABOVE IS
C     DETERMINED BY THE (INPUT) VALUE OF I.  THE RESULTS FOR
C     VARIOUS VALUES OF I ARE DISCUSSED BELOW.
C
```

```
C  I/O UNIT NUMBERS.
C    I1MACH( 1) = THE STANDARD INPUT UNIT.
C    I1MACH( 2) = THE STANDARD OUTPUT UNIT.
C    I1MACH( 3) = THE STANDARD PUNCH UNIT.
C    I1MACH( 4) = THE STANDARD ERROR MESSAGE UNIT.
C
C  WORDS.
C    I1MACH( 5) = THE NUMBER OF BITS PER INTEGER STORAGE UNIT.
C    I1MACH( 6) = THE NUMBER OF CHARACTERS PER INTEGER STORAGE UNIT.
C
C  INTEGERS.
C    ASSUME INTEGERS ARE REPRESENTED IN THE S-DIGIT, BASE-A FORM
C
C               SIGN ( X(S-1)*A**(S-1) + ... + X(1)*A + X(0) )
C
C               WHERE 0 .LE. X(I) .LT. A FOR I=0,...,S-1.
C    I1MACH( 7) = A, THE BASE.
C    I1MACH( 8) = S, THE NUMBER OF BASE-A DIGITS.
C    I1MACH( 9) = A**S - 1, THE LARGEST MAGNITUDE.
C
C  FLOATING-POINT NUMBERS.
C    ASSUME FLOATING-POINT NUMBERS ARE REPRESENTED IN THE T-DIGIT,
C    BASE-B FORM
C               SIGN (B**E)*( (X(1)/B) + ... + (X(T)/B**T) )
C
C               WHERE 0 .LE. X(I) .LT. B FOR I=1,...,T,
C               0 .LT. X(1), AND EMIN .LE. E .LE. EMAX.
C    I1MACH(10) = B, THE BASE.
C
C  SINGLE-PRECISION
C    I1MACH(11) = T, THE NUMBER OF BASE-B DIGITS.
C    I1MACH(12) = EMIN, THE SMALLEST EXPONENT E.
C    I1MACH(13) = EMAX, THE LARGEST EXPONENT E.
C
C  DOUBLE-PRECISION
C    I1MACH(14) = T, THE NUMBER OF BASE-B DIGITS.
C    I1MACH(15) = EMIN, THE SMALLEST EXPONENT E.
C    I1MACH(16) = EMAX, THE LARGEST EXPONENT E.
C
C  TO ALTER THIS FUNCTION FOR A PARTICULAR ENVIRONMENT,
C  THE DESIRED SET OF DATA STATEMENTS SHOULD BE ACTIVATED BY
C  REMOVING THE C FROM COLUMN 1.  ALSO, THE VALUES OF
C  I1MACH(1) - I1MACH(4) SHOULD BE CHECKED FOR CONSISTENCY
C  WITH THE LOCAL OPERATING SYSTEM.
C
C      ADAPTED FROM THE BELL LABS PORT MATHEMATICAL SUBROUTINE LIBRARY
C      REF. P.A. FOX, A.D. HALL, AND N.L. SCHRYER
C           *THE PORT MATHEMATICAL SUBROUTINE LIBRARY*
C           BELL LABS COMPUTING SCIENCE TECHNICAL REPORT NO. 47
C           SEPTEMBER 1976
C
      INTEGER IMACH(16),OUTPUT
C
      EQUIVALENCE (IMACH(4),OUTPUT)
C
C     MACHINE CONSTANTS FOR THE BURROUGHS 1700 SYSTEM.
C
```



```
C     DATA IMACH( 1) /    7 /
C     DATA IMACH( 2) /    2 /
C     DATA IMACH( 3) /    2 /
C     DATA IMACH( 4) /    2 /
C     DATA IMACH( 5) /   36 /
C     DATA IMACH( 6) /    4 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /   33 /
C     DATA IMACH( 9) / Z1FFFFFFFF /
C     DATA IMACH(10) /    2 /
C     DATA IMACH(11) /   24 /
C     DATA IMACH(12) / -256 /
C     DATA IMACH(13) /  255 /
C     DATA IMACH(14) /   60 /
C     DATA IMACH(15) / -256 /
C     DATA IMACH(16) /  255 /
C
C     MACHINE CONSTANTS FOR THE BURROUGHS 5700 SYSTEM.
C
C     DATA IMACH( 1) /    5 /
C     DATA IMACH( 2) /    6 /
C     DATA IMACH( 3) /    7 /
C     DATA IMACH( 4) /    6 /
C     DATA IMACH( 5) /  48 /
C     DATA IMACH( 6) /    6 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /  39 /
C     DATA IMACH( 9) / O0007777777777777 /
C     DATA IMACH(10) /    8 /
C     DATA IMACH(11) /  13 /
C     DATA IMACH(12) / -50 /
C     DATA IMACH(13) /  76 /
C     DATA IMACH(14) /  26 /
C     DATA IMACH(15) / -50 /
C     DATA IMACH(16) /  76 /
C
C     MACHINE CONSTANTS FOR THE BURROUGHS 6700/7700 SYSTEMS.
C
C     DATA IMACH( 1) /    5 /
C     DATA IMACH( 2) /    6 /
C     DATA IMACH( 3) /    7 /
C     DATA IMACH( 4) /    6 /
C     DATA IMACH( 5) /  48 /
C     DATA IMACH( 6) /    6 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /  39 /
C     DATA IMACH( 9) / O0007777777777777 /
C     DATA IMACH(10) /    8 /
C     DATA IMACH(11) /  13 /
C     DATA IMACH(12) / -50 /
C     DATA IMACH(13) /  76 /
C     DATA IMACH(14) /  26 /
C     DATA IMACH(15) / -32754 /
C     DATA IMACH(16) /  32780 /
C
C     MACHINE CONSTANTS FOR THE CDC 6000/7000 SERIES.
C
```

```
      DATA IMACH( 1) /    5 /
      DATA IMACH( 2) /    6 /
      DATA IMACH( 3) /    7 /
      DATA IMACH( 4) /6LOUTPUT/
      DATA IMACH( 5) /   60 /
      DATA IMACH( 6) /   10 /
      DATA IMACH( 7) /    2 /
      DATA IMACH( 8) /   48 /
      DATA IMACH( 9) / 00007777777777777777B /
      DATA IMACH(10) /    2 /
      DATA IMACH(11) /   48 /
      DATA IMACH(12) / -974 /
      DATA IMACH(13) / 1070 /
      DATA IMACH(14) /   96 /
      DATA IMACH(15) / -927 /
      DATA IMACH(16) / 1070 /
C
C     MACHINE CONSTANTS FOR THE CRAY 1
C
C     DATA IMACH( 1) /   100 /
C     DATA IMACH( 2) /   101 /
C     DATA IMACH( 3) /   102 /
C     DATA IMACH( 4) /   101 /
C     DATA IMACH( 5) /    64 /
C     DATA IMACH( 6) /     8 /
C     DATA IMACH( 7) /     2 /
C     DATA IMACH( 8) /    63 /
C     DATA IMACH( 9) /  777777777777777777777B /
C     DATA IMACH(10) /     2 /
C     DATA IMACH(11) /    48 /
C     DATA IMACH(12) / -8192 /
C     DATA IMACH(13) /  8191 /
C     DATA IMACH(14) /    96 /
C     DATA IMACH(15) / -8192 /
C     DATA IMACH(16) /  8191 /
C
C     MACHINE CONSTANTS FOR THE DATA GENERAL ECLIPSE S/200
C
C     DATA IMACH( 1) /   11 /
C     DATA IMACH( 2) /   12 /
C     DATA IMACH( 3) /    8 /
C     DATA IMACH( 4) /   10 /
C     DATA IMACH( 5) /   16 /
C     DATA IMACH( 6) /    2 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /   15 /
C     DATA IMACH( 9) /32767 /
C     DATA IMACH(10) /   16 /
C     DATA IMACH(11) /    6 /
C     DATA IMACH(12) /  -64 /
C     DATA IMACH(13) /   63 /
C     DATA IMACH(14) /   14 /
C     DATA IMACH(15) /  -64 /
C     DATA IMACH(16) /   63 /
C
C     MACHINE CONSTANTS FOR THE HARRIS 220
C
```



```
C     DATA IMACH( 1) /        5 /
C     DATA IMACH( 2) /        6 /
C     DATA IMACH( 3) /        0 /
C     DATA IMACH( 4) /        6 /
C     DATA IMACH( 5) /       24 /
C     DATA IMACH( 6) /        3 /
C     DATA IMACH( 7) /        2 /
C     DATA IMACH( 8) /       23 /
C     DATA IMACH( 9) / 8388607 /
C     DATA IMACH(10) /        2 /
C     DATA IMACH(11) /       23 /
C     DATA IMACH(12) /     -127 /
C     DATA IMACH(13) /      127 /
C     DATA IMACH(14) /       38 /
C     DATA IMACH(15) /     -127 /
C     DATA IMACH(16) /      127 /
C
C     MACHINE CONSTANTS FOR THE HONEYWELL 600/6000 SERIES.
C
C     DATA IMACH( 1) /    5 /
C     DATA IMACH( 2) /    6 /
C     DATA IMACH( 3) /   43 /
C     DATA IMACH( 4) /    6 /
C     DATA IMACH( 5) /   36 /
C     DATA IMACH( 6) /    6 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /   35 /
C     DATA IMACH( 9) / 0377777777777 /
C     DATA IMACH(10) /    2 /
C     DATA IMACH(11) /   27 /
C     DATA IMACH(12) / -127 /
C     DATA IMACH(13) /  127 /
C     DATA IMACH(14) /   63 /
C     DATA IMACH(15) / -127 /
C     DATA IMACH(16) /  127 /
C
C     MACHINE CONSTANTS FOR THE IBM 360/370 SERIES,
C     THE XEROX SIGMA 5/7/9 AND THE SEL SYSTEMS 85/86.
C
C     DATA IMACH( 1) /   5 /
C     DATA IMACH( 2) /   6 /
C     DATA IMACH( 3) /   7 /
C     DATA IMACH( 4) /   6 /
C     DATA IMACH( 5) /  32 /
C     DATA IMACH( 6) /   4 /
C     DATA IMACH( 7) /   2 /
C     DATA IMACH( 8) /  31 /
C     DATA IMACH( 9) / Z7FFFFFFF /
C     DATA IMACH(10) /  16 /
C     DATA IMACH(11) /   6 /
C     DATA IMACH(12) / -64 /
C     DATA IMACH(13) /  63 /
C     DATA IMACH(14) /  14 /
C     DATA IMACH(15) / -64 /
C     DATA IMACH(16) /  63 /
C
C     MACHINE CONSTANTS FOR THE PDP-10 (KA PROCESSOR).
```

```
C
C     DATA IMACH( 1) /    5 /
C     DATA IMACH( 2) /    6 /
C     DATA IMACH( 3) /    5 /
C     DATA IMACH( 4) /    6 /
C     DATA IMACH( 5) /   36 /
C     DATA IMACH( 6) /    5 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /   35 /
C     DATA IMACH( 9) / "377777777777 /
C     DATA IMACH(10) /    2 /
C     DATA IMACH(11) /   27 /
C     DATA IMACH(12) / -128 /
C     DATA IMACH(13) /  127 /
C     DATA IMACH(14) /   54 /
C     DATA IMACH(15) / -101 /
C     DATA IMACH(16) /  127 /
C
C     MACHINE CONSTANTS FOR THE PDP-10 (KI PROCESSOR).
C
C     DATA IMACH( 1) /    5 /
C     DATA IMACH( 2) /    6 /
C     DATA IMACH( 3) /    5 /
C     DATA IMACH( 4) /    6 /
C     DATA IMACH( 5) /   36 /
C     DATA IMACH( 6) /    5 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /   35 /
C     DATA IMACH( 9) / "377777777777 /
C     DATA IMACH(10) /    2 /
C     DATA IMACH(11) /   27 /
C     DATA IMACH(12) / -128 /
C     DATA IMACH(13) /  127 /
C     DATA IMACH(14) /   62 /
C     DATA IMACH(15) / -128 /
C     DATA IMACH(16) /  127 /
C
C     MACHINE CONSTANTS FOR PDP-11 FORTRAN(S SUPPORTING
C     32-BIT INTEGER ARITHMETIC.
C
C     DATA IMACH( 1) /    5 /
C     DATA IMACH( 2) /    6 /
C     DATA IMACH( 3) /    5 /
C     DATA IMACH( 4) /    6 /
C     DATA IMACH( 5) /   32 /
C     DATA IMACH( 6) /    4 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /   31 /
C     DATA IMACH( 9) / 2147483647 /
C     DATA IMACH(10) /    2 /
C     DATA IMACH(11) /   24 /
C     DATA IMACH(12) / -127 /
C     DATA IMACH(13) /  127 /
C     DATA IMACH(14) /   56 /
C     DATA IMACH(15) / -127 /
C     DATA IMACH(16) /  127 /
C
```



```
C     MACHINE CONSTANTS FOR PDP-11 FORTRAN(S SUPPORTING
C     16-BIT INTEGER ARITHMETIC.
C
C     DATA IMACH( 1) /    5 /
C     DATA IMACH( 2) /    6 /
C     DATA IMACH( 3) /    5 /
C     DATA IMACH( 4) /    6 /
C     DATA IMACH( 5) /   16 /
C     DATA IMACH( 6) /    2 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /   15 /
C     DATA IMACH( 9) / 32767 /
C     DATA IMACH(10) /    2 /
C     DATA IMACH(11) /   24 /
C     DATA IMACH(12) / -127 /
C     DATA IMACH(13) /  127 /
C     DATA IMACH(14) /   56 /
C     DATA IMACH(15) / -127 /
C     DATA IMACH(16) /  127 /
C
C     MACHINE CONSTANTS FOR THE UNIVAC 1100 SERIES.
C
C     NOTE THAT THE PUNCH UNIT, I1MACH(3), HAS BEEN SET TO 7
C     WHICH IS APPROPRIATE FOR THE UNIVAC-FOR SYSTEM.
C     IF YOU HAVE THE UNIVAC-FTN SYSTEM, SET IT TO 1.
C
C     DATA IMACH( 1) /    5 /
C     DATA IMACH( 2) /    6 /
C     DATA IMACH( 3) /    7 /
C     DATA IMACH( 4) /    6 /
C     DATA IMACH( 5) /   36 /
C     DATA IMACH( 6) /    6 /
C     DATA IMACH( 7) /    2 /
C     DATA IMACH( 8) /   35 /
C     DATA IMACH( 9) / O377777777777 /
C     DATA IMACH(10) /    2 /
C     DATA IMACH(11) /   27 /
C     DATA IMACH(12) / -128 /
C     DATA IMACH(13) /  127 /
C     DATA IMACH(14) /   60 /
C     DATA IMACH(15) /-1024 /
C     DATA IMACH(16) / 1023 /
C
      IF (I .LT. 1  .OR.  I .GT. 16) GO TO 10
C
      I1MACH=IMACH(I)
      RETURN
C
   10 CONTINUE
      CALL XERROR(25HI1MACH -- I OUT OF BOUNDS,25,1,2)
C
      END
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
  5  I1MACH           1           389          394

