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ANALYSIS OF STRUCTURAL SHELLS WITH TRANSVERSE SHEAR DEFORMATION

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FOREWORD

This final technical report was prepared by Anamet Laboratories, Inc., Berkeley, California, under Air Force Contract No. AF 33(615)-70-C-1019. It was administered under the Structures Division, Air Force Flight Dynamics Laboratory, with Messrs. T. N. Bernstein (FBR) and J. L. Rudd (FBR), acting as project engineers.

This report was completed in June 1971 and covers the work performed from June 1969 to February 1971. The supervision of the project, the development of the mathematical analyses, and the programming of the modified Kalnins Static Program were carried out by Richard L. Citerley.

This technical report has been reviewed and is approved.

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ABSTRACT

This report describes the results of an investigation for the numerical analysis procedures of shells of revolution and consultation on the execution of shell problems at the Air Force Flight Dynamics Laboratory Facilities. A computer program for the analysis of the thick shells of revolution, the analysis of thin shells subjected to torsion and the theory upon which it is based is presented. This computer program is tailored to an existing program previously written by Dr. Kalnins under Air Force Contract No. 33 (615)-3870. Detailed input instructions and three example problems are included to illustrate the added capabilities of the computer program. In addition, numerical procedures and subroutines that effect an improvement in numerical integration procedures and efficient eigenvalue search techniques are discussed.

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ILLUSTRATIONS

TABLES

SYMBOLS

u v w β	Displacement and Rotation Components
N N_n Q	Membrane Stress Resultants
n	Fourier Harmonic Index
M_ϕ, M_θ, $M_{\phi\theta}$	Moment Resultants
m	Surface Moments
P	Surface Pressure
T	Temperature
Z	Coordinate of Layers
R	Radius of Curvature
K, C	Membrane Stiffness
D	Bending Stiffness
B, a, G, H, E, F	Material Elastic Properties
h	Thickness of Shell
θ, s, r, ϕ	Coordinates for a Shell of Revolution
$\vec{t}_\phi$, $\vec{t}_\theta$, $\vec{n}$	Coordinate Vectors
ω	Circular Frequency
σ	Stress
ε	Strain
ν	Poisson's Ratio
Δ	FORTRAN Blank
λ	Eigenvalue
Ω	Characteristic Frequency
c	Velocity of Sound

SECTION I
INTRODUCTION

The following report covers the consulting effort Anamet has performed for the Air Force Flight Dynamics Laboratory (AFFDL/FBR) over the period from June 1969 to February 1971. The primary purpose of the consultation is to provide a computer program for the analysis of shells of revolution to include the effects of transverse shear deformation. The second purpose is to investigate numerical procedures that may effect an improvement in computer efficiency and cost effectiveness for numerical integration procedures and for eigenvalue search techniques. The third purpose is to provide consultation on the execution of shell problems at the AFFDL computer facilities.

The presentation of a thick shell program is made on the basis of developing the governing system of first order linear differential equations using an existing shell theory. The development is tailored to an existing equation solver. The analysis of multi-layered orthotropic shells of revolution subjected to nonaxisymmetric surface loads is provided by the computer program written by Dr. Kalnins under USAF Contract No. 33(615)-3870[1].

The numerical analysis of the governing system of equations based upon classical shell theory was partially developed during past association with and during the course of research by the personnel of Anamet and Dr. Kalnins[2]. The basis of the basic computational method has been well documented in both private[3][4][5] and archive sources[6][7]. Other authors have also independently developed the basic numerical analysis technique to other classes of shells and structures. This has been adequately brought out during early discussions[8] as well as excellent presentations by Kraus[9] and by Anderson et al[10].

The formulation for the governing equations for the deformation of layered orthotropic shells of revolution including the effects of transverse shear deformation and normal stress has been presented by Hildebrand, Reissner and Thomas[11]. The presentation of an early version of a computer program based upon Reissner's equations was supplied to FBR at the onset of this consulting effort. FBR found it desirable to be capable of analyzing thick or thin shells of revolution subjected to nonsymmetric surface loads with the same basic shell code. On the assumption that transverse shear deformation can account for the static behavior of moderately thick shells, the same program could be used as previously developed. In this way, minimum changes in the input parameters could be attained. The user would not have to drastically revamp his input data format. Thus, his utilization of the basic shell code could continue.

SECTION II
THIN SHELL COMPUTER PROGRAM

The development of the fundamental equations for shell analysis has been presented in Chapter III, Reference 1. In addition the procedure for generating the terms from a particular shell theory to a set of linear first order differential equations has been presented. In order to make this report complete, the derivation of the system of equations is repeated. The equations are again as they appear in Reference 11, pages 48-53.

1. BASIC ASSUMPTIONS AND GEOMETRY

The stress-strain relations for each layer of a layered orthotropic shell of revolution where effects of normal stress have been ignored are given by the following:[12]

$$\begin{bmatrix} \varepsilon_{11} \\ \varepsilon_{22} \\ \varepsilon_{12} \\ \varepsilon_{13} \\ \varepsilon_{23} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ 0 & 0 & a_{44} & 0 & 0 \\ 0 & 0 & 0 & a_{55} & 0 \\ 0 & 0 & 0 & 0 & a_{66} \end{bmatrix} \begin{bmatrix} \sigma_{11} \\ \sigma_{22} \\ \sigma_{12} \\ \sigma_{13} \\ \sigma_{23} \end{bmatrix} \qquad (1)$$

where:

$$a_{11} = \frac{1}{E_1} \; ; \quad a_{12} = -\frac{\nu 12}{E_2} \; ; \quad a_{22} = \frac{1}{E_2}$$

$$a_{44} = \frac{1}{G_{12}} \; ; \quad a_{55} = \frac{1}{G_{13}} \; ; \quad a_{66} = \frac{1}{G_{23}}$$

In describing the shell's properties, and deformations, it is convenient to choose directions depicting the shape of the shell by specifying the two principal radii of curvature; therefore, the indexed directions in Equation (1) would replace 1 by ϕ, 2 by θ and 3 by z. If the material lines of orthotropy do not coincide with the principal directions of the radii of curvature and differ by an angle α, the new coefficients are expressed as:

$$a^*_{11} = a_{11} \cos^4 \alpha + (2a_{12} + a_{66}) \sin^2 \alpha \cos^2 \alpha + a_{22} \sin^4 \alpha$$

$$a^*_{12} = (a_{11} + a_{22} - 2a_{12} - a_{66}) \sin^2 \alpha \cos^2 \alpha + a_{12}$$

$$a^*_{16} = [a_{22} \sin^2 \alpha - a_{11} \cos^2 \alpha + 1/2\, (2a_{12} + a_{66}) \cos 2\alpha] \sin 2\alpha$$

$$a^*_{22} = a_{11} \sin^4 \alpha + (2a_{12} + a_{66}) \sin^2 \alpha \cos^2 \alpha + a_{22} \cos^4 \alpha$$

$$a^*_{26} = [a_{22} \cos^2 \alpha - a_{11} \sin^2 \alpha - 1/2\, (2a_{12} + a_{66}) \cos 2\alpha] \sin 2\alpha$$

$$a^*_{66} = 4(a_{11} + a_{22} - 2a_{12} - a_{66}) \sin^2 \alpha \cos^2 \alpha + a_{66}$$

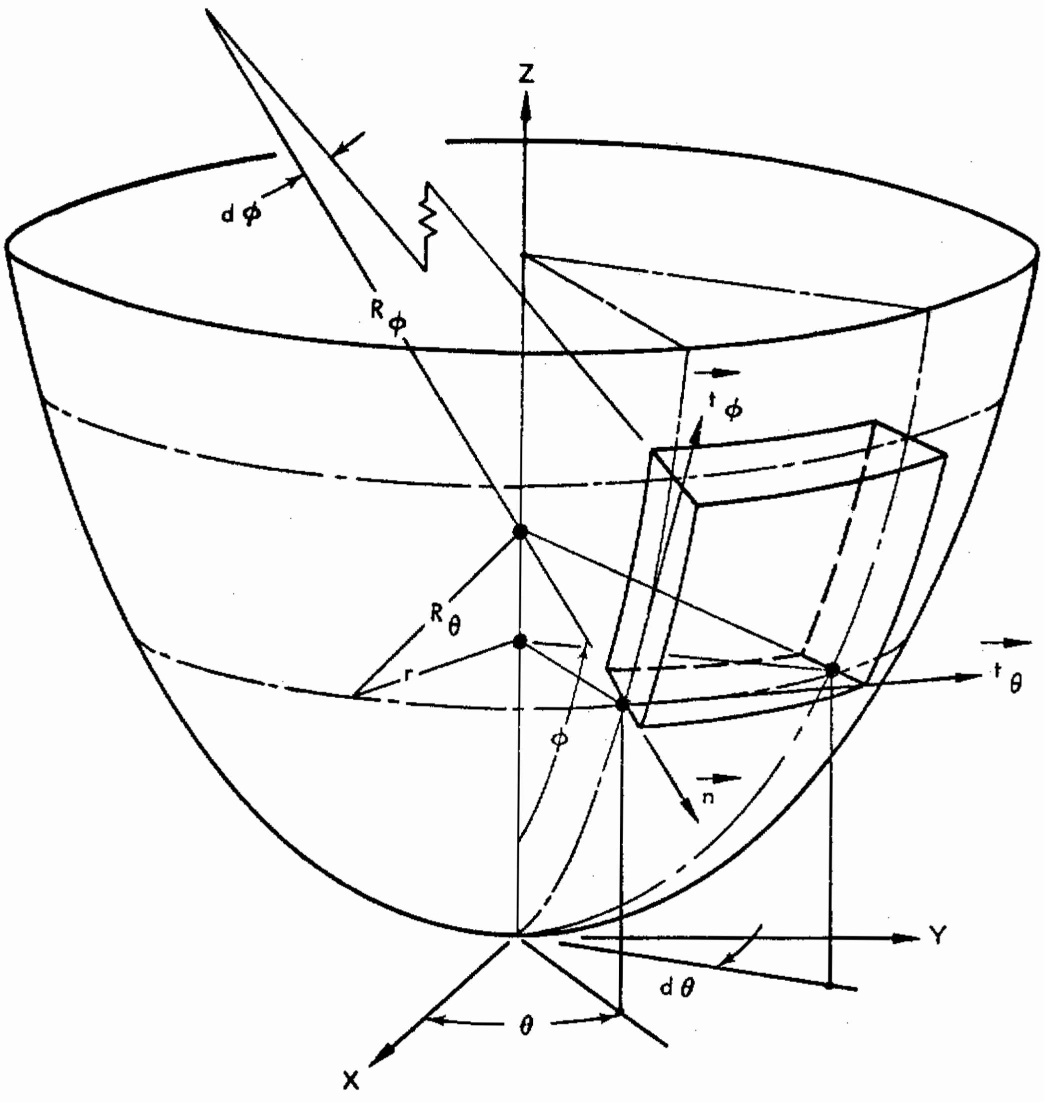

Figure 1. Element of a Shell of Revolution

If the lines of orthotropy do not coincide with the lines of principal curvature for the shell, the shell's deformations and stress distribution will no longer follow the laws governing orthotropic shells of revolution and the procedures developed in this report would not be applicable.

The remaining assumption restricting the behavior of the orthotropic shell is the displacement vector (referenced to triad, Figure 1) given by the relation:

$$\vec{u} = \vec{t}_\phi \, (u_\phi + z\beta_\phi) + \vec{t}_\theta \, (u_\theta + a\beta_\theta) + \vec{n}w \qquad (2)$$

where all deformed parameters are only functions of ϕ and θ. Again, it should be pointed out (Reference 6) that once $\vec{t}_\phi$ and $\vec{t}_\theta$ have been chosen, the direction for the normal vector is dictated by:

$$\vec{n} = \vec{t}_\phi \times \vec{t}_\theta$$

Using the above assumed relation for the displacement vector, the strain-displacement relations are taken to be:

$$(1 + \frac{z}{R_\phi})\ \varepsilon_\phi = \bar{\varepsilon}_\phi + z\kappa_\phi \qquad (3.a)$$

$$(1 + \frac{z}{R_\theta}\ \ \varepsilon_\theta = \bar{\varepsilon}_\theta + z\kappa_\theta \qquad (3.b)$$

$$2(1 + \frac{z}{R_\phi})\ (1 + \frac{z}{R_\theta})\ \varepsilon_{\phi\theta} = (1 + \frac{z}{R_\theta})\ (\gamma_\phi + z\delta_\phi) + (1 + \frac{z}{R_\phi})\ (\gamma_\theta + z\delta_\theta) \qquad (3.c)$$

$$2(1 + \frac{z}{R_\phi})\ \varepsilon_{\phi z} = \gamma_{\phi z} \qquad (3.d)$$

$$2(1 + \frac{z}{R_\theta})\ \varepsilon_{\theta z} = \gamma_{\theta z} \qquad (3.e)$$

where:

$$\bar{\varepsilon}_\phi = \frac{1}{R_\theta}\ (u_{\phi,\phi} + w) \qquad (3.f)$$

$$\bar{\varepsilon}_\theta = \frac{1}{r}\ u_{\theta,\theta} + \frac{\cos\phi}{r}\ u_\phi + \frac{\sin\phi}{r}\ w \qquad (3.g)$$

$$\kappa_\phi = \frac{\beta_{\phi,\phi}}{R_\phi}\ ;\ \delta_\phi = \frac{\beta_{\theta,\phi}}{R_\phi} \qquad (3.h\text{-}3.i)$$

$$\kappa_\theta = \frac{1}{r}\ \beta_{\theta,\theta} + \frac{\cos\phi}{r}\ \beta_\phi\ ; \qquad (3.j)$$

$$\delta_\theta = \frac{1}{r}\ \beta_{\phi,\theta} - \frac{\cos\phi}{r}\ \beta_\theta \qquad (3.k)$$

$$\gamma_\phi = \frac{u_{\theta,\phi}}{R_\phi}\ ;\ \gamma_\theta = \frac{1}{r}\ u_{\phi,\theta} - \frac{\cos\phi}{r}\ u_\theta \qquad (3.l\text{-}3m)$$

$$\gamma_{\phi z} = \frac{1}{R_\phi}\ (w,_\phi - u_\phi) + \beta_\phi \qquad (3.n)$$

$$\gamma_{\theta z} = \frac{1}{r}\ (w,_\theta - \sin\phi\ u_\theta) + \beta_\theta \qquad (3.o)$$

For a multilayered orthotropic shell containing m-layers (Figure 2) with a total thickness h, where z_i denotes the distance from the bottom surface of the shell to the top surface of the i-th layer, and where z_r is the reference distance from the bottom of the shell surface to the reference surface, the stress resultants are defined by:

$$
\begin{aligned}
\begin{bmatrix} N_\phi \\ N_{\theta\phi} \\ N_{\phi\theta} \\ N_\theta \end{bmatrix} &= \sum_{i=1}^{m} \int_{z_i - z_r}^{z_{i+1} - z_r} \begin{bmatrix} \sigma_\phi \left(1 + \frac{z}{R_\theta}\right) \\ \sigma_{\phi\theta} \left(1 + \frac{z}{R_\theta}\right) \\ \sigma_{\phi\theta} \left(1 + \frac{z}{R_\phi}\right) \\ \sigma_\theta \left(1 + \frac{z}{R_\phi}\right) \end{bmatrix} dz \\
\begin{bmatrix} M_\phi \\ M_{\phi\theta} \\ M_{\theta\phi} \\ M_\theta \end{bmatrix} &= \sum_{i=1}^{m} \int_{z_i - z_r}^{z_{i+1} - z_r} \begin{bmatrix} \sigma_\phi \left(1 + \frac{z}{R_\theta}\right) \\ \sigma_{\phi\theta} \left(1 + \frac{z}{R_\theta}\right) \\ \sigma_{\phi\theta} \left(1 + \frac{z}{R_\phi}\right) \\ \sigma_\theta \left(1 + \frac{z}{R_\phi}\right) \end{bmatrix} z\,dz \qquad (4) \\
\begin{bmatrix} Q_\phi \\ Q_\theta \end{bmatrix} &= \sum_{i=1}^{m} \int_{z_i - z_r}^{z_{i+1} - z_r} \begin{bmatrix} \sigma_{\phi z} \left(1 + \frac{z}{R_\theta}\right) \\ \sigma_{\theta z} \left(1 + \frac{z}{R_\phi}\right) \end{bmatrix} dz
\end{aligned}
$$

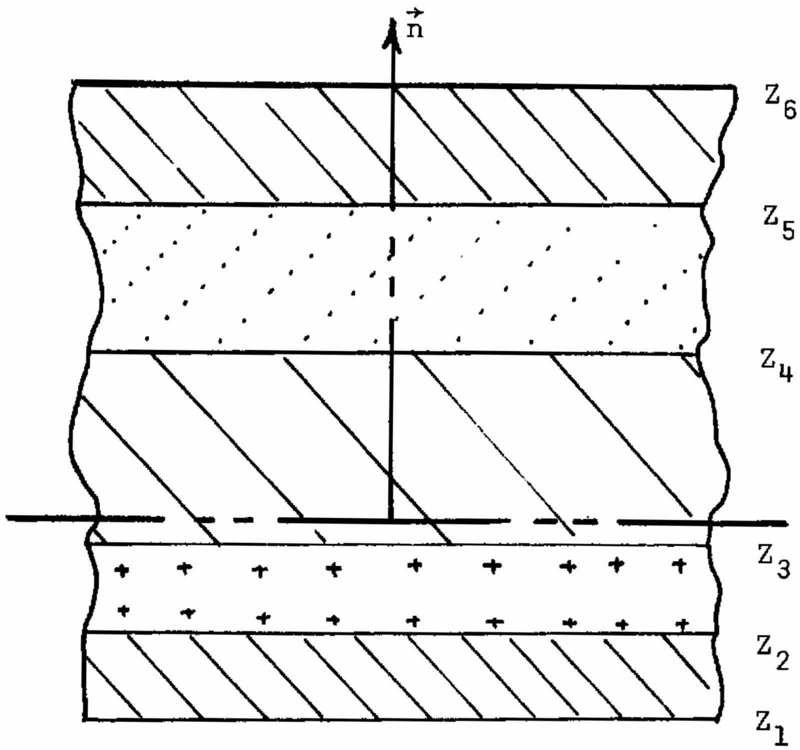

Figure 2. Multilayered Shell Element

Substituting Equations (3) and (4) into the inverse of Equation (1) with the usual assumptions that:

$$\frac{h^2}{R^2} << 1$$

the resulting stress resultant-strain relations are obtained:

$$N_\phi = C_{11}\,\varepsilon_\phi + C_{12}\,\varepsilon_\theta + K_{11}\,\gamma_\phi + K_{12}\,\gamma_\theta \quad (5.a)$$

$$N_{\phi\theta} = E_{11}\,\gamma_\phi + E_{12}\,\gamma_\theta + F_{11}\,\delta_\phi + F_{12}\,\delta_\theta \quad (5.b)$$

$$N_{\theta\phi} = E_{12}\,\gamma_\phi + E_{22}\,\gamma_\theta + F_{12}\,\delta_\phi + F_{22}\,\delta_\theta \quad (5.c)$$

$$N_\theta = C_{12}\,\varepsilon_\phi + C_{22}\,\varepsilon_\theta + K_{12}\,\gamma_\phi + K_{22}\,\gamma_\theta \quad (5.d)$$

$$M_\phi = K_{11}\,\varepsilon_\phi + K_{12}\,\varepsilon_\theta + D_{11}\,\gamma_\phi + D_{12}\,\gamma_\theta \quad (5.e)$$

$$M_{\phi\theta} = F_{11}\,\gamma_\phi + F_{12}\,\gamma_\theta + H_{11}\,\delta_\phi + H_{12}\,\delta_\theta \quad (5.f)$$

$$M_{\theta\phi} = F_{12}\,\gamma_\phi + F_{22}\,\gamma_\theta + H_{12}\,\delta_\phi + H_{22}\,\delta_\theta \quad (5.g)$$

$$M_\theta = K_{12}\,\varepsilon_\phi + K_{22}\,\varepsilon_\theta + D_{12}\,\gamma_\phi + D_{22}\,\gamma_\theta \quad (5.h)$$

$$Q_\phi = H_{55}\,\gamma_{\phi z} \quad (5.i)$$

$$Q_\theta = H_{66}\,\gamma_{\theta z} \quad (5.j)$$

where the elastic parameter is given for a layered shell:

$$\begin{Bmatrix} C_{11} \\ C_{12} \\ C_{22} \end{Bmatrix} = \sum_{i=1}^{m} \begin{Bmatrix} B_{11} \\ B_{12} \\ B_{22} \end{Bmatrix} \left\{ \left(z_{i+1} - z_i \right) + \left(1 - \frac{R_2}{R_1} \right) \sum_{n=2}^{m} \left(-\frac{1}{R_2} \right)^{n-1} z_n \right\} \quad (6)$$

$$\begin{Bmatrix} K_{11} \\ K_{12} \\ K_{22} \end{Bmatrix} = \frac{1}{2} \sum_{i=1}^{m} \begin{Bmatrix} B_{11} \\ B_{12} \\ B_{22} \end{Bmatrix} \left\{ \left[\left(z_{i+1} - z_r \right) - \left(z_i - z_r \right) \right] + \left(1 - \frac{R_2}{R_1} \right) \sum_{n=3}^{m} \left(-\frac{1}{R_2} \right)^{n-2} z_n \right\} \quad (7)$$

$$\begin{Bmatrix} D_{11} \\ D_{12} \\ D_{22} \end{Bmatrix} = \frac{1}{3} \sum_{i=1}^{m} \begin{Bmatrix} B_{11} \\ B_{12} \\ B_{22} \end{Bmatrix} \left\{ \left[\left(z_{i+1} - z_r \right) - \left(z_i - z_r \right) + \left(1 - \frac{R_2}{R_1} \right) \sum_{n=4}^{m} \left(-\frac{1}{R_2} \right)^{n-3} z_n \right] \right\} \quad (8)$$

$$E_{11} = E_{12} = E_{22} = \sum_{i=1}^{m} B_{44}^{i} \left(z_{i+1} - z_i\right) + \left(1 - \frac{R_2}{R_1}\right) \sum_{n=2}^{m} \left(-\frac{1}{R_2}\right)^{n-1} z_n \tag{9}$$

$$F_{11} = F_{12} = F_{22} = \frac{1}{2} \sum_{i=1}^{m} B_{44}^{i} \left[\left(z_{i+1} - z_r\right)^2 - \left(z_i - z_r\right)^2\right] + \left(1 - \frac{R_2}{R_1}\right) \sum_{n=3}^{m} \left(-\frac{1}{R_2}\right)^{n-2} z_n \tag{10}$$

$$H_{11} = H_{12} = H_{22} = \frac{1}{3} \sum_{i=1}^{m} B_{44}^{i} \left[\left(z_{i+1} - z_r\right)^3 - \left(z_i - z_r\right)\right]^3 + \left(1 - \frac{R_2}{R_1}\right) \sum_{n=4}^{m} \left(-\frac{1}{R_2}\right)^{n-3} z_n \tag{11}$$

where $z_n = (z_{i+1}^n - z_i^n)/n$

$$H_{55} = \sum_{i=1}^{m} B_{55}^{i} \left(z_{i+1} - z_i\right) \tag{12}$$

$$H_{66} = \sum_{i=1}^{m} B_{66}^{i} \left(z_{i+1} - z_i\right) \tag{13}$$

and where:

$$B_{11}^{i} = \frac{E_\phi^i}{1 - \nu_\phi^i \nu_\theta^i} \quad ; \quad B_{12}^{i} = \frac{\nu_\theta^i E_\phi^i}{1 - \nu_\phi^i \nu_\theta^i} \quad ; \quad B_{22}^{i} = \frac{E_\theta^i}{1 - \nu_\phi^i \nu_\theta^i} \tag{14}$$

$$B^i_{44} = G_{\phi\theta} \quad ; \quad B^i_{55} = G_{\phi z} \quad ; \quad B^i_{66} = G_{\theta z} \tag{15}$$

Finally basic equations of equilibrium for a shell element and in terms of the stress resultants defined in Equation (4) are required:

$$N_{\theta,\theta} + \frac{r}{R_\phi} N_{\phi\theta,\phi} + 2 \cos\phi \, N_{\theta\phi} + Q_\theta \sin\phi + rp_\theta = 0 \tag{16a}$$

$$N_{\theta\phi,\theta} + \frac{r}{R_\phi} N_{\phi,\phi} + (n_\phi - n_\theta) \cos\phi + \frac{r}{R_\phi} Q_\phi + rp_\phi = 0 \tag{16b}$$

$$Q_{\theta,\theta} + \frac{r}{R_\phi} Q_{\phi,\phi} + Q_\phi \cos\phi - \sin\phi \, N_\theta - \frac{r}{R_\phi} N_\phi + rp_n = 0 \tag{16c}$$

$$M_{\theta,\theta} + \frac{r}{R_\phi} M_{\phi\theta,\theta} + 2 \cos\phi \, M_{\theta\phi} - rQ_\theta + rm_\theta = 0 \tag{17a}$$

$$M_{\theta\phi,\theta} + \frac{r}{R_\phi} M_{\phi,\phi} + (M_\phi - M_\theta) \cos\phi - rQ_\phi + rm_\phi = 0 \tag{17b}$$

As established for the isotropic case, Equations (3) through (17) have the order of 10 when transverse shear deformation is included, and the order of eight when transverse shear is neglected. Since the above defined displacements and stress resultants enter into natural boundary conditions at the edge of a medium plane where ϕ=constant, then the two point boundary problem for rotationally symmetric shells can be solved.