VARIABLES       SN  TYPE                RELOCATION
  0  I              INTEGER                  F.P.      REFS       2*386      388    DEFINED        1
 35  IMACH          INTEGER     ARRAY                  REFS        109       388    DEFINED      172        173        174        175
                                                        176        177       178        179      180        181        182        183
                                                        184        185       186        187
 33  I1MACH         INTEGER                          DEFINED       388
 34  OUTPUT     *   INTEGER     *UNDEF                 REFS        109

EXTERNALS              TYPE    ARGS         REFERENCES
     XERROR                     4               392

STATEMENT LABELS                DEF LINE    REFERENCES
  20  10                           391          386

STATISTICS
  PROGRAM LENGTH                   61B        49
```



```
      REAL FUNCTION R1MACH(I)
C
C     SANDIA MATHEMATICAL PROGRAM LIBRARY
C     APPLIED MATHEMATICS DIVISION 2646
C     SANDIA LABORATORIES
C     ALBUQUERQUE, NEW MEXICO  87185
C     CONTROL DATA 6600/7600  VERSION 8.1  AUGUST 1980
C                    *************************
C                    *       ISSUED BY       *
C                    *  SANDIA LABORATORIES, *
C                    *   A PRIME CONTRACTOR  *
C                    ********     TO THE     *
C                           *  UNITED STATES *
C                           *   DEPARTMENT   *
C                           *       OF       *
C                           *     ENERGY     *
C      *********************  ---NOTICE---  *********************
C      *THIS REPORT WAS PREPARED AS AN ACCOUNT OF WORK SPONSORED*
C      *  BY THE UNITED STATES GOVERNMENT.  NEITHER THE UNITED  *
C      *   STATES NOR THE UNITED STATES DEPARTMENT OF ENERGY,   *
C      *               NOR ANY OF THEIR EMPLOYEES,              *
C      * NOR ANY OF THEIR CONTRACTORS, SUBCONTRACTORS, OR THEIR *
C      * EMPLOYEES, MAKES ANY WARRANTY, EXPRESS OR IMPLIED, OR  *
C      * ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE  *
C      *          **********    ACCURACY,    **********         *
C      *          *        *  COMPLETENESS  *        *          *
C      *          *        *  OR USEFULNESS *        *          *
C      *          *        *     OF ANY     *        *          *
C      *          *        *  INFORMATION,  *        *          *
C      *          *        *   APPARATUS,   *        *          *
C      *       ****        *     PRODUCT    *        ****       *
C      *       *           *   OR PROCESS   *           *       *
C      *       *           *   DISCLOSED,   *           *       *
C      *       *           *  OR REPRESENTS *           *       *
C      *       *          **    THAT ITS    **          *       *
C      *       *          **  USE WOULD NOT **          *       *
C      *********          **    INFRINGE    **          *********
C                         **    PRIVATELY   **
C                         **      OWNED     **
C                         **     RIGHTS.    **
C                         **                **
C                         **                **
C                         **                **
C                         ********************
C
C
C     R1MACH CAN BE USED TO OBTAIN MACHINE-DEPENDENT PARAMETERS
C     FOR THE LOCAL MACHINE ENVIRONMENT.  IT IS A FUNCTION
C     SUBROUTINE WITH ONE (INPUT) ARGUMENT, AND CAN BE CALLED
C     AS FOLLOWS, FOR EXAMPLE
C
C          A = R1MACH(I)
C
C     WHERE I=1,...,5.  THE (OUTPUT) VALUE OF A ABOVE IS
C     DETERMINED BY THE (INPUT) VALUE OF I.  THE RESULTS FOR
C     VARIOUS VALUES OF I ARE DISCUSSED BELOW.
C
```

```
C  SINGLE-PRECISION MACHINE CONSTANTS
C  R1MACH(1) = B**(EMIN-1), THE SMALLEST POSITIVE MAGNITUDE.
C  R1MACH(2) = B**EMAX*(1 - B**(-T)), THE LARGEST MAGNITUDE.
C  R1MACH(3) = B**(-T), THE SMALLEST RELATIVE SPACING.
C  R1MACH(4) = B**(1-T), THE LARGEST RELATIVE SPACING.
C  R1MACH(5) = LOG10(B)
C
C  TO ALTER THIS FUNCTION FOR A PARTICULAR ENVIRONMENT,
C  THE DESIRED SET OF DATA STATEMENTS SHOULD BE ACTIVATED BY
C  REMOVING THE C FROM COLUMN 1.
C
C  WHERE POSSIBLE, OCTAL OR HEXADECIMAL CONSTANTS HAVE BEEN USED
C  TO SPECIFY THE CONSTANTS EXACTLY WHICH HAS IN SOME CASES
C  REQUIRED THE USE OF EQUIVALENT INTEGER ARRAYS.
C
C     ADAPTED FROM THE BELL LABS PORT MATHEMATICAL SUBROUTINE LIBRARY
C     REF. P.A. FOX, A.D. HALL, AND N.L. SCHRYER
C          *THE PORT MATHEMATICAL SUBROUTINE LIBRARY*
C          BELL LABS COMPUTING SCIENCE TECHNICAL REPORT NO. 47
C          SEPTEMBER 1976
C
      INTEGER SMALL(2)
      INTEGER LARGE(2)
      INTEGER RIGHT(2)
      INTEGER DIVER(2)
      INTEGER LOG10(2)
C
      REAL RMACH(5)
C
      EQUIVALENCE (RMACH(1),SMALL(1))
      EQUIVALENCE (RMACH(2),LARGE(1))
      EQUIVALENCE (RMACH(3),RIGHT(1))
      EQUIVALENCE (RMACH(4),DIVER(1))
      EQUIVALENCE (RMACH(5),LOG10(1))
C
C     MACHINE CONSTANTS FOR THE BURROUGHS 1700 SYSTEM.
C
C     DATA RMACH(1) / Z400800000 /
C     DATA RMACH(2) / Z5FFFFFFFF /
C     DATA RMACH(3) / Z4E9800000 /
C     DATA RMACH(4) / Z4EA800000 /
C     DATA RMACH(5) / Z500E730E8 /
C
C     MACHINE CONSTANTS FOR THE BURROUGHS 5700/6700/7700 SYSTEMS.
C
C     DATA RMACH(1) / O1771000000000000 /
C     DATA RMACH(2) / O0777777777777777 /
C     DATA RMACH(3) / O1311000000000000 /
C     DATA RMACH(4) / O1301000000000000 /
C     DATA RMACH(5) / O1157163034761675 /
C
C     MACHINE CONSTANTS FOR THE CDC 6000/7000 SERIES.
C
      DATA RMACH(1) / 00014000000000000000B /
      DATA RMACH(2) / 37767777777777777777B /
      DATA RMACH(3) / 16404000000000000000B /
      DATA RMACH(4) / 16414000000000000000B /
```

```
                DATA RMACH(5) / 1716464202324117572OB /
      C
      C         MACHINE CONSTANTS FOR THE CRAY 1
      C
      C         DATA RMACH(1) / 200004000000000000000B /
      C         DATA RMACH(2) / 577777777777777777777B /
      C         DATA RMACH(3) / 377214000000000000000B /
      C         DATA RMACH(4) / 377224000000000000000B /
      C         DATA RMACH(5) / 377774642023241175720B /
      C
      C         MACHINE CONSTANTS FOR THE DATA GENERAL ECLIPSE S/200
      C
      C         NOTE - IT MAY BE APPROPRIATE TO INCLUDE THE FOLLOWING CARD -
      C         STATIC RMACH(5)
      C
      C         DATA SMALL/20K,0/,LARGE/77777K,177777K/
      C         DATA RIGHT/35420K,0/,DIVER/36020K,0/
      C         DATA LOG10/40423K,42023K/
      C
      C         MACHINE CONSTANTS FOR THE HARRIS 220
      C
      C         DATA SMALL(1),SMALL(2) / [20000000, [00000201 /
      C         DATA LARGE(1),LARGE(2) / [37777777, [00000177 /
      C         DATA RIGHT(1),RIGHT(2) / [20000000, [00000352 /
      C         DATA DIVER(1),DIVER(2) / [20000000, [00000353 /
      C         DATA LOG10(1),LOG10(2) / [23210115, [00000377 /
      C
      C         MACHINE CONSTANTS FOR THE HONEYWELL 600/6000 SERIES.
      C
      C         DATA RMACH(1) / 0402400000000 /
      C         DATA RMACH(2) / 0376777777777 /
      C         DATA RMACH(3) / 0714400000000 /
      C         DATA RMACH(4) / 0716400000000 /
      C         DATA RMACH(5) / 0776464202324 /
      C
      C         MACHINE CONSTANTS FOR THE IBM 360/370 SERIES,
      C         THE XEROX SIGMA 5/7/9 AND THE SEL SYSTEMS 85/86.
      C
      C         DATA RMACH(1) / Z00100000 /
      C         DATA RMACH(2) / Z7FFFFFFF /
      C         DATA RMACH(3) / Z3B100000 /
      C         DATA RMACH(4) / Z3C100000 /
      C         DATA RMACH(5) / Z41134413 /
      C
      C         MACHINE CONSTANTS FOR THE PDP-10 (KA OR KI PROCESSOR).
      C
      C         DATA RMACH(1) / "000400000000 /
      C         DATA RMACH(2) / "377777777777 /
      C         DATA RMACH(3) / "146400000000 /
      C         DATA RMACH(4) / "147400000000 /
      C         DATA RMACH(5) / "177464202324 /
      C
      C         MACHINE CONSTANTS FOR PDP-11 FORTRAN(S SUPPORTING
      C         32-BIT INTEGERS (EXPRESSED IN INTEGER AND OCTAL).
      C
      C         DATA SMALL(1) /    8388608 /
      C         DATA LARGE(1) / 2147483647 /
```



```
      C         DATA RIGHT(1) /  880803840 /
      C         DATA DIVER(1) /  889192448 /
      C         DATA LOG10(1) / 1067065499 /
      C
      C         DATA RMACH(1) / 000040000000 /
      C         DATA RMACH(2) / 017777777777 /
      C         DATA RMACH(3) / 006440000000 /
      C         DATA RMACH(4) / 006500000000 /
      C         DATA RMACH(5) / 007746420233 /
      C
      C         MACHINE CONSTANTS FOR PDP-11 FORTRAN(S SUPPORTING
      C         16-BIT INTEGERS  (EXPRESSED IN INTEGER AND OCTAL).
      C
      C         DATA SMALL(1),SMALL(2) /   128,      0 /
      C         DATA LARGE(1),LARGE(2) / 32767,     -1 /
      C         DATA RIGHT(1),RIGHT(2) / 13440,      0 /
      C         DATA DIVER(1),DIVER(2) / 13568,      0 /
      C         DATA LOG10(1),LOG10(2) / 16282,   8347 /
      C
      C         DATA SMALL(1),SMALL(2) / 0000200, 0000000 /
      C         DATA LARGE(1),LARGE(2) / 0077777, 0177777 /
      C         DATA RIGHT(1),RIGHT(2) / 0032200, 0000000 /
      C         DATA DIVER(1),DIVER(2) / 0032400, 0000000 /
      C         DATA LOG10(1),LOG10(2) / 0037632, 0020233 /
      C
      C         MACHIME CONSTANTS FOR THE UNIVAC 1100 SERIES.
      C
      C         DATA RMACH(1) / 0000400000000 /
      C         DATA RMACH(2) / 0377777777777 /
      C         DATA RMACH(3) / 0146400000000 /
      C         DATA RMACH(4) / 0147400000000 /
      C         DATA RMACH(5) / 0177464202324 /
      C
      C         THESE MACHINE CONSTANTS WERE ADDED TO THE FUNCTION R1MACH BY
      C         SANDIA LABORATORIES, ALBUQUERQUE, FOR USE ON THE VAX 11/780.
      C
      C         DATA RMACH(1) /'00000000200'O/
      C         DATA RMACH(2) /'37777677777'O/
      C         DATA RMACH(3) /'00000032200'O/
      C         DATA RMACH(4) /'00000032400'O/
      C         DATA RMACH(5) /'04046437632'O/
      C
                IF (I .LT. 1  .OR.  I .GT. 5)
               1   CALL XERROR (25HR1MACH -- I OUT OF BOUNDS,25,1,2)
      C
                R1MACH = RMACH(I)
                RETURN
      C
                END
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS       DEF LINE      REFERENCES
   5  R1MACH           1            218

VARIABLES        SN  TYPE             RELOCATION
   34  DIVER         INTEGER    ARRAY                 REFS         82         90
    0  I             INTEGER                F.P.      REFS       2*214       217      DEFINED         1
   32  LARGE         INTEGER    ARRAY                 REFS         80         88
   35  LOG10         INTEGER    ARRAY                 REFS         83         91
   33  RIGHT         INTEGER    ARRAY                 REFS         81         89
   31  RMACH         REAL       ARRAY                 REFS         85         87         88         89         90         91        217
                                                   DEFINED        111        112        113        114        115
   30  R1MACH        REAL                          DEFINED        217
   31  SMALL         INTEGER    ARRAY                 REFS         79         87

EXTERNALS            TYPE    ARGS        REFERENCES
         XERROR               4             214

STATISTICS
  PROGRAM LENGTH                      43B       35
```



```
      DOUBLE PRECISION FUNCTION D1MACH(I)
C
C     SANDIA MATHEMATICAL PROGRAM LIBRARY
C     APPLIED MATHEMATICS DIVISION 2646
C     SANDIA LABORATORIES
C     ALBUQUERQUE, NEW MEXICO  87185
C     CONTROL DATA 6600/7600  VERSION 8.1  AUGUST 1980
C                   *************************
C                   *       ISSUED BY       *
C                   *  SANDIA LABORATORIES, *
C                   *   A PRIME CONTRACTOR  *
C                   ********    TO THE      *
C                           * UNITED STATES *
C                           *   DEPARTMENT  *
C                           *       OF      *
C                           *     ENERGY    *
C      ********************  ---NOTICE---   *********************
C      *THIS REPORT WAS PREPARED AS AN ACCOUNT OF WORK SPONSORED*
C      *  BY THE UNITED STATES GOVERNMENT.  NEITHER THE UNITED  *
C      *   STATES NOR THE UNITED STATES DEPARTMENT OF ENERGY,   *
C      *               NOR ANY OF THEIR EMPLOYEES,              *
C      * NOR ANY OF THEIR CONTRACTORS, SUBCONTPACTORS, OR THEIR *
C      * EMPLOYEES, MAKES ANY WARRANTY, EXPRESS OR IMPLIED, OR  *
C      * ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE  *
C      *          **********    ACCURACY,   **********          *
C      *          *         * COMPLETENESS  *        *          *
C      *          *         * OR USEFULNESS *        *          *
C      *          *         *    OF ANY     *        *          *
C      *          *         * INFORMATION,  *        *          *
C      *          *         *  APPARATUS,   *        *          *
C      *       ****         *    PRODUCT    *        ****       *
C      *       *            *  OR PROCESS   *           *       *
C      *       *            *  DISCLOSED,   *           *       *
C      *       *            * OR REPRESENTS *           *       *
C      *       *           **   THAT ITS    **          *       *
C      *       *           ** USE WOULD NOT **          *       *
C      *********           **   INFRINGE    **          *********
C                          **   PRIVATELY   **
C                          **     OWNED     **
C                          **    RIGHTS.    **
C                          **               **
C                          **               **
C                          **               **
C                          *******************
C
C
C     D1MACH CAN BE USED TO OBTAIN MACHINE-DEPENDENT PARAMETERS
C     FOR THE LOCAL MACHINE ENVIRONMENT.  IT IS A FUNCTION
C     SUBROUTINE WITH ONE (INPUT) ARGUMENT, AND CAN BE CALLED
C     AS FOLLOWS, FOR EXAMPLE
C
C          D = D1MACH(I)
C
C     WHERE I=1,...,5.  THE (OUTPUT) VALUE OF D ABOVE IS
C     DETERMINED BY THE (INPUT) VALUE OF I.  THE RESULTS FOR
C     VARIOUS VALUES OF I ARE DISCUSSED BELOW.
C
```

```
C  DOUBLE-PRECISION MACHINE CONSTANTS
C  D1MACH( 1) = B**(EMIN-1), THE SMALLEST POSITIVE MAGNITUDE.
C  D1MACH( 2) = B**EMAX*(1 - B**(-T)), THE LARGEST MAGNITUDE.
C  D1MACH( 3) = B**(-T), THE SMALLEST RELATIVE SPACING.
C  D1MACH( 4) = B**(1-T), THE LARGEST RELATIVE SPACING.
C  D1MACH( 5) = LOG10(B)
C
C  TO ALTER THIS FUNCTION FOR A PARTICULAR ENVIRONMENT,
C  THE DESIRED SET OF DATA STATEMENTS SHOULD BE ACTIVATED BY
C  REMOVING THE C FROM COLUMN 1.
C
C  WHERE POSSIBLE, OCTAL OR HEXADECIMAL CONSTANTS HAVE BEEN USED
C  TO SPECIFY THE CONSTANTS EXACTLY WHICH HAS IN SOME CASES
C  REQUIRED THE USE OF EQUIVALENT INTEGER ARRAYS.
C
C     ADAPTED FROM THE BELL LABS PORT MATHEMATICAL SUBROUTINE LIBRARY
C     REF. P.A. FOX, A.D. HALL, AND N.L. SCHRYER
C          *THE PORT MATHEMATICAL SUBROUTINE LIBRARY*
C          BELL LABS COMPUTING SCIENCE TECHNICAL REPORT NO. 47
C          SEPTEMBER 1976
C
      INTEGER SMALL(4)
      INTEGER LARGE(4)
      INTEGER RIGHT(4)
      INTEGER DIVER(4)
      INTEGER LOG10(4)
C
      DOUBLE PRECISION DMACH(5)
C
      EQUIVALENCE (DMACH(1),SMALL(1))
      EQUIVALENCE (DMACH(2),LARGE(1))
      EQUIVALENCE (DMACH(3),RIGHT(1))
      EQUIVALENCE (DMACH(4),DIVER(1))
      EQUIVALENCE (DMACH(5),LOG10(1))
C
C     MACHINE CONSTANTS FOR THE BURROUGHS 1700 SYSTEM.
C
C     DATA SMALL(1) / ZC00800000 /
C     DATA SMALL(2) / Z000000000 /
C
C     DATA LARGE(1) / ZDFFFFFFFF /
C     DATA LARGE(2) / ZFFFFFFFFF /
C
C     DATA RIGHT(1) / ZCC5800000 /
C     DATA RIGHT(2) / Z000000000 /
C
C     DATA DIVER(1) / ZCC6800000 /
C     DATA DIVER(2) / Z000000000 /
C
C     DATA LOG10(1) / ZD00E730E7 /
C     DATA LOG10(2) / ZC77800DC0 /
C
C     MACHINE CONSTANTS FOR THE BURROUGHS 5700 SYSTEM.
C
C     DATA SMALL(1) / O1771000000000000 /
C     DATA SMALL(2) / O0000000000000000 /
C
```



```
C     DATA LARGE(1) / O0777777777777777 /
C     DATA LARGE(2) / O0007777777777777 /
C
C     DATA RIGHT(1) / O1461000000000000 /
C     DATA RIGHT(2) / O0000000000000000 /
C
C     DATA DIVER(1) / O1451000000000000 /
C     DATA DIVER(2) / O0000000000000000 /
C
C     DATA LOG10(1) / O1157163034761674 /
C     DATA LOG10(2) / O0006677466732724 /
C
C     MACHINE CONSTANTS FOR THE BURROUGHS 6700/7700 SYSTEMS.
C
C     DATA SMALL(1) / O1771000000000000 /
C     DATA SMALL(2) / O7770000000000000 /
C
C     DATA LARGE(1) / O0777777777777777 /
C     DATA LARGE(2) / O7777777777777777 /
C
C     DATA RIGHT(1) / O1461000000000000 /
C     DATA RIGHT(2) / O0000000000000000 /
C
C     DATA DIVER(1) / O1451000000000000 /
C     DATA DIVER(2) / O0000000000000000 /
C
C     DATA LOG10(1) / O1157163034761674 /
C     DATA LOG10(2) / O0006677466732724 /
C
C     MACHINE CONSTANTS FOR THE CDC 6000/7000 SERIES.
C
      DATA SMALL(1) / 00604000000000000000B /
      DATA SMALL(2) / 00000000000000000000B /
C
      DATA LARGE(1) / 37767777777777777777B /
      DATA LARGE(2) / 37167777777777777777B /
C
      DATA RIGHT(1) / 15604000000000000000B /
      DATA RIGHT(2) / 15000000000000000000B /
C
      DATA DIVER(1) / 15614000000000000000B /
      DATA DIVER(2) / 15010000000000000000B /
C
      DATA LOG10(1) / 17164642023241175717B /
      DATA LOG10(2) / 16367571421742254654B /
C
C     MACHINE CONSTANTS FOR THE CRAY 1
C
C     DATA SMALL(1) / 200004000000000000000B /
C     DATA SMALL(2) / 000000000000000000000B /
C
C     DATA LARGE(1) / 577777777777777777777B /
C     DATA LARGE(2) / 000007777777777777777B /
C
C     DATA RIGHT(1) / 377214000000000000000B /
C     DATA RIGHT(2) / 000000000000000000000B /
C
```

```
C       DATA DIVER(1) / 37722400000000000000B /
C       DATA DIVER(2) / 00000000000000000000B /
C
C       DATA LOG10(1) / 37777464202324117571B /
C       DATA LOG10(2) / 00007571421742254654B /
C
C       MACHINE CONSTANTS FOR THE DATA GENERAL ECLIPSE S/200
C
C       NOTE - IT MAY BE APPROPRIATE TO INCLUDE THE FOLLOWING CARD -
C       STATIC DMACH(5)
C
C       DATA SMALL/20K,3*0/,LARGE/77777K,3*177777K/
C       DATA RIGHT/31420K,3*0/,DIVER/32020K,3*0/
C       DATA LOG10/40423K,42023K,50237K,74776K/
C
C       MACHINE CONSTANTS FOR THE HARRIS 220
C
C       DATA SMALL(1),SMALL(2) / [20000000, [00000201 /
C       DATA LARGE(1),LARGE(2) / [37777777, [37777577 /
C       DATA RIGHT(1),RIGHT(2) / [20000000, [00000333 /
C       DATA DIVER(1),DIVER(2) / [20000000, [00000334 /
C       DATA LOG10(1),LOG10(2) / [23210115, [10237777 /
C
C       MACHINE CONSTANTS FOR THE HONEYWELL 600/6000 SERIES.
C
C       DATA SMALL(1),SMALL(2) / 0402400000000, 0000000000000 /
C       DATA LARGE(1),LARGE(2) / 0376777777777, 0777777777777 /
C       DATA RIGHT(1),RIGHT(2) / 0604400000000, 0000000000000 /
C       DATA DIVER(1),DIVER(2) / 0606400000000, 0000000000000 /
C       DATA LOG10(1),LOG10(2) / 0776464202324, 0117571775714 /
C
C       MACHINE CONSTANTS FOR THE IBM 360/370 SERIES,
C       THE XEROX SIGMA 5/7/9 AND THE SEL SYSTEMS 85/86.
C
C       DATA SMALL(1),SMALL(2) / Z00100000, Z00000000 /
C       DATA LARGE(1),LARGE(2) / Z7FFFFFFF, ZFFFFFFFF /
C       DATA RIGHT(1),RIGHT(2) / Z33100000, Z00000000 /
C       DATA DIVER(1),DIVER(2) / Z34100000, Z00000000 /
C       DATA LOG10(1),LOG10(2) / Z41134413, Z509F79FF /
C
C       MACHINE CONSTANTS FOR THE PDP-10 (KA PROCESSOR).
C
C       DATA SMALL(1),SMALL(2) / "033400000000, "000000000000 /
C       DATA LARGE(1),LARGE(2) / "377777777777, "344777777777 /
C       DATA RIGHT(1),RIGHT(2) / "113400000000, "000000000000 /
C       DATA DIVER(1),DIVER(2) / "114400000000, "000000000000 /
C       DATA LOG10(1),LOG10(2) / "177464202324, "144117571776 /
C
C       MACHINE CONSTANTS FOR THE PDP-10 (KI PROCESSOR).
C
C       DATA SMALL(1),SMALL(2) / "000400000000, "000000000000 /
C       DATA LARGE(1),LARGE(2) / "377777777777, "377777777777 /
C       DATA RIGHT(1),RIGHT(2) / "103400000000, "000000000000 /
C       DATA DIVER(1),DIVER(2) / "104400000000, "000000000000 /
C       DATA LOG10(1),LOG10(2) / "177464202324, "476747767461 /
C
C       MACHINE CONSTANTS FOR PDP-11 FORTRAN[S SUPPORTING
```



```
C       32-BIT INTEGERS (EXPRESSED IN INTEGER AND OCTAL).
C
C       DATA SMALL(1),SMALL(2) /    8388608,           0 /
C       DATA LARGE(1),LARGE(2) / 2147483647,          -1 /
C       DATA RIGHT(1),RIGHT(2) /  612368384,           0 /
C       DATA DIVER(1),DIVER(2) /  620756992,           0 /
C       DATA LOG10(1),LOG10(2) / 1067065498, -2063872008 /
C
C       DATA SMALL(1),SMALL(2) / 000040000000, 000000000000 /
C       DATA LARGE(1),LARGE(2) / 017777777777, 037777777777 /
C       DATA RIGHT(1),RIGHT(2) / 004440000000, 000000000000 /
C       DATA DIVER(1),DIVER(2) / 004500000000, 000000000000 /
C       DATA LOG10(1),LOG10(2) / 007746420232, 020476747770 /
C
C       MACHINE CONSTANTS FOR PDP-11 FORTRAN[S SUPPORTING
C       16-BIT INTEGERS (EXPRESSED IN INTEGER AND OCTAL).
C
C       DATA SMALL(1),SMALL(2) /    128,      0 /
C       DATA SMALL(3),SMALL(4) /      0,      0 /
C
C       DATA LARGE(1),LARGE(2) /  32767,     -1 /
C       DATA LARGE(3),LARGE(4) /     -1,     -1 /
C
C       DATA RIGHT(1),RIGHT(2) /   9344,      0 /
C       DATA RIGHT(3),RIGHT(4) /      0,      0 /
C
C       DATA DIVER(1),DIVER(2) /   9472,      0 /
C       DATA DIVER(3),DIVER(4) /      0,      0 /
C
C       DATA LOG10(1),LOG10(2) /  16282,   8346 /
C       DATA LOG10(3),LOG10(4) / -31493, -12296 /
C
C       DATA SMALL(1),SMALL(2) / 0000200, 0000000 /
C       DATA SMALL(3),SMALL(4) / 0000000, 0000000 /
C
C       DATA LARGE(1),LARGE(2) / 0077777, 0177777 /
C       DATA LARGE(3),LARGE(4) / 0177777, 0177777 /
C
C       DATA RIGHT(1),RIGHT(2) / 0022200, 0000000 /
C       DATA RIGHT(3),RIGHT(4) / 0000000, 0000000 /
C
C       DATA DIVER(1),DIVER(2) / 0022400, 0000000 /
C       DATA DIVER(3),DIVER(4) / 0000000, 0000000 /
C
C       DATA LOG10(1),LOG10(2) / 0037632, 0020232 /
C       DATA LOG10(3),LOG10(4) / 0102373, 0147770 /
C
C       MACHINE CONSTANTS FOR THE UNIVAC 1100 SERIES.
C
C       DATA SMALL(1),SMALL(2) / 0000040000000, 0000000000000 /
C       DATA LARGE(1),LARGE(2) / 0377777777777, 0777777777777 /
C       DATA RIGHT(1),RIGHT(2) / 0170540000000, 0000000000000 /
C       DATA DIVER(1),DIVER(2) / 0170640000000, 0000000000000 /
C       DATA LOG10(1),LOG10(2) / 0177746420232, 0411757177572 /
C
C       THESE MACHINE CONSTANTS WERE ADDED TO THE FUNCTION D1MACH BY
C       SANDIA LABORATORIES, ALBUQUERQUE, FOR USE ON THE VAX 11/780.
```

```
      C
      C        DATA DMACH(1) /'00000000000000000200'O/
      C        DATA LARGE(1) /'37777677777'O/
      C        DATA LARGE(2) /'37777777777'O/
      C        DATA DMACH(3) /'00000000000000022200'O/
      C        DATA DMACH(4) /'00000000000000022400'O/
      C        DATA LOG10(1) /'04046437632'O/
      C        DATA LOG10(2) /'33775702373'O/
      C
               IF (I .LT. 1  .OR.  I .GT. 5)
              1   CALL XERROR(25HD1MACH -- I OUT OF BOUNDS,25,1,2)
      C
               D1MACH = DMACH(I)
               RETURN
      C
               END
```

```
SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
   6  D1MACH         1            299

VARIABLES      SN   TYPE              RELOCATION
   42  DIVER        INTEGER    ARRAY                    REFS        82       90    DEFINED      155       156
   34  DMACH        DOUBLE     ARRAY                    REFS        85       87         88       89        90       91       298
   32  D1MACH       DOUBLE                           DEFINED       298
    0  I            INTEGER               F.P.          REFS     2*295      298    DEFINED        1
   36  LARGE        INTEGER    ARRAY                    REFS        80       88    DEFINED      149       150
   44  LOG10        INTEGER    ARRAY                    REFS        83       91    DEFINED      158       159
   40  RIGHT        INTEGER    ARRAY                    REFS        81       89    DEFINED      152       153
   34  SMALL        INTEGER    ARRAY                    REFS        79       87    DEFINED      146       147