2. DERIVATION OF THE GOVERNING SET OF EQUATIONS

The object of the following procedure is to develop a set of first order ordinary differential equations. The fundamental set of generalized displacements w, u_ϕ, u_θ, β_ϕ, β_θ, and generalized stress resultants Q_ϕ, N_ϕ, $N_{\theta\phi}$, M_ϕ, $M_{\theta\phi}$ can be expressed in such a manner as to be consistent with the thin shell theory of either Reissner or Naghdi. Also it is convenient to reference all derivatives to the intrinsic coordinate system along the surface meridional length. In this way, continuous shells having a geometry where more than one radial station lies at one latitude plane of the shell can be analyzed (e.g. a circular plate). In addition, it is assumed that the variables are separable in the form:

$$\begin{Bmatrix} w, \ u_\phi, \ \beta_\phi \\ Q_\phi, \ N_\phi, \ M_\phi, \ N_\theta, \ M_\theta \end{Bmatrix} = \begin{Bmatrix} w_n, \ u_{\phi n}, \ \beta_{\phi n} \\ Q_{\phi n}, \ N_{\phi n}, \ M_{\phi n}, \ N_{\theta n}, \ M_{\theta n} \end{Bmatrix} \cos n\theta$$

$$\begin{Bmatrix} u_\theta, \ \beta_\theta, \ Q_\theta, \ M_{\theta\phi} \\ M_{\phi\theta}, \ N_{\theta\phi}, \ N_{\phi\theta} \end{Bmatrix} = \begin{Bmatrix} u_{\theta n}, \ \beta_{\theta n}, \ Q_{\theta n}, \ M_{\theta\phi n} \\ M_{\phi\theta n}, \ N_{\theta\phi n}, \ N_{\phi\theta n} \end{Bmatrix} \sin n\theta$$

To set up displacement derivatives it is necessary to use Equation (5). Considering Equations (5a) and (5c), we obtain:

$$\varepsilon_{\phi n} = \frac{1}{[C_{11}D_{11} - K_{11}^2]} \left\{ D_{11}(N_{\phi n} - C_{12}\varepsilon_{\theta n} - K_{12}\kappa_{\theta n}) - K_{11}(M_{\phi n} - K_{12}\varepsilon_{\theta n} - D_{12}\kappa_{\theta n}) \right\} \tag{18a}$$

$$\kappa_{\phi n} = \frac{-1}{[C_{11}D_{11} - K_{11}^2]} \quad K_{11}(N_{\phi n} - C_{12}\varepsilon_{\theta n} - K_{12}\kappa_{\theta n}) \tag{18b}$$

$$- C_{11}(M_{\phi n} - K_{12}\varepsilon_{\theta n} - D_{12}\kappa_{\theta n})$$

Combining Equations (5e) and (5b) we obtain:

$$\gamma_{\phi n} = \frac{1}{[E_{11}H_{11} - F_{11}^2]} \quad H_{11}(N_{\phi\theta n} - E_{12}\gamma_{\theta n} - F_{12}\delta_{\theta n}) \tag{19a}$$

$$- F_{11}(M_{\phi\theta n} - F_{12}\gamma_{\theta n} - H_{12}\delta_{\theta n})$$

$$\delta_{\phi n} = \frac{-1}{[E_{11}H_{11} - F_{11}^2]} \quad F_{11}(N_{\phi\theta n} - E_{12}\gamma_{\theta n} - F_{12}\delta_{\theta n}) \tag{19b}$$

$$- E_{11}(M_{\phi\theta n} - F_{12}\gamma_{\theta n} - H_{12}\delta_{\theta n})$$

From Equations (3c), (3n), and (5c) we get:

$$w_{n,s} = \frac{u_{\phi n}}{R_\phi} - \beta_{\phi n} + \gamma_{\phi zn} \tag{20}$$

or using Equation (5i)

$$w_{n,s} = \frac{u_{\phi n}}{R_\phi} - \beta_{\phi n} + \frac{Q_{\phi n}}{H_{55}} \tag{21a}$$

From Equation (3) we obtain:

$$u_{\phi n,s} = \varepsilon_{\phi n} - \frac{1}{R_\phi} w_n \tag{21b}$$

$$u_{\theta n,s} = \gamma_{\phi n} \tag{21c}$$

$$\beta_{\phi n,s} = \kappa_{\phi n} \tag{21d}$$

$$\beta_{\theta n,s} = \delta_{\phi n} \tag{21e}$$

Noting that these quantities are already functions of the fundamental variables:

$$\varepsilon_{\theta n} = \frac{n}{r} u_{\theta n} + \frac{\cos \phi}{r} u_{\phi n} + \frac{\sin \phi}{r} w_n \tag{22}$$

$$\kappa_{\theta n} = \frac{n}{r} \beta_{\theta n} + \frac{\cos \phi}{r} \beta_{\phi n} \tag{23}$$

$$\gamma_{\theta n} = -\frac{n}{r} u_{\phi n} - \frac{\cos \phi}{r} u_{\theta n} \tag{24}$$

$$\delta_{\theta n} = -\frac{n}{r} \beta_{\phi n} - \frac{\cos \phi}{r} \beta_{\theta n} \tag{25}$$

$$\gamma_{\theta z n} = -(\frac{n}{r} w_n - \frac{\sin \phi}{r} u_{\theta n}) \beta_{\theta n} \tag{26}$$

the following functions, therefore, can be solved using Equation (5):

$$\begin{aligned}
N_{\theta n} &= C_{12}\varepsilon_{\phi n} + C_{22}\varepsilon_{\phi n} + K_{12}\kappa_{\phi n} + K_{22}\kappa_{\theta n} \\
M_{\theta n} &= K_{12}\varepsilon_{\phi n} + K_{22}\varepsilon_{\phi n} + D_{12}\kappa_{\phi n} + D_{22}\kappa_{\theta n} \\
N_{\theta\phi n} &+ E_{12}\gamma_{\phi n} + E_{22}\gamma_{\theta n} + F_{12}\delta_{\phi n} + F_{22}\delta_{\theta n} \\
M_{\theta\phi n} &= F_{12}\gamma_{\phi n} + F_{22}\gamma_{\theta n} + H_{12}\delta_{\phi n} = H_{22}\delta_{\theta n} \\
Q_{\theta n} &= H_{66}\gamma_{\theta z n}
\end{aligned} \tag{27}$$

Finally from the equations of equilibrium,

$$Q_{\phi n,s} = -\frac{\cos\phi}{r} Q_{\phi n} - \frac{n}{r} Q_{\theta n} + \frac{N_{\phi n}}{R_\phi} + \frac{\sin\phi}{r} N_{\theta n} - P_n$$

$$N_{\phi n,s} = -\frac{\cos\phi}{r} N_{\phi n} - \frac{n}{r} N_{\theta\phi n} + \frac{\cos\phi}{r} N_{\theta n} - \frac{Q_{\phi n}}{R_\phi} - P_{\phi n}$$

$$N_{\phi\theta n,s} = -\frac{\cos\phi}{r} (N_{\phi\theta n}+N_{\theta\phi n}) - \frac{n}{r} N_{\theta n} - \frac{\sin\phi}{r} Q_{\theta n} - P_{\theta n} \qquad (28)$$

$$M_{\phi n,s} = -\frac{\cos\phi}{r} (M_{\phi n}-M_{\theta n}) - \frac{n}{r} M_{\theta\phi n} + Q_{\phi n} - M_{\phi n}$$

$$M_{\phi\theta n,s} = -\frac{\cos\phi}{r} (M_{\phi\theta n}+M_{\theta\phi n}) - \frac{n}{r} M_{\theta n} + Q_{\theta n} - M_{\theta n}$$

By calculating Equations(18)through (28) we develop the set of first order differential equations. Therefore, these equations can be solved numerically using a direct integration over a segment length where sufficient accuracy is maintained and the numerical scheme discussed earlier.

3. PROGRAM MODIFICATION

The computer program SP presented in Reference 1 had been written for the IBM 7094. Modifications to this program to accept the effects of transverse shear deformation have been forwarded to FBR. This program has modification identifiers located in column 80. This particular listing for the IBM 7094 is on file at FBR but will not be maintained. A CDC 6600 version under the UPDATE mode will be maintained at this facility and is presented in Appendix A. This version remains within a core limit of 77777_8. However to remain within the framework of the original program and core limit, the total number of segments had to be reduced (from 100 to 65 segments) for the thick shell option. The thin option can still use 100 segments. Other versions have been submitted for the IBM 7094 utilizing overlays that permit 150 segments but again will not be maintained.

Program size and governing common block allocations will be deferred from discussion until Part 5. In order to maintain the essential input parameters and organization of the original code, the description of those modified parameter cards are presented. Since the thick shell equations are based upon an order of 10, modification to the original code is required. For axisymmetrically loaded shells the order is reduced to six. Thus every parameter defined in the original code relating to nonaxisymmetric loads had to be redefined. Further additional subroutines and control cards are employed. All other parameter cards not mentioned herein remain the same.

The following card is added and must precede the original data deck:

Card 1	Analysis	Control	Format (A6,4X,A8)
Col. 1-6	ITYPE	If ITYPE = THICK$_{\Delta}$ Thick Shell equations are to be used. If ITYPE = THIN$_{\Delta\Delta}$ Thin Shell equations are to be used.	
Col.11-18	JTYPE	If JTYPE = TORSION$_{\Delta}$ Torsion problem to be solved. ITYPE must equal THIN$_{\Delta\Delta}$ Normally JTYPE = blank	

Elastic Parameter Card

Application - SP, AEP, NEP

Number of consecutive cards = as many as the number of layers (MLY), starting with Layer No. 1. One such set per Part.

Variables	Format	Column	Description
If ITYPE = THIN$_{\Delta\Delta}$			
B11	F10.0	1-10	Isotropic - Young's modulus Orthotropic - $E_\phi/(1-\nu_\phi\nu_\theta)$
B12	F10.0	11-20	Isotropic - Poisson's ratio Orthotropic - $\nu_\phi E_\phi/(1-\nu_\phi\nu_\theta)$
B22	F10.0	21-30	Isotropic - Blank Orthotropic - $E_\theta/(1-\nu_\phi\nu_\theta)$
B66	F10.0	31-40	Isotropic - Blank Orthotropic - $G_{\phi\theta}$
AL1	F10.0	41-50	Coefficient of thermal expansion in meridional direction. Not used in AEP and NEP

Variables	Format	Column	Description
AL2	F10.0	51-60	Coefficient of thermal expansion in circumferential direction. Not used in AEP and NEP.
RHO	F10.0	61-70	Mass density of material. For SP used only in spinning shell is analyzed. Not used for stability analysis.
IL1	I5	71-75	If IL1=0, then all elastic parameters are constant in this layer. For variable elastic parameters, see Comments.
If ITYPE = THICK$_\Delta$			
B11	F10.0	1-10	Isotropic - Young's modulus Orthotropic - $E_\phi/(1-\nu_\phi\nu_\theta)$
B12	F10.0	11-20	Isotropic - Poisson's ratio Orthotropic - $\nu_\phi E_\phi/(1-\nu_\phi\nu_\theta)$
B22	F10.0	21-30	Isotropic - Blank Orthotropic - $E_\theta/(1-\nu_\phi\nu_\theta)$
B66	F10.0	31-40	Isotropic - Blank Orthotropic - $G_{\phi\theta}$
AL1	F10.0	41-50	Coefficient of thermal expansion, in meridional direction. Not used in AEP and NEP.
AL2	F10.0	51-60	Coefficient of thermal expansion, in circumferential direction. Not used in AEP and NEP.

Variables	Format	Column	Description
RHO	F10.0	61-70	Mass density of material. For SP used only if spinning shell is analyzed. Not used for stability analysis.
IL1	I5	71-75	If IL1=0, then all elastic parameters are constant in this layer. For variable elastic parameters, see Comments.
If ITYPE = THICK$_\Delta$ and B22≠0			
B55	F10.0	1-10	Orthotropic $G_{\phi z}$
B44	F10.0	11-20	Orthotropic $G_{\theta z}$

Comments

1. An isotropic layer is identified by setting B22=0.0.
2. E_ϕ = Young's modulus in meridional direction.
   E_θ = Young's modulus in circumferential direction.
   ν_ϕ = Poisson's ratio (contraction) in ϕ direction produced by normal stress in θ direction.
   ν_θ = Poisson's ratio (contraction) in ϕ direction produced by normal stress in θ direction.
   $G_{\phi\theta}$ = Shear modulus in ϕ, θ plane.
   $G_{\phi z}$ = Shear modulus in ϕ, z plane.
   $G_{\theta z}$ = Shear modulus in θ, z plane.
   [Note that $\nu_\phi E_\phi = \nu_\theta E_\theta$]
3. If IL1=+N and ITYPE=THIN$_{\Delta\Delta}$ then N designates the code number of the first of six FGEN card sets, by which variables B11, B12, B22, B66, AL1, AL2 are read, in that order, immediately after the Elastic Parameter Card of an orthotropic layer.

4. If IL1=-N, then N designates the code number of one FGEN set, by which Young's modulus is read immediately after the Elastic Parameter Card of an isotropic layer.

Boundary Condition Card

If ITYPE = $THICK_{\Delta}$ and NX on the wave number card $\neq 0$ additional boundary conditions need to be considered. Two additional parameters need to be defined. The complete set would be:

1 for u_1;	2 for Q_1;	3 for u_2;
4 for Q_2;	5 for β_ϕ;	6 for M_ϕ;
7 for u_θ;	8 for $N_{\phi\theta}$;	9 for β_θ;
10 for $M_{\phi\theta}$.		

Starting Edge

Application - SP, AEP, NEP

Number of consecutive cards = one per subcase.

Variables	Format	Columns	Description
1A(1)	I5	1-5	Code number of first prescribed variable on Starting Edge.
GA(1)	F10.0	6-15	Its prescribed value.
IA(2)	I5	16-20	Second prescribed variable.
GA(2)	F10.0	21-30	Its prescribed value.
IA(3)	I5	31-35	Third prescribed variable.
GA(3)	F10.0	36-45	Its prescribed value.
IA(4)	I5	46-50	Fourth prescribed variable. If NX≠0
GA(4)	F10.0	51-60	Its prescribed value.
IA(5)	I5	61-65	Fifth prescribed variable. If NX≠0 and ITYPE=$THICK_{\Delta}$
GA(5)	F10.0	66-75	Its prescribed value.

Comments:

1. For code numbers of prescribed variables see Item 6, Section 2, Chapter I, of Part II[1].
2. Remember that the prescribed edge loads are actually the Fourier coefficients for a given wave number NX.

Final or Branch Edges

Application - SP, AEP, NEP

Number of consecutive cards = as many as Branches plus one. One set per subcase.

Variables	Format	Columns	Description
IB(1,K)	I5	1-5	Code number of first prescribed variable on Final or Branch Edge.
GB(1,K)	F10.0	6-15	Its prescribed value.
IB(2,K)	I5	16-20	Second prescribed variable.
GB(2,K)	F10.0	21-30	Its prescribed value.
IB(3,K)	I5	31-35	Third prescribed variable.
GB(3,K)	F10.0	36-45	Its prescribed value.
IB(4,K)	I5	46-50	Fourth prescribed variable. If NX≠0
GB(4,K)	F10.0	51-60	Its prescribed value.
IB(5,K)	I5	61-65	Fifth prescribed variable. If NX≠0 and ITYPE=$THICK_{\Delta}$
GB(5,K)	F10.0	66-75	Its prescribed value.

Comments

1. The first card of this set refers to the Final Edge of Main Shell. The second, third, etc., cards refer to Branch Edges in the order in which they are encountered, when going from the Starting to Final Edge of Main Shell.
2. For code numbers of prescribed variables, see Item 6, Section2, Chapter I, of Part II. (Reference 1)

3. Remember that the prescribed edge loads are actually the Fourier coefficients for a given wave number NX.

Load Parameter Card

Application - SP only

Number of consecutive cards = one per Part.

Variables	Format	Columns	Description
VK(I,1)	F10.0	1-10	If INORM=0, then surface load along normal, p. If INORM=1, then surface load parallel to axis of symmetry, p_1.
VK(I,2)	F10.0	11-20	If INORM=0, then surface load along meridian, p_ϕ. If INORM=1, then surface load perpendicular to axis of symmetry, p_2.
VK(I,3)	F10.0	21-30	Surface load along circumference, p_θ.
VK(I,4)	F10.0	31-40	Temperature on inside bounding surface of shell (in -Z direction), T_L.
VK(I,5)	F10.0	41-50	Temperature on outside bounding surface of shell (in +Z direction), T_U.
IK2	I5	51-55	If IK2=0, then all loads are constant along meridian. Otherwise, IL2=number of variable loads.
INORM	I3	56-58	INORM=0 means that surface loads are along the normal and meridional tangent of Reference Surface. INORM=1 means that they are parallel and perpendicular to axis of symmetry.

Variables	Format	Columns	Description
IPRESS	I1	59	1 Pressure on outside specified else 0
	I1	60	1 Pressure on inside specified else 0
RPM	F10.0	61-70	Revolutions per minute for a shell spinning about its axis of symmetry.

Comments

1. For positive directions of rotated loads, P_1 and P_2, see Figure 9.(Reference 1)
2. The values of variable loads, entered on Load Parameter Card, are used for reference only.
3. Remember that the loads entered here are actually Fourier coefficients for a given wave number NX.
4. For a spinning shell, the same RPM must be entered on Load Parameter Card for every Part.
5. IPRESS is normally set equal to zero for the pressure is stated at the reference surface. When IPRESS=10 the pressure is assumed to be along the outside surface and then calculated within the program as:

$$p = p_\theta \left[1 - \frac{z_{last} - z_{ref}}{R_\theta}\right]$$

When IPRESS=01 the pressure is assumed to be acting along the inside surface.

$$p = p_i \left[1 + \frac{z_{ref} - z_1}{R_\theta}\right]$$

Note: If above option is used, z_{ref} cannot be at z_{last} or z_1.

4. DEVELOPMENT OF TORSION

Under the assumptions in the development of the thin shell equations, the Reissner equations uncouple for the Fourier harmonic n=0. They take the form:

$$\frac{d}{ds}\begin{Bmatrix} y_o \\ \hline \bar{y}_n \end{Bmatrix} = \begin{bmatrix} A(s)_o & 0 \\ \hline 0 & \bar{A}(s)_n \end{bmatrix} \begin{Bmatrix} y_o \\ \hline \bar{y}_n \end{Bmatrix} + \begin{Bmatrix} B_o \\ \hline \bar{B}_n \end{Bmatrix}$$

If the usual initial boundary value problems are determined in the form:

$$\begin{Bmatrix} y_1 \\ \hline y_2 \end{Bmatrix}_{i+1} = \begin{bmatrix} Y_1 & Y_2 \\ \hline Y_3 & Y_4 \end{bmatrix} \begin{Bmatrix} Y_1 \\ \hline Y_2 \end{Bmatrix}_i$$

two rows and columns of matrix Y_2 are singular for the n=o torsion problem. Re-arrangement of the rows and columns of Y_4 and Y_2 will permit successful solution. If JTYPE=TORSION$_{\Delta}$ on the first control card and ITYPE=THIN$_{\Delta\Delta}$, the singular matrices are converted to nonsingular matrices.

5. PROGRAM SIZE

The present version compiled on RUN compiler of the CDC 6600 system has a program length of 65100_8 or 27100_{10}. The size of the program is based upon the number of parts, segments, materials, layers, branches etc. Common block size and allocation are described below. Their names in general follow the association or area to which each common block pertains.

Common Block Name	Size	Principal Size Governing Equation
GARB	8109	[NSEG(NDE+1)+1] [NDE+1]
RUN	64	--
MATL	720	PARTS * NL *9
XM17	54	--
GEOM	1235	(NL+10)PARTS + NBR+1 +(NBR+ 2) NDE *NDE
THICK	15	--
TRIA	130	NDE/2 * (NBR+1)+NSEG+5
ADAM	3	--

For the present case, the maximum values are:

NSEG = 100
NDE = 10
PARTS= 20
NL = 4
NBR = 4

Note for NDE = 10(THICK option) NSEG $\leq$ 65, for [65(10+1)+1] [10+1] = [65 x 11 x 1] [11] = 7876 which is less than the limit 8109. If one wanted to use a single variable Blank Common, the above calculation for each common length could be used to RFL the length of the program to meet the problem being considered.

SECTION III
THE EIGENSOLUTION

The present dynamic shell program uses a "cut and try" method for an eigensolution. For a system of homogeneous equations that govern the free vibration of shells of revolution, nontrivial solutions exist when the determinant of coefficients vanish. Blum and Fulton[13] have shown that the problems associated with the determinant using Potter's method (which is the essential basis for the multisegment method) are:

1) "changes in sign of the residual associated with the poles may be incorrectly interpreted as crossings (zeros) of the residual.

2) if the poles are near the zeros, two successive choices of λ (eigenvalue) ..no change in sign, and a zero may be missed in the search." The same procedure can be followed and stated with the present program's parameters. If the parameter DETB is plotted as a function of Omega, ω, the zero of the parameter DETB will be λ, the eigenvalue. The present program utilizes an interpolation procedure which is adequate when $\omega \simeq \lambda$. If $\omega >> \lambda$, one would have to review the modal pattern in order to establish which way should be applied. For some shell structures, this modal pattern behavior may not be as well behaved as one would like, especially for highly orthotropic junctured shells.

For any search method utilizing the determinant of coefficient the procedure that should be followed is:

(1) examine the determinant relative to determinants at adjacent frequencies for an indicated zero by change in sign.

2) examine the modified determinant for change in sign.

3) examine mode shape.

When all three items are satisfied, the assumed frequencies can be utilized for an interpolation of the true eigenvalue. The pitfall in employing this procedure occurs when one or more of the items indicate a zero (and in particular the mode shape). If the step size ($\Delta\omega$) is sufficiently small, one may circumvent one of the pitfalls and the present interpolation procedure may be utilized with some partial success but at the expense of a great amount of computer time. This procedure can be followed provided the eigenvalue is known a priori.

To illustrate the possible difficulties with and to further amplify on Blum and Fulton's observations one could experience utilizing the above technique, we present results of some problems that were recently solved. In Table I a list is presented of frequencies, determinants, modified determinants and nodal (number of zero crossings) points for a cantilevered conical shell having variable extensional and bending rigidities.

From Table I the first indicated zero lies between $\Omega = \omega L/c = .004$ and .005. The next indicated zero (by mode shape) lies between $\Omega = .006$ and .008. This turns out to be a false indicated root. In fact a total of five false zeros were encountered for the entire frequency range investigated. In order to verify the existence or nonexistence of each indicated eigenvalue, three to five additional runs had to be performed.

TABLE I

RESULTS FOR CANTILEVERED CONICAL SHELL

Ω	$Z = \frac{C_m}{Y_{c+1}}$	C_M	Nodes
.002	-0.120	$.34 \times 10^{+9}$	0
.003	-0.624	$.39 \times 10^{+8}$	0
.004	-0.028	$.62 \times 10^{+6}$	0
.005	0.567	$-.58 \times 10^{+7}$	1
.006	1.350	$-.53 \times 10^{+7}$	1
.008	1.370	$-.42 \times 10^{+7}$	3
.010	0.517	$-.16 \times 10^{+7}$	1
.012	-1.210	$-.10 \times 10^{+8}$	2
.014	-2.470	$-.30 \times 10^{+7}$	4
.016	-2.200	$-.17 \times 10^{+7}$	2
.018	-0.400	$-.70 \times 10^{+6}$	2
.020	-0.200	$.29 \times 10^{+6}$	4
.022	4.200	$-.22 \times 10^{+7}$	3
.024	-0.190	$.93 \times 10^{+8}$	4
.026	0.256	$.13 \times 10^{+7}$	4
.028	0.251	$.61 \times 10^{+6}$	5
.030	-0.470	$-.17 \times 10^{+9}$	6

Thus a total of sixty-seven computer runs were required to establish the eigenvalues. Approximately one and one half hours of computing time were required to produce these results. Similar results were obtained for other classes of problems that typify the above findings. During the course of our investigations, many numerical procedures have been attempted that show the futility of the present approach for engineering problems when the eigenvalue cannot be adequately estimated. More direct methods are available such as Stodola, Rayleigh quotient, Householder or even Jacobi. These methods require an extensive modification to AEP and would require discarding the bulk of the present program.

1. MODIFICATION TO AEP

An attempt to salvage the program and develop a more automatic procedure within the framework of the program has been made. This modification is primarily concentrated on the subroutine TRIANG and in MAIN immediately after the call to TRIANG. The modification of the program's logic is set so it will follow the original execution path if $\Delta\omega$ (DOMEGA) in the program is read in as a nonzero value. Otherwise, the alternate path will be followed. Figure 3 gives the logical flow for the alternate procedure. The dotted lines signify the same logical path as the original AEP.

The method is simply to specify the range of the eigenvalue search by ω_o and ω_f. $\Delta\omega$ is set by:

$$\Delta\omega = \frac{\omega_f - \omega_o}{2}$$

A solution is obtained at three frequencies ω_o, $\omega_M=\omega_o+\Delta\omega$ and ω_f. If the parameter C_M(DETB) is the same sign for all three values, two additional points are obtained at:

$$\omega = \omega_o + \Delta\omega/4$$

and

$$\omega = \omega_o + 3\Delta\omega/4$$

The sign between adjacent values of C_M are again checked. If no change is seen the interval of $\Delta\omega$ is halved and new values are obtained. This procedure is followed for six iterations. If unsuccessful, the procedure is stopped. If successful the usual interpolation formulae are used to obtain λ. If the solution converges the procedure is continued between λ_i and ω_f until all the desired numbers of eigenvalues are found.

Again, it must be noted that the above procedure has the same shortcomings of the original procedure. The method will, however, allow for a more systematic search.

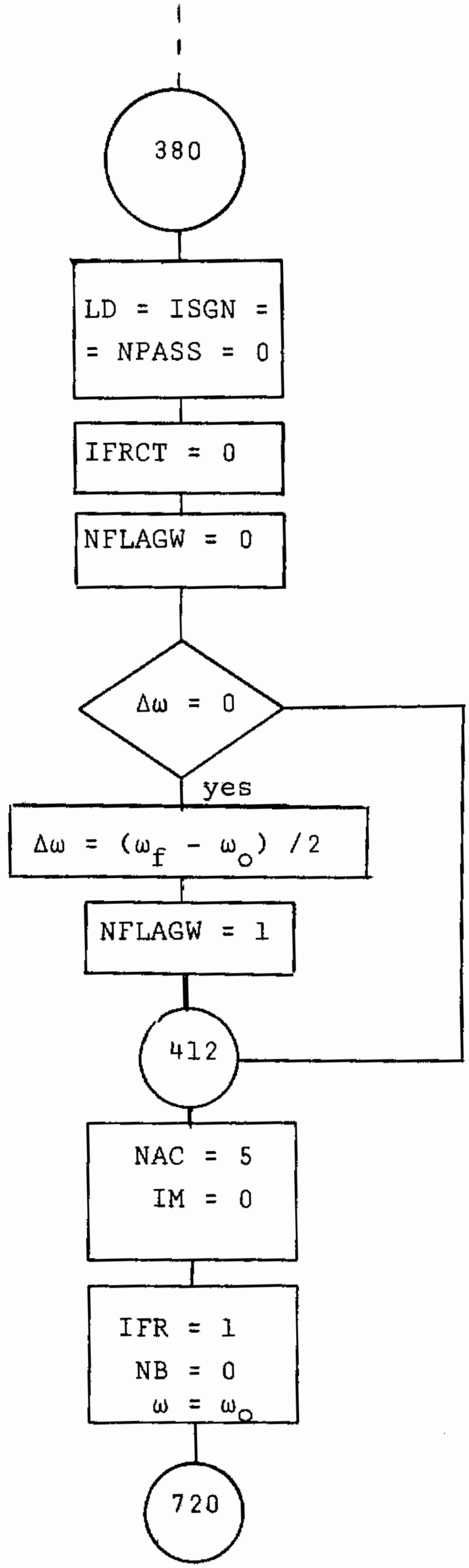

Figure 3 Flow Chart of AEP

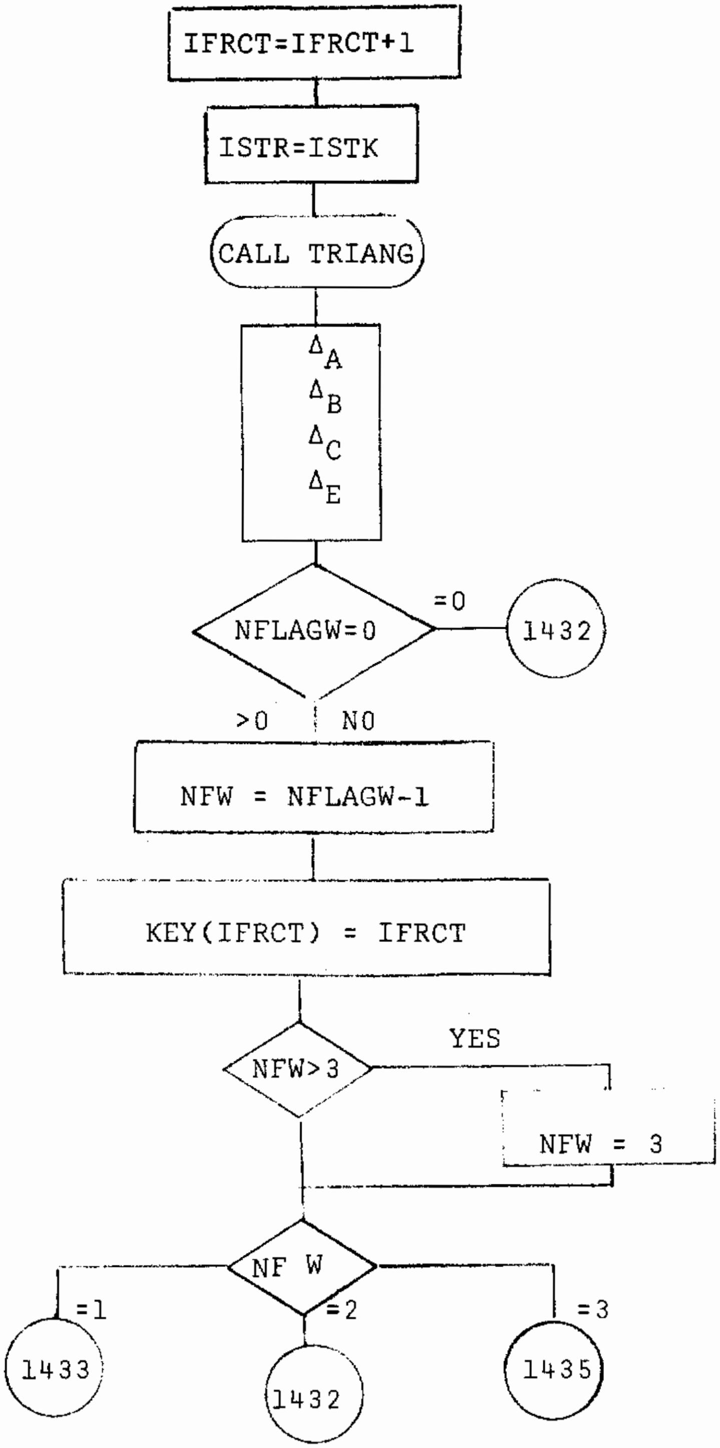

Figure 3 (con't)

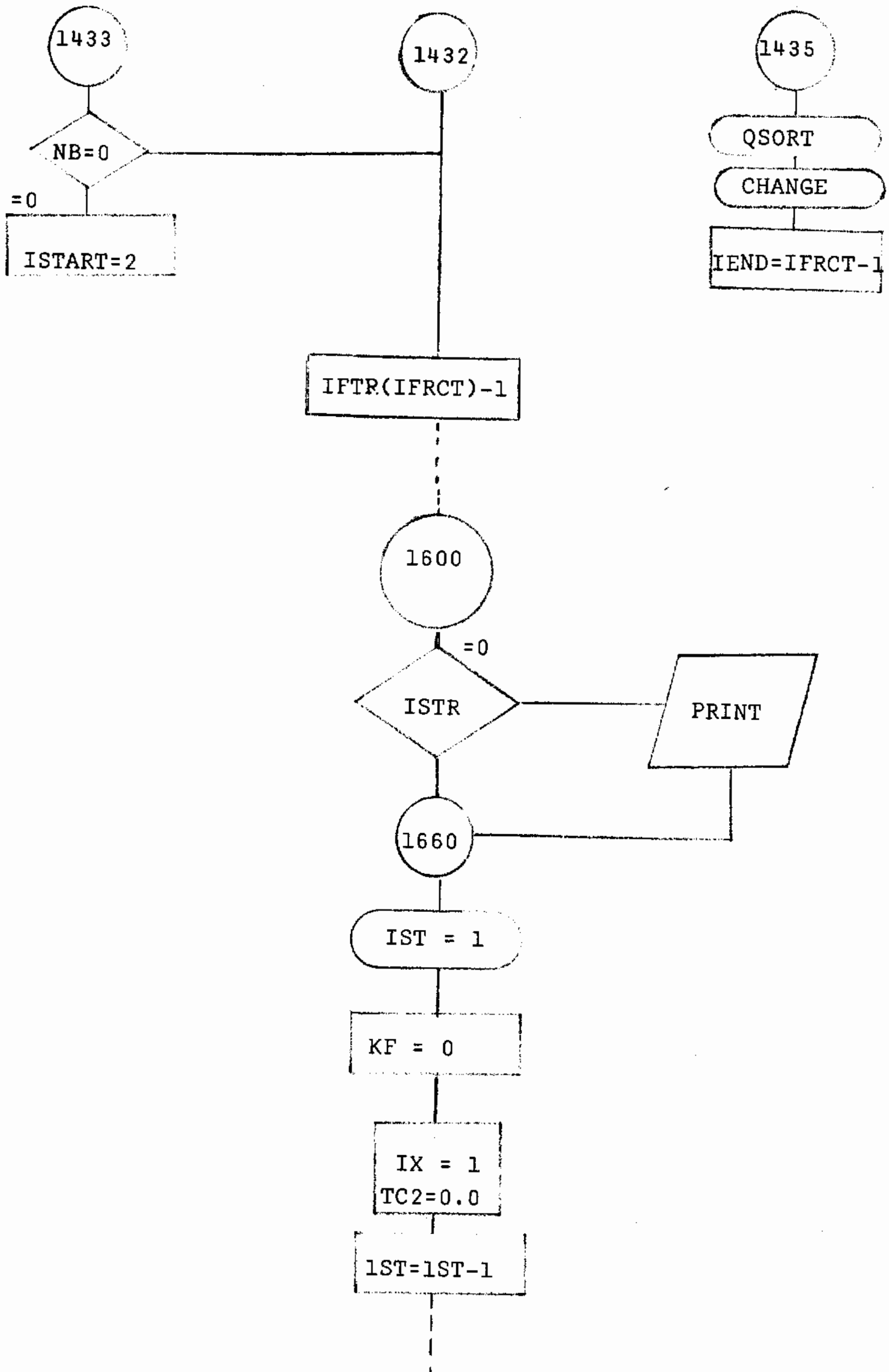

Figure 3 (con't)

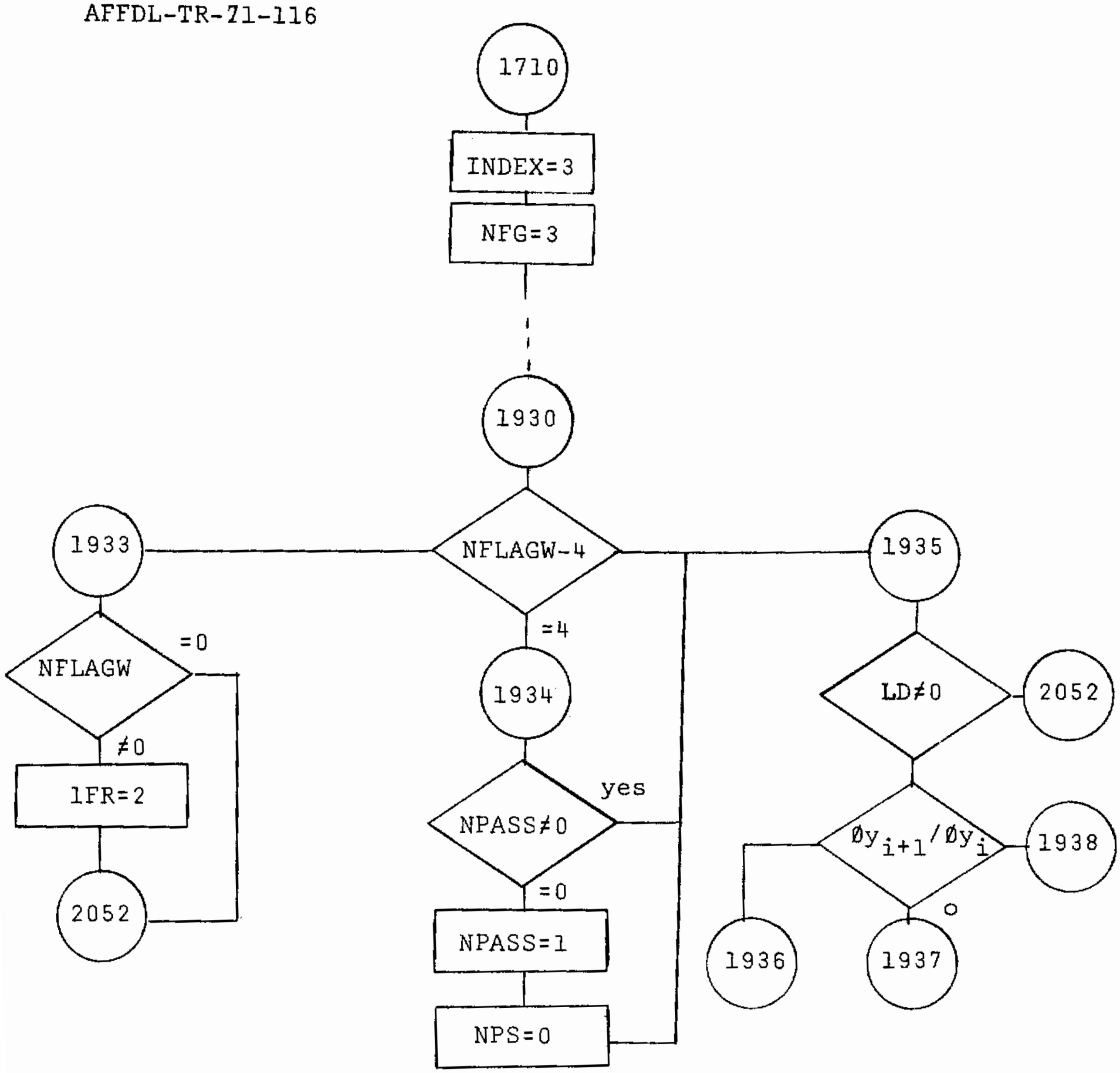

Figure 3 (con't)

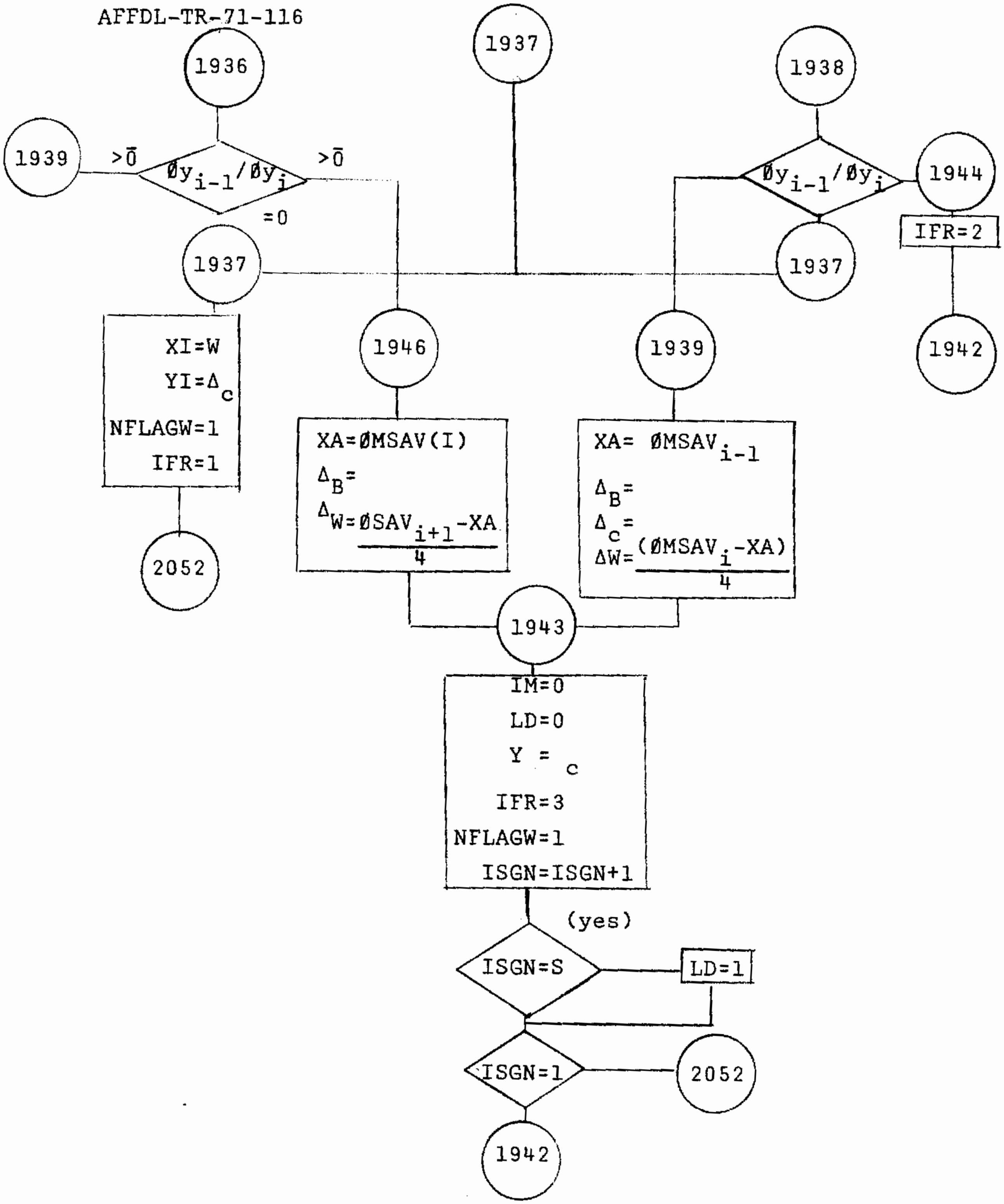

Figure 3 (con't)

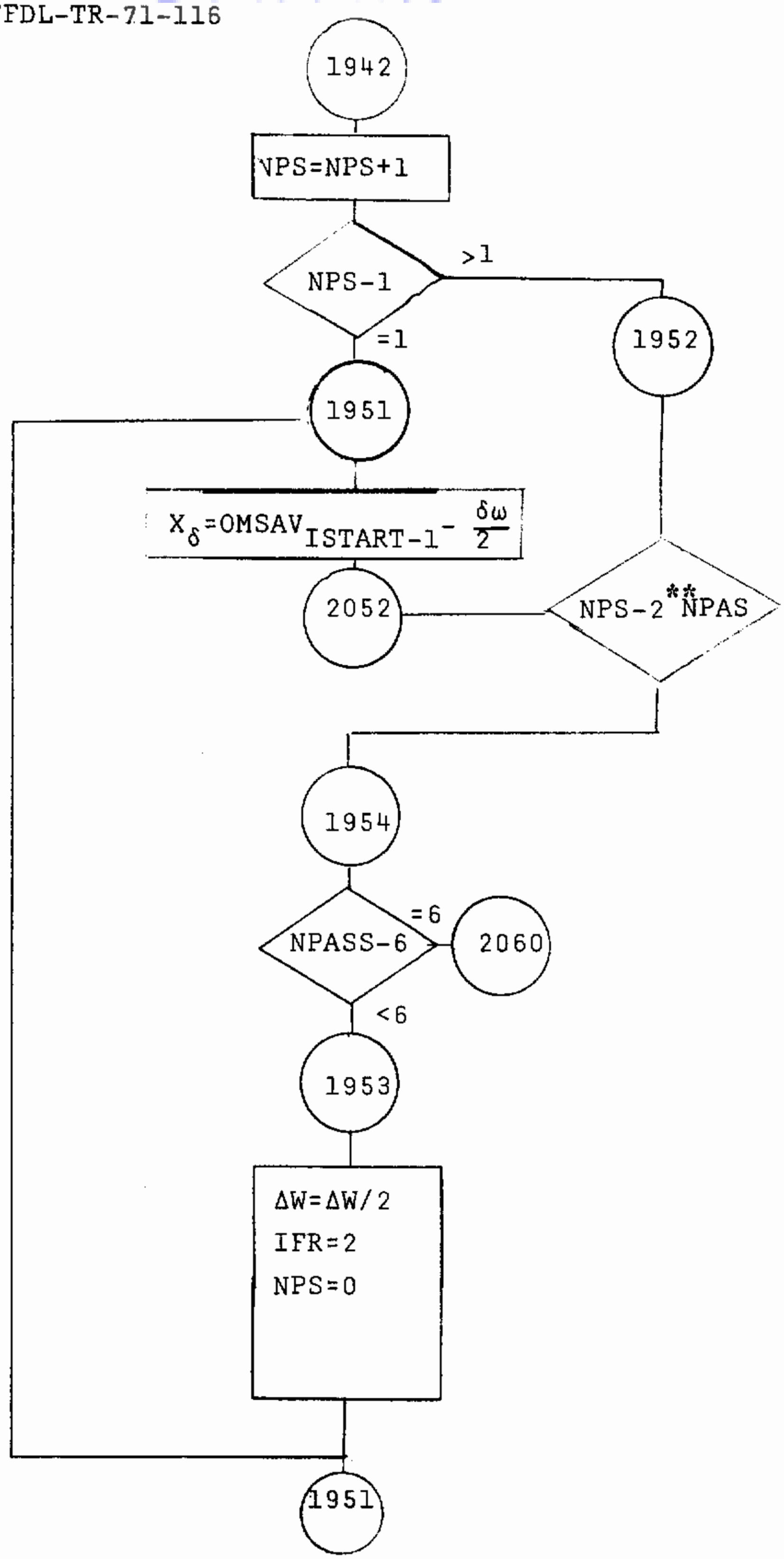

Figure 3 (con't)

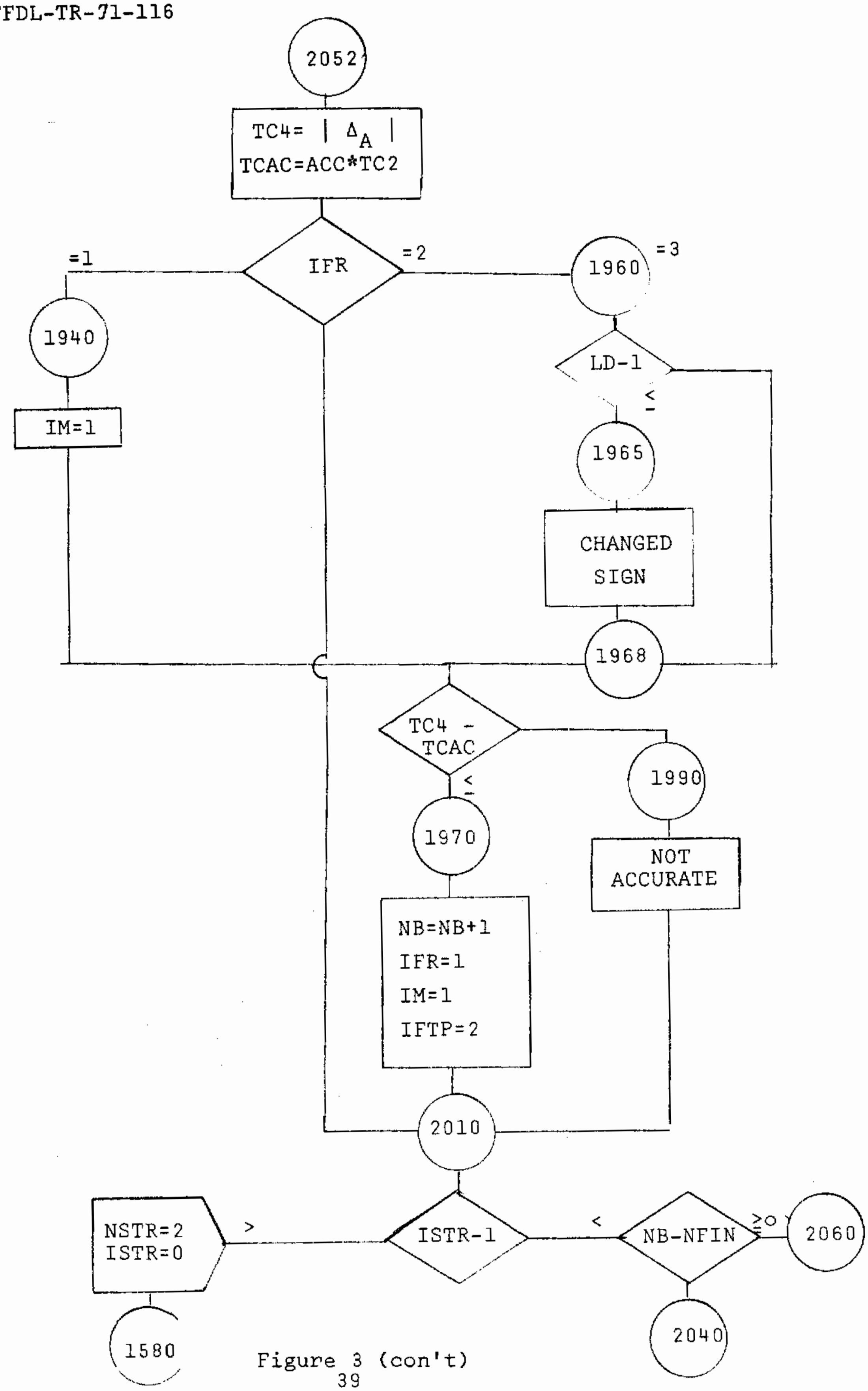

Figure 3 (con't)

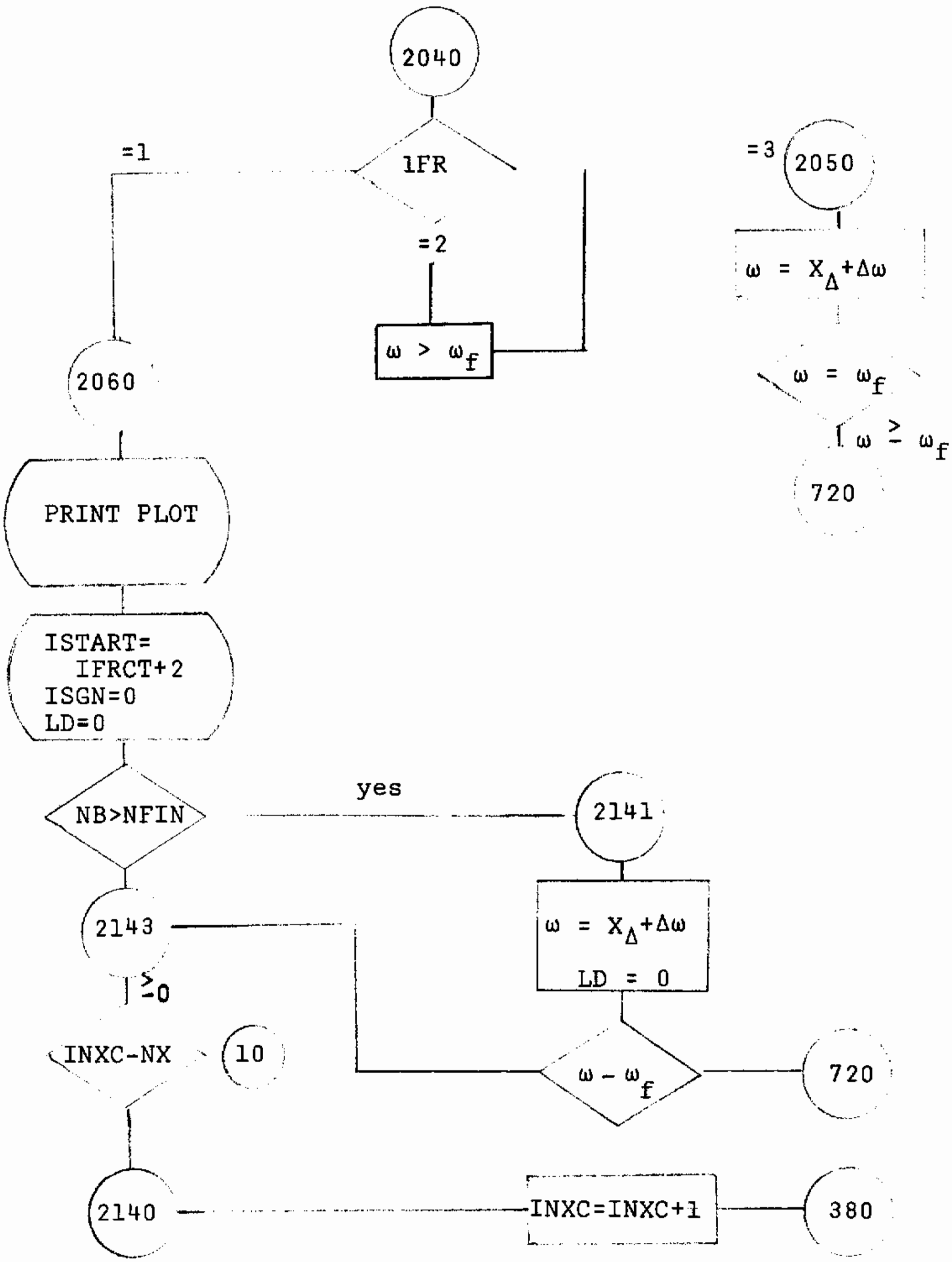

Figure 3 (con't)

SECTION IV
NUMERICAL INTEGRATION PACKAGES

One of the common problems when a researcher is investigating a particular area within his particular sphere of influence is that he must utilize tools that have been developed by others. An independent evaluation is sometimes difficult to obtain. It is not the intent to suggest a better numerical scheme on the basis of running time or solution accuracy alone. Running time, solution accuracy, ease of application and implementation are all necessary factors for evaluation. Acceptance of a method must be on the basis of the general problem solver. For example, if the problem requires a good starting estimate, one may use a Runge-Kutta method. If a considerable amount of halving or doubling is required, Adams' method is attractive.