EXTERNALS            TYPE    ARGS         REFERENCES
       XERROR                  4              295

STATISTICS
  PROGRAM LENGTH                   54B       44
```



```
               SUBROUTINE RFBS(ND,N,ALU,IN,X,KER)
      C
      C        SANDIA MATHEMATICAL PROGRAM LIBRARY
      C        APPLIED MATHEMATICS DIVISION 2646
      C        SANDIA LABORATORIES
      C        ALBUQUERQUE, NEW MEXICO  87185
      C        CONTROL DATA 6600/7600  VERSION 8.1  AUGUST 1980
      C                        *************************
      C                        *       ISSUED BY       *
      C                        *  SANDIA LABORATORIES, *
      C                        *   A PRIME CONTRACTOR  *
      C                        ********     TO THE     *
      C                               *  UNITED STATES *
      C                               *    DEPARTMENT  *
      C                               *        OF      *
      C                               *      ENERGY    *
      C         ********************  ---NOTICE---  ********************
      C         *THIS REPORT WAS PREPARED AS AN ACCOUNT OF WORK SPONSORED*
      C         *  BY THE UNITED STATES GOVERNMENT.  NEITHER THE UNITED  *
      C         *    STATES NOR THE UNITED STATES DEPARTMENT OF ENERGY,  *
      C         *               NOR ANY OF THEIR EMPLOYEES,              *
      C         * NOR ANY OF THEIR CONTRACTORS, SUBCONTRACTORS, OR THEIR *
      C         * EMPLOYEES, MAKES ANY WARRANTY, EXPRESS OR IMPLIED, OR  *
      C         * ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE  *
      C         *         **********    ACCURACY,   **********           *
      C         *         *        *  COMPLETENESS  *        *           *
      C         *         *        *  OR USEFULNESS *        *           *
      C         *         *        *     OF ANY     *        *           *
      C         *         *        *  INFORMATION,  *        *           *
      C         *         *        *   APPARATUS,   *        *           *
      C         *      ****        *    PRODUCT     *        ****        *
      C         *      *           *   OR PROCESS   *           *        *
      C         *      *           *   DISCLOSED,   *           *        *
      C         *      *           *  OR REPRESENTS *           *        *
      C         *      *          **    THAT ITS    **          *        *
      C         *      *          **  USE WOULD NOT **          *        *
      C         ********          **    INFRINGE    **          ********
      C                           **    PRIVATELY   **
      C                           **      OWNED     **
      C                           **     RIGHTS.    **
      C                           **                **
      C                           **                **
      C                           **                **
      C                           ********************
      C
      C        WRITTEN BY CARL B. BAILEY, MAY 1972.
      C
      C        ABSTRACT
      C            RFBS SOLVES A FACTORED SYSTEM OF REAL LINEAR ALGEBRAIC
      C            EQUATIONS OF THE FORM LUX=PB, WHERE -L- IS A UNIT LOWER
      C            TRIANGULAR MATRIX, -U- IS AN UPPER TRIANGULAR MATRIX, -P-
      C            IS A PERMUTATION MATRIX, AND BOTH -X- AND -B- ARE VECTORS.
      C            THE METHOD USED IS THE SECOND STEP IN GAUSSIAN ELIMINATION.
      C            FIRST THE SYSTEM LY=PB IS SOLVED BY FORWARD SUBSTITUTION.
      C            THEN THE SYSTEM UX=Y IS SOLVED BY BACKWARD SUBSTITUTION.
      C            -P- IS DEFINED IMPLICITLY BY THE ORDER OF ROW INTERCHANGES.
      C
```

```
      C         FORWARD-BACKWARD SUBSTITUTION IS THE SECOND STEP IN SOLVING
      C         A SYSTEM OF LINEAR ALGEBRAIC EQUATIONS.  ONCE A COEFFICIENT
 60   C         MATRIX -A- HAS BEEN FACTORED BY RLUD, ANY NUMBER OF SYSTEMS
      C         OF EQUATIONS ALL HAVING THE SAME COEFFICIENT MATRIX CAN BE
      C         SOLVED EFFICIENTLY BY FORWARD-BACKWARD SUBSTITUTION WITH RFBS.
      C         RFBS IS CALLED BY SAXB, SAXBI, RIMP, CAXBI, AND CRIMP.
      C
 65   C     REFERENCE
      C       1.  G.E.FORSYTHE AND C.B.MOLER, COMPUTER SOLUTION OF LINEAR
      C           ALGEBRAIC EQUATIONS, PRENTICE-HALL, 1967
      C
      C     DESCRIPTION OF ARGUMENTS
 70   C       --INPUT---
      C         ND      - THE ACTUAL FIRST DIMENSION OF THE ARRAY -ALU-.
      C         N       - NUMBER OF EQUATIONS (1 .LE. N .LE. ND)
      C         ALU     - AN ARRAY DIMENSIONED WITH EXACTLY -ND- ROWS AND
      C                   AT LEAST -N- COLUMNS.  THE LEADING -N- BY -N-
 75   C                   SUBARRAY MUST CONTAIN L-I+U AS COMPUTED BY RLUD.
      C         X       - AN ARRAY DIMENSIONED AT LEAST -N-.  THE FIRST -N-
      C                   ELEMENTS MUST CONTAIN THE VECTOR -B- OF CONSTANTS.
      C         IN      - AN ARRAY DIMENSIONED AT LEAST -N-.  THE FIRST -N-
      C                   ELEMENTS MUST CONTAIN INDICES AS COMPUTED BY RLUD.
 80   C
      C       --OUTPUT--
      C         X       - THE FIRST -N- ELEMENTS WILL CONTAIN THE SOLUTION.
      C         KER     - AN ERROR CODE
      C                 --NORMAL CODES
 85   C                    0 MEANS NO ERRORS WERE DETECTED
      C                 --ABNORMAL CODES
      C                    1 MEANS -ND- WAS NOT IN THE RANGE 1 .LE. ND .LE. 325
      C                    2 MEANS -N- WAS NOT IN THE RANGE 1 .LE. N .LE. ND.
      C                    3 MEANS THE TRIANGULAR FACTOR -U- OF -A- IS SINGULAR.
 90         DIMENSION ALU(ND,N),IN(N),X(N)
            DATA NDMAX/325/
            NN = N
            IF(ND .LT. 1 .OR. ND .GT. NDMAX) GO TO 6
            IF(NN .LT. 1 .OR. NN .GT. ND) GO TO 7
 95         IF(IN(NN) .EQ. 0) GO TO 8
            KER = 0
            NM1 = NN-1
            IF(NM1 .EQ. 0) GO TO 5
      C     SOLVE  LY = B      (FORWARD SUBSTITUTION)
100         DO 2 L = 1,NM1
            K = IN(L)
            Z = X(K)
            X(K) = X(L)
            X(L) = Z
105         LP1 = L + 1
            DO 1 K = LP1,NN
          1 X(K) = X(K) - ALU(K,L)*Z
          2 CONTINUE
      C     SOLVE  UX = Y      (BACKWARD SUBSTITUTION)
110         DO 4 I = 1,NM1
            K = NN - I
            KP1 = K + 1
            X(KP1) = X(KP1) / ALU(KP1,KP1)
            Z = -X(KP1)
```



```
115         DO 3 L = 1,K
          3 X(L) = X(L) + ALU(L,KP1)*Z
          4 CONTINUE
          5 X(1) = X(1)/ALU(1,1)
            GO TO 9
120       6 KER = 1
            CALL XERROR (80HRFBS - ARGUMENT ND IS INVALID.  IT IS REQUIRED THA
           1T ND .GE. 1 .AND. ND .LE. 325.,80,2,1)
            GO TO 9
          7 KER = 2
125         CALL XERROR (76HRFBS - ARGUMENT N IS INVALID.  IT IS REQUIRED THAT
           1 N .GE. 1 .AND. N .LE. ND.,76,2,1)
            GO TO 9
          8 KER = 3
            CALL XERROR (87HRFBS - THE TRIANGULAR FACTOR -U- OR -A- IS SINGULA
130        1R.  A UNIQUE SOLUTION DOES NOT EXIST.,87,8,1)
          9 RETURN
            END
```

```
     SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
    4  RFBS          1          131

VARIABLES      SN  TYPE           RELOCATION
    0  ALU          REAL      ARRAY    F.P.      REFS        90       107       113       116       118
                                              DEFINED         1
  223  I            INTEGER                        REFS       111   DEFINED       110
    0  IN           INTEGER   ARRAY    F.P.      REFS        90        95       101   DEFINED         1
  220  K            INTEGER                        REFS       102       103     3*107       112       115
                                              DEFINED       101       106       111
    0  KER          INTEGER            F.P.   DEFINED         1        96       120       124       128
  224  KP1          INTEGER                        REFS     4*113       114       116   DEFINED       112
  217  L            INTEGER                        REFS       101       103       104       105       107     3*116
                                              DEFINED       100       115
  222  LP1          INTEGER                        REFS       106   DEFINED       105
    0  N            INTEGER            F.P.      REFS      3*90        92   DEFINED         1
    0  ND           INTEGER            F.P.      REFS        90      2*93        94   DEFINED         1
  206  NDMAX        INTEGER                        REFS        93   DEFINED        91
  216  NM1          INTEGER                        REFS        98       100       110   DEFINED        97
  215  NN           INTEGER                        REFS      2*94        95        97       106       111
                                              DEFINED        92
    0  X            REAL      ARRAY    F.P.      REFS        90       102       103       107       113       114       116
                                                   118   DEFINED         1       103       104       107       113       116
                                                   118
  221  Z            REAL                           REFS       104       107       116   DEFINED       102       114

EXTERNALS          TYPE   ARGS       REFERENCES
     XERROR                 4          121       125       129

STATEMENT LABELS              DEF LINE   REFERENCES
    0  1                        107        106
    0  2                        108        100
```

```
STATEMENT LABELS                   DEF LINE   REFERENCES
     0  3                             116        115
     0  4                             117        110
   137  5                             118         98
   143  6                             120         93
   151  7                             124         94
   157  8                             128         95
   164  9                             131        119          123          127

LOOPS  LABEL     INDEX        FROM-TO     LENGTH       PROPERTIES
   46  2        * L           100 108       34B                    NOT INNER
   67  1          K           106 107       10B           OPT
  104  4        * I           110 117       32B                    NOT INNER
  123  3          L           115 116       10B           OPT

STATISTICS
  PROGRAM LENGTH                      306B      198
```



```
      SUBROUTINE RLUD(ND,N,ALU,IN,SCALE,KER)
C
C     SANDIA MATHEMATICAL PROGRAM LIBRARY
C     APPLIED MATHEMATICS DIVISION 2646
C     SANDIA LABORATORIES
C     ALBUQUERQUE, NEW MEXICO  87185
C     CONTROL DATA 6600/7600  VERSION 8.1  AUGUST 1980
C                       ***************************
C                       *        ISSUED BY        *
C                       *  SANDIA LABORATORIES,   *
C                       *   A PRIME CONTRACTOR    *
C                       ********      TO THE      *
C                               *  UNITED STATES  *
C                               *   DEPARTMENT    *
C                               *       OF        *
C                               *     ENERGY      *
C      **********************  ---NOTICE---  *********************
C      *THIS REPORT WAS PREPARED AS AN ACCOUNT OF WORK SPONSORED*
C      *  BY THE UNITED STATES GOVERNMENT.  NEITHER THE UNITED  *
C      *   STATES NOR THE UNITED STATES DEPARTMENT OF ENERGY,   *
C      *               NOR ANY OF THEIR EMPLOYEES,              *
C      * NOR ANY OF THEIR CONTRACTORS, SUBCONTRACTORS, OR THEIR *
C      * EMPLOYEES, MAKES ANY WARRANTY, EXPRESS OR IMPLIED, OR  *
C      * ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE  *
C      *           **********    ACCURACY,    **********        *
C      *           *        *  COMPLETENESS  *        *        *
C      *           *        *  OR USEFULNESS *        *        *
C      *           *        *     OF ANY     *        *        *
C      *           *        *  INFORMATION,  *        *        *
C      *           *        *   APPARATUS,   *        *        *
C      *        ****        *    PRODUCT     *        ****     *
C      *        *           *   OR PROCESS   *           *     *
C      *        *           *   DISCLOSED,   *           *     *
C      *        *           *  OR REPRESENTS *           *     *
C      *        *          **    THAT ITS    **          *     *
C      *        *          **  USE WOULD NOT **          *     *
C      *********           **    INFRINGE    **          *********
C                          **    PRIVATELY   **
C                          **      OWNED     **
C                          **     RIGHTS.    **
C                          **                **
C                          **                **
C                          **                **
C                          ********************
C
C     WRITTEN BY CARL B. BAILEY, MAY 1972.
C
C     ABSTRACT
C         RLUD DECOMPOSES (FACTORS) A MATRIX -PA- INTO THE PRODUCT -LU-,
C         WHERE -A- IS A GIVEN MATRIX, -P- IS A PERMUTATION MATRIX, -L-
C         IS A UNIT LOWER TRIANGULAR AND -U- AN UPPER TRIANGULAR MATRIX.
C         THE METHOD USED IS THE FIRST STEP IN GAUSSIAN ELIMINATION WITH
C         PARTIAL (ROW) PIVOTING AND IMPLICIT ROW SCALING.  DURING THE
C         SELECTION OF THE PIVOT ELEMENTS, EACH ROW IS SCALED BY
C         WEIGHTING IT IN INVERSE PROPORTION TO THE MAXIMUM NORM OF THE
C         ROW.  ROW PIVOTING IS EQUIVALENT TO MULTIPLICATION BY A
C         PERMUTATION MATRIX.  THE PERMUTATION MATRIX -P- IS DEFINED
```

```
C         IMPLICITLY BY THE ORDER OF ROW INTERCHANGES.
C
C         LU DECOMPOSITION IS THE FIRST STEP IN SOLVING A SYSTEM OF
C         LINEAR ALGEBRAIC EQUATIONS.  ONCE A COEFFICIENT MATRIX -A- IS
C         FACTORED USING RLUD, ANY NUMBER OF SYSTEMS OF EQUATIONS ALL
C         HAVING THE SAME COEFFICIENT MATRIX CAN BE SOLVED EFFICIENTLY
C         BY FORWARD-BACKWARD SUBSTITUTION USING RFBS.
C         RLUD IS CALLED BY SAXB, SAXBI, CAXB, AND CAXBI.
C
C     REFERENCE
C       1.  G.E.FORSYTHE AND C.B.MOLER, COMPUTER SOLUTION OF LINEAR
C           ALGEBRAIC EQUATIONS, PRENTICE-HALL, 1967
C
C     DESCRIPTION OF ARGUMENTS
C       --INPUT---
C         ND     - THE ACTUAL FIRST DIMENSION OF THE ARRAY -ALU-.
C         N      - NUMBER OF ROWS IN MATRIX -A- (1 .LE. N .LE. ND)
C         ALU    - AN ARRAY DIMENSIONED WITH EXACTLY -ND- ROWS AND
C                  AT LEAST -N- COLUMNS.  THE -N- BY -N- LEADING
C                  SUBARRAY MUST CONTAIN THE COEFFICIENT MATRIX -A-.
C
C       --OUTPUT--
C         ALU    - THE LEADING -N- BY -N- SUBARRAY WILL CONTAIN L-I+U
C                  WHERE -L- AND -U- ARE TRIANGULAR FACTORS OF -PA-.
C                  -L- IS UNIT LOWER TRIANGULAR, -I- IS THE IDENTITY.
C                  (ACTUALLY, IT IS NOT L-I+U WHICH IS STORED IN -A- BUT
C                  LL-I+U WHERE LL IS A REARRANGEMENT OF ELEMENTS OF L.
C                  -L- CAN BE CONSTRUCTED FROM -LL- AND -IN-.)
C                  THIS DATA IS REQUIRED INPUT FOR RFBS AND RIMP.
C         IN     - AN ARRAY DIMENSIONED AT LEAST -N-.  THE FIRST N-1
C                  VALUES WILL BE THE INDICES OF THE FIRST N-1 PIVOT
C                  ROWS.  THE N-TH VALUE WILL BE 1, -1, OR 0.  THE
C                  DETERMINANT OF -A- IS IN(N) * THE DETERMINANT OF -U-.
C                  THIS DATA IS REQUIRED INPUT FOR RFBS AND RIMP.
C         KER    - AN ERROR CODE
C                --NORMAL CODES
C                  0 MEANS NO ERRORS WERE DETECTED
C                --ABNORMAL CODES
C                  1 MEANS -ND- HAS NOT IN THE RANGE 1 .LT. ND .LE. 325
C                  2 MEANS -N- HAS NOT IN THE RANGE 1 .LE. N .LE. ND.
C
C       --WORK--
C         SCALE  - AN ARRAY DIMENSIONED AT LEAST -N-.  IT WILL CONTAIN
C                  1.0 / THE MAXIMUM NORM OF EACH ROW OF -A-.
      DIMENSION ALU(ND,N),IN(N),SCALE(N)
      DATA NDMAX/325/
      NN = N
      IF (ND .LT. 1 .OR. ND .GT. NDMAX) GO TO 10
      IF (NN .LT. 1 .OR. NN .GT. ND) GO TO 11
C     COMPUTE SCALE(I) = 1.0/ INFINITY NORM OF ROW(I) OF A
      DO 2 I = 1,NN
      ROWNRM = 0.0
      DO 1 J = 1,NN
    1 ROWNRM = AMAX1(ROWNRM,ABS(ALU(I,J)))
      IF(ROWNRM .EQ. 0.0) ROWNRM = 1.0
    2 SCALE(I) = 1.0/ROWNRM
C     LU DECOMPOSITION BY GAUSSIAN ELIMINATION.  L HAS UNIT DIAGONAL.
```

```
      C     EXPLICIT ROW INTERCHANGE  WITH IMPLICIT EQUILIBRATION IS USED.
            IS = 1
            DO 9 I = 1,NN
            IND = I
            IF(I .EQ. NN) GO TO 8
            BIG = 0.0
            DO 3 K = I,NN
            T = SCALE(K)*ABS(ALU(K,I))
            IF(T .LE. BIG) GO TO 3
            IND = K
            BIG = T
          3 CONTINUE
            IF(BIG .EQ. 0.0) GO TO 8
            IF(IND .EQ. I) GO TO 5
            DO 4 J = I,NN
            T = ALU(IND,J)
            ALU(IND,J) = ALU(I,J)
          4 ALU(I,J) = T
            SCALE(IND) = SCALE(I)
            IS = -IS
          5 IP1 = I+1
            PIVOT = ALU(I,I)
            DO 7 K = IP1,NN
            EL = -ALU(K,I)/PIVOT
            ALU(K,I) = -EL
            IF(EL .EQ. 0.0) GO TO 7
            DO 6 J = IP1,NN
          6 ALU(K,J) = ALU(K,J) + EL*ALU(I,J)
          7 CONTINUE
          8 IF(ALU(I,I) .EQ. 0.0) IS = 0
          9 IN(I) = IND
            IN(NN) = IS
            KER = 0
            GO TO 12
         10 KER = 1
            CALL XERROR (80HRLUD - ARGUMENT ND IS INVALID.  IT IS REQUIRED THA
           1T ND .GE. 1 .AND. ND .LE. 325.,80,2,1)
            GO TO 12
         11 KER = .
            CALL XERROR (76HRLUD - ARGUMENT N IS INVALID.  IT IS REQUIRED THAT
           1 N .GE. 1 .AND. N .LE. ND.,76,2,1)
         12 RETURN
            END
```

```
     SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
   4  RLUD            1         156

VARIABLES       SN  TYPE            RELOCATION
   0  ALU           REAL      ARRAY     F.P.      REFS       102       111       122       130       131       136       138
                                                  2*142      144   DEFINED         1       131       132       139       142
 305  BIG           REAL                          REFS       123       127   DEFINED       120       125
```



```
VARIABLES       SN  TYPE            RELOCATION
 312  EL            REAL                          REFS       139       140       142   DEFINED       138
 300  I             INTEGER                       REFS       111       113       118       119       121       122       128
                                                   129       131       132       133       135     2*136       138       139
                                                   142     2*144       145   DEFINED       108       117
   0  IN            INTEGER   ARRAY     F.P.      REFS       102   DEFINED         1       145       146
 304  IND           INTEGER                       REFS       128       130       131       133       145
                                               DEFINED       118       124
 310  IP1           INTEGER                       REFS       137       141   DEFINED       135
 303  IS            INTEGER                       REFS       134       146   DEFINED       116       134       144
 302  J             INTEGER                       REFS       111       130     2*131       132     3*142
                                               DEFINED       110       129       141
 306  K             INTEGER                       REFS     2*122       124       138       139     2*142
                                               DEFINED       121       137
   0  KER           INTEGER             F.P.   DEFINED         1       147       149       153
   0  N             INTEGER             F.P.      REFS     3*102       104   DEFINED         1
   0  ND            INTEGER             F.P.      REFS       102     2*105       106   DEFINED         1
 271  NDMAX         INTEGER                       REFS       105   DEFINED       103
 277  NN            INTEGER                       REFS     2*106       108       110       117       119       121       129
                                                   137       141       146   DEFINED       104
 311  PIVOT         REAL                          REFS       138   DEFINED       136
 301  ROWNRM        REAL                          REFS       111       112       113   DEFINED       109       111       112
   0  SCALE         REAL      ARRAY     F.P.      REFS       102       122       133   DEFINED         1       113       133
 307  T             REAL                          REFS       123       125       132   DEFINED       122       130

EXTERNALS          TYPE    ARGS         REFERENCES
      XERROR                4               150       154

INLINE FUNCTIONS   TYPE    ARGS           DEF LINE  REFERENCES
      ABS          REAL     1  INTRIN                  111       122
      AMAX1        REAL     0  INTRIN                  111

STATEMENT LABELS                   DEF LINE   REFERENCES
   0  1                              111       110
   0  2                              113       108
 114  3                              126       121       123
   0  4                              132       129
 155  5                              135       128
   0  6                              142       141
 214  7                              143       137       140
 220  8                              144       119       127
   0  9                              145       117
 240  10                             149       105
 246  11                             153       106
 253  12                             156       148       152

LOOPS  LABEL     INDEX      FROM-TO    LENGTH    PROPERTIES
  34   2        * I         108 113      25B             NOT INNER
  40   1          J         110 111      11B        OPT
  65   9        * I         117 145     144B             NOT INNER
  76   3          K         121 126      21B        OPT
 126   4          J         129 132      21B        OPT
 165   7        * K         137 143      32B             NOT INNER
 202   6          J         141 142      11B        OPT

STATISTICS
  PROGRAM LENGTH                  370B      248
```

```
      SUBROUTINE SAXB(ND,N,M,A,B,INIT,IN,KER)
C
C     SANDIA MATHEMATICAL PROGRAM LIBRARY
C     APPLIED MATHEMATICS DIVISION 2646
C     SANDIA LABORATORIES
C     ALBUQUERQUE, NEW MEXICO  87185
C     CONTROL DATA 6600/7600  VERSION 8.1  AUGUST 1980
C                   **************************
C                   *       ISSUED BY        *
C                   *  SANDIA LABORATORIES,  *
C                   *   A PRIME CONTRACTOR   *
C                   *********    TO THE      *
C                           * UNITED STATES  *
C                           *  DEPARTMENT    *
C                           *      OF        *
C                           *    ENERGY      *
C      ********************** ---NOTICE---  **********************
C      *THIS REPORT WAS PREPARED AS AN ACCOUNT OF WORK SPONSORED*
C      *  BY THE UNITED STATES GOVERNMENT.  NEITHER THE UNITED   *
C      *   STATES NOR THE UNITED STATES DEPARTMENT OF ENERGY,   *
C      *               NOR ANY OF THEIR EMPLOYEES,              *
C      * NOR ANY OF THEIR CONTRACTORS, SUBCONTRACTORS, OR THEIR  *
C      * EMPLOYEES, MAKES ANY WARRANTY, EXPRESS OR IMPLIED, OR   *
C      * ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE   *
C      *           **********   ACCURACY,    **********          *
C      *           *        * COMPLETENESS   *        *          *
C      *           *        * OR USEFULNESS  *        *          *
C      *           *        *    OF ANY      *        *          *
C      *           *        * INFORMATION,   *        *          *
C      *           *        *  APPARATUS,    *        *          *
C      *       ****         *    PRODUCT     *        ****       *
C      *       *            *  OR PROCESS    *           *       *
C      *       *            *  DISCLOSED,    *           *       *
C      *       *            * OR REPRESENTS  *           *       *
C      *       *           **   THAT ITS     **          *       *
C      *       *           ** USE WOULD NOT  **          *       *
C      *********           **   INFRINGE     **          *********
C                          **   PRIVATELY    **
C                          **     OWNED      **
C                          **    RIGHTS.     **
C                          **                **
C                          **                **
C                          **                **
C                          ********************
C
C     WRITTEN BY CARL B. BAILEY, NOVEMBER 1973.
C
C     ABSTRACT
C         SAXB SOLVES A NONSINGULAR SYSTEM OF REAL LINEAR ALGEBRAIC
C         EQUATIONS, AX=B.
C         THE METHOD USED IS GAUSSIAN ELIMINATION (LU DECOMPOSITION
C         FOLLOWED BY FORWARD-BACKWARD SUBSTITUTION) WITH IMPLICIT ROW
C         SCALING AND PARTIAL (ROW) PIVOTING.  SAXB IS ESPECIALLY
C         EFFICIENT FOR SOLVING A SEQUENCE OF SYSTEMS OF EQUATIONS ALL
C         HAVING THE SAME COEFFICIENT MATRIX -A-.  IN SUCH A CASE, THE
C         LU DECOMPOSITION IS PERFORMED ONLY ON THE FIRST CALL AND THE
C         LU FACTORS ARE STORED IN -A-.  ON SUBSEQUENT CALLS, FORWARD-
```



```
C         BACKWARD SUBSTITUTION IS PERFORMED IMMEDIATELY ON -B- USING
C         THE PREVIOUSLY COMPUTED LU FACTORS.
C
C         SAXB CALLS THE ROUTINE RLUD TO PERFORM LU DECOMPOSITION AND
C         RFBS TO PERFORM FORWARD-BACKWARD SUBSTITUTION.
C         FOR GREATER ACCURACY AND AN ERROR ESTIMATE USE SAXBI.
C
C     REFERENCE
C       1.  G.E.FORSYTHE AND C.B.MOLER, COMPUTER SOLUTION OF LINEAR
C           ALGEBRAIC EQUATIONS, PRENTICE-HALL, 1967
C
C     DESCRIPTION OF ARGUMENTS
C         THE USER MUST DIMENSION ALL ARRAYS APPEARING IN THE CALL LIST
C              A(ND,N), B(ND,M), IN(N)
C         IF M=1 THEN THE DIMENSION OF B MAY BE B(N)
C
C       --INPUT---
C         ND      - THE ACTUAL FIRST DIMENSION OF ARRAYS -A- AND -B-.
C                   (I.E. THE MAXIMUM NUMBER OF EQUATIONS THAT CAN BE
C                   SOLVED USING -A- TO STORE THE COEFFICIENTS.)
C         N       - THE NUMBER OF EQUATIONS TO BE SOLVED IN THIS CALL.
C                   (1 .LE. N .LE. ND)
C         M       - NUMBER OF COLUMNS OF -B-.  (NORMALLY M=1)
C         A       - THE LEADING -N- BY -N- SUBARRAY OF -A- MUST CONTAIN
C                   THE COEFFICIENT MATRIX ON THE INITIAL CALL FOR EACH
C                   SEQUENCE OF RELATED SYSTEMS OF EQUATIONS.  (INIT=0)
C                   ON ANY SUBSEQUENT CALL FOR A SYSTEM WITH THE SAME
C                   COEFFICIENT MATRIX BUT DIFFERENT VALUES OF -B-, -A-
C                   MUST CONTAIN THE LU FACTORS THAT WERE RETURNED IN -A-
C                   ON THE FIRST CALL.  (INIT"0)
C         B       - THE LEADING -N- BY -M- SUBARRAY OF -B- MUST CONTAIN
C                   THE MATRIX (OR VECTOR) OF CONSTANTS.
C         INIT    - IS A FLAG WHICH PROVIDES FOR THE ESPECIALLY EFFICIENT
C                   SOLUTION OF A SEQUENCE OF SYSTEMS OF EQUATIONS HAVING
C                   THE SAME -A- BUT DIFFERENT -B- VECTORS.
C                   ON THE INITIAL CALL FOR A SEQUENCE OF RELATED SYSTEMS
C                   OF EQUATIONS, INIT MUST BE ZERO AND THE ARRAY -A-
C                   MUST CONTAIN THE COEFFICIENT MATRIX -A-.
C                   IN ORDER TO SOLVE ANY RELATED SYSTEM EFFICIENTLY
C                   ON ANY SUBSEQUENT CALL FOR A SYSTEM WITH THE SAME
C                   COEFFICIENT MATRIX BUT DIFFERENT VALUES FOR -B-,
C                   INIT MUST BE NONZERO AND -A- MUST CONTAIN THE LU
C                   FACTORS THAT WERE RETURNED IN -A- ON THE FIRST CALL.
C         IN      - PROVIDES STORAGE FOR THE ROW INTERCHANGE INDICES.
C                   ON THE INITIAL CALL FOR A SEQUENCE OF RELATED SYSTEMS
C                   OF EQUATIONS, -IN- IS JUST A WORK ARRAY.  ON ANY
C                   SUBSEQUENT CALL FOR A RELATED SYSTEM OF EQUATIONS,
C                   -IN- MUST CONTAIN THE INDICES THAT WERE RETURNED IN
C                   -IN- ON THE FIRST CALL.
C
C       --OUTPUT--
C         A       - THE LEADING -N- BY -N- SUBARRAY WILL CONTAIN L-I+U
C                   WHERE -L- AND -U- ARE TRIANGULAR FACTORS OF -A-,
C                   -L- IS UNIT LOWER TRIANGULAR, -I- IS THE IDENTITY.
C                   (ACTUALLY, IT IS NOT L-I+U WHICH IS STORED IN -A- BUT
C                   LL-I+U WHERE LL IS A REARRANGEMENT OF ELEMENTS OF L.)
C         B       - THE LEADING -N- BY -M- SUBARRAY OF -B- WILL CONTAIN
```