For in-core solvers, the Adams' predictor-corrector method appears to be one of the more overall efficient techniques. The inherent difficulty with the Adams' method is that it requires a separate starter procedure.

The original shell program developed in conjunction with Dr. Kalnins used a sixth order Adams' method. This FORTRAN II program required parameter definition through Common. A listing of several differential equation solvers is presented.

1. ADMIP

USAGE

1) Set up initial values in YTAB(I) and Y(I,1)

2) Set up Starting XO and Finishing S_{max} values for interval of integration. STA array will contain these values.

3) YTAB(I) will contain the corrected terms at S_{max}.

Typical Call

```
      DØ I N=1, NSEG
      XO = STA(N)
      Smax = STA(N+1)
      Dϕ 2 I=1,NDE
      Y(I,1)=0.0
 2    YTAB(J)=0.0
      Dϕ 3 I=1,NDE
      J = NBCON(I)
      Y(J,1) = 1.0
      YTAB(J) = 1.0
      CALL AMIP
      Dϕ 3 K=1,NDE
 3    D(N,I,K)=YTAB(K)
 1    Continue
```

Since this routine was written for the FORTRAN II compiler on the IBM 7094 computer, double precision arithmetic is required. Further the starting procedure requires six evaluations prior to testing for halving or doubling the step size. This routine may be used on CDC machine but extensive revisions would be required.

AFFDL-TR-71-116

```
*       AMIP
*       LIST8
*       LABEL
*       DIAGOL
        SUBROUTINE AMIP
CAMIP
C
C
        COMMON YTAB, ZTAB, Z, ATAB, ITAB
        COMMON YDP, YPD, YPDP, YCD, YCDP, Y
        COMMON WANL, VANL, UANL, BANL
        DIMENSION YTAB(10), ZTAB(10), Z(10,12), ATAB(20), ITAB(10)
        DIMENSION YDP(10), YPD(10), YPDP(10), YCD(10), YCDP(10), Y(10,12)
        EQUIVALENCE  (YTAB( 1),  WN), (YTAB( 2),  VN), (YTAB( 3),  UN),
       1             (YTAB(4 ),  BN), (YTAB( 5), XMN), (YTAB( 6), XNPN),
       2             (YTAB( 7), XNN), (YTAB( 8),  QN)
        EQUIVALENCE (ZTAB( 1), WDOT), (ZTAB( 2), VDOT), (ZTAB( 3), UDOT),
       1             (ZTAB( 4), BDOT), (ZTAB( 5), XMDOT),(ZTAB( 6),XNPDOT),
       2,            (ZTAB( 7),XNNDOT), (ZTAB( 8),  QDOT)
        EQUIVALENCE  (ATAB( 1),    XO), (ATAB( 2),      S), (ATAB( 3),    H),
       1             (ATAB( 4),EPSIL), (ATAB( 5),    DX), (ATAB(6), FLAG),
       2             (ATAB( 7),DELTA), (ATAB( 8),  RTN), (ATAB( 9), SM[illegible]),
       3             (ATAB(10),HSTAR), (ATAB(11),DBLGT), (ATAB(12),HAV[illegible]),
       4             (ATAB(13),GAMMA)
        EQUIVALENCE  (ITAB( 1), NDEQ), (ITAB( 2),    L), (ITAB( 3),INDEX),
       1             (ITAB( 4),    K)
        L = 1
        RTN = 0.0
        H = DX
        S = XO
```

```
   10 CALL DEQNS
      DO 20 I = 1, NDEQ
   20 Z(I,L) = ZTAB(I)
      IF(L - 5) 30, 30, 40
   30 CALL START(1)
      GOTO 10
   40 LSTAR = L
   50 L = LSTAR
      S = XO + H
      INDEX = 1
      K = 2
      CALL START(2)
  130 FLAG = 0.0
      CALL TEST
      IF (INDEX -1) 170, 150, 150
  150 DO 160 J = 2, 6
      DO 160 I = 1, NDEQ
D 160 Y(I,J) = Y(I, J+5)
      GOTO 50
  170 S= XO
      DO 175 I = 1, NDEQ
  175 YTAB(I) = Y(I,1)
C     CALL DEQNS
      CALL OUT(1)
      DO 190 J = 2, 6
      S = S + H
      DO 180 I = 1, NDEQ
  180 YTAB(I) = Y(I,J)
C     CALL DEQNS
  190 CALL OUT(2)
      DO 195 I = 1,NDEQ
D     YDP(I)   = 0.0
D 195 YDP(I)   = Y(I,6)
  200 S = XO + 6.0 * H
  215 CALL PRED
      CALL TEST
      IF (HAVGT) 230,230,220
  220 CALL HAV
      GOTO 215
  230 IF (DBLGT) 245, 245, 240
  240 CALL DBL
  245 IF(RTN) 215, 215, 250
  250 RETURN
      END


*     START
*     LIST8
*     LABEL
*     DIAGOL
      SUBROUTINE START(IX)
CSTART
C
C
```

```
      COMMON YTAB, ZTAB, Z, ATAB, ITAB
      COMMON YDP, YPD, YPDP, YCD, YCDP, Y
      COMMON WANL, VANL, UANL, BANL
      DIMENSION YTAB(10), ZTAB(10), Z(10,12), ATAB(20), ITAB(10)
D     DIMENSION YDP(10), YPD(10), YPDP(10), YCD(10), YCDP(10), Y(10,12)
      EQUIVALENCE  (YTAB( 1),   WN), (YTAB( 2),   VN), (YTAB( 3),  UN),
     1             (YTAB(4 ),   BN), (YTAB( 5), XMN), (YTAB( 6), XNPN),
     2             (YTAB( 7), XNN), (YTAB( 8),   QN)
      EQUIVALENCE (ZTAB( 1), WDOT), (ZTAB( 2), VDOT), (ZTAB( 3), UDOT),
     1             (ZTAB( 4), BDOT), (ZTAB( 5), XMDOT),(ZTAB( 6),XNPDOT)
     2,            (ZTAB( 7),XNNDOT), (ZTAB( 8),   QDOT)
      EQUIVALENCE  (ATAB( 1),    XO), (ATAB( 2),      S), (ATAB( 3),    H),
     1             (ATAB( 4),EPSIL), (ATAB( 5),    DX), (ATAB(6), FLAG),
     2             (ATAB( 7),DELTA), (ATAB( 8),  RTN), (ATAB( 9), SMAX),
     3             (ATAB(10),HSTAR), (ATAB(11),DBLGT), (ATAB(12),HAVGT),
     4             (ATAB(13),GAMMA)
      EQUIVALENCE  (ITAB( 1), NDEQ), (ITAB( 2),    L), (ITAB( 3),INDEX),
     1             (ITAB( 4),    K)
      GOTO(10,30), IX
   10 DO 20 I = 1, NDEQ
D     DUM = 0.0
      DUM = H * Z(I,L)
D     Y(I,L+1) = Y(I,L) + DUM
   20 YTAB(I) = Y(I,L+1)
      S = S + H
      L = L + 1
 9999 RETURN
   30 INDEX=INDEX
      GOTO (40,50,60,70,80), INDEX
      DO 41 I = 1, NDEQ
D     DUM = 0.0
      DUM    =            H / 1440.0 * (475.0 * Z(I,1) + 1427.0 * Z(I,2)
     1 -798.0 * Z(I,3) + 482.0 * Z(I,4) - 173.0 * Z(I,5) +27.0 * Z(I,6))
D     Y(I,L+1) = Y(I,1) + DUM
      GOTO 100
      DO 51 I = 1, NDEQ
D     DUM = 0.0
      DUM    =            H/90.0 * (28.0 * Z(I,1) + 129.0 * Z(I,2) + 14.0
     1 * Z(I,3) + 14.0 * Z(I,4) - 6.0 * Z(I,5) + Z(I,6))
   51 Y(I,L+1) = Y(I,1) + DUM
      GOTO 100
   60 DO 61 I = 1, NDEQ
D     DUM = 0.0
      DUM    =            H * 0.01875 * (17.0 * Z(I,1) + 73.0 * Z(I,2) +
     1 38.0 * Z(I,3) + 38.0 * Z(I,4) - 7.0 * Z(I,5) + Z(I,6))
D  61 Y(I,L+1) = Y(I,1) + DUM
      GOTO 100
   70 DO 71 I = 1, NDEQ
D     DUM = 0.0
      DUM    =            2.0 * H / 45.0 * (7.0 * Z(I,1) + 32.0 * Z(I,2) +
     1 12.0 * Z(I,3) + 32.0 * Z(I,4) + 7.0 * Z(I,5))
D  71 Y(I,L+1  = Y(I,1) + DUM
      GOTO 100
   80 DO 81 I = 1, NDEQ
D     DUM = 0.0
```

```
      DUM     =          5.0 * H / 288.0 * (19.0 * Z(I,1) + 75.0 * Z(I,2)
     1 + 50.0 * Z(I,3) + 50.0 * Z(I,4) + 75.0 * Z(I,5) + 19.0 * Z(I,6))
D  81 Y(I,L+1) = Y(I,1) + DUM
  100 DO 101 I = 1, NDEQ
  101 YTAB(I) = Y(I,L+1)
      CALL DEQNS
      DO 110 I = 1, NDEQ
  110 Z(I,K) = ZTAB(I)
      L = L + 1
      K = K + 1
      INDEX = INDEX + 1
      S = S + H
      IF(K-6) 30,30, 9999
      END


*     PRED
*     LIST8
*     LABEL
*     DIAGOL
      SUBROUTINE PRED
CPRED
C
C
      COMMON YTAB, ZTAB, Z, ATAB, ITAB
      COMMON YDP, YPD, YPDP, YCD, YCDP, Y
      COMMON WANL, VANL, UANL, BANL
      DIMENSION YTAB(10), ZTAB(10), Z(10,12), ATAB(20), ITAB(10)
D     DIMENSION YDP(10), YPD(10), YPDP(10), YCD(10), YCDP(10), Y(10,12)
      EQUIVALENCE  (YTAB( 1),   WN), (YTAB( 2),   VN), (YTAB( 3),   UN),
     1             (YTAB(4 ),   BN), (YTAB( 5), XMN), (YTAB( 6), XNPN),
     2             (YTAB( 7), XNN), (YTAB( 8),   QN)
      EQUIVALENCE (ZTAB( 1), WDOT), (ZTAB( 2), VDOT), (ZTAB( 3), UDOT),
     1             (ZTAB( 4), BDOT), (ZTAB( 5), XMDOT),(ZTAB( 6),XNPDOT)
     2,            (ZTAB( 7),XNNDOT), (ZTAB( 8),  QDOT)
      EQUIVALENCE  (ATAB( 1),    XO), (ATAB( 2),      S), (ATAB( 3),    H),
     1             (ATAB( 4),EPSIL), (ATAB( 5),    DX), (ATAB(6), FLAG),
     2             (ATAB( 7),DELTA), (ATAB( 8),  RTN), (ATAB( 9), SMAX),
     3             (ATAB(10),HSTAR), (ATAB(11),DBLGT), (ATAB(12),HAVGT),
     4             (ATAB(13),GAMMA)
      EQUIVALENCE  (ITAB( 1), NDEQ), (ITAB( 2),    L), (ITAB( 3),INDEX),
     1             (ITAB( 4),     K)
      DO 10 I = 1, NDEQ
      DUM      = H / 1440.0 * (4277.0 * Z(I,K-1) - 7923.0 * Z(I,K-2) +
     1 9982.0 * Z(I,K-3) - 7298.0 * Z(I,K-4) + 2877.0 * Z(I,K-5) -
     2 475.0 * Z(I,K-6))
D     YPD(I)     = 0.0
      YPD(I)     = DUM
D     YPDP(I)     = 0.0
D     YPDP(I)     = YDP(I)     + YPD(I)
   10 YTAB(I) = YPDP(I)
      CALL DEQNS
      DO 20 I = 1, NDEQ
      Z(I,K) = ZTAB(I)
```

```
      DUM      = H / 1440.0 * (475.0 *  Z(I,K) + 1427.0 * Z(I,K-1) -
     1 798.0 * Z(I,K-2) + 482.0 * Z(I,K-3) - 173.0 * Z(I,K-4) + 27.0 *
     2 Z(I,K-5))
D     YCD(I)     = 0.0
      YCD(I)     = DUM
D     YCDP(I)     = 0.0
D     YCDP(I)     = YDP(I)    + YCD(I)
   20 YTAB(I) = YCDP(I)
      CALL DEQNS
      FLAG = 1
      RETURN
      END
```

```
*     DEQNS
*     LIST8
*     LABEL
*     DIAGOL
      SUBROUTINE DEQNS                                                   10
CDEQNS
      COMMON YTAB, ZTAB, Z, ATAB, ITAB
      COMMON YDP, YPD, YPDP, YCD, YCDP, Y
      COMMON IND, NHALT
      DIMENSION YTAB(10), ZTAB(10), Z(10,12), ATAB(20), ITAB(10)
D     DIMENSION YDP(10), YPD(10), YPDP(10), YCD(10), YCDP(10), Y(10,12)
      DIMENSION A(64)
      EQUIVALENCE  (YTAB( 1),   Q1), (YTAB( 2),   Q2), (YTAB( 3),   Q3),
     1             (YTAB( 4),   Q4), (YTAB( 5),   Q5), (YTAB( 6),   Q6),
     2             (YTAB( 7),   Q7), (YTAB( 8),   Q8)
      EQUIVALENCE  (ZTAB( 1),   P1), (ZTAB( 2),   P2), (ZTAB( 3),   P3),
     1             (ZTAB( 4),   P4), (ZTAB( 5),   P5), (ZTAB( 6),   P6),
     2             (ZTAB( 7),   P7), (ZTAB( 8),   P8)
      EQUIVALENCE  (ATAB( 1),   XO), (ATAB( 2),    S), (ATAB( 3),    H),
     1             (ATAB( 4),EPSIL), (ATAB( 5),   DX), (ATAB(6), FLAG),
     2             (ATAB( 7),DELTA), (ATAB( 8),  RTN), (ATAB( 9), SMAX),
     3             (ATAB(10),HSTAR), (ATAB(11),DBLGT), (ATAB(12),HAVGT),
     4             (ATAB(13),GAMMA), (ATAB(18),   XN)
      EQUIVALENCE  (ITAB( 1), NDEQ), (ITAB( 2),    L), (ITAB( 3),INDEX),
     1             (ITAB( 4),    K)
      EQUIVALENCE (ITAB( 6), JUMP)
      IF(IND) 10,10,20
   10 READ INPUT TAPE 5, 1, NFGN, E, XMU, C, ZZ
    1 FORMAT (I10, 6F10.0)                                               66
      WRITE OUTPUT TAPE 6, 3, E, XMU, XN, C, ZZ
    3 FORMAT (1H0/8X,1HE,16X,3HXMU,11X,2HXN,13X,1HC,14X,2HZZ /1PE14.4,
     1  0PF16.4,F11.0, F15.1, F15.1 //)
      DO 15 I = 1,8                                                      70
   15 BUD = FGEN(I,1,S)                                                  80
      N = NFGN - 8                                                       90
      DO 16 I = 1,N                                                     100
      J = I + N + 7
   16 BUD = FGEN(J,1,S)
      WRITE OUTPUT TAPE 6, 4
    4 FORMAT (1H1/)
```

```
    100 IF(ABSF(H)-HMIN)120,120,101
    101 DO 103 I=1,NDEQ
D       DIF(I) = 0.0
D       DIF(I)  = ABSF(YPD(I) - YCD(I))
    103 EMAX(I) = MAX1F(ABSF(YCDP(I)), GAMMA)
    104 DO 105 I = 1, NDEQ
C       TEMAX(I)= 0.25 * ABSF(YCDP(I)) + 0.75 * EMAX(I)
C       EMAX(I) = MAX1F (ABSF(YCDP(I)), GAMMA)
C       IF(DIF(I)  - C1 * TEMAX(I)) 105, 105, 110
        IF (DIF(I) - C1 * EMAX(I)) 105, 105, 110
    105 CONTINUE
C       DO 106 I = 1, NDEQ
C   106 EMAX(I) = TEMAX(I)
        GOTO 120
    110 HAVGT = 1.0
        CALL OUT(2)
        GOTO 70
    120 DO 125 I = 1, NDEQ
        Z(I,K) = ZTAB(I)
D   125 YDP(I)    = YCDP(I)
        IF (K - 11) 130, 140, 140
    130 K = K + 1
    135 CALL OUT(2)
        S = S + H
        GOTO 200
    140 IF(ABSF(H)-HMAX)141,160,160
    141 DO 150 I = 1, NDEQ
D       DIF(I) = 0.0
D       DIF(I) = ABSF(YPD(I) - YCD(I))
        EMAX(I) = MAX1F(ABSF(YCDP(I)), GAMMA)
        IF(DIF(I) - C2 * EMAX(I)) 150, 150, 160
    150 CONTINUE
        DBLGT = 1.0
        CALL OUT(2)
        GOTO 70
    160 DO 170 I = 1, NDEQ
        DO 170 J = 1, 10
    170 Z(I,J) = Z(I,J+1)
        GOTO 135
    200 IF (SIGNH * (S - SMAX)) 65, 220, 210
    210 HSTAR = SMAX - S + H
        CALL MOD
    220 S = SMAX - 0.00001
    221 CALL PRED
        S = SMAX
        CALL OUT(1)
        RTN = 1.0
        GOTO 65
        END

*       RA /
*       LISTB
*       LABEL
```

```
*       DIAGOL
        SUBROUTINE HAV
CHAV
C
C
        COMMON YTAB, ZTAB, Z, ATAB, ITAB
        COMMON YDP, YPD, YPDP, YCD, YCDP, Y
        COMMON WANL, VANL, UANL, BANL
        DIMENSION YTAB(10), ZTAB(10), Z(10,12), ATAB(20), ITAB(10)
D       DIMENSION YDP(10), YPD(10), YPDP(10), YCD(10), YCDP(10), Y(10,12)
        DIMENSION ZH(10,3)
        EQUIVALENCE  (YTAB( 1),   WN), (YTAB( 2),   VN), (YTAB( 3),   UN),
     1               (YTAB(4 ),   BN), (YTAB( 5), XMN), (YTAB( 6), XNPN),
     2               (YTAB( 7), XNN), (YTAB( 8),   QN)
        EQUIVALENCE (ZTAB( 1), WDOT), (ZTAB( 2), VDOT), (ZTAB( 3), UDOT),
     1               (ZTAB( 4), BDOT), (ZTAB( 5), XMDOT),(ZTAB( 6),XNPDOT)
     2,              (ZTAB( 7),XNNDOT), (ZTAB( 8),  QDOT)
        EQUIVALENCE  (ATAB( 1),    XO), (ATAB( 2),     S), (ATAB( 3),    H),
     1               (ATAB( 4),EPSIL), (ATAB( 5),    DX), (ATAB(6), FLAG),
     2               (ATAB( 7),DELTA), (ATAB( 8),  RTN), (ATAB( 9), SMAX),
     3               (ATAB(10),HSTAR), (ATAB(11),DBLGT), (ATAB(12),HAVGT),
     4               (ATAB(13),GAMMA)
        EQUIVALENCE  (ITAB( 1), NDEQ),                   (ITAB( 3),INDEX),
     1               (ITAB( 4),    K)
        H = H / 2.0
        CON = 1.0 / 256.0
        IF (SENSE SWITCH 6) 1, 2
      1 CALL OUT(3)
      2 DO 5 I = 1, NDEQ
        ZH(I,1) = CON * (7.0 * Z(I,K-6) - 45.0 * Z(I,K-5) + 126.0 *
     1 Z(I,K-4) - 210.0 * Z(I,K-3) + 315.0 * Z(I,K-2) + 63.0 * Z(I,K-1))
        ZH(I,2) = CON * (-3.0 * Z(I,K-6) + 21.0 * Z(I,K-5) - 70.0 *
     1 Z(I,K-4) + 210.0 * Z(I,K-3) + 105.0 * Z(I,K-2) - 7.0 * Z(I,K-1))
        ZH(I,3) = CON * (3.0 * Z(I,K-6) - 25.0 * Z(I,K-5) + 150.0 *
     1 Z(I,K-4) + 150.0 * Z(I,K-3) -25.0 * Z(I,K-2) + 3.0 * Z(I,K-1))
      5 CONTINUE
        L = - 1
        M = 5
        DO 10 J = 1, 4
        L = L + 2
        M = M - 1
        N = K - M
        DO 10 I = 1, NDEQ
     10 Z(I,L) = Z(I,N)
        L = 8
        DO 20 N = 1, 3
        L = L - 2
        DO 20 I = 1, NDEQ
     20 Z(I,L) = ZH(I,N)
        K = 8
        S = S - H
        IF (SENSE SWITCH 6) 30, 100
     30 WRITE OUTPUT TAPE 6, 3, ((Z(I,L), L = 1, 6), I = 1, 4)
      3 FORMAT (28H  VALUES OF PAST DERIVATIVES/(1P6E20.7/)//)
    100 RETURN
```

```
      END

*     DBL
*     LIST8
*     LABEL
*     DIAGOL
      SUBROUTINE DBL
CDBL
C
C
      COMMON YTAB, ZTAB, Z, ATAB, ITAB
      COMMON YDP, YPD, YPDP, YCD, YCDP, Y
      COMMON WANL, VANL, UANL, BANL
      DIMENSION YTAB(10), ZTAB(10), Z(10,12), ATAB( 20), ITAB(10)
      DIMENSION SAVZ(10,12)
D     DIMENSION YDP(10), YPD(10), YPDP(10), YCD(10), YCDP(10), Y(10,12)
      EQUIVALENCE  (YTAB( 1),   WN), (YTAB( 2),   VN), (YTAB( 3),   UN),
     1             (YTAB(4 ),   BN), (YTAB( 5), XMN), (YTAB( 6), XNPN),
     2             (YTAB( 7), XNN), (YTAB( 8),   QN)
      EQUIVALENCE (ZTAB( 1), WDOT), (ZTAB( 2), VDOT), (ZTAB( 3), UDOT),
     1             (ZTAB( 4), BDOT), (ZTAB( 5), XMDOT),(ZTAB( 6),XNPDOT)
     2,            (ZTAB( 7),XNNDOT), (ZTAB( 8),   QDOT)
      EQUIVALENCE  (ATAB( 1),    XO), (ATAB( 2),      S), (ATAB( 3),    H),
     1             (ATAB( 4),EPSIL), (ATAB( 5),    DX), (ATAB(6), FLAG),
     2             (ATAB( 7),DELTA), (ATAB( 8),   RTN), (ATAB( 9), SMAX),
     3             (ATAB(10),HSTAR), (ATAB(11),DBLGT), (ATAB(12),HAVGT),
     4             (ATAB(13),GAMMA)
      EQUIVALENCE  (ITAB( 1), NDEQ), (ITAB( 2),     L), (ITAB( 3),INDEX),
     1             (ITAB( 4),     K)
      SAVS=S
      SAVH=H
      H = 2.0 * H
      S=S+H
      FLAG=2.0
      CALL TEST
      IF(RTN-1.0)20,100,100
   20 DO 30 I=1,NDEQ
      DO 30 J=1,11
   30 SAVZ(I,J)=Z(I,J)
      DO 40 I=1,NDEQ
      DO 40 J=1,6
      K=2*J-1
   40 Z(I,J)=SAVZ(I,K)
      K=7
      CALL PRED
      CALL TEST
      IF(HAVGT)100,100,50
   50 DO 60 I=1,NDEQ
      DO 60 J=1,10
   60 Z(I,J)=SAVZ(I,J+1)
      K=11
      HAVGT = 0.0
      H=SAVH
```

```
      S=SAVS+H
  100 RETURN
      END
```

```
*     MOD
*     LIST8
*     LABEL
*     DIAGOL
      SUBROUTINE  MOD
CMOD
C
C
      COMMON YTAB, ZTAB, Z, ATAB, ITAB
      COMMON YDP, YPD, YPDP, YCD, YCDP, Y
      COMMON WANL, VANL, UANL, BANL
      DIMENSION YTAB(10), ZTAB(10), Z(10,12), ATAB(20), ITAB(10)
D     DIMENSION YDP(10), YPD(10), YPDP(10), YCD(10), YCDP(10), Y(10,12)
      DIMENSION YST(10, 5)
      EQUIVALENCE  (YTAB( 1),  WN), (YTAB( 2),  VN), (YTAB( 3),  UN),
     1             (YTAB(4 ),  BN), (YTAB( 5), XMN), (YTAB( 6), XNPN),
     2             (YTAB( 7), XNN), (YTAB( 8),  QN)
      EQUIVALENCE (ZTAB( 1), WDOT), (ZTAB( 2), VDOT), (ZTAB( 3), UDOT),
     1             (ZTAB( 4), BDOT), (ZTAB( 5), XMDOT),(ZTAB( 6),XNPDOT)
     2,            (ZTAB( 7),XNNDOT), (ZTAB( 8),  QDOT)
      EQUIVALENCE  (ATAB( 1),    XO), (ATAB( 2),     S), (ATAB( 3),    H),
     1             (ATAB( 4),EPSIL), (ATAB( 5),   DX), (ATAB(6), FLAG),
     2             (ATAB( 7),DELTA), (ATAB( 8),  RTN), (ATAB( 9), SMAX),
     3             (ATAB(10),HSTAR), (ATAB(11),DBLGT), (ATAB(12),HAVGT),
     4             (ATAB(13),GAMMA)
      EQUIVALENCE  (ITAB( 1), NDEQ), (ITAB( 2),   L), (ITAB( 3),INDEX),
     1             (ITAB( 4),    K)
      CON = 1.0 / 120.0
      HI  = HSTAR / H
      DO 10 M = 1, 5
      XM  = M
      XMH = XM * HI
      A = 5.0 - XMH
      B = A - 1.0
      C = B - 1.0
      D = C - 1.0
      E = D - 1.0
      F = E - 1.0
      DO 10 I = 1, NDEQ
   10 YST(I,M) = CON * (-B * C * D * E * F * Z(I,K-6) + 5.0 * A * C *  D
     1 * E * F * Z(I,K-5) - 10.0 * A * B * D * E * F * Z(I,K-4) + 10.0 *
     2 A * B * C * E * F * Z(I,K-3) - 5.0 * A * B * C * D * F * Z(I,K-2)
     3 + A * B * C * D * E * Z(I,K-1))
      DO 5 I = 1, NDEQ
    5 Z(I,6) = Z(I,K-1)
      M = 6
      DO 20 J = 1, 5
      M = M - 1
      DO 20 I = 1, NDEQ
```

```
20 Z(I,M) = YST(I,J)
   H = HSTAR
   K = 7
   RETURN
   END
```