```
 115       C                THE SOLUTION -X-.
           C         IN     - WILL CONTAIN THE ROW INTERCHANGE INDICES COMPUTED
           C                DURING LU DECOMPOSITION.  IN(N) WILL CONTAIN
           C                 +1 IF AN EVEN NUMBER OF INTERCHANGES WERE PERFORMED,
           C                 -1 IF AN ODD NUMBER OF INTERCHANGES WERE PERFORMED,
 120       C                  0 IF THE MATRIX -A- AND THE FACTOR U ARE SINGULAR.
           C         KER    - AN ERROR CODE
           C                --NORMAL CODES
           C                  0 MEANS NO ERRORS WERE DETECTED
           C                --ABNORMAL CODES
 125       C                  1 MEANS -ND- WAS NOT IN THE RANGE 1 .LT. ND .LE. 325
           C                  2 MEANS -N- WAS NOT IN THE RANGE 1 .LE. N .LE. ND.
           C                  3 MEANS THE TRIANGULAR FACTOR -U- OF -A- IS SINGULAR.
           C
           C     NOTE --- AFTER SOLVING A SYSTEM OF EQUATIONS USING SAXB
 130       C              ONE CAN EASILY COMPUTE THE DETERMINANT OF -A-,
           C              AT LEAST IN PRINCIPAL.  FOR EXAMPLE,
           C                   DET = IN(N)
           C                   DO 1 I =1,N
           C                 1 DET = DET*A(I,I)
 135       C              HOWEVER, THAT COMPUTATION MAY OFTEN RESULT IN EXPONENTIAL
           C              OVERFLOW OR UNDERFLOW, ESPECIALLY IF THE COEFFICIENTS
           C              IN -A- WERE VERY LARGE OR VERY SMALL.
                 DIMENSION A(ND,N), B(ND,M), IN(N)
                 DATA NDMAX/325/
 140             IF(ND .LT. 1 .OR. ND .GT. NDMAX) GO TO 3
                 IF(N .LT. 1 .OR. N .GT. ND) GO TO 4
                 IF(INIT .EQ. 0) CALL RLUD(ND,N,A,IN,IN,KER)
                 IF(IN(N) .EQ. 0) GO TO 5
                 IF(M .LE. 0) GO TO 2
 145             DO 1 J = 1,M
               1 CALL RFBS(ND,N,A,IN,B(1,J),KER)
               2 KER = 0
                 GO TO 6
               3 KER = 1
 150             CALL XERROR (80HSAXB - ARGUMENT ND IS INVALID.  IT IS REQUIRED THA
                1T ND .GE. 1 .AND. ND .LE. 325.,80,2,1)
                 GO TO 6
               4 KER = 2
                 CALL XERROR (76HSAXB - ARGUMENT N IS INVALID.  IT IS REQUIRED THAT
 155            1 N .GE. 1 .AND. N .LE. ND.,76,2,1)
                 GO TO 6
               5 KER = 3
                 CALL XERROR (89HSAXB - LU DECOMPOSITION OF -A- YIELDED A SINGULAR
                1-U-.  A UNIQUE SOLUTION DOES NOT EXIST.,89,8,1)
 160           6 RETURN
                 END
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
    4  SAXB          1          160
```



```
VARIABLES      SN  TYPE           RELOCATION
    0  A           REAL      ARRAY    F.P.        REFS      138      142      146    DEFINED      1
    0  B           REAL      ARRAY    F.P.        REFS      138      146   DEFINED      1
    0  IN          INTEGER   ARRAY    F.P.        REFS      138    2*142      143      146    DEFINED      1
    0  INIT        INTEGER            F.P.        REFS      142   DEFINED      1
  163  J           INTEGER                        REFS      146   DEFINED      145
    0  KER         INTEGER            F.P.        REFS      142      146   DEFINED      1        147      149      153
                                                  157
    0  M           INTEGER            F.P.        REFS      138      144      145    DEFINED      1
    0  N           INTEGER            F.P.        REFS    2*138    2*141      142      143      146
                                               DEFINED      1
    0  ND          INTEGER            F.P.        REFS    2*138    2*140      141      142      146
                                               DEFINED      1
  154  NDMAX       INTEGER                        REFS      140   DEFINED      139

EXTERNALS          TYPE   ARGS      REFERENCES
       RFBS               6           146
       RLUD               6           142
       XERROR             4           150      154      158

STATEMENT LABELS              DEF LINE   REFERENCES
    0  1                        146        145
   70  2                        147        144
   73  3                        149        140
  101  4                        153        141
  107  5                        157        143
  114  6                        160        148      152      156

LOOPS  LABEL     INDEX       FROM-TO    LENGTH    PROPERTIES
   52  1        * J          145 146      158B             EXT REFS

STATISTICS
  PROGRAM LENGTH                  240B      160
```

```
      C
      C   IMSL ROUTINES FOLLOW
      C   IMSL ROUTINES ARE PROPRIETARY IN NATURE. BY CONTRACT THEY
      C   MAY BE DISSEMINATED BY SANDIA AS PART OF CODE, BUT SHALL NOT
      C   (MAY NOT) BE FURTHER DISSEMINATED.
      C
      C   IMSL ROUTINE NAME   - UERTST
      C
      C-----------------------------------------------------------------------
      C
      C   COMPUTER            - CDC/SINGLE
      C
      C   LATEST REVISION     - JANUARY 1, 1978
      C
      C   PURPOSE             - PRINT A MESSAGE REFLECTING AN ERROR CONDITION
      C
      C   USAGE               - CALL UERTST (IER,NAME)
      C
      C   ARGUMENTS    IER    - ERROR PARAMETER. (INPUT)
      C                           IER = I+J WHERE
      C                             I = 128 IMPLIES TERMINAL ERROR,
      C                             I =  64 IMPLIES WARNING WITH FIX, AND
      C                             I =  32 IMPLIES WARNING.
      C                             J = ERROR CODE RELEVANT TO CALLING
      C                                 ROUTINE.
      C                NAME   - A SIX CHARACTER LITERAL STRING GIVING THE
      C                           NAME OF THE CALLING ROUTINE. (INPUT)
      C
      C   PRECISION/HARDWARE  - SINGLE/ALL
      C
      C   REQD. IMSL ROUTINES - UGETIO
      C
      C   NOTATION            - INFORMATION ON SPECIAL NOTATION AND
      C                           CONVENTIONS IS AVAILABLE IN THE MANUAL
      C                           INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
      C
      C   REMARKS      THE ERROR MESSAGE PRODUCED BY UERTST IS WRITTEN
      C                ONTO THE STANDARD OUTPUT UNIT. THE OUTPUT UNIT
      C                NUMBER CAN BE DETERMINED BY CALLING UGETIO AS
      C                FOLLOWS..   CALL UGETIO(1,NIN,NOUT).
      C                THE OUTPUT UNIT NUMBER CAN BE CHANGED BY CALLING
      C                UGETIO AS FOLLOWS..
      C                                NIN = 0
      C                                NOUT = NEW OUTPUT UNIT NUMBER
      C                                CALL UGETIO(3,NIN,NOUT)
      C                SEE THE UGETIO DOCUMENT FOR MORE DETAILS.
      C
      C   COPYRIGHT           - 1978 BY IMSL, INC. ALL RIGHTS RESERVED.
      C
      C   WARRANTY            - IMSL WARRANTS ONLY THAT IMSL TESTING HAS BEEN
      C                           APPLIED TO THIS CODE. NO OTHER WARRANTY,
      C                           EXPRESSED OR IMPLIED, IS APPLICABLE.
      C
      C-----------------------------------------------------------------------
      C
            SUBROUTINE UERTST (IER,NAME)
      C                                  SPECIFICATIONS FOR ARGUMENTS
```



```
            INTEGER            IER,NAME
      C                                  SPECIFICATIONS FOR LOCAL VARIABLES
            INTEGER            NAMSET,NAMEQ
            DATA               NAMSET/6HUERSET/
            DATA               NAMEQ/6H      /
      C--     FOR IMSL INFORMATION AND HELP SEE   THOMAS JEFFERSON, D8332,SLL
      C  THIS CARD IS IN COMDECK IMSLUSE
      C                                  FIRST EXECUTABLE STATEMENT
            DATA               LEVEL/4/,IEQDF/0/,IEQ/1H=/
            IF (IER.GT.999) GO TO 25
            IF (IER.LT.-32) GO TO 55
            IF (IER.LE.128) GO TO 5
            IF (LEVEL.LT.1) GO TO 30
      C                                  PRINT TERMINAL MESSAGE
            CALL UGETIO(1,NIN,IOUNIT)
            IF (IEQDF.EQ.1) WRITE(IOUNIT,35) IER,NAMEQ,IEQ,NAME
            IF (IEQDF.EQ.0) WRITE(IOUNIT,35) IER,NAME
            GO TO 30
          5 IF (IER.LE.64) GO TO 10
            IF (LEVEL.LT.2) GO TO 30
      C                                  PRINT WARNING WITH FIX MESSAGE
            CALL UGETIO(1,NIN,IOUNIT)
            IF (IEQDF.EQ.1) WRITE(IOUNIT,40) IER,NAMEQ,IEQ,NAME
            IF (IEQDF.EQ.0) WRITE(IOUNIT,40) IER,NAME
            GO TO 30
         10 IF (IER.LE.32) GO TO 15
      C                                  PRINT WARNING MESSAGE
            IF (LEVEL.LT.3) GO TO 30
            CALL UGETIO(1,NIN,IOUNIT)
            IF (IEQDF.EQ.1) WRITE(IOUNIT,45) IER,NAMEQ,IEQ,NAME
            IF (IEQDF.EQ.0) WRITE(IOUNIT,45) IER,NAME
            GO TO 30
         15 CONTINUE
      C                                  CHECK FOR UERSET CALL
            IF (NAME.NE.NAMSET) GO TO 25
            LEVOLD = LEVEL
            LEVEL = IER
            IER = LEVOLD
            IF (LEVEL.LT.0) LEVEL = 4
            IF (LEVEL.GT.4) LEVEL = 4
            GO TO 30
         25 CONTINUE
            IF (LEVEL.LT.4) GO TO 30
      C                                  PRINT NON-DEFINED MESSAGE
            CALL UGETIO(1,NIN,IOUNIT)
            IF (IEQDF.EQ.1) WRITE(IOUNIT,50) IER,NAMEQ,IEQ,NAME
            IF (IEQDF.EQ.0) WRITE(IOUNIT,50) IER,NAME
         30 IEQDF = 0
            RETURN
         35 FORMAT(19H *** TERMINAL ERROR,10X,7H(IER = ,I3,
           1       20H) FROM IMSL ROUTINE ,A6,A1,A6)
         40 FORMAT(36H *** WARNING WITH FIX ERROR  (IER = ,I3,
           1       20H) FROM IMSL ROUTINE ,A6,A1,A6)
         45 FORMAT(18H *** WARNING ERROR,11X,7H(IER = ,I3,
           1       20H) FROM IMSL ROUTINE ,A6,A1,A6)
         50 FORMAT(20H *** UNDEFINED ERROR,9X,7H(IER = ,I5,
           1       20H) FROM IMSL ROUTINE ,A6,A1,A6)
```

```
      SUBROUTINE UERTST     74/74   OPT=0 TRACE                  FTN 4.6+439        07/22/81  14.56.32       PAGE      3

115         C                                                SAVE P FOR P = R CASE
            C                                                  P IS THE PAGE NAME
            C                                                  R IS THE ROUTINE NAME
                  55 IEQDF = 1
                     NAMEQ = NAME
120               65 RETURN
                     END
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS        DEF LINE       REFERENCES
    4  UERTST           56           106           120

VARIABLES        SN  TYPE              RELOCATION
   152  IEQ          INTEGER                            REFS        73        80         87        103    DEFINED         66
   151  IEQDF        INTEGER                            REFS        73        74         60         81         87         88        103
                                                         104   DEFINED        66        105        118
     0  IER          INTEGER                   F.P.     REFS        58        67         68         69         73         74         76
                                                          80        81        83         87         88         94        103        104
                                                     DEFINED        56        95
   276  IOUNIT       INTEGER                            REFS        72        79         86        102   I/O REFS         73         74
                                                          80        81        87         88        103        104
   150  LEVEL        INTEGER                            REFS        70        77         85         93         96         97        100
                                                     DEFINED        66        94         96         97
   277  LEVOLD       INTEGER                            REFS        95   DEFINED         93
     0  NAME         INTEGER                   F.P.     REFS        58        73         74         80         81         87         88
                                                          92       103       104        119    DEFINED         56
   147  NAMEQ        INTEGER                            REFS        60        73         80         87        103
                                                     DEFINED        62       119
   146  NAMSET       INTEGER                            REFS        60        92    DEFINED         61
   275  NIN          INTEGER                            REFS        72        79         86        102
        VARIABLES USED AS FILE NAMES, SEE ABOVE

EXTERNALS            TYPE    ARGS         REFERENCES
        UGETIO                 3              72         79         86        102

STATEMENT LABELS                  DEF LINE    REFERENCES
    35  5                            76          69
    55  10                           83          76
    75  15                           90          83
   116  25                           99          67         92
   133  30                          105          70         75         77         82         85         89         98        100
   233  35          FMT             107          73         74
   243  40          FMT             109          80         81
   254  45          FMT             111          87         88
   264  50          FMT             113         103        104
   136  55                          118          68
     0  65             INACTIVE     120

STATISTICS
  PROGRAM LENGTH                   300B        192
```

```
                           74/74   OPT=0 TRACE                  FTN 4.6+439        07/22/81  14.56.32       PAGE      1