2. GLAUZ

The second package used a routine obtained from SHARE written by R. Glauz. This routine was written in FAP and later converted to MAP. The program used a third order Runge-Kutta as a starter routine and then switched over to Adams' method. The nice feature about this routine is that after a full difference table has been set, halving and doubling could be accomplished without re-evaluation of the derivatives at three or four additional points. A FORTRAN subroutine has been written following the general logic.

```
*     FAP
*     GLAUZ     SUBROUTINE - ADAMS METHOD INTEGRATION                  AS124001
* GLAUZ - ADAMS METHOD OF INTEGRATION                                  AS124003
        ENTRY   ADMSET                                                 AS124005
        ENTRY   ADMRES                                                 AS124006
        ENTRY   ADMINT                                                 AS124007
        ENTRY   ADMCOR                                                 AS124008
        ENTRY   ADMPAR                                                 AS124009
ADMSET  CLA*    1,4                 N TO ACC                           AS124010
        ARS     18                  N TO ADDR                          AS124011
        STA     BZ                  N TO ADDR OF BZ                    AS124012
        STO     TEMP                N IN ADDR                          AS124013
        ALS     2                   4N                                 AS124014
        ADD     TEMP                +N                                 AS124015
        STA     CF                  5N TO ADDR CF                      AS124016
        STO     TEMPA               5N IN ADDR                         AS124017
        CLA     2,4                 F FUNCTICN LOC.                    AS124018
        ADD     ADMSET              1 IN ADDR                          AS124019
        STA     LF                  FUNCTION VALUE LOCATION            AS124020
        CLA     3,4                 DERIV LOC                          AS124021
        ADD     ADMSET              +1                                 AS124022
        STA     LD                  DERIV VALUE LOC.                   AS124023
        CLA     4,4                 PARTIAL STEP LOC.                  AS124024
        ADD     ADMSET              +1                                 AS124025
        STA     CP                  PARTIAL STEP LOCATION              AS124026
        CLA     5,4                 DIFF TABLE LOC.                    AS124027
        ADD     ADMSET              +1                                 AS124028
        STA     CC                  DIFF TABLE LOC.                    AS124029
        SUB     TEMPA               -5N                                AS124030
        STA     CK                  OLD FCN. LCC.                      AS124031
        SUB     TEMP                -N                                 AS124032
        STA     CA                  ACCURACY EXPONENT TABLE            AS124033
        SUB     TEMP                -N                                 AS124034
        STA     LG                  TEST VALUE LOC                     AS124035
        CLA     6,4                                                    AS124036
        STA     CX                  X LOC.                             AS124037
        CLA     7,4                                                    AS124038
        STA     CH                  H LOC.                             AS124039
        CLA     8,4                                                    AS124040
        ADD     ADMSET                                                 AS124041
        STA     CD                  ACCURACY INPUT TABLE               AS124042
        TXI     *+1,4,-8                                               AS124043
ADMRES  STZ     FLAG                ZERO FLAG                          AS124044
        SXA     IR4A,4                                                 AS124045
        LXA     BZ,4                N TO IR4                           AS124046
CD      CAL     **,4                ACCURACY INPUT,4                   AS124047
        NZT*    CD                  TEST FOR ZERO ACCURACY INPUT       AS124048
        CLA     TEST                ACCURACY SET EQUAL TO +152         AS124049
        ANA     MASKT                                                  AS124050
        ADD     FACT                                                   AS124051
CA      STO     **,4                ACCURACY EXPONENT,4                AS124052
        TIX     CD,4,1                                                 AS124053
IR4A    AXT     **,4                                                   AS124054
        SXA     IR1R,1                                                 AS124055
        LXA     CF,1                5N TO IR1                          AS124056
        STZ*    CC                  DIFF TABLE,1                       AS124057
        TIX     *-1,1,1             LOOP TO ZERO TABLE                 AS124058
        AXT     5,1                                                    AS124059
        SXD     CNT,1                                                  AS124060
IR1R    AXT     **,1                                                   AS124061
        TRA     1,4                                                    AS124062
```

```
ADMINT SXA     IR41,4                   STORE RETURN ADDR.              AS124063
       NZT     FLAG                                                     AS124064
       TRA     1,4                      RETURN IF FLAG=0                AS124065
BZ     AXT     **,4                     N TO IR4                        AS124066
       CLA*    LF                       FUNCTION,4                      AS124067
CK     STO     **,4                     OLD FUNCTION,4                  AS124068
       TIX     *-2,4,1                                                  AS124069
BF     AXT     COEFP,4                  PRED TABLE LOC                  AS124070
       SXA     CO,4                                                     AS124071
       TSX     COMP,4                                                   AS124072
CX     CLA     **                       X                               AS124073
CH     FAD     **                       H                               AS124074
       STO*    CX                       STORE IN X                      AS124075
IR4I   AXT     **,4                                                     AS124076
       TRA     1,4                                                      AS124077
COMP   SXA     IR1,1                                                    AS124078
       SXA     IR2,2                                                    AS124079
       SXA     IR4,4                                                    AS124080
       LXA     BZ,4                     N TO IR4                        AS124081
CF     AXT     **,1                     5N TO IR1                       AS124082
CB     AXT     5,2                      5 TO IR2                        AS124083
       STZ     TEMP                                                     AS124084
CC     LDQ     **,1                     DIFF TABLE,1                    AS124085
CO     FMP     **,2                     COEF,2                          AS124086
       FAD     TEMP                                                     AS124087
       STO     TEMP                                                     AS124088
       TXI     *+1,1,-1                 NEXT DIFFERENCE                 AS124089
       TIX     CC,2,1                   NEXT COEF                       AS124090
       AXT     0,2                      0 TO IR2                        AS124091
LD     LDQ     **,4                     DERIV,4                         AS124092
       FMP*    CO                       COEF,2                          AS124093
       FAD     TEMP                                                     AS124094
       XCA                                                              AS124095
       FMP*    CH                       H                               AS124096
LG     STO     **,4                     TEST VALUE,4                    AS124097
CCM    FAD*    CK                       OLD FUNCTICN,4                  AS124098
CM     STO*    LF                       FUNCTION,4                      AS124099
       TIX     CB,4,1                   NEXT EQUATION                   AS124100
IR4    AXT     **,4                                                     AS124101
IR2    AXT     **,2                                                     AS124102
IR1    AXT     **,1                                                     AS124103
       TRA     1,4                                                      AS124104
ADMCOR CLA     FLAG                                                     AS124105
       TZE     FIRST                    ZERO FLAG GO TO FIRST           AS124106
       SXA     IR40,4                                                   AS124107
       STD     TT                       0 TO DECR TT                    AS124108
       LXA     BZ,4                     N TO IR4                        AS124109
DA     CLA*    LG                       TEST VALUE,4                    AS124110
       STO     TEMPA,4                  PREDICTOR TEST VALUE,4          AS124111
       TIX     DA,4,1                                                   AS124112
       AXT     COEFC,4                  CORRECTOR TABLE LOC             AS124113
       SXA     CO,4                                                     AS124114
       TSX     COMP,4                                                   AS124115
       LXA     BZ,4                     N TO IR4                        AS124116
LF     CAL     **,4                     FUNCTION,4                      AS124117
       ANA     MASKT                    KEEP EXPONENT ONLY              AS124118
       SUB     FACS                     SHIFT EXPONENT                  AS124119
       UFA*    LG                       TEST VALUE,4                    AS124120
       UFS     TEMPA,4                  DEL YC - DEL YP                 AS124121
       SSP                                                              AS124122
       UFA*    CA                                                       AS124123
```

```
         ANA    MASKD          DOUBLING TEST 0 DOUBLE            AS124124
         TZE    *+2                                              AS124125
         SXD    TT,4           NO DOUBLE FLAG OVER 0             AS124126
         ANA    MASKH          HALVING TEST  0 NO HALVE          AS124127
         TNZ    HALV           NO ZERO HALVE                     AS124128
DE       TIX    LF,4,1                                           AS124129
         LXA    BZ,4           N TO IR4                          AS124130
         LXD    CNT,1                                            AS124131
         TXL    *+3,1,0                                          AS124132
         TXI    *+1,1,-1       REDUCE CNT BY 1                   AS124133
         SXD    CNT,1                                            AS124134
         LXA    CF,1           5N TO IR1                         AS124135
LP       AXT    5,2            5 TO IR2                          AS124136
         LDQ*   LD             DERIV,4                           AS124137
CPR      CLS*   CC             DIFF TABLE,1                      AS124138
         STQ*   CC             DIFF TABLE,1                      AS124139
         FAD*   CC             DIFF TABLE,1                      AS124140
CP       XCA    **,4                                             AS124141
CNT      TXH    *+2,2,**                                         AS124142
         LDQ    COEFP          0.                                AS124143
         TXI    *+1,1,-1       NEXT DIFF                         AS124144
         TIX    CPR,2,1                                          AS124145
         TIX    LP,4,1                                           AS124146
TT       TXL    IR40,4,**      ** ZERO DOUBLE                    AS124147
         AXT    TDBL,4                                           AS124148
         SXA    TY,4                                             AS124149
         TSX    MAT,4                                            AS124150
         LDQ*   CH             H                                 AS124151
         FMP    THAL+1         2.0                               AS124152
         STO*   CH             H                                 AS124153
IR40     AXT    **,4                                             AS124154
         TRA    IR2
HALV     AXT    THAL,4         HALVING TABLE                     AS124156
         SXA    TY,4                                             AS124157
         TSX    MAT,4                                            AS124158
         CLA*   CX             X                                 AS124159
         FSB*   CH             H                                 AS124160
         STO*   CX             X BACKED UP                       AS124161
         LDQ*   CH             H                                 AS124162
         FMP    TPBL           .5                                AS124163
         STO*   CH             NEW H                             AS124164
         TSX    IR2,4          RESTORE IR1,IR2 DESTROYED BY MAT  AS124165
         TRA    BF                                               AS124166
FIRST    STL    FLAG           FLAG NOT EQUAL ZERO               AS124167
         SXA    IR1F,1         STORE IR1                         AS124168
         LXA    BZ,4           N TO IR4                          AS124169
         LXA    CF,1           5N TO IR1                         AS124170
         CLA*   LD             DERIV,4                           AS124171
         STO*   CC             DIFF TABLE,1                      AS124172
         TXI    *+1,1,-5       MOVE TO NEXT DERIV IN DIFF TABLE  AS124173
         TIX    *-3,4,1                                          AS124174
IR1F     AXT    **,1                                             AS124175
         TRA    ADMINT+3                                         AS124176
MAT      LXA    CF,1           5N TO IR1                         AS124177
         SXA    IR4M,4                                           AS124178
TM       AXT    4,4            4 TO IR4                          AS124179
         AXT    9,2            9 TO IR2                          AS124180
TV       SXD    TU,4           STORE IR4 IN SHIFT LOC.           AS124181
         TXI    *+1,1,-1       MOVE PAST Y OR PAST DIFF.         AS124182
         STZ    TEMP                                             AS124183
TX       LDQ*   CC             DIFF TABLE,1                      AS124184
```

```
TY      FMP     **,2            MAT COEF,2                      AS124185
        FAD     TEMP                                            AS124186
        STO     TEMP                                            AS124187
        TXI     *+1,1,-1        MOVE TO NEXT DIFF.              AS124188
        TXI     *+1,2,-1        MOVE TO NEXT COEF.              AS124189
        TIX     TX,4,1          GO FOR MORE TERMS               AS124190
TU      TXI     *+1,1,**        MOVE BACK TO ORIG DIFF          AS124191
TZ      STO*    CC              DIFF TABLE,1                    AS124192
        LXD     TU,4            RESET IR4                       AS124193
        TIX     TV,4,1          REDUCE IR4 BY 1                 AS124194
        TIX     TW,1,1          MOVE TO Y TERM OR ALL THROUGH   AS124195
IR4M    AXT     **,4                                            AS124196
        TRA     1,4                                             AS124197
ADMPAR  SXA     IR2,2                                           AS124198
        SXA     IR1,1                                           AS124199
        SXA     IR4PA,4                                         AS124200
        CLA*    1,4             XP                              AS124201
        FSB*    CX              XP-X                            AS124202
        FDP*    CH              XP-X/H=P                        AS124203
        STQ     TEMPA-5         P TO TEMPA-5                    AS124204
        STZ     TEMPA                                           AS124205
        AXT     -4,4            GENERATE POWERS OF P            AS124206
        FMP     TEMPA-5                                         AS124207
        STO     TEMPB-4,4                                       AS124208
        XCA                                                     AS124209
        TXI     *+1,4,1                                         AS124210
        TXH     *-4,4,0                                         AS124211
        AXT     5,1                                             AS124212
        AXT     CPP,4                                           AS124213
        SXA     TX,4                                            AS124214
        SXA     TZ,4                                            AS124215
        AXT     TPBL,4                                          AS124216
        SXA     TY,4                                            AS124217
        TSX     MAT+1,4         AVOIDS 5N TO IR1                AS124218
        AXT     CC,4                                            AS124219
        SXA     TX,4                                            AS124220
        SXA     TZ,4                                            AS124221
        AXT     1,1                                             AS124222
        AXT     4,2                                             AS124223
CPP     CLA     TEMPB+1,1                                       AS124224
        STO     TEMPA,2                                         AS124225
        TXI     *+1,1,1                                         AS124226
        TIX     *-3,2,1                                         AS124227
        AXT     TEMPA,4                                         AS124228
        SXA     CD,4                                            AS124229
        AXT     LF,4                                            AS124230
        SXA     CCM,4                                           AS124231
        AXT     CP,4                                            AS124232
        SXA     CM,4                                            AS124233
        TSX     COMP+2,4                                        AS124234
        AXT     LF,4                                            AS124235
        SXA     CM,4                                            AS124236
        AXT     CK,4                                            AS124237
        SXA     CCM,4                                           AS124238
IR4PA   AXT     **,4                                            AS124239
        TRA     2,4                                             AS124240
MASKH   OCT     000777777600                                    AS124241
MASKD   OCT     000777777776                                    AS124242
MASKT   OCT     +377000000000                                   AS124243
FACS    OCT     +002000000000                                   AS124244
FACT    OCT     +022000000000                                   AS124245
```

```
TEST   OCT    +152000000000                                  AS124246
FLAG   NOP    0                                              AS124247
       DEC    1.              1                              AS124248
       DEC    .5              1/2                            AS124249
       OCT    +177652525253   .416666667   5/12              AS124250
       DEC    .375            3/8                            AS124251
       OCT    +177544764477   .348611111   251/720           AS124252
COEFP  DEC    0.                                             AS124253
       OCT    +200515405541   .651388889    469/720          AS124254
       OCT    +176466026603   .151388889     109/720         AS124255
       DEC    .0680555556     49/720                         AS124256
       OCT    +173660266027   .026388889    19/720           AS124257
       DEC    0.                                             AS124258
COEFC  OCT    +177544764477   .348611111   251/720           AS124259
       DEC    .00833333333    6/720                          AS124260
       DEC    .0625           45/720=1/16                    AS124261
       DEC    .152777778      110/720                        AS124262
       DEC    .125            90/720=1/8                     AS124263
       DEC    .0416666667     1/24                           AS124264
       DEC    .166666667      1/6                            AS124265
       DEC    .166666667      1/6                            AS124266
       DEC    .166666667      1/6                            AS124267
       DEC    .25             1/4                            AS124268
TPBL   DEC    .5                                             AS124269
       DEC    .125                                           AS124270
       DEC    .0625                                          AS124271
       DEC    .0390625                                       AS124272
       DEC    .25                                            AS124273
       DEC    .125                                           AS124274
       DEC    .078125                                        AS124275
       DEC    .125                                           AS124276
       DEC    .09375                                         AS124277
THAL   DEC    .0625                                          AS124278
       DEC    2.                                             AS124279
       DEC    -1.                                            AS124280
       DEC    0.                                             AS124281
       DEC    0.                                             AS124282
       DEC    4.                                             AS124283
       DEC    -4.                                            AS124284
       DEC    1.                                             AS124285
       DEC    8.                                             AS124286
       DEC    -12.                                           AS124287
TDBL   DEC    16.                                            AS124288
       COMMCN -206                                           AS124289
TEMP   COMMON                                                AS124290
TEMPA  SYN    TEMP-1                                         AS124291
TEMPB  SYN    TEMP-10                                        AS124292
       END                                                   AS124293
```

3. DZ BKY ZAM

A subroutine written by Meissner at University of California, Berkeley Lawrence Radiation Lab, using an Adams-Moulton predictor-corrector method, with a starting procedure based upon Zonneveld formulae. The subroutine uses a variable step size, but the steps are forced to land on multiples of the specified print interval. If change in step size is encountered, re-evaluation of the difference table is required.

```
      FORTRAN IV SUBROUTINE INTO(NO,X,DERI ,Y,F,T,HPRO)
      COMMON /INTC/ IPMX,AREF,EMAX,SSSR,HFAC,SWAM,SWEX
      COMMON /INTP/ HPR,XX,N,EUB,ELE,IP,IT,NRKS,SWIN
      DIMENSION Y(1),F(1),T(8,1)
      LOGICAL SWAM,SWEX,SWIN
      INTEGER HFAC
      DOUBLE PRECISION T,HPRO,HPR,XX
      DATA IPMX,AREF,EMAX,SSSR,HFAC,SWAM,SWEX
     $     /1024,1.0,1.0E-6,100.0,2,.TRUE.,.TRUE./
C
      HPR=HPRO
      XX=DBLE(X)
      N=NO
      EUB=EMAX
      ELB=EMAX/SSSR
      IP=1
      IT=0
      NRKS=0
      SWIN=SWEX
      CALL DERI (X,Y,F)
      DO 9 I=1,N
      T(5,I)=DBLE(Y(I))
    9 CONTINUE
      RETURN
      END
       SUBROUTINE INT(X,DERI ,Y,F,T,SWPR
     X )
      COMMON /INTC/ IPMX,AREF,EMAX,SSSR,HFAC,SWAM,SWEX
      COMMON /INTP/ HPR,XX,N,EUB,ELE,IP,IT,NRKS,SWIN
C
       DIMENSION Y(1),F(1),T(8,1)
      LOGICAL SWAM,SWEX,SWIN
      LOGICAL SWPR
      INTEGER HFAC
       DOUBLE PRECISION T,HPR,XX
       DOUBLE PRECISION D,H
 6000  FORMAT (36H0 CANNOT DECREASE H BECAUSE OF HMIN.    ,1PE16.8,I20)
C
 1     CONTINUE
       SWPR=.FALSE.
       TEST=0.0
       H=HPR/DBLE(FLOAT(IP*24))
       IF ((NRKS .LT. 3) .OR. (.NOT. SWAM)) GO TO 200
```

```
C
C      ADAMS-MOULTON STEP.
  100  CONTINUE
       DO 109 I=1,N
       D=DBLE(F(I))
       T(4,I)=D
       Y(I)=SNGL(T(5,I)+H*(
     X 55.0D0*D-59.0D0*T(3,I)+37.0D0*T(2,I)- 9.0D0*T(1,I) ))
  109  CONTINUE
       X=SNGL(XX+24.0D0*H)
      CALL DERI (X,Y,F)
       DO 119 I=1,N
       D=DBLE(F(I))
       D=(     T(5,I)+H*(
     X  9.0D0*D+19.0D0*T(4,I)- 5.0D0*T(3,I)+        T(2,I) ))
       T(6,I)=D
       E=ABS(SNGL(D)-Y(I))/14.0
       TEST=AMAX1(E/AMAX1(AREF,ABS(SNGL(D))),TEST)
  119  CONTINUE
C
       GO TO 300
C
C      ZONNEVELD STEP.
  200  CONTINUE
       DO 209 I=1,N
       D=DBLE(F(I))
       T(4,I)=D
C      1
       Y(I)=SNGL(T(5,I)+H*(
     X 12.0D0*D                                          ))
  209  CONTINUE
       X=SNGL(XX+12.0D0*H)
      CALL DERI (X,Y,F)
       DO 219 I=1,N
       D=DBLE(F(I))
       T(6,I)=D
C      2
       Y(I)=SNGL(T(5,I)+H*(
     X 12.0D0*D                                          ))
  219  CONTINUE
      CALL DERI (X,Y,F)
       DO 229 I=1,N
       D=DBLE(F(I))
       T(7,I)=D
C      3
       Y(I)=SNGL(T(5,I)+H*(
     X 24.0D0*D                                          ))
  229  CONTINUE
       X=SNGL(XX+24.0D0*H)
      CALL DERI (X,Y,F)
       DO 239 I=1,N
       D=DBLE(F(I))
       T(8,I)=D
C      4
       Y(I)=SNGL(T(5,I)+H*(
     X 3.75D0*T(4,I)+5.25D0*T(6,I)+9.75D0*T(7,I)-0.75D0*D ))
  239  CONTINUE
       X=SNGL(XX+18.0D0*H)
      CALL DERI (X,Y,F)
       DO 249 I=1,N
```

```
      D=DBLE(F(I))
      E=ABS(SNGL(H*(
     X -16.0D0*T(4,I)+48.0D0*T(6,I)+48.0D0*T(7,I)+48.0D0*T(8,I)
     X -128.0D0*D    )))
C     5
      D=(     T(5,I)+H*(
     X 4.0D0*T(4,I)+ 8.0D0*T(6,I)+ 8.0D0*T(7,I)+ 4.0D0*T(8,I)
     X ))
      T(6,I)=D
      TEST=AMAX1(E/AMAX1(AREF,ABS(SNGL(D))),TEST)
  249 CONTINUE
C
C     BOTH ADAMS-MOULTON AND ZONNEVELD METHODS CONTINUE FROM HERE.
  300 CONTINUE
     X=SNGL(XX+24.0D0*H)
      IF (TEST .LE. EUB) GO TO 310
      IF (IP*HFAC .GT. IPMX) GO TO 309
C
C     REPEAT STEP WITH SMALLER H.
      NRKS=0
      IP=IP*HFAC
      IT=IT*HFAC
      DO 305 I=1,N
      Y(I)=SNGL(T(5,I))
      F(I)=SNGL(T(4,I))
  305 CONTINUE
      GO TO 1
C
C     CANNOT DECREASE H BECAUSE OF HMIN.
  309 CONTINUE
     IF (.NOT. SWIN) GO TO 310
      PRINT 6000, X,IPMX
     SWIN=.FALSE.
C
  310 CONTINUE
C
C
C     ACCEPT CURRENT STEP.
C
C     XX STILL HAS NOT BEEN CHANGED SINCE ENTRY.
C     YY(XX) IS STILL IN T(5, ).
C     F(YY) IS IN T(4, ).
C
      IT=IT+1
      XX=XX+HPR/DBLE(FLOAT(IP))
      NRKS=MIN0(NRKS+1,4)
      DO 319 I=1,N
      D=T(6,I)
      T(5,I)=D
      Y(I)=SNGL(D)
  319 CONTINUE
      X=SNGL(XX)
     CALL DERI (X,Y,F)
      IF (IT .LT. IP) GO TO 320
C
C     X IS A MULTIPLE OF HPRINT.
      SWPR=.TRUE.
      IT=IT-IP
C
  320 CONTINUE
```

```
      IF (TEST .GE. ELB) GO TO 330                                      Z
      IF (MOD(IP,HFAC)+MOD(IT,HFAC) .NE. 0) GO TO 330                   Z
C                                                                       Z
C     PROCEED TO NEXT STEP WITH LARGER H, USING ZONNEVELD METHOD.       Z
      NRKS=0                                                            Z
      IP=IP/HFAC                                                        Z
      IT=IT/HFAC                                                        Z
      RETURN                                                            Z
C                                                                       Z
C                                                                       Z
C     PROCEED TO NEXT STEP WITH SAME H.                                 Z
  330 CONTINUE                                                          Z
      DO 339 I=1,N                                                      Z
      T(1,I)=T(2,I)                                                     Z
      T(2,I)=T(3,I)                                                     Z
      T(3,I)=T(4,I)                                                     Z
  339 CONTINUE                                                          Z
      RETURN                                                            Z
      END                                                               Z
```

4. AL ADAM

This subroutine written by Jeske at NASA-Ames uses a fourth order Adams' method with an iterated fourth order Adams' first sum method with a Mersman starter included. This routine uses a fixed step.

```
      SUBROUTINE ADAMS(T,A,DERIV,H,K,N)
      DIMENSION A(9,N)
C
C     DO LOOPS ON THE SECOND SUBSCRIPT IN THE A ARRAY ARE INDICATED BY
C     J=1(1)N IN THE COMMENTS. THE SUBSCRIPT J DENOTES THE JTH COMPONENT
C     OF WHATEVER VECTOR IS INDICATED (I.E., THE JTH COMPONENT OF X,F,
C     ETC.). SECOND SUBSCRIPT IS OMITTED IN THE COMMENTS (I.E.,A1=A(1,J)
C     A2=A(2,J),ETC.).
C
C     NOTATION--
C     T=INDEPENDENT VARIABLE
C     A=ARRAY OF DEPENDENT VARIABLES,DERIVATIVES,BACKWARD DIFFERENCES,
C       AND FIRST SUMS
C     DERIV=NAME OF THE SUBROUTINE THAT CALCULATES THE DERIVATIVES
C          F(X,T) AND STORES THEM IN A2 FOR J=1(1)N.
C     H=INCREMENT OF INTEGRATICN (I.E.,INTEGRATION STEP,STEP-SIZE,OR
C       DELTA T)
C     K=ENTRY CODE (DEFINED BELOW)
C     N=NUMBER OF FIRST ORDER DIFFERENTIAL EQUATIONS
C
C *** FOR A DISCUSSION OF THE METHOC SEE NASA TN D-2936, SELF-STARTING
C     MULTISTEP METHODS FOR THE NUMERICAL INTEGRATION OF ORDINARY
C*** DIFFERENTIAL EQUATIONS, BY WILLIAM A. MERSMAN, JULY, 1965.
C
C     ENTRY POINT--BEGIN SUBROUTINE--
C
      IF (H.EQ.0.0) CALL EXIT
      DT=H
      B=T
      M=N
C
C     SELECT MODE--
C       A. FORWARD STARTER (K=0)
C       B. BACKWARD STARTER (K=-1)
C       C. INTEGRATE ONE STEP WITH PREDICTOR  -  CORRECTOR (K GE 1)
C
C
      IF (K.LT.0) GO TO 2
      IF (K.GT.0) GO TO 49
C     - - F O R W A R D  - B A C K W A R D   S T A R T E R - - - - - -
C
C
C     H IS SET TO -H IF THE FORWARD STARTER IS REQUESTED.
C     THE CODING IS WRITTEN FOR THE BACKWARD STARTER.
C
```

```
C       BEFORE THE FORWARD OR BACKWARD STARTERS CAN BE EXECUTED THE A
C       ARRAY MUST CONTAIN --
C          A1=X0, THE INITIAL VALUES OF X FOR J=1(1)N, ALSO SET T=T0, THE
C          INITIAL VALUE OF T.
C
      3 DT=-DT
      2 D=DT/1440.
        CALL DERIV(B,A)
        DO 24 J=1,M
        A(9,J)=A(1,J)
        A(8,J)=A(1,J)-0.5*DT*A(2,J)
        DO 26 I=3,7
     26 A(I,J)=A(2,J)
     24 CONTINUE
C
C       STATEMENTS 2 - 24 CALCULATES F0, SAVES X0, SETS F0=F1=F2=F3=F4,
C       AND COMPUTES FS4 (THE FIRST SUM AT T=T0+4H). THIS COMMENT, AND ALL
C       FURTHER COMMENTS FOR THE FORWARD STARTER, APPLIES TO THE BACKWARD
C       STARTER, TOO, IN WHICH CASE REPLACE F1 BY F-1, F2 BY F-2, F3 BY
C       F-3, F4 BY F-4, FS4 BY FS0 AND X1 TO X4 BY X-1 TO X-4.
C
C       THE A ARRAY NOW CONTAINS FOR J=1(1)N
C       A1=X0
C       A2=F0
C       A3=F0
C       A4=F0
C       A5=F0
C       A6=F0
C       A7=F0
C       A8=FS4 OR FS0
C       A9=X0
C
        DO 38 II=1,8
     28 B=B-DT
C
C       SET T=T0+H OR T=T0-H
C
        DO 27 J=1,M
     27 A(1,J)=A(8,J)+D*(11.0*A(7,J)-66.0*A(6,J)+192.0*A(5,J)-830.0*A(4,J)
      1-1467.0*A(3,J))
        CALL DERIV(B,A)
        DO 29 J=1,M
     29 A(4,J)=A(2,J)
C
C       A NOW CONTAINS FOR J=1(1)N
C       A1=X1 OR X-1
C       A2=F1 OR F-1
C       A3=F0
C       A4=F1 OR F-1
C       A5=F0
C       A6=F0
C       A7=F0
C       A8=FS4 OR FS0
C       A9=X0
C
        B=B-DT
C
C       SET T=T0+2H OR T=T0-2H
C
        DO 30 J=1,M
```

```
   30 A(1,J)=A(8,J)-D*(11.0*A(7,J)-82.0*A(6,J)+720.0*A(5,J)+1522.0*A(4,J
     1)+1429.0*A(3,J))
      CALL DERIV(B,A)
      DO 31 J=1,M
   31 A(5,J)=A(2,J)
C
C     A NOW CONTAINS FOR J=1(1)N
C     A1=X2 OR X-2
C     A2=F2 OR X-2.
C     A3=F0
C     A4=F1  OR F-1
C     A5=F2  OR F-2
C     A6=F0
C     A7=F0
C     A8=FS4 OR FS0
C     A9=X0
C
      B=B-DT
C
C     SET T=T0+3H OR T=T0-3H
C
      DO 32 J=1,M
   32 A(1,J)=A(8,J)+D*(27.0*A(7,J)-610.0*A(6,J)-1632.0*A(5,J)-1374.0*A(4
     1,J)-1451.0*A(3,J))
      CALL DERIV(B,A)
      DO 33 J=1,M
   33 A(6,J)=A(2,J)
C
C     A NOW CONTAINS FOR J=1(1)N
C     A1=X3 OR X-3
C     A2=F3 OR F-3
C     A3=F0
C     A4=F1 OR F-1
C     A5=F2 OR F-2
C     A6=F3 OR F-3
C     A7=F0
C     A8=FS4 OR FS0
C     A9=X0
C
      B=B-DT
C
C     SET T=T0+4H OR T=T0-4H
C
      DO 34 J=1,M
   34 A(1,J)=A(8,J)-D*(475.0*A(7,J)+1902.0*A(6,J)+1104.0*A(5,J)+1586.0*A
     1(4,J)+1413.0*A(3,J))
      CALL DERIV(B,A)
      DO 35 J=1,M
   35 A(7,J)=A(2,J)
C
C     A NOW CONTAINS FOR J=1(1)N
C     A1=X4 OR X-4
C     A2=F4 OR F-4
C     A3=F0
C     A4=F1 OR F-1
C     A5=F2 OR F-2
C     A6=F3 OR F-3
C     A7=F4 OR F-4
C     A8=FS4 OR FS0
C     A9=X0
```

```
C
      DO 36 J=1,M
   36 A(8,J)=A(9,J)+D*(27.0*A(7,J)-146.0*A(6,J)+336.0*A(5,J)-462.0*A(4,J
     1)+965.0*A(3,J))
      B=T
   38 CONTINUE
C
C     STATEMENTS 28 THROUGH 38 CONSTITUTE AN ITERATION LOOP (WITH EIGHT
C     ITERATIONS) FOR THE FORWARD OR BACKWARD STARTER.
C
C     DURING THE ITERATION THE A ARRAY CONTAINS FOR J=1(1)N
C     A1=X1,X2,X3, OR X4 -- OR X-1,X-2,X-3, OR X-4
C     A2=F1,F2,F3, OR F4 -- OR F-1,F-2,F-3, OR F-4
C     A3=F0          (ORIGINAL VALUE)
C     A4=F1 OR F-1 (CURRENT VALUE)
C     A5=F2 OR F-2 (CURRENT VALUE)
C     A6=F3 OR F-3 (CURRENT VALUE)
C     A7=F4 OR F-4 (CURRENT VALUE)
C     A8=FS4 OR FS0 (CURRENT VALUE)
C     A9=X0          (ORIGINAL VALUE)
C
C     BEGIN CALCULATION OF BACKWARD DIFFERENCES --
C
   37 IF(K.LT.0) GO TO 39
C
C     DIFFERENCES FOR FORWARD STARTER --
C
C     THE A ARRAY CONTAINS FOR J=1(1)N
C     A1=X4
C     A2=F4
C     A3=F0
C     A4=F1
C     A5=F2
C     A6=F3
C     A7=F4
C     A8=FS4
C     A9=X0
C
      DO 40 J=1,M
C
C     STEP ONE
C
      A(1,J)=A(9,J)
      A(2,J)=A(3,J)
      DO 41 I=3,6
   41 A(I,J)=A(I+1,J)-A(I,J)
C
C     STEP TWO
C
      DO 42 I=1,3
      L=7-I
   42 A(L,J)=A(L,J)-A(L-1,J)
C
C     STEP THREE
C
      A(6,J)=A(6,J)-A(5,J)
      A(5,J)=A(5,J)-A(4,J)
C
C     STEP FOUR
C
```

```
      A(6,J)=A(6,J)-A(5,J)
      DO 43 I=1,3
      L=6-I
   43 A(L,J)=A(L,J)-A(L+1,J)
C
C     STEP FIVE
C
      A(7,J)=A(5,J)-A(6,J)
      A(4,J)=A(4,J)-A(7,J)
   40 A(5,J)=A(7,J)-A(6,J)
C
C     THE DIFFERENCES OF F0 HAVE BEEN CONSTRUCTED ACCORDING TO THE
C     FOLLOWING TABLE.  AN EXAMPLE CF THE NOTATION IS 2D2F3, WHICH MEAN
C     THAT THE SECOND ITEM STORED IN THIS COLUMN (INDICATED BY THE FIRS
C     DIGIT 2) IS THE SECOND DIFFERENCE (INDICATED BY D2) OF F3.  THE
C     SECOND COLUMN IS THE DATA THAT WAS IN THE A ARRAY AT THE TIME OF
C      COMPLETION OF THE ITERATION.  ALL TABLE VALUES ARE FOR J=1(1)N.
C
C     LOC        STEP ONE  STEP TWO  STEP THREE  STEP FOUR  STEP FIVE
C
C     A1   X4    1X0
C     A2   F4    2F0
C     A3   F0    3D1F1                           4D1F0
C     A4   F1    4D1F2     3D2F2                 3D2F1      2D2F0
C     A5   F2    5D1F3     2D2F3     2D3F3       2D3F2      3D3F0
C     A6   F3    6D1F4     1D2F4     1D3F4       1D4F0
C     A7   F4                                               1D3F1
C     A8   FS4
C     A9   X0
C
C     NOTE -- IT IS ASSUMED THAT D4F4=D4F3=D4F2=D4F1=D4F0=CONSTANT
C
C     THE A ARRAY NOW CONTAINS FOR J=1(1)N
C     A1=X0
C     A2=F0
C     A3=D1F0
C     A4=D2F0
C     A5=D3F0
C     A6=D4F0
C     A7=D3F1
C     A8=FS4
C     A9=X0
C
C     FS0 WILL NOW BE CALCULATED AND STORED IN A8
C
      D=-D
   93 DO 44 J=1,M
   44 A(8,J)=A(1,J)+D*(27.0*A(6,J)+38.0*A(5,J)+60.0*A(4,J)+120.0*A(3,J)
     1720.0*A(2,J))
C
C     END OF FORWARD STARTER
C
      CALL DERIV(T,A)
      RETURN
C
C     DIFFERENCES FOR BACKWARD STARTER
C
   39 DO 45 J=1,M
C
C     STEP ONE
```

```
C
      A(1,J)=A(9,J)
      A(2,J)=A(3,J)
      DO 46 I=3,6
   46 A(I,J)=A(I,J)-A(I+1,J)
C
C     STEPS TWO, THREE AND FOUR
C
      DO 47 I=1,3
      L=6
      LL=I+2
   48 A(L,J)=A(L-1,J)-A(L,J)
      L=L-1
      IF (L.NE.LL) GO TO 48
   47 CONTINUE
   45 CONTINUE
C
C     THE DIFFERENCES OF F0 HAVE BEEN COMPUTED ACCORDING TO THE
C     FOLLOWING TABLE.  AN EXAMPLE OF THE  NOTATION IS 2D2F-1, WHICH
C     MEANS THAT THE SECOND ITEM STORED IN THIS COLUMN (INDICATED BY TI
C     FIRST DIGIT 2) IS THE SECOND DIFFERENCE (INDICATED BY D2) OF F-1.
C     THE SECOND COLUMN IS THE DATA THAT WAS IN THE A ARRAY AT THE TIMI
C     OF COMPLETION  OF THE ITERATION. ALL VALUES ARE FOR J=1(1)N.
C
C     LOC.       STEP ONE    STEP TWO    STEP THREE    STEP FOUR
C
C     A1   X-4   1X0
C     A2   F-4   2F0
C     A3   F0    3D1F0
C     A4   F-1   4DIF-1     3D2F0
C     A5   F-2   5D1F-2      2D2F-1      2D3F0
C     A6   F-3   6D1F-3      1D2F-2      1D3F-1        1D4F0
C     A7   F-4
C     A8   FS0
C     A9   X0
C
C     THE A ARRAY NOW CONTAINS FOR J=1(1)N
C     A1=X0
C     A2=F0
C     A3=D1F0
C     A4=D2F0
C     A5=D3F0
C     A6=D4F0
C     A7=F-4
C     A8=FS0
C     A9=X0
C
C     END OF BACKWARD STARTER
C
      GO TO 93
C
C     BEGIN INTEGRATION WITH THE ADAMS-BASHFORTH PREDICTOR AND THE
C     ADAMS-MOULTON CORRECTOR.  AT THIS ENTRY POINT THE A ARRAY CONTAII
C     FOR J=1(1)N
C     A1=XI
C     A2=FI
C     A3=D1FI
C     A4=D2FI
C     A5=D3FI
C     A6=D4FI
```

```
C        A7=D5FI
C        A8=FSI
C        A9=PREDICTED VALUE OF FI FROM THE PREVIOUS INTEGRATION STEP
C
C        WHERE FI=F(X(T0+IH),T0+IH), I=1,2,3,...
C
C        D5FI SHOULD BE NEARLY ZERO AND IS AN INDICATION OF THE ACCURACY
C        OF THE INTEGRATION.
C
C         - - A D A M S - B A S H F O R T H   P R E D I C T O R - - - - - -
C
C        BEGIN PREDICTOR
C
      49 DO 570 KK=1,K
         B=B+DT
         DO 92 J=1,M
         I=7
      50 A(I,J)=A(I-1,J)
         I=I-1
         IF (I.NE.2) GO TO 50
      92 CONTINUE
         D=DT/1440.0
         DO 51 J=1,M
      51 A(1,J)=A(8,J)+D*(475.0*A(7,J)+502.0*A(6,J)+540.0*A(5,J)+600.0*A(4,
        1J)+720.0*A(3,J))
         CALL DERIV(B,A)
         DO 52 J=1,M
         DO 53 L=3,7
      53 A(L,J)=A(L-1,J)-A(L,J)
      52 CONTINUE
C
C        THE SOLUTIONS X(I+1)=X(T0+(I+1)H), DERIVATIVES AND BACKWARD
C        DIFFERENCES HAVE BEEN COMPUTED IN THE ORDER INDICATED IN THE
C        FOLLOWING TABLE
C
C        LOC.            ONE     TWO       THREE
C
C        A1    XI                X(I+1)
C        A2    FI                F(I+1)
C        A3    D1FI     FI                 D1F(I+1)
C        A4    D2FI     D1FI               D2F(I+1)
C        A5    D3FI     D2FI               D3F(I+1)
C        A6    D4FI     D3FI               D4F(I+1)
C        A7    D5FI     D4FI               D5F(I+1)
C        A8    FSI
C
C        END PREDICTOR
C
C         - - A D A M S - M O U L T O N   C O R R E C T O R - - - - - - - -
C
C        BEGIN CORRECTOR
C
C        THE A ARRAY CONTAINS THE FOLLOWING FROM THE PREDICTOR FOR J=1(1)N
C        (THE LEADING P IN THE ENTRIES MEANS PREDICTED VALUE)
C
C        A1=PX(I+1)
C        A2=PF(I+1)
C        A3=PD1F(I+1)
C        A4=PD2F(I+1)
C        A5=PD3F(I+1)
```

```
C       A6=PD4F(I+1)
C       A7=PD5F(I+1)
C       A8=FSI
C
    556 DO 557 J=1,N
        A(1,J)=A(1,J)+475.0*D*A(7,J)
    557 A(9,J)=A(2,J)
        CALL DERIV(B,A)
    559 DO 565 J=1,N
        DELTA=A(2,J)-A(9,J)
        DO 566 I=3,7
    566 A(I,J)=A(I,J)+DELTA
    565 CONTINUE
C
C       THE CORRECTOR FORMULA HAS NOW BEEN APPLIED TO THE PREDICTED
C       VALUES, AND THE PREDICTED BACKWARD DIFFERENCES HAVE BEEN ADJUSTED
C       IN TERMS OF THE CORRECTED VALUES. THE ORDER IN WHICH ALL THIS WAS
C       DONE IS SHOWN IN THE FOLLOWING TABLE.(THE LEADING P INDICATES
C       PREDICTED VALUES AND THE LEADING C INDICATES CORRECTED VALUES).
C       ALL ENTRIES IN THE TABLE ARE FOR J=1(1)N.
C
C       LOC.                 ONE        TWO        THREE
C
C       A1    PX(I+1)                   1CX(I+1)
C       A2    PF(I+1)                   2CF(I+1)
C       A3    PD1F(I+1)                            1CD1F(I+1)=PD1F(I+1)+DELTA
C       A4    PD2F(I+1)                            2CD2F(I+1)=PD2F(I+1)+DELTA
C       A5    PD3F(I+1)                            3CD3F(I+1)=PD3F(I+1)+DELTA
C       A6    PD4F(I+1)                            4CD4F(I+1)=PD4F(I+1)+DELTA
C       A7    PD5F(I+1)                            5CD5F(I+1)=PD5F(I+1)+DELTA
C       A8    FSI
C       A9                   PF(I+1)
C
C       THE LEADING DIGIT IN COLUMNS TWO AND THREE INDICATES THE ORDER IN
C       WHICH THE ENTRIES WERE STORED.
C
C       THE A ARRAY NOW CONTAINS FOR J=1(1)N
C       A1=CX(I+1)=X
C       A2=CF(I+1)=F
C       A3=CD1F(I+1)=D1F
C       A4=CD2F(I+1)=D2F
C       A5=CD3F(I+1)=D3F
C       A6=CD4F(I+1)=D4F
C       A7=CD5F(I+1)=D5F
C       A8=FSI
C
C       END OF PREDICTOR CORRECTOR
C
C       COMPUTE FIRST SUM
     54 DO 59 J=1,M
     59 A(8,J)=A(8,J)+H*A(2,J)
    570 CONTINUE
        T=B
        RETURN
C       ON RETURN- A ARRAY CONTAINS FOR J=1(1)N--
C       A1=X
C       A2=F
C       A3=D1F
C       A4=D2F
C       A5=D3F
```

```
C       A6=D4F
C       A7=D5F
C       A8=FS
C
        END
```