            C   IMSL ROUTINE NAME   - UGETIO
            C
            C-----------------------------------------------------------------------
            C
            C   COMPUTER            - CDC/SINGLE
            C
            C   LATEST REVISION     - JANUARY 1, 1978
            C
            C   PURPOSE             - TO RETRIEVE CURRENT VALUES AND TO SET NEW
            C                           VALUES FOR INPUT AND OUTPUT UNIT
            C                           IDENTIFIERS.
            C
            C   USAGE               - CALL UGETIO(IOPT,NIN,NOUT)
            C
            C   ARGUMENTS    IOPT   - OPTION PARAMETER. (INPUT)
            C                           IF IOPT=1, THE CURRENT INPUT AND OUTPUT
            C                           UNIT IDENTIFIER VALUES ARE RETURNED IN NIN
            C                           AND NOUT, RESPECTIVELY.
            C                           IF IOPT=2 (3) THE INTERNAL VALUE OF
            C                           NIN (NOUT) IS RESET FOR SUBSEQUENT USE.
            C                NIN    - INPUT UNIT IDENTIFIER.
            C                           OUTPUT IF IOPT=1, INPUT IF IOPT=2.
            C                NOUT   - OUTPUT UNIT IDENTIFIER.
            C                           OUTPUT IF IOPT=1, INPUT IF IOPT=3.
            C
            C   PRECISION/HARDWARE  - SINGLE/ALL
            C
            C   REQD. IMSL ROUTINES - NONE REQUIRED
            C
            C   NOTATION            - INFORMATION ON SPECIAL NOTATION AND
            C                           CONVENTIONS IS AVAILABLE IN THE MANUAL
            C                           INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
            C
            C   REMARKS      EACH IMSL ROUTINE THAT PERFORMS INPUT AND/OR OUTPUT
            C                OPERATIONS CALLS UGETIO TO OBTAIN THE CURRENT UNIT
            C                IDENTIFIER VALUES. IF UGETIO IS CALLED WITH IOPT=2 OR 3
            C                NEW UNIT IDENTIFIER VALUES ARE ESTABLISHED. SUBSEQUENT
            C                INPUT/OUTPUT IS PERFORMED ON THE NEW UNITS.
            C
            C   COPYRIGHT           - 1978 BY IMSL, INC. ALL RIGHTS RESERVED.
            C
            C   WARRANTY            - IMSL WARRANTS ONLY THAT IMSL TESTING HAS BEEN
            C                           APPLIED TO THIS CODE. NO OTHER WARRANTY,
            C                           EXPRESSED OR IMPLIED, IS APPLICABLE.
            C
            C-----------------------------------------------------------------------
            C
                  SUBROUTINE UGETIO(IOPT,NIN,NOUT)
            C                                  SPECIFICATIONS FOR ARGUMENTS
                  INTEGER            IOPT,NIN,NOUT
            C                                  SPECIFICATIONS FOR LOCAL VARIABLES
                  INTEGER            NIND,NOUTD
                  DATA               NIND/5LINPUT/,NOUTD/6LOUTPUT/
            C--     FOR IMSL INFORMATION AND HELP SEE   THOMAS JEFFERSON, D8332,SLL
            C  THIS CARD IS IN COMDECK IMSLUSE
            C                                  FIRST EXECUTABLE STATEMENT
                  IF (IOPT.EQ.3) GO TO 10
```

```
      IF (IOPT.EQ.2) GO TO 5
      IF (IOPT.NE.1) GO TO 9005
      NIN = NIND
      NOUT = NOUTD
      GO TO 9005
    5 NIND = NIN
      GO TO 9005
   10 NOUTD = NOUT
 9005 RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS        DEF LINE       REFERENCES
    4  UGETIO          48             66

VARIABLES       SN  TYPE              RELOCATION
    0  IOPT         INTEGER              F.P.          REFS         50        57          58         59   DEFINED        48
    0  NIN          INTEGER              F.P.          REFS         50        63    DEFINED          48        60
   35  NIND         INTEGER                            REFS         52        60    DEFINED          53        63
    0  NOUT         INTEGER              F.P.          REFS         50        65    DEFINED          48        61
   36  NOUTD        INTEGER                            REFS         52        61    DEFINED          53        65

STATEMENT LABELS                  DEF LINE    REFERENCES
   25  5                             63          58
   31  10                            65          57
   34  9005                          66          59          62          64

STATISTICS
  PROGRAM LENGTH                    37B         31
```



```
C   IMSL ROUTINE NAME   - ZSYSTM
C
C-----------------------------------------------------------------------
C
C   COMPUTER            - CDC/SINGLE
C
C   LATEST REVISION     - JANUARY 1, 1978
C
C   PURPOSE             - DETERMINATION OF A ROOT OF A SYSTEM OF N
C                           SIMULTANEOUS NONLINEAR EQUATIONS IN N
C                           UNKNOWNS, F(X)=0, IN VECTOR FORM.
C
C   USAGE               - CALL ZSYSTM (F,EPS,NSIG,N,X,ITMAX,WA,PAR,IER)
C
C   ARGUMENTS    F      - F IS THE NAME OF THE FUNCTION CALLED BY
C                           ZSYSTM TO FURNISH THE VALUES OF THE
C                           EQUATIONS BEING SOLVED. THE USER SPECIFIES
C                           F BY WRITING A FUNCTION SUBPROGRAM
C                           F(X,K,PAR) WHICH COMPUTES THE K-TH
C                           COMPONENT OF F EVALUATED AT X. F MUST
C                           APPEAR IN AN EXTERNAL STATEMENT IN THE
C                           CALLING PROGRAM. F MUST BE TYPED
C                           APPROPRIATELY. SEE PRECISION/HARDWARE.
C                EPS    - FIRST STOPPING CRITERION. A ROOT X(1),...,
C                           X(N) IS ACCEPTED IF THE MAXIMUM ABSOLUTE
C                           VALUE OF F(X,K,PAR) IS LESS THAN OR EQUAL
C                           TO EPS, WHERE K=1,...,N. (INPUT)
C                NSIG   - SECOND STOPPING CRITERION. A ROOT IS ACCEPTED
C                           IF TWO SUCCESSIVE APPROXIMATIONS TO A GIVEN
C                           ROOT AGREE IN THE FIRST NSIG DIGITS. (INPUT)
C                             NOTE. IF EITHER, OR BOTH, OF THE STOPPING
C                                   CRITERIA ARE SATISFIED, THE ROOT IS
C                                   ACCEPTED.
C                N      - THE NUMBER OF EQUATIONS (= NUMBER OF UNKNOWNS)
C                           N CAN BE 1. (INPUT)
C                X      - THE VECTOR X OF LENGTH N. AS INPUT, IS THE
C                           INITIAL GUESS FOR THE ROOT. AS OUTPUT, IT
C                           IS THE COMPUTED SOLUTION.
C                ITMAX  - ON INPUT = THE MAXIMUM ALLOWABLE NUMBER OF
C                           ITERATIONS AND ON OUTPUT = THE NUMBER OF
C                           ITERATIONS USED IN FINDING THE COMPUTED
C                           SOLUTION.
C                WA     - AN ARRAY WORK AREA OF SIZE ((N+2)*(N-1))/2 +
C                           3*N SUPPLIED BY THE USER.
C                PAR    - PAR CONTAINS A PARAMETER SET (POSSIBLY A
C                           FUNCTION NAME) WHICH IS PASSED TO THE USER
C                           SUPPLIED FUNCTION F. PAR MAY BE USED TO
C                           PASS ANY AUXILIARY PARAMETERS NECESSARY FOR
C                           COMPUTATION OF THE FUNCTION F. PAR IS A TYPE
C                           REAL VECTOR IN ZSYSTM. (INPUT)
C                IER    - ERROR PARAMATER. (OUTPUT)
C                         TERMINAL ERROR
C                           IER = 129 INDICATES THE ALGORITHM FAILED TO
C                             CONVERGE WITHIN ITMAX ITERATIONS.
C                           IER = 130 INDICATES SINGULARITY (OF THE
C                             JACOBIAN MATRIX) HAS BEEN ENCOUNTERED
C                             TWICE.
```

```
      C
      C   PRECISION/HARDWARE  - SINGLE AND DOUBLE/H32
      C                       - SINGLE/H36,H48,H60
      C
      C   REQD. IMSL ROUTINES - UERTST,UGETIO
      C
      C   NOTATION            - INFORMATION ON SPECIAL NOTATION AND
      C                           CONVENTIONS IS AVAILABLE IN THE MANUAL
      C                           INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
      C
      C   COPYRIGHT           - 1978 BY IMSL, INC. ALL RIGHTS RESERVED.
      C
      C   WARRANTY            - IMSL WARRANTS ONLY THAT IMSL TESTING HAS BEEN
      C                           APPLIED TO THIS CODE. NO OTHER WARRANTY,
      C                           EXPRESSED OR IMPLIED, IS APPLICABLE.
      C
      C-----------------------------------------------------------------------
      C
            SUBROUTINE ZSYSTM (F,EPS,NSIG,N,X,ITMAX,WA,PAR,IER)
      C
            DIMENSION          X(1),WA(1),PAR(1)
            DATA               PREC,DELTA/5.E-12,5.E-9/
            DATA               ZERO,PM1,PT1,P2/0.0,.1,.0001,.002/
      C--     FOR IMSL INFORMATION AND HELP SEE   THOMAS JEFFERSON, D8332,SLL
      C  THIS CARD IS IN COMDECK IMSLUSE
      C                                  FIRST EXECUTABLE STATEMENT
            IER=0
      C                                  PREC IS A FUNCTION OF THE MACHINE
      C                                  SIGNIFICANCE, SIG, AND SHOULD BE
      C                                  COMPUTED AS PREC=5.*10.**(-SIG+2).
      C                                  IN THIS INSTANCE WE WERE DEALING
      C                                  WITH A 14 DIGIT MACHINE.
      C                                  DELTA SHOULD BE TAKEN AS
      C                                  5.*10.**(-(SIG+4)/2), FOR SIG EVEN,
      C                                  AND 16.*10.**(-(SIG+5)/2, FOR SIG ODD
            N2 = N+N
            RELCON=10.0**(-NSIG)
            JTEST = 1
            IERROR=0
            IPART=((N+2)*(N-1))/2
            ITMP=IPART+N
            LKSUB=ITMP+N
            DO 130 M = 1, ITMAX
               IQUIT=0
               FMAX=ZERO
               M1 = M-1
               K1 = LKSUB + 1
               KMIN = LKSUB + N
               XTEMP = ZERO
      C                                  THE ARRAY WA(LKSUB+1),....,WA(LKSUB+N)
      C                                  PERMITS A PARTIAL PIVOTING EFFECT
      C                                  WITHOUT HAVING TO PHYSICALLY
      C                                  INTERCHANGE ROWS OR COLUMNS.
               DO 5 J = K1,KMIN
                  XTEMP = XTEMP+1.0
                  WA(J) = XTEMP
          5    CONTINUE
```



```
               K = 1
         10    IF(K .LE. 1) GO TO 30
               KMIN = K-1
      C                                  THE FOLLOWING CODE BACK-SOLVES THE
      C                                  FIRST KMIN ROWS OF A TRIANGULARIZED
      C                                  LINEAR SYSTEM FOR IMPROVED X VALUES
      C                                  IN TERMS OF PREVIOUS ONES.
               KK = 1
         15    DO 25 K1=1,KMIN
                  ISUB=K-K1
                  MM=((ISUB-1)*(N2 -ISUB))/2
                  LIM=N-ISUB
                  KPOINT = WA(LKSUB+ISUB)+PM1
      C                                  THE ADDITION OF .1 (PM1) IN THE LAST
      C                                  STATEMENT (AND OTHERS LIKE IT
      C                                  BELOW) IS ESSENTIAL, SINCE WA
      C                                  CONTAINS INTEGERS AS WELL AS FLOATING
      C                                  POINT NUMBERS.  FOR EXAMPLE, SUPPOSE
      C                                  THE INTEGER 3 WAS STORED AS
      C                                  2.99999999999998
                  ISUB1 = ISUB-1
                  X(KPOINT)=ZERO
                  DO 20 L1=1,LIM
                     JS1=ISUB1+L1
                     LKJSUB=LKSUB + JS1 +1
                     IJ=MM+JS1
                     JPOINT= WA(LKJSUB) + PM1
                     X(KPOINT)=X(KPOINT) + WA(IJ)*X(JPOINT)
         20       CONTINUE
                  X(KPOINT)=X(KPOINT) + WA(MM+N)
         25    CONTINUE
               GO TO (30,45,105), KK
      C
      C                                  SET UP PARTIAL DERIVATIVES OF
      C                                  KTH FUNCTION..
      C
         30    E=F(X,K,PAR)
               FMAX =AMAX1(FMAX,ABS(E))
               IF( ABS(E) .GE. EPS) GO TO 35
               IQUIT=IQUIT+1
               IF(IQUIT .EQ. N) GO TO 140
         35    I = K
         40    IP=IPART+I
               ITEMP = WA(LKSUB+I) + PM1
               HOLD = X(ITEMP)
               ETA=.001*ABS(HOLD)
               IF (ABS(HOLD) .LT.PREC)  ETA=DELTA
               H =AMIN1(FMAX,ETA)
               IF(H .LT. PREC) H=PREC
               X (ITEMP)=HOLD+H
               IF (K .LE. 1) GO TO 45
               KK = 2
               GO TO 15
         45    FPLUS=F(X,K,PAR)
               TOP=FPLUS-E
         50    WA(IP)=TOP/H
         55    X(ITEMP)=HOLD
```

```
      I = I + 1
      IF (I .LE. N) GO TO 40
      IF (K .LT. N) GO TO 60
      IP=IPART+N
      IF (ABS( WA(IP)) .EQ. ZERO)  GO TO 80
      X(ITEMP) = -E/ WA(IP) + X(ITEMP)
      GO TO 100
C
C                                 FIND PARTIAL DERIVATIVE OF LARGEST
C                                 ABSOLUTE VALUE..
C
   60 KL=LKSUB+K
      LOOK= WA(KL) + PM1
      KMAX=LOOK
      IP=IPART+K
      DERMAX= ABS( WA(IP))
      KPLUS = K+1
      DO 65 I = KPLUS,N
         TEST= ABS( WA(IPART+I))
         IF(TEST .LE. DERMAX) GO TO 65
         DERMAX = TEST
         KMAX=I
   65 CONTINUE
      IF(LOOK .EQ. KMAX) GO TO 75
      LKMAX=LKSUB+KMAX
      WA(KL)=WA(LKMAX)
      WA(LKMAX)=LOOK
      IP=IPART+KMAX
      XTEMP= WA(IP)
      IPK=IPART+K
      WA(IP)=WA(IPK)
      WA(IPK)=XTEMP
      IF(K .LT. 2) GO TO 75
      KMIN=K-1
      I1 = 0
      DO 70 I=1,KMIN
         L=((I1 )*(N2 -I1))/2-1
         J=L+KMAX
         XTEMP= WA(J)
         JJ=L+K
         WA(J)=WA(JJ)
         WA(JJ)=XTEMP
         I1 = I
   70 CONTINUE
   75 IF ( ABS(WA(IPART+K)).NE. ZERO) GO TO 90
   80 IF(IERROR .EQ. 1) GO TO 135
      DO 85  I=1,N
C                                 IF THE MODIFIED JACOBIAN IS SINGULAR
C                                 AT X, CHANGE THE COMPONENTS OF X AND
C                                 PROCEED WITH THE ITERATIONS.  IF IT
C                                 HAPPENS A SECOND TIME, TERMINATE.
         X(I) = 0.9*X(I) + .12345
   85 CONTINUE
      IERROR=1
      GO TO 105
C
C                                 SET UP COEFFICIENTS FOR KTH ROW
```