5. DZ C STR

This routine was written by Hudson from Commonwealth Scientific and Industrial Research Organization, Canberra, Australia. Two FORTRAN statements require a CDC 3600 configuration. A trivial modification can be made and this program can be executed on the CDC 6600. The basic integration is a self-starting variation of the Adams' method incorporating automatic step size control.

```
FTN5.3A                                          06/19/67                                PAGE NO.     1
      SUBROUTINE NORDSET (K,T,H,N,Y,F,DELTAY,B,NTL,TL,NPL,PL)
C
C     K         CONTROL INTEGER FOR USER  STATEMENTS          INTEGER
C     T         INDEPENDENT VARIABLE                          REAL
C     H         INTEGRATION STEP SIZE                         REAL
C     N         NUMBER OF FIRST ORDER EQUATIONS               INTEGER
C     Y         DEPENDENT VARIABLES                           REAL
C     F         DERIVATIVES                                   REAL
C     DELTAY    ERROR CONTROL VECTOR                          REAL
C     B         TEMPORARY STORAGE, DIMENSION 10*N             REAL
C     NTL       NUMBER OF ENTRIES IN TL                       INTEGER
C     TL        LIST OF INTERUPT TIMES                        REAL
C     NPL       NUMBER OF ENTRIES IN PL                       INTEGER
C     PL        LIST OF INTERUPT FUNCTIONS                    REAL
C
C     B(1,I)    EQUIVALENT
C     B(2,I)        OF
C     B(3,I)            ADAMS
C     B(4,I)                DIFFERENCES
C     B(5,I)    PREDICTED DERIVATIVES
C     B(6,I)    Y AT START OF INTEGRATION STEP
C     B(7,I)    SECOND PRECISION PART OF Y ABOVE
C     B(8,I)    F AT START OF INTEGRATION STEP
C     B(9,I)    HOLE FOR INITIAL Y  WHILE STARTING
C     B(10,I)   SECOND PRECISION PART OF Y
C
      DIMENSION Y(1),F(1),B(10,N),TL(1),PL(1),DPTA(2),TEST(2)
     1FIND(10),PLEFT(10),PRITE(10)
      EQUIVALENCE (DPTA,DPTEMA)
      TYPE INTEGER STEP
      TYPE DOUBLE DPTEMA
      TYPE LOGICAL FIND,HALVE,DOUBLE
      COMMON/NORDCOM/IDER,IEOS,ITL,IPL,STEP,HMAX,HMIN,HBIG,HL
      DATA (HBIG=0),(HL=0)
C
      DELY(I)=H*(B(8,I)+(B(1,I)+(B(2,I)+(B(3,I)+(B(4,I)+Z)))))
      RETURN
      ENTRY NORDINT
      IF (K) GO TO KFLIP
C
C     TEST FOR CALLING SEQUENCE ERROR
C
      IF (H.LE.0.OR.N.LE.0.OR.N.GT.2000.OR.NTL.LT.0.OR.NTL.GT.500.OR.NPL
     X.LT.0.OR.NPL.GT.500.OR.DELTAY.LE.0.OR.T.LT.0)
     XCALL Q8QERROR (0,34HERROR IN NORDSET CALLING SEQUENCE.)
C
C     SET SUBROUTINE COUNTERS AND STEP SIZE DATA
C
      HMAX=HMIN=IDER=IEOS=ITL=IPL=STEP=0
C
C     CONTROL SECTION FOR STARTING INTEGRATION
C
      ASSIGN 3000 TO KFLIP
      GO TO 1001
 3000 H=H.AND.37774000000000000B
      DO 3002 J=1,NTL
```

```
FTN5.3A                                                06/19/67                      PAGE NO.     2
            IF (T.EQ.TL(J)) 3001,3002                                      NORD0560
      3001  ASSIGN 3002 TO KFLIP                                           NORD0570
            GO TO 1002                                                     NORD0580
      3002  CONTINUE                                                       NORD0590
            T LEFT=T                                                       NORD0600
            DO 3004 J=1,NPL                                                NORD0610
            PLEFT(J)=PL(J)                                                 NORD0620
            IF(PL(J).EQ.0.)3003,3004                                       NORD0630
      3003  ASSIGN 3004 TO KFLIP                                           NORD0640
            GO TO 1003                                                     NORD0650
      3004  CONTINUE                                                       NORD0660
            DO 3010 I=1,N                                                  NORD0670
      3010  B(9,I)=Y(I)                                                    NORD0680
            DI=-1.                                                         NORD0690
            ASSIGN 3100 TO ISFOUR                                          NORD0700
            GO TO 1400                                                     NORD0710
      3020  I=STEP.AND.3                                                   NORD0720
            IF (I) GO TO 2000                                              NORD0730
            I=STEP/4                                                       NORD0740
            GO TO (3030,3050,3030,3080,3030,3040) I                        NORD0750
      3030  DI=-1.                                                         NORD0760
            ASSIGN 2000 TO ISFOUR                                          NORD0770
            GO TO 1400                                                     NORD0780
      3040  DI=2.                                                          NORD0790
            HMAX=HMIN=-H                                                   NORD0800
            ASSIGN 3050 TO ISFOUR                                          NORD0810
            GO TO 1400                                                     NORD0820
      3050  DO 3060 I=1,N                                                  NORD0830
            Y(I)=B(9,I)                                                    NORD0840
      3060  B(10,I)=0.0                                                    NORD0850
      3070  ASSIGN 3030 TO KFLIP                                           NORD0860
            GO TO 1000                                                     NORD0870
      3080  DI=.5                                                          NORD0880
            ASSIGN 3090 TO ISFOUR                                          NORD0890
            GO TO 1400                                                     NORD0900
      3090  IF(HALVE)3100,3050                                             NORD0910
      3100  STEP=0                                                         NORD0920
            DO 3110 I=1,N                                                  NORD0930
      3110  B(1,I)=B(2,I)=B(3,I)=B(4,I)=0.0                                NORD0940
            GO TO 3050                                                     NORD0950
C                                                                          NORD0960
C           CONTROL SECTION FOR TIME INTERUPTS DURING NORMAL INTEGRATION   NORD0970
C                       STATEMENT 1700 INTEGRATES FORWARD,RETURNING TO 1701 NORD0980
C                                                                          NORD0990
      1700  GO TO 1600                                                     NORD1000
      1701  DO 1702 I=1,N                                                  NORD1010
            B(6,I)=Y(I)                                                    NORD1020
      1702  B(8,I)=F(I)                                                    NORD1030
            TSAVE=T                                                        NORD1040
      1703  Z=2.*TSAVE                                                     NORD1050
            DO 1705 I=1,NTL                                                NORD1060
            IF (TL(I).LT.Z) 1704,1705                                      NORD1070
      1704  Z=TL(I)                                                        NORD1080
            J=I                                                            NORD1090
      1705  CONTINUE                                                       NORD1100
            IF (Z.GE.TSAVE) GO TO 1707                                     NORD1110
```

```
FTN5.3A                                                   06/19/67                    PAGE NO.    3
            ASSIGN 1706 TOKFLIP                                               NORD1120
            RTEST=TSAVE/Z                                                     NORD1130
            RTEST=RTEST.AND..NOT.3                                            NORD1140
            IF (RTEST.EQ.1.0) 17051,17053                                     NORD1150
      17051 DO 17052 I=1,N                                                    NORD1151
      17052 Y(I)=B(6,I)                                                       NORD1152
            T=TSAVE                                                           NORD1153
            GO TO 1001                                                        NORD1154
      17053 HP=Z-TSAVE                                                        NORD1160
            ASSIGN 1001 TO ISTWO                                              NORD1170
            GO TO 1200                                                        NORD1180
       1706 ASSIGN 1703 TO KFLIP                                              NORD1190
            ASSIGN 1002 TO ISTHREE                                            NORD1200
            GO TO 1300                                                        NORD1210
       1707 DO 1708 I=1,N                                                     NORD1220
            F(I)=B(8,I)                                                       NORD1230
       1708 Y(I)=B(6,I)                                                       NORD1240
            T=TSAVE                                                           NORD1250
            ASSIGN 1300 TO KFLIP                                              NORD1260
            ASSIGN 1709 TO ISTHREE                                            NORD1270
            GO TO 1001                                                        NORD1280
       1709 RTEST=Z/T                                                         NORD1290
            RTEST=RTEST.AND..NOT.3                                            NORD1300
            IF (RTEST.EQ.1.0) 1710,1711                                       NORD1310
       1710 ASSIGN 1711 TO KFLIP                                              NORD1320
            GO TO 1002                                                        NORD1330
       1711 DO 1712 I=1,NPL                                                   NORD1340
       1712 FIND(I)=.FALSE.                                                   NORD1350
            GO TO 1700                                                        NORD1360
      C                                                                       NORD1370
      C     INTEGRATE ONE STEP                                                NORD1380
      C                                                                       NORD1390
      C                      SAVE CONDITIONS AT START OF STEP                 NORD1400
      C                                                                       NORD1410
       2000 DO 2010 I=1,N                                                     NORD1420
            B(6,I)=Y(I)                                                       NORD1430
            B(7,I)=B(10,I)                                                    NORD1440
       2010 B(8,I)=F(I)                                                       NORD1450
            TSTART=T                                                          NORD1460
      C                                                                       NORD1470
      C                      ENTRY FOR HALVED STEP                            NORD1480
      C                                                                       NORD1490
       2020 T=T+H                                                             NORD1500
            DO 2030 I=1,N                                                     NORD1510
            Z=0                                                               NORD1520
            Y(I)=B(6,I)+DELY(I)                                               NORD1530
       2030 B(5,I)=F(I)+(2.*B(1,I)+(3.*B(2,I)+(4.*B(3,I)+5.*B(4,I))))         NORD1540
      C                                                                       NORD1550
      C                      ITERATE TWICE,DEVELOP TEST PARAMETERS            NORD1560
      C                                                                       NORD1570
            HALVE=.FALSE.                                                     NORD1580
            DOUBLE=.TRUE.                                                     NORD1590
            TEST(1)=TEST(2)=0.                                                NORD1600
            DO 2070 J=1,2                                                     NORD1610
            ASSIGN 2040 TO KFLIP                                              NORD1620
            GO TO 1000                                                        NORD1630
```

```
PTNS,3A                                          06/19/67                      PAGE NO.     4
      2040 DO 2070 I=1,N                                                NORD1640
           Z=F(I)-B(5,I)                                                NORD1650
           IF(J.EQ.2) 2050,2060                                         NORD1660
      2050 ZZ=ABSF(Z*H)                                                 NORD1670
           RTEST=DELTAY*ABSF(Y(I))                                      NORD1680
           IF (ZZ.GT.RTEST) HALVE=.TRUE.                                NORD1690
           IF (ZZ.GT.RTEST*.015625) DOUBLE=.FALSE.                      NORD1700
      2060 DPTA(1)=B(6,I)                                               NORD1710
           DPTA(2)=B( 7,I)                                              NORD1720
           Z=Z*.32986111111                                             NORD1730
           DPTEMA=DPTEMA+DELY(I)                                        NORD1740
           ZZ=ABSF(DPTA(1)-Y(I))                                        NORD1750
           IF (ZZ.GT.TEST(J))  TEST(J)=ZZ                               NORD1760
           Y(I)=DPTA(1)                                                 NORD1770
           B(10,I)=DPTA(2)                                              NORD1780
      2070 CONTINUE                                                     NORD1790
C                                                                       NORD1800
C          CHECK TEST PARAMETERS,BUMP COUNT OF INTEGRATION STEPS        NORD1810
C                                                                       NORD1820
           STEP=STEP+1                                                  NORD1830
           IF (STEP.GT.1.AND.STEP.LT.25) GO TO 1100                     NORD1840
           IF (8.*TEST(2).GT.TEST(1).AND..NOT.DOUBLE) GO TO 1500        NORD1850
           IF (8.*TEST(2).GT.TEST(1)) DOUBLE=.FALSE.                    NORD1860
           IF (STEP.EQ.1) GO TO 1100                                    NORD1870
           IF (HALVE) GO TO 1500,1100                                   NORD1880
C                                                                       NORD1890
C          UPDATE ROUTINE,RETURNS TO 3020 IF STARTING - 1701 OTHERWISE  NORD1900
C                                                                       NORD1910
      1100 DO1101 I=1,N                                                 NORD1920
           Z=F(I)-B(5,I)                                                NORD1930
           B(1,I)=B(1,I)+(3.*B(2,I)+(6.*B(3,I)+(10.*B(4,I)+Z/.96)))    NORD1940
           B(2,I)=B(2,I)+(4.*B(3,I)+(10.*B(4,I)+Z*0.486111111111))     NORD1950
           B(3,I)=B(3,I)+(5.*B(4,I)+Z/9.6)                             NORD1960
      1101 B(4,I)=B(4,I)+Z/120.                                         NORD1970
           IF (STEP.LE.24) GO TO 3020                                   NORD1980
           IF (H.GT.HMAX) HMAX=H                                        NORD1990
           IF (H.LT.HMIN) HMIN=H                                        NORD2000
           GO TO 1701                                                   NORD2010
C                                                                       NORD2020
C          ROUTINE TESTPHI,FALSE EXIT IS $1300,TRUE EXIT IS 1800        NORD2030
C                                                                       NORD2040
      1300 DO 1301 I=1,NPL                                              NORD2050
           IF (FIND(I)) GO TO 1301                                      NORD2060
           IF (PL(I)*PLEFT(I).LT.0) GO TO 1303                          NORD2070
      1301 CONTINUE                                                     NORD2080
           DO 1302 I=1,NPL                                              NORD2090
      1302 PLEFT(I)=PL(I)                                               NORD2100
           TLEFT=T                                                      NORD2110
           GO TO ISTHREE                                                NORD2120
      1303 DO 1304 I=1,NPL                                              NORD2130
      1304 PRITE(I)=PL(I)                                               NORD2140
           TRITE=T                                                      NORD2150
           GO TO 1800                                                   NORD2160
C                                                                       NORD2170
C          DEPENDENT VARIABLE SEARCH PROCEDURE,ENTERED IF PL(I) CHANGES SIGN NORD2180
C                                                                       NORD2190
```

```
FTN5.3A                                   06/19/67                        PAGE NO.   5
 1800 Z=0.0                                                   NORD2200
      DO 1802 I=1,NPL                                         NORD2210
      IF (FIND(I)) GO TO 1802                                 NORD2220
      IF (PRITE(I).EQ.0) PLEFT(I)=0                           NORD2230
      ZZ=PLEFT(I)/PRITE(I)                                    NORD2240
      IF (ZZ.LE.Z) 1801,1802                                  NORD2250
 1801 Z=ZZ                                                    NORD2260
      J=I                                                     NORD2270
 1802 CONTINUE                                                NORD2280
      HP=(TRITE-TSAVE)-(TRITE-TLEFT)/(1.-Z)                   NORD2290
      IF ((TSAVE+HP).EQ.T.OR.Z.EQ.0) 1803, 804                NORD2300
 1803 ASSIGN 1703 TO KFLIP                                    NORD2310
      FIND(J)=.TRUE.                                          NORD2320
      GO TO 1003                                              NORD2330
 1804 ASSIGN 1001 TO ISTWO                                    NORD2340
      ASSIGN 1300 TO KFLIP                                    NORD2350
      ASSIGN 1800 TO IS THREE                                 NORD2360
      GO TO 1200                                              NORD2370
C                                                             NORD2380
C     CHECK FOR DOUBLE OF STEP SIZE                           NORD2390
C                                                             NORD2400
 1600 IF (DOUBLE.AND.(.NOT.HBIG.OR.(H+H).LE.HBIG)) 1601,2000  NORD2410
 1601 D1=2.                                                   NORD2420
      ASSIGN 2000 TO ISFOUR                                   NORD2430
      GO TO 1400                                              NORD2440
C                                                             NORD2450
C     SUBROUTINE CALLS, ASSUMES KFLIP SET PRIOR TO ENTRY      NORD2460
C                                                             NORD2470
 1000 K=1                                                     NORD2480
      IDER=IDER+1                                             NORD2490
      RETURN                                                  NORD2500
 1001 K=2                                                     NORD2510
      IEOS=IEOS+1                                             NORD2520
      RETURN                                                  NORD2530
 1002 K=J+2                                                   NORD2540
      ITL=ITL+1                                               NORD2550
      RETURN                                                  NORD2560
 1003 K=J+NTL+2                                               NORD2570
      IPL=IPL+1                                               NORD2580
      RETURN                                                  NORD2590
C                                                             NORD2600
C     SUBROUTINE TO CHANGE STEP SIZE                          NORD2610
C                                                             NORD2620
 1400 H=H*D1                                                  NORD2630
      D2=D1*D1                                                NORD2640
      D3=D2*D1                                                NORD2650
      D4=D3*D1                                                NORD2660
      DO 1401 I=1,N                                           NORD2670
      B(1,I)=B(1,I)*D1                                        NORD2680
      B(2,I)=B(2,I)*D2                                        NORD2690
      B(3,I)=B(3,I)*D3                                        NORD2700
 1401 B(4,I)=B(4,I)*D4                                        NORD2710
      GO TO ISFOUR                                            NORD2720
C                                                             NORD2730
C     ROUTINE TO PREDICT INTERMEDIATE VALUES OF Y(I)          NORD2740
C                                                             NORD2750
```

```
FYNS,3A                                            06/19/67                      PAGE NO.    6
      1200 T=TSAVE+HP                                                           NORD2760
           D1=HP/H                                                              NORD2770
           D2=D1*D1                                                             NORD2780
           D3=D2*D1                                                             NORD2790
           D4=D3*D1                                                             NORD2800
           DO 1201 I=1,N                                                        NORD2810
      1201 Y(I)=B(6,I)+HP*(B(8,I)+(D1*B(1,I)+(D2*B(2,I)+(D3*B(3,I)+D4*B(4,I     NORD2820
          I)))))                                                                NORD2830
           GO TO ISTWO                                                          NORD2840
     C                                                                          NORD2850
     C     RESTORE T,Y,F.  HALVE STEP SIZE, TRY STEP AGAIN                      NORD2860
     C                                                                          NORD2870
      1500 RTEST=H/2                                                            NORD2880
           IF (HL.AND.RTEST.LT.HL) GO TO 2020                                   NORD2890
           IF (T.EQ.(T+RTEST)) CALL QQQERROR (0,23HH LESS THAN 2**(-36)*T.)     NORD2900
           STEP=STEP-1                                                          NORD2910
           T=TSTART                                                             NORD2920
           DO 1501 I=1,N                                                        NORD2930
           Y(I)=B(6,I)                                                          NORD2940
           B(10,I)=B(7,I)                                                       NORD2950
      1501 F(I)=B(8,I)                                                          NORD2960
           D1=.5                                                                NORD2970
           ASSIGN 2020 TO ISFOUR                                                NORD2980
           GO TO 1400                                                           NORD2990
           END                                                                  NORD3000
```

6. D2 GDC CSPDIF

This routine is a single step integration procedure utilizing a pseudo-Runge-Kutta method. This program is a catalog routine from Data Centers Division - CDC.

```
D2 GDC CSPDIF        AFFDL-TR-71-116
D2 CS PDIFE1,DIFE11PSEUDO-RUNGE-KUTTA METHOD
                   PDIFE1 PERFORMS A SUNGLE STEP OF INTEGRATION BY A PSEUDO-
                   RUNGE-KUTTA METHOD. IT REQUIRES A ≠STARTER≠ ROUTINE FOR THE
                   FIRST STEP. THE ROUTINE USED IS CALLED DIFE11 WHICH USES
                   THE RUNGE-KUTTA-MERSON METHOD.

      SUBROUTINE PDIFE1(DERIW,NDUMMY,HDUMMY,X,Y,YZ)
C
C
C     THIS SUBROUTINE PERFORMS ONE STEP OF INTEGRATION BY THE
C     PSEUDO-RUNGE-KUTTA METHOD. IT USES THREE EVALUATIONS
C     OF THE DERIVATIVES PER INTEGRATION STEP.
C
C     DERIW     =EXTERNAL NAME OF SUBROUTINE WHICH EVALUATES THE DERIVATI
C     NDUMMY    =NUMBER OF DIFFERENTIAL EQUATIONS IN THE SYSTEM
C     HDUMMY    =INTEGRATION STEP SIZE
C     X         =VALUE OF INDEPENDENT VARIABLE
C     Y         =VECTOR OF VALUES OF THE INTEGRATION VARIABLES
C     YZ        =VECTOR OF VALUES OF THE DERIVATIVES OF THE INTEGRATION
C                VARIABLES. THESE ARE INCLUDED FOR THE PURPOSE OF OUTPUT
C
      EXTERNAL DERIW
      COMMON / DIFE00 / YY(78),P1(78),P2(78),P3(78),P4(78),P5(78),P6(78)
     *          ,YZ(78),XLDP,DUDP,HDP
      DOUBLE PRECISION  XLDP,YLDP,      DUDP,HDP
      DIMENSION Y(1)
      COMMON / YLDP / YLDP(78)
      H= HDUMMY
      N= NDUMMY
      IF (H.GT.0.0) GO TO 100
      CALL DIFE11(DERIW,N,0.0,X,Y,P5,YZ)
      ASSIGN 200 TO IP
      RETURN
  100 GO TO IP ,(200,550)
  200 ASSIGN 550 TO IP
      DO 250 I=1,N
  250 YY(I)=Y(I)
      X1=X
      CALL DIFE11(DERIW,N,H,X,Y,P5,YZ)
      U1=.541
      U2=.763
      U3= 2.0*U2*(U2-U1)/(U1*(4.0-5.0*U1))
      C1= (5.0*(U1+U2)-6.0*U1*U2-4.0)/(12.0*U1*U2)
      C2=  (4.0-5.0*U2)/(12.0*U1*(U1-U2))
      C3=  (5.0*U1-4.0)/(12.0*U2*(U1-U2))
      U2MU3=U2-U3
  300 CALL DERIW(X1,YY,P1)
      X2=X1+U1*H
      X3=X1+U2*H
      DO 400 I=1,N
      P1(I)=H*P1(I)
  400 YZ(I)= YY(I)+ U1*P1(I)
      CALL DERIW(X2,YZ,P2)
```

```
      DO 500 I=1,N
      P2(I)=P2(I)*H
  500 YZ(I)= YY(I)+U2MU3*P1(I)+U3*P2(I)
      CALL DERIW(X3,YZ,P3)
      DO 600 I=1,N
      YZ(I)=P5(I)
  600 P3(I)=P3(I)*H
      RETURN
  550 CONTINUE
      X4=X+U1*H
      X5=X+U2*H
      CALL DERIW(X,Y,P4)
      DO 700 I=1,N
      P4(I)=P4(I)*H
  700 YZ(I)= Y(I)+U1*P4(I)
      CALL DERIW(X4,YZ,P5)
      DO 800 I=1,N
      P5(I)=P5(I)*H
  800 YZ(I)= Y(I)+U2MU3*P4(I)+U3*P5(I)
      CALL DERIW(X5,YZ,P6)
      DO 900 I=1,N
      YZ(I)=P6(I)
      P6(I)=P6(I)*H
      DU=           P4(I) -C1*(P4(I)-P1(I)) + C2*(P5(I)-P2(I))
     *  +C3*(P6(I)-P3(I))
      DUDP=DBLE(DU)
      YLDP(I)=YLDP(I)+DUDP
      Y(I)= SNGL(YLDP(I))
      P1(I)=P4(I)
      P2(I)=P5(I)
  900 P3(I)=P6(I)
      XLDP= XLDP+HDP
      X= SNGL(XLDP)
      RETURN
      END
      SUBROUTINE DIFE11(DERIW,NDUMMY,HDUMMY,X,Y,P5,YY)
C
C
C
C     THIS SUBROUTINE PERFORMS ONE STEP OF INTEGRATION BY THE
C     MERSONS MODIFIED RUNGE-KUTTA METHOD. IT USES FIVE SUBSTITUTIONS
C     INTO THE DIFFERENTIAL-EQUATIONS AND GIVES AN ESTIMATE OF THE
C     LOCAL TRUNCATION ERROR, WHICH CAN BE USED FOR THE ADJUSTMENT
C     OF THE STEP-SIZE
C
C        DERIW      = DUMMY-NAME FOR SUBROUTINE FOR THE EVALUATION
C                     OF THE RIGHT HAND SIDES OF THE DIFF.-EQUATIONS
C         N         = NUMBER OF THE EQUATIONS IN THE SYSTEM
C         H         = STEPSIZE
C         X         = INDEPENDENT VARIABLE
C        Y(I)       = DEPENDENT VARIABLE
C       ERR(I)      = LOCAL TRUNCATION ERROR
C
C     THE COMPUTED VALUES OF X AND Y ARE SAVED IN DOUBLE-PRECISION
C     FOR THE USE AS INITIAL-VALUES IN THE NEXT STEP
C
C     EACH TIME WHEN A NEW INTEGRATION SEQUENCE IS STARTED, THE
C     SUBROUTINE MUST BE CALLED WITH H=0 AND THE INITIAL-VALUES OF X AND
C     Y(I).
C
```

```
C
C     THE SUBROUTINE TESTS IF THE VALUE OF H IS THE SAME AS IN THE
C     PREVIOUS STEP
C        IF YES.. IT COMPUTES THE NEW STEP WITH THE X AND Y-VALUES
C                 AT THE END OF THE LAST STEP
C
C        IF NO..  IT COMPUTES THE NEW STEP WITH THE X AND Y-VALUES
C                 AT THE BEGINNING OF THE LAST STEP
C
C     TO REDUCE THE ROUND-OFF ERROR,DOUBLE -PRECISION IS USED IN
C     INCREMENTING THE DEPENDENT AND THE INDEPENDENT VARIABLES
C
C
C
C
      COMMON / DIFE00 / YY(78),P1(78),P2(78),P3(78),P4(78),P5(78),P6(78)
     *          ,YZ(78),XLDP,DUDP,HDP
      DOUBLE PRECISION  XLDP,YLDP,     DUDP,HDP
      COMMON /YLDP/ YLDP(78)
      DIMENSION Y(1)
      EXTERNAL DERIW
      H = HDUMMY
      N = NDUMMY
      IF (H) 60,20,60
   20 XLDP=DBLE(X)
      DO 40 I=1,N
   40 YLDP(I)=DBLE(Y(I))
      ASSIGN 80 TO IP
      RETURN
   60 GO TO IP, (80,160)
   80 ASSIGN 160 TO IP
C *** RESTORE X AND Y
  100 DO 120 I=1,N
  120 Y(I)=SNGL (YLDP(I))
      X = SNGL(XLDP)
  140 H0 = H
      HDP = DBLE(H)
      H2 = H/2.
      H3 = H/3.
      H6 = H/6.
      H8 = H/8.
      H15= H/15.
      GO TO 220
  160 CONTINUE
C *** PERFORM ACTUAL INTEGRATION
  220 CALL DERIW (X,Y,P1)
      DO 240 I=1,N
  240 YY(I) = Y(I)  + P1(I)*H3
      XX=X + H3
      CALL DERIW (XX,YY,P2)
      DO 260 I=1,N
  260 YY(I) = Y(I)  + (P1(I)+P2(I))*H6
      CALL DERIW (XX,YY,P3)
      DO 280 I=1,N
      P3(I) = P3(I)*3.
  280 YY(I) = Y(I)  + (P1(I)+P3(I))*H8
      XX = X + H2
      CALL DERIW (XX,YY,P4)
      DO 300 I=1,N
      P4(I) = P4(I)  * 4.
```

```
  300 YY(I) = Y(I) + (P1(I)-P3(I)+P4(I))*H2
      XX = X+H
      CALL DERIW (XX,YY,P5)
      DO 320 I=1,N
C *** DU = SINGLE PRECISION INCREMENT IN DEPENDENT VARIABLE
      DU = (P1(I) + P4(I) + P5(I))*H6
      DUDP = DBLE (DU)
      YLDP(I) = YLDP(I) + DUDP
      Y(I) = SNGL (YLDP(I))
  320 CONTINUE
      XLDP = XLDP + HDP
      X = SNGL (XLDP)
      RETURN
      END
```

SECTION V
SOLUTION OF EXAMPLE PROBLEMS

The following three problems typify the extended use of the SP computer program. The first case illustrates the program's capability to accept torsion. The second and third cases illustrate the effects of pressure on the inside and outside surfaces of a cylindrical shell respectively.

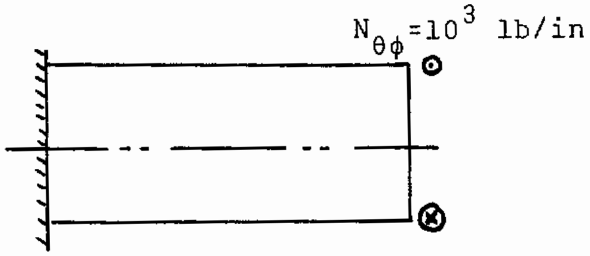

Figure 4
Torsional Problem

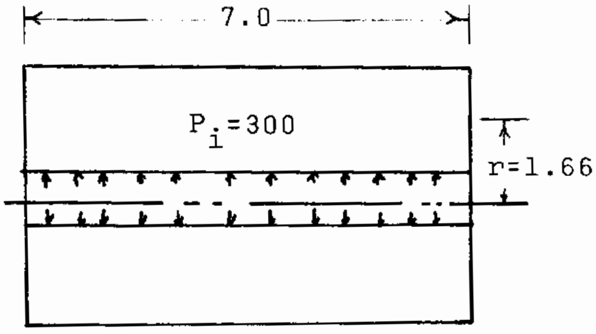

Figure 5
Internal Pressure Loading

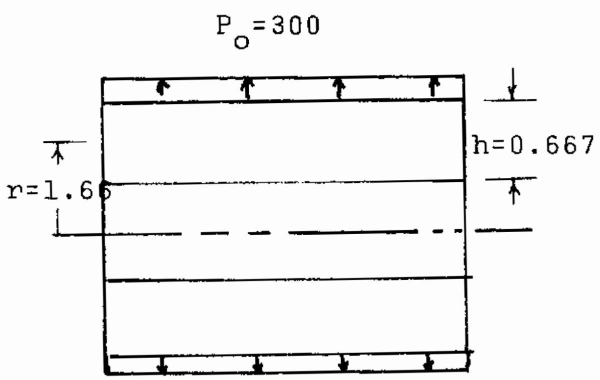

Figure 6
External Pressure Loading

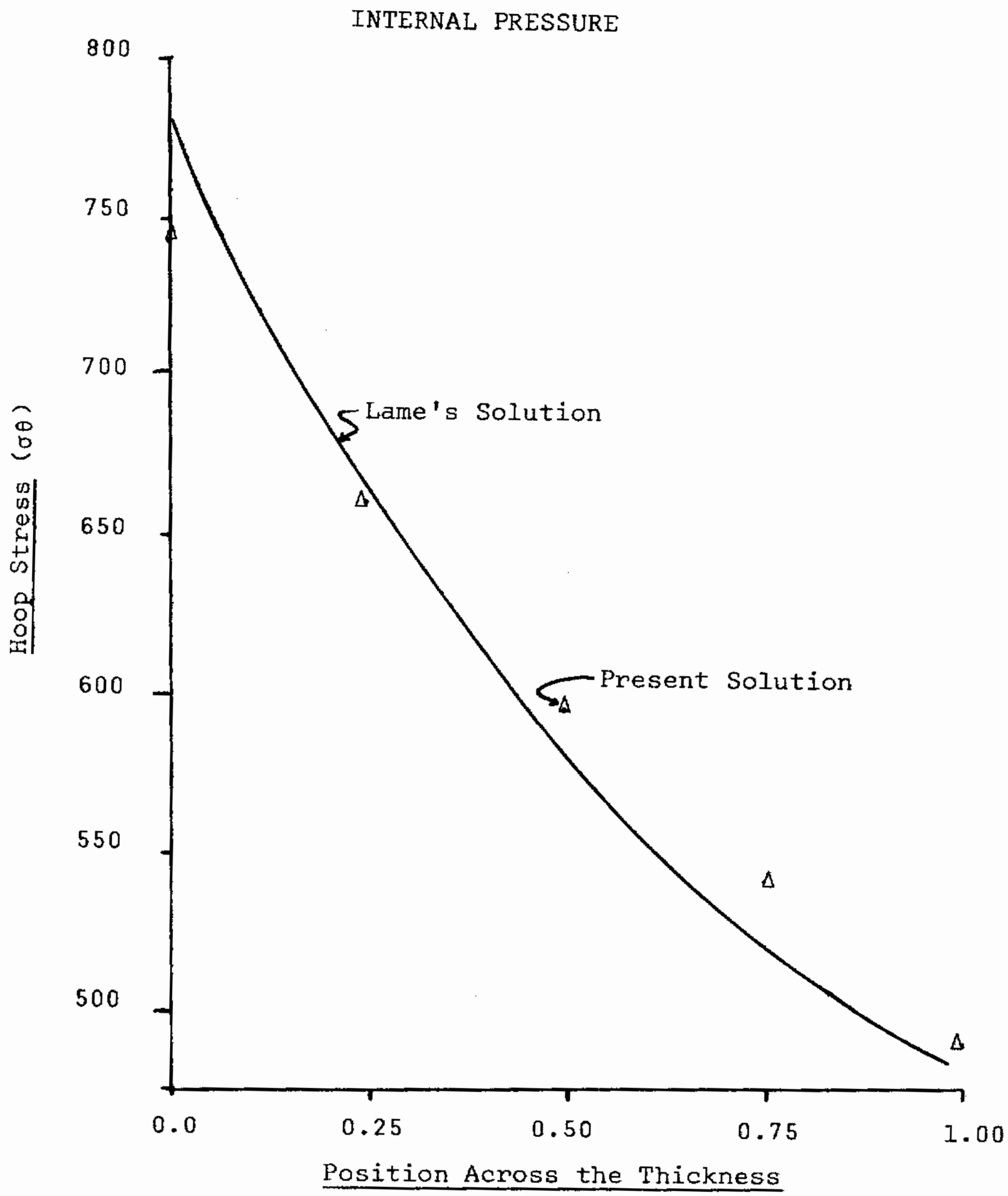

Figure 7
Hoop Stress Versus Position Across Thickness
(Internal Pressure Loading)