```
      C                                 OF TRIANGULAR LINEAR SYSTEM USED
      C                                 TO BACK-SOLVE FOR THE FIRST K X(I)
      C                                 VALUES...
      C
   90    L=((K-1)*(N2 -K))/2
         KN=L+N
         I1 = L-1
         WA(KN)=ZERO
         IPK=IPART+K
         DO 95  J = KPLUS,N
            JSUB= WA(LKSUB+J) + PM1
            JJ=I1+J
            IPJ=IPART+J
            WA(JJ)=-WA(IPJ)/WA(IPK)
            WA(KN)=WA(KN)+WA(IPJ)*X(JSUB)
   95    CONTINUE
         LK= WA(LKSUB+K) + PM1
         WA(KN)=(WA(KN)-E)/WA(IPK) + X(LK)
         K = K+1
         IF (K .LE. N) GO TO 10
      C                                 BACK SUBSTITUTE TO OBTAIN NEXT
      C                                 APPROXIMATION TO X
  100    IF( N .EQ. 1) GO TO 105
         KMIN=N-1
         KK = 3
         GO TO 15
  105    IF (M .LE. 1) GO TO 120
      C
      C                                 TEST FOR CONVERGENCE..
      C
         DO 110 I = 1,N
            IF (ABS(WA(ITMP+I)-X(I)) .GT. ABS(X(I))*RELCON) GO TO 115
  110    CONTINUE
         JTEST = JTEST+1
         IF (JTEST-3)120,140,140
  115    JTEST = 1
  120    DO 125 I = 1,N
            WA(ITMP+I)=X(I)
  125    CONTINUE
  130 CONTINUE
      M=ITMAX
      IER = 129
      GO TO 240
  135 IER = 130
  140 FMAX=ZERO
      TEST=1.0E+15
      IF (N .GT. 1) GO TO 145
      WA(IPART+2) = F(X,1,PAR)
      FMAX =AMAX1(FMAX,ABS(WA(IPART+2)))
      GO TO 155
  145 DO 150 I = 1,N
         IP=IPART+I
         WA(IP)=F(X,I,PAR)
         FMAX=AMAX1(FMAX, ABS(WA(IP)))
  150 CONTINUE
      C                                 CHECK TO SEE IF SMALL COMPONENTS ARE
      C                                 ACTUALLY ZERO
```



```
  155 K=1
      DO 160 I=1,N
         WA(I)=X(I)
         IF (ABS(X(I)) .GT. P2) GO TO 160
         K=2
         WA(I)=ZERO
  160 CONTINUE
      IF(K .EQ. 1) GO TO 195
      KK = 1
      GO TO 205
  165 IF(FMAX .LT. TEST) GO TO 190
      C                                 NOTE THAT SMALL COMPONENTS ARE SET
      C                                 TO ZERO ONLY IF THE NORM OF THE
      C                                 FUNCTION VECTOR IS REDUCED AS A
      C                                 RESULT OF THIS PROCESS.
      DO 170 I=1,N
         X(I)= WA(I)
  170 CONTINUE
      IF (N .GT. 1) GO TO 175
      WA(IPART+2) = WA(ITMP+2)
      GO TO 185
  175 DO 180 I = 1,N
         WA(IPART+I) = WA(ITMP+I)
  180 CONTINUE
  185 FMAX=TEST
      C                                 CHECK FOR INTEGER COMPONENTS
  190 K=1
  195 ITEST=0
      DO 200 I=1,N
         WA(I)=X(I)
         IF (ABS(X(I)) .LE. P2) GO TO 200
         L=X(I)+PT1
         J=X(I)-PT1
         IF(L .EQ. J) GO TO 200
         WA(I) =ISIGN(1,J)*MAX0(IABS(L),IABS(J))
         K=2
  200 CONTINUE
      IF(K .EQ. 1) GO TO 235
      KK = 2
  205 TEST=ZERO
      IF (N .GT. 1) GO TO 210
      WA(ITMP+2) = F(WA,1,PAR)
      TEST =AMAX1(TEST,ABS(WA(ITMP+2)))
      GO TO 220
  210 DO 215 I=1,N
         IT=ITMP+I
         WA(IT)=F(WA,I,PAR)
         TEST=AMAX1(TEST, ABS(WA(IT)))
  215 CONTINUE
  220 GO TO (165,225), KK
  225 IF(FMAX .LT. TEST) GO TO 235
      C                                 NOTE THAT NEAR-INTEGER COMPONENTS
      C                                 ARE SET TO BE INTEGERS ONLY IF THE
      C                                 NORM OF THE FUNCTION VECTOR IS
      C                                 REDUCED AS A RESULT OF THIS PROCESS.
      DO 230 I=1,N
         X(I)= WA(I)
```

```
                 230 CONTINUE
                     ITEST=1
   345             C                                        TEST FOR CONVERGENCE
                 235 IF(FMAX .LT. EPS .OR. TEST .LT. EPS)  IER = 0
                 240 ITMRX=M1 + 1
                9000 CONTINUE
                     IF (IER .NE. 0) CALL UERTST(IER,6HZSYSTM)
   350          9005 RETURN
                     END
```

```
CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

   146      I                 AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
   335      I                 AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
```

SYMBOLIC REFERENCE MAP (R=2)

```
ENTRY POINTS       DEF LINE       REFERENCES
   4  ZSYSTM            76         350

VARIABLES      SN  TYPE              RELOCATION
  1267  DELTA      REAL                                REFS      161    DEFINED      79
  1352  DERMAX     REAL                                REFS      191    DEFINED     187       192
  1336  E          REAL                                REFS      152        153     169       177       246
                                                    DEFINED      151
     0  EPS        REAL                    F.P.        REFS      153      2*346  DEFINED       76
  1343  ETA        REAL                                REFS      162    DEFINED     160       161
  1314  FMAX       REAL                                REFS      152        162     277       282       296       336       346
                                                    DEFINED      102        152     273       277       282       310
  1345  FPLUS      REAL                                REFS      169    DEFINED     168
  1344  H          REAL                                REFS      163        164     170   DEFINED       162       163
  1342  HOLD       REAL                                REFS      160        161     164       171   DEFINED       159
  1337  I          INTEGER                             REFS      157        158     172       173       190       193       208
                                                        214    2*223      3*260   2*266       280       281     2*288       289
                                                        291    2*302      2*308   2*315       316       317       318       320
                                                        331      332      2*342  DEFINED      156       172       189       207
                                                        218      259        265     279       287       301       307       314
                                                        330      341
     0  IER        INTEGER                 F.P.        REFS    2*349    DEFINED      76        84       270       272       346
  1306  IERROR     INTEGER                             REFS      217    DEFINED      96       225
  1334  IJ         INTEGER                             REFS      142    DEFINED     140
  1340  IP         INTEGER                             REFS      170        176     177       187       200       202       281
                                                        282  DEFINED        157     175       186       199       280
  1307  IPART      INTEGER                             REFS       98        157     175       186       190       199       201
                                                        216      237        241     276       277       280       305       308
                                                    DEFINED       97
  1364  IPJ        INTEGER                             REFS      242        243  DEFINED       241
  1356  IPK        INTEGER                             REFS      202        203     242       246   DEFINED       201       237
  1313  IQUIT      INTEGER                             REFS      154        155  DEFINED       101       154
  1324  ISUB       INTEGER                             REFS    2*125        126     127       135   DEFINED       124
```



```
VARIABLES      SN  TYPE              RELOCATION
  1330  ISUB1      INTEGER                             REFS      138    DEFINED     135
  1367  IT         INTEGER                             REFS      332        337  DEFINED       331
  1341  ITEMP      INTEGER                             REFS      159        164     171     2*177   DEFINED       158
  1366  ITEST      INTEGER                          DEFINED      313        344
     0  ITMAX      INTEGER                 F.P.        REFS      100        269  DEFINED       76       347
  1310  ITMP       INTEGER                             REFS       99        260     266       305       308       327       328
                                                        331  DEFINED         98
  1357  I1         INTEGER                             REFS      208        240  DEFINED       206       214       235
  1321  J          INTEGER                             REFS      113        210     212       239       240       241       319
                                                      2*320  DEFINED        111     209       238       318
  1361  JJ         INTEGER                             REFS      212        213     242   DEFINED       211       240
  1335  JPOINT     INTEGER                             REFS      142    DEFINED     141
  1363  JSUB       INTEGER                             REFS      243    DEFINED     239
  1332  JS1        INTEGER                             REFS      139        140  DEFINED       138
  1305  JTEST      INTEGER                             REFS      262        263  DEFINED        95       262       264
  1322  K          INTEGER                             REFS      116        117     124       151       156       165       168
                                                        174      183        186     188       201       204       205       211
                                                        216    2*233        237     245       247       248       293       323
                                                    DEFINED      115        247     286       290       312       321
  1323  KK         INTEGER                             REFS      146        335  DEFINED       122       166       253       294
                                                        324
  1347  KL         INTEGER                             REFS      184        197  DEFINED       183
  1351  KMAX       INTEGER                             REFS      195        196     199       209   DEFINED       185       193
  1317  KMIN       INTEGER                             REFS      111        123     207   DEFINED       105       117       205
                                                        252
  1362  KN         INTEGER                             REFS      236      2*243   2*246   DEFINED       234
  1353  KPLUS      INTEGER                             REFS      189        238  DEFINED       188
  1327  KPOINT     INTEGER                             REFS      136      2*142   2*144   DEFINED       127
  1316  K1         INTEGER                             REFS      111        124  DEFINED       104       123
  1360  L          INTEGER                             REFS      209        211     234       235       319       320
                                                    DEFINED      208        233     317
  1326  LIM        INTEGER                             REFS      137    DEFINED     126
  1365  LK         INTEGER                             REFS      246    DEFINED     245
  1333  LKJSUB     INTEGER                             REFS      141    DEFINED     139
  1355  LKMAX      INTEGER                             REFS      197        198  DEFINED       196
  1311  LKSUB      INTEGER                             REFS      104        105     127       139       158       183       196
                                                        239      245    DEFINED      99
  1350  LOOK       INTEGER                             REFS      185        195     198   DEFINED       184
  1331  L1         INTEGER                             REFS      138    DEFINED     137
  1312  M          INTEGER                             REFS      103        255  DEFINED       100       269
  1325  MM         INTEGER                             REFS      140        144  DEFINED       125
  1315  M1         INTEGER                             REFS      347    DEFINED     103
     0  N          INTEGER                 F.P.        REFS     2*93       2*97      98        99       105       126       144
                                                        155      173        174     175       189       218       234       238
                                                        248      251        252     259       265       275       279       287
                                                        301      304        307     314       326       330       341
                                                    DEFINED       76
     0  NSIG       INTEGER                 F.P.        REFS       94    DEFINED      76
  1303  N2         INTEGER                             REFS      125        208     233   DEFINED        93
     0  PAR        REAL        ARRAY       F.P.        REFS       78        151     168       276       281       327       332
                                                    DEFINED       76
  1271  PM1        REAL                                REFS      127        141     158       184       239       245
                                                    DEFINED       80
  1266  PREC       REAL                                REFS      161      2*163  DEFINED       79
  1272  PT1        REAL                                REFS      317        318  DEFINED       80
  1273  P2         REAL                                REFS      289        316  DEFINED       80
  1304  RELCON     REAL                                REFS      260    DEFINED      94
```

```
VARIABLES      SN  TYPE             RELOCATION
 1354  TEST        REAL                              REFS       191        192        296        310        328        333        336
                                                     346   DEFINED        190        274        325        328        333
 1346  TOP         REAL                              REFS       170    DEFINED        169
    0  WA          REAL         ARRAY      F.P.      REFS        78        127        141        142        144        158        176
                                                     177        184        187        190        197        200        202        210
                                                     212        216        239      2*242      2*243        245      2*246        260
                                                     277        282        302        305        308        327        328        332
                                                     333        342    DEFINED         76        113        170        197        198
                                                     202        203        212        213        236        242        243        246
                                                     266        276        281        288        291        305        308        315
                                                     320        327        332
    0  X           REAL         ARRAY      F.P.      REFS        78      2*142        144        151        159        168        177
                                                     223        243        246      2*260        266        276        281        288
                                                     289        315        316        317        318    DEFINED         76        136
                                                     142        144        164        171        177        223        302        342
 1320  XTEMP       REAL                              REFS       112        113        203        213    DEFINED        106        112
                                                     200        210
 1270  ZERO        REAL                              REFS       102        106        136        176        216        236        273
                                                     291        325    DEFINED         80

EXTERNALS              TYPE    ARGS         REFERENCES
       F               REAL      3   F.P.      151        168        276        281        327        332
       UERTST                    2             349

INLINE FUNCTIONS       TYPE    ARGS          DEF LINE  REFERENCES
       ABS             REAL      1   INTRIN              152        153        160        161        176        187        190        216
                                                       2*260        277        282        289        316        328        333
       AMAX1           REAL      0   INTRIN              152        277        282        328        333
       AMIN1           REAL      0   INTRIN              162
       IABS            INTEGER   1   INTRIN            2*320
       ISIGN           INTEGER   2   INTRIN              320
       MAX0            INTEGER   0   INTRIN              320

STATEMENT LABELS                   DEF LINE     REFERENCES
    0   5                            114          111
  104   10                           116          248
  114   15                           123          167         254
    0   20                           143          137
    0   25                           145          123
  212   30                           151          116         146
  235   35                           156          153
  240   40                           157          173
  303   45                           168          146         165
    0   50           INACTIVE        170
    0   55           INACTIVE        171
  347   60                           183          174
  406   65                           194          189         191
    0   70                           215          207
  507   75                           216          195         204
  515   80                           217          176
    0   85                           224          218
  534   90                           233          216
    0   95                           244          238
  626   100                          251          178
  637   105                          255          146         226         251
    0   110                          261          259
  663   115                          264          260
```



```
STATEMENT LABELS                   DEF LINE     REFERENCES
  665   120                          265          255         263
    0   125                          267          265
    0   130                          268          100
  705   135                          272          217
  710   140                          273          155       2*263
  735   145                          279          275
    0   150                          283          279
  757   155                          286          278
  777   160                          292          287         289
 1011   165                          296          335
    0   170                          303          301
 1034   175                          307          304
    0   180                          309          307
 1045   185                          310          306
 1050   190                          312          296
 1052   195                          313          293
 1112   200                          322          314         316         319
 1123   205                          325          295
 1146   210                          330          326
    0   215                          334          330
 1170   220                          335          329
 1200   225                          336          335
    0   230                          343          341
 1215   235                          346          323         336
 1223   240                          347          271
    0   9000         INACTIVE        348
    0   9005         INACTIVE        350

LOOPS  LABEL     INDEX      FROM-TO     LENGTH    PROPERTIES
   47  130     * M          100 268      630B                EXT REFS    EXITS   NOT INNER
   70  5         J          111 114       11B        OPT
  115  25      * K1         123 145       64B                NOT INNER
  144  20        L1         137 143       25B        OPT
  372  65        I          189 194       17B        OPT
  456  70        I          207 215       30B        OPT
  521  85        I          218 224        7B     INSTACK
  556  95        J          238 244       27B        OPT
  643  110     * I          259 261       12B        OPT      EXITS
  666  125       I          265 267        6B     INSTACK
  736  150     * I          279 283       20B                EXT REFS
  762  160       I          287 292       20B        OPT
 1015  170       I          301 303        6B     INSTACK
 1035  180       I          307 309        7B     INSTACK
 1055  200       I          314 322       40B        OPT
 1147  215     * I          330 334       20B                EXT REFS
 1204  230       I          341 343        6B     INSTACK

STATISTICS
  PROGRAM LENGTH                  1562B      882
```