EXTERNAL PRESSURE

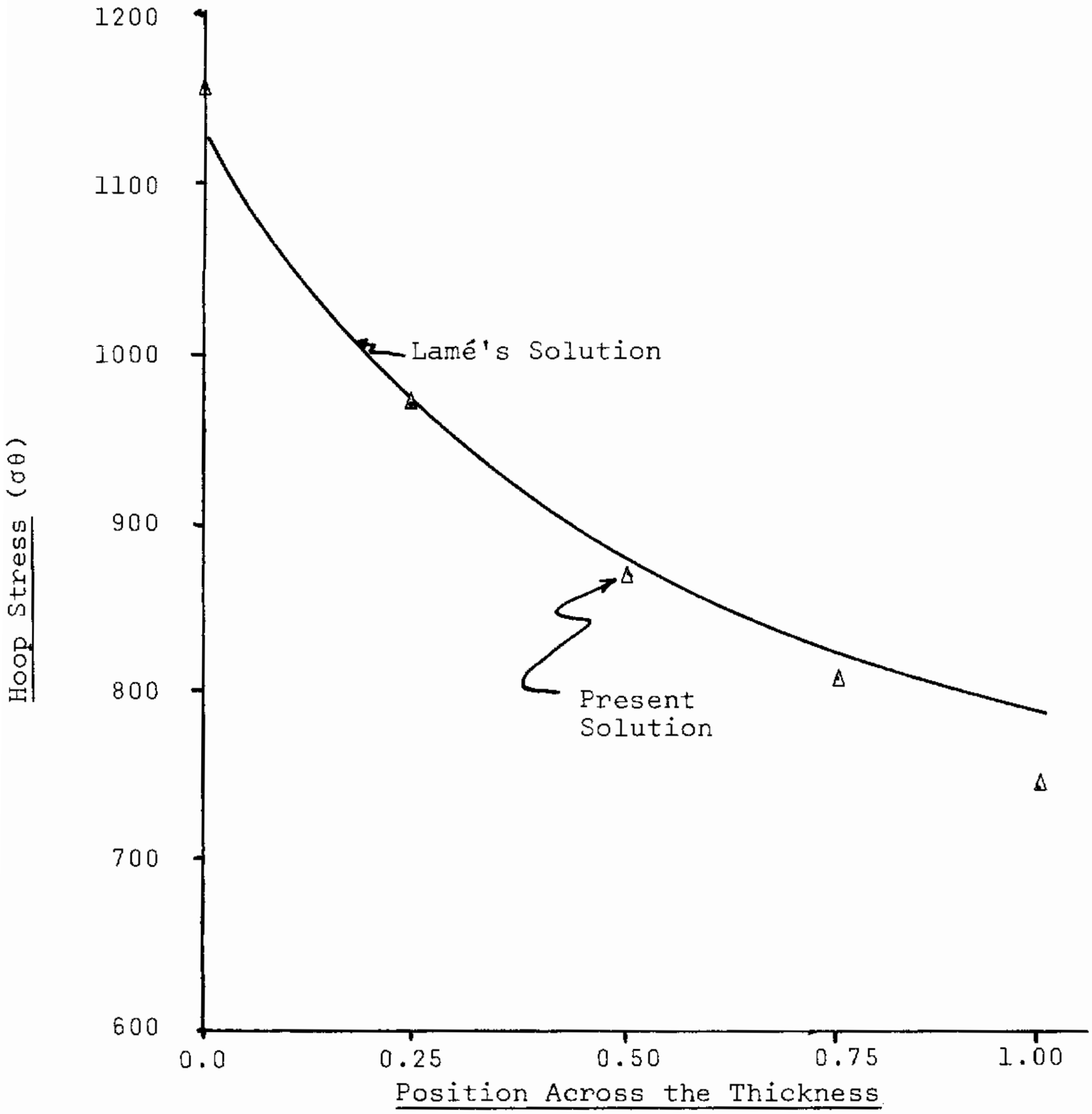

Figure 8
Hoop Stress Versus Position Across Thickness
(External Pressure Loading)

The analysis of a circular cylinder subjected to a torsional end moment is known from elementary beam theory. The angular twist is linear with the meridional length and the shear stress is constant. Problem one illustrates this solution and is trivial.

Problems two and three illustrate the effects of a thick shell solution. For a free circular cylinder, the Lamé solution away from the ends is given by:

for internal pressure:

$$\sigma_\theta = P_i \frac{a^2(b^2+r^2}{r^2(b^2-a^2)}$$

for external pressure:

$$\sigma_\theta = -P_o \frac{b^2(a^2+r^2)}{r^2(b^2-a^2)}$$

The Lamé solution assumes $\sigma_r+\sigma_\theta$ is invariant through the thickness. Since the shell equations are based on the assumption that σ_r=o, a discrepancy in the two theories are known at the onset. Even so, the numerical deviation is less than ten percent as indicated in the two solutions.

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10. Anderson, M.F.; R.E.Fulton; W.L.Heard, Jr; J.E.Walz, "Stress, Buckling and Vibration Analysis of Shells of Revolution," AFFDL Conference on Computer Oriented Analysis of Shell Structures, Aug. 1970.

11. Hildebrand, F.B.; E. Reissner and G.B. Thomas, "Notes on the Foundations of the Theory of Small Displacements of Orthotropic Shells." NACA TN 1833, March 1949.

12. Ambartsumyan, S.A., "Theory of Anisotropic Shells." NASA TT F 118.

13. Blum, R.E. and R.E. Fulton, "A Modification of Potter's Method for Solving Eigenvalue Problems Involving Tridiagonal Matrices." AIAA Journal Vol. 4, No. 12, page 2231, Sept. 1966.

APPENDIX A
TKSHL COMPUTER PROGRAM LISTING

```
PROGRAM    TKSHL                                        CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    1

              PROGRAM TKSHL                                                          THICK      2
             *(INPUT,OUTPUT,PUNCH,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7=PUNCH)              FEB6       1
              COMMON/RUN/ NDE,S,Y(10),YD(10),HR,J9,JMAX,M9,XOUT,IFREQ,DUMM(33),      THICK      4
             1IBCL,KORTN,ERP                                                         THICK      5
              COMMON/GARB/ D(7200),DM(909)                                           THICK      6
              COMMON/XDUM/JTYPE,IBRM                                                 FEB6       2
            5 READ(5,100) ITYPE,JTYPE                                                FEB6       3
          100 FORMAT(A6,4X,A8)
                                                                                     FEB6       4
      C       REMOVE THIS CARD AND THE NEXT THREE CARDS IF RUNNING ON IBM EQUIP.     THICK      9
              IF(EOF(5)) 3333,3334                                                   JUN16      1
         3333 CALL EXIT                                                              THICK     11
         3334 CONTINUE                                                               THICK     12
              WRITE(6,999) ITYPE,JTYPE                                               JUN16      2
          999 FORMAT(5X,A6,5X,A8)                                                    JUN16      3
              IF(ITYPE.EQ.6HSTOP  ) CALL EXIT                                        THICK     13
              KORTN=0                                                                THICK     14
              IF(ITYPE.EQ.6HTHICK )KORTN=1                                           THICK     15
              IF(KORTN)2,1,2                                                         THICK     16
            1 CALL MAIN(D,100,8,9,DM,101,9)                                          THICK     17
              GO TO 5                                                                THICK     18
            2 CALL MAIN(D,65,10,11,DM,66,11)                                         THICK     19
              GO TO 5                                                                THICK     20
              END                                                                    THICK     21
```

```
         PROGRAM      TKSHL                                       CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      2

         SYMBOLIC REFERENCE MAP

 ENTRY POINTS
  6076   TKSHL

 VARIABLES       SN  TYPE            RELOCATION
      0  D            REAL      ARRAY    GARB           16040  DM         REAL       ARRAY     GARB
     34  DUMM         REAL      ARRAY    RUN               77  ERP        REAL                 RUN
     26  HH           REAL               RUN               75  IBCL       INTEGER              RUN
      1  IBRM         INTEGER            XDUM              33  IFREQ      INTEGER              RUN
   6206  ITYPE        INTEGER                              30  JMAX       INTEGER              RUN
      0  JTYPE        INTEGER            XDUM              27  J9         INTEGER              RUN
     76  KORTN        INTEGER            RUN               31  M9         INTEGER              RUN
      0  NDE          INTEGER            RUN                1  S          REAL                 RUN
     32  XOUT         REAL               RUN                2  Y          REAL       ARRAY     RUN
     14  YD           REAL      ARRAY    RUN

 FILE NAMES          MODE
      0  INPUT                     2022  OUTPUT                     4044  PUNCH                        0  TAPE5       FMT
   2022  TAPE6         FMT         4044  TAPE7

 EXTERNALS             TYPE   ARGS
         EOF           REAL      1                            EXIT                     0
         MAIN                    7

 STATEMENT LABELS
      0  1               INACTIVE              6137  2                                      6077  5
   6165  100         FMT                       6167  999       FMT                             0  3333          INACTIVE
   6112  3334

 COMMON BLOCKS     LENGTH
         RUN           64
         GARB        8109
         XDUM           2

 STATISTICS
   PROGRAM LENGTH     121B       81
    BUFFER LENGTH    6066B     3126
    COMMON LENGTH   17757B     8175
```

```
SUBROUTINE  MAIN                                  CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.        PAGE      1

          SUBROUTINE  MAIN   (D,IRC,JRC,KRC,DM,ISY,JSY)                             THICK      22
      C   THIS PROGRAM IS A MODIFICATION OF THE SHELL OF REVOLUTION CODE WRI  THICK      23
      C   TTEN BY A. KALNINS DATED 22 JULY , 1968.  THOSE CHANGES FOR THE       THICK      24
      C   INCORPARATION OF TRANSVERSE SHEAR DEFORMATION REQUIRING ALTERATION  THICK      25
      C   ARE DENOTED BY AN * IN COLUMN 80.  ADDED CARDS ARE DENOTED BY A       THICK      26
      C   SEQUENCE NUMBER IN COLUMN 80.                                         THICK      27
      C   STATIC PROGRAM FOR STRESS ANALYSIS OF SHELLS OF REVOLUTION            THICK      28
          DIMENSION D(IRC,JRC,KRC),DM(ISY,JSY)                                  THICK      29
          COMMON/XDUM/JTYPE,IBRM                                                FEB6        6
          COMMON/RUN/ NDE,S,Y(10),YD(10),HH,J9,JMAX,M9,XOUT,IFREQ,DUMM(33),     THICK      31
         1IBCL,KORTN,ERP                                                        THICK      32
          COMMON/MATL/ B11(20,4),B12(20,4),B22(20,4),B66(20,4),B44(20,4),       THICK      33
         1B55(20,4),AL1(20,4),AL2(20,4),RHO(20,4)                               THICK      34
          COMMON/XMIT/ IBR,ISH,XN,XLD,OMSQ,HTT,R1,R2,R3,SXN,CXS,INDEX,PN,PL,    THICK      35
         1PC,T0,T1,RH1,RH2,RH3,NBR,C11,C12,C22,C66,E11,E12,E22,E66,D11,D12,     THICK      36
         2D22,D66,H44,H55,H66,XK11,XK12,XK22,XE66,F11,F12,F22,XH11,XH12,XH22    THICK      37
         3,EMFI,EMTH,H11,H12,H22,H21,G12,G21                                    THICK      38
          COMMON/GEOM/ SI(20),SX(20),XPR(20),ING(20),IPAR(20),Z(20),ISS(20),    THICK      39
         1TR1(10,10),TR2(10,10),NTP(20),DSC(20,10),MLY(20),ZLY(20,5),IA(10),    THICK      40
         2IB(10,4),ALFL          ,TR(10,10,4),TLI(10,10),ALFR(4)                THICK      41
          COMMON/THICK/ XNT,XMT,XNTP,XMTP,GPZ,GTZ,QT,CPP,EPP,CPT,DLP,EPT,       THICK      42
         1GMP,DLT,GMT                                                           THICK      43
          COMMON/TRIA/ GA(5),GB(5,4),ITP(100),NH,NF,NPL  ,NFP,NPRT              THICK      44
          COMMON/ADAM/ HDMAX,INTG,XLAST                                         THICK      45
          DIMENSION ID(33)                                                      THICK      46
          EQUIVALENCE (ID,DUMM)                                                 THICK      47
          DATA IN/3H IN/,IOR/8HTORSION   /,IOUT/3HOUT/                          JUN16       4
       10 READ (5,19)    IBRM,ISTK,NBR,NXT,IVB,NPRT,ERP                         THICK      48
      C   REMOVE THIS CARD AND THE NEXT THREE CARDS IF RUNNING ON IBM EQUIP.    THICK      49
          IF(EOF(5)) 3333,3334                                                  JUN16       5
     3333 RETURN                                                                FEB6        7
     3334 CONTINUE                                                              THICK      52
       19 FORMAT(6I5,E10.2)                                                     THICK      53
       20 FORMAT (16I5)                                                         THICK      54
          IF(IBRM)          30,30,50                                            THICK      55
       30 WRITE (6,40)IBRM                                                      THICK      56
       40 FORMAT (1H0,50HIBRM=0 WHICH INDICATES END OF JOB. EXIT IS CALLED )    THICK      57
          CALL EXIT                                                             THICK      58
       50 CONTINUE                                                              THICK      59
          IF(ERP.LE.0.0) ERP=1.0E-05                                            THICK      60
          K100=100                                                              THICK      61
          K4=4                                                                  THICK      62
          K8=8                                                                  THICK      63
          IF(KORTN) 51,52,51                                                    THICK      64
       51 K4=5                                                                  THICK      65
          K8=10                                                                 THICK      66
      221 K100=65                                                               THICK      67
       52 XLU=0.0                                                               THICK      68
          IBCL=0                                                                THICK      69
          INXC=1                                                                THICK      70
          WRITE  (6,60)                                                         THICK      71
       60 FORMAT (1H1, 26X,  67HSTRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUT    THICK      72
         1ION UNDER STATIC LOADS                   /                            THICK      73
         220X,40HWRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY     THICK      74
         3VERSION, 22 JULY 1968/ 15X,                                           THICK      75
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      4           88H MODIFIED PROGRAM TO ACCOUNT FOR TRANSVERSE SHEAR DEF THICK   76
     1ORMATION --WRITTEN BY R.L. CITERLEY/                                 THICK   77
      5                     27X,              66HANAMET LABORATORIES INC.  THICK   78
      6    BERKELEY, CALIFORNIA            1 OCT,1969)                     THICK   79
      WRITE (6,70)  IBRM,NBR,NXT                                           THICK   80
   70 FORMAT (1H0, 20X, 18HSTATIC ANALYSIS    , 8H  PARTS=,I3,             THICK   81
     111H  BRANCHES=,I3,21H  NUMBER OF SUBCASES=,I3)                       THICK   82
      IF(NBR-3) 100,100,80                                                 THICK   83
   80 WRITE (6,90) NBR                                                     THICK   84
   90 FORMAT (1H0,I3,38H  BRANCHES EXCEED ALLOWED MAXIMUM OF 3)            THICK   85
      CALL EXIT                                                            THICK   86
  100 CONTINUE                                                             THICK   87
      IF(IBRM-20) 130,130,110                                              THICK   88
  110 WRITE (6,120) IBRM                                                   THICK   89
  120 FORMAT (1H0,I3,36H  PARTS EXCEED ALLOWED MAXIMUM OF 20)              THICK   90
      CALL EXIT                                                            THICK   91
  130 CONTINUE                                                             THICK   92
      NBR=NBR+1                                                            THICK   93
      READ (5,140) ALFL, (ALFR(I),I=1,NBR)                                 THICK   94
  140 FORMAT (5F10.5)                                                      THICK   95
      WRITE (6,150) ALFL, (ALFR(I),I=1,NBR)                                THICK   96
  150 FORMAT (1H0, 51HANGLES OF ROTATION OF BOUNDARY CONDITIONS ARE ALFL THICK   97
     1=,  E12.5, 8H  ALFRS=, 4E12.5)                                       THICK   98
      IGCT=0                                                               THICK   99
      DO 220 I=1,IBRM                                                      THICK  100
      IBR=I                                                                THICK  101
      WRITE (6,160) I                                                      THICK  102
  160 FORMAT (1H0, 10X, 7HPART NO,I3)                                      THICK  103
      READ (5,170)                                                         THICK  104
     1 SI(I),SX(I),IPAR(I),ING(I),ISS(I),NTP(I),MLY(I)                     THICK  105
  170 FORMAT (2F10.5,5I5)                                                  THICK  106
      WRITE (6,180)                                                        THICK  107
     1SI(I),SX(I),IPAR(I),ING(I),ISS(I),NTP(I),MLY(I)                      THICK  108
  180 FORMAT (1H0,3HSI=,E12.5,6H   SX=,E12.5, 8H   IPAR=,I3,7H   ING=,I3 THICK  109
     1,14H    SHELL TYPE,I2, 7H   NTP=,I2, 14H   LAYERS MLY=,I2)           THICK  110
      IGCT=IGCT+IPAR(I)                                                    THICK  111
      ISH=ISS(I)                                                           THICK  112
      INDEX=1                                                              THICK  113
      CALL INPUT                                                           THICK  114
      CALL ORTHO                                                           THICK  115
      IF(MLY(I)-4) 210,210,190                                             THICK  116
  190 WRITE (6,200) MLY(I),I                                               THICK  117
  200 FORMAT(1H0,I3,19H  LAYERS IN PART NO,I3,22H  EXCEED ALLOWED MAX 4) THICK  118
      CALL EXIT                                                            THICK  119
  210 CONTINUE                                                             THICK  120
  220 WRITE (6,1830)                                                       THICK  121
  222 IF(IGCT-K100) 250,250,230                                            THICK  122
  230 WRITE (6,240) IGCT    ,K100                                          THICK  123
  240 FORMAT (1H0, I3, 37H  SEGMENTS EXCEED ALLOWED MAXIMUM OF ,I4)        THICK  124
      CALL EXIT                                                            THICK  125
  250 CONTINUE                                                             THICK  126
  260 LD=0                                                                 THICK  127
      READ (5,20) NX,NPCH                                                  THICK  128
C     NPCH=0 MEANS PRESTRESS IS NOT PUNCHED, NPCH=1 MEANS IT IS PUNCHED    THICK  129
      NNN=0                                                                THICK  130
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      SUBROUTINE  MAIN                                    CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE     3
              WRITE (6,60)                                                          THICK      131
              IF(NX) 290,270,270                                                    THICK      132
          270 WRITE (6,280) INXC,NX                                                 THICK      133
          280 FORMAT (1H0,30X, 10HSUBCASE NO,I3,27H   FOR FOURIER HARMONIC COS,     THICK      134
             1I2, 6H THETA)                                                         THICK      135
              GO TO 310                                                             THICK      136
          290 I=-NX                                                                 THICK      137
              WRITE (6,300)  INXC,I                                                 THICK      138
          300 FORMAT (1H0,30X, 10HSUBCASE NO,I3,27H   FOR FOURIER HARMONIC SIN,     THICK      139
             1I2, 6H THETA)                                                         THICK      140
          310 CONTINUE                                                              THICK      141
              XN=NX                                                                 THICK      142
              IF(NX.EQ.0.AND.JTYPE.NE.IOR) K4=3                                     FEB6         8
              READ (5,320)  (IA(I),GA(I),I=1,K4)                                    THICK      144
          320 FORMAT  (5(I5,F10.5))                                                 THICK      145
              WRITE   (6,330)                                                       THICK      146
             1(IA(I),GA(I),I=1,K4)                                                  THICK      147
          330 FORMAT(1H0,39HBOUNDARY CONDITIONS AT STARTING EDGE    ,5(I5,E12.5))   THICK      148
              DO 380 K=1,NBR                                                        THICK      149
              READ (5,320)                                                          THICK      150
             1(ID(I)      ,GB(I,K),I=1,K4)                                          THICK      151
              DO 339 I=1,K4                                                         THICK      152
          339 IB(I+K4,K)=ID(I)                                                      THICK      153
              IF(K-1) 340,340,360                                                   THICK      154
          340 WRITE (6,350) (ID(I)     ,GB(I,K), I=1,K4)                            THICK      155
          350 FORMAT(1H0,39HBOUNDARY CONDITIONS AT FINAL     EDGE   ,5(I5,E12.5))   THICK      156
              GO TO 380                                                             THICK      157
          360 J=K-1                                                                 THICK      158
              WRITE (6,370) J,                                                      THICK      159
             1(ID(I)     ,GB(I,K),I=1,K4)                                           THICK      160
          370 FORMAT(1H0,36HBOUNDARY CONDITION AT BRANCH EDGE NO,I3,5(I5,E12.5))    THICK      161
          380 CONTINUE                                                              THICK      162
              IF(NX.NE.0.OR.JTYPE.EQ.IOR) GO TO 410                                 FEB6         9
          390 NDE=6                                                                 THICK      164
              DO 400 L=7,10                                                         THICK      165
              IA(L)=0                                                               THICK      166
              DO 400 K=1,NBR                                                        THICK      167
          400 IB(L,K)=0                                                             THICK      168
              GO TO 420                                                             THICK      169
          410 NDE=10                                                                THICK      170
              IF(KURTN)420,411,420                                                  THICK      171
          411 NDE=8                                                                 THICK      172
              DO 412 L=9,10                                                         THICK      173
              IA(L)=0                                                               THICK      174
              DO 412 K=1,NBR                                                        THICK      175
          412 IB(L,K)=0                                                             THICK      176
          420 NH=NDE/2                                                              THICK      177
              M=NH+1                                                                THICK      178
              L=1                                                                   THICK      179
              DO 460 IK=M,NDE                                                       THICK      180
              DO 440 N=L,NDE                                                        THICK      181
              DO 430 J=1,NH                                                         THICK      182
              IF(IA(J)-N) 430,440,430                                               THICK      183
          430 CONTINUE                                                              THICK      184
              GO TO 450                                                             THICK      185
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  440 CONTINUE
  450 L=N+1
  460 IA(IK)=N
      DO 500 K=1,NBR
      L=1
      DO 500 IK=1,NH
      DO 480 N=L,NDE
      DO 470 J=M,NDE
      IF( IB(J,K)-N) 470,480,470
  470 CONTINUE
      GO TO 490
  480 CONTINUE
  490 L=N+1
  500 IB(IK,K)=N
      DO 510 I=1,20
      DO 510 J=1,K8
  510 DSC(I,J)=0.0
      DO 520 I=1,K8
      Y(I)=0.0
      Z(I)=0.0
      DO 520 L=1,K8
      TR1(I,L)=0.0
  520 TR2(I,L)=0.0
      CALL BCOND
      DO 530 J=1,NDE
      K=IA(J)
      DO 530 I=1,NDE
  530 DM(I,J)=TLI(I,K)
      DO 540 I=1,NDE
      DO 540 J=1,NDE
  540 TLI(I,J)=DM(I,J)
      DO 560 K=1,NBR
      DO 550 J=1,NDE
      DO 550 I=1,NDE
      L=IB(I,K)
  550 DM(I,J)=TR(L,J,K)
      DO 560 I=1,NDE
      DO 560 J=1,NDE
  560 TR(I,J,K)=DM(I,J)
      IF(NDE-8) 570,580,581
  570 TR1(3,5)=1.0
      TR1(6,6)=1.0
      TR2(5,3)=1.0
      TR2(6,6)=1.0
      GO TO 590
  580 TR1(3,7)=1.0
      TR1(4,5)=1.0
      TR1(7,8)=1.0
      TR1(8,6)=1.0
      TR2(5,4)=1.0
      TR2(6,8)=1.0
      TR2(7,3)=1.0
      TR2(8,7)=1.0
      GO TO   590
  581 TR1(3,7)=1.0
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SUBROUTINE  MAIN                                 CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    5

              TR1(4,5)=1.0                                                          THICK   241
              TR1(5,9)=1.0                                                          THICK   242
              TR1(8,8)=1.0                                                          THICK   243
              TR1(9,6)=1.0                                                          THICK   244
              TR1(10,10)=1.0                                                        THICK   245
              TR2(5,4)=1.00                                                         THICK   246
              TR2(6,9)=1.00                                                         THICK   247
              TR2(7,3)=1.00                                                         THICK   248
              TR2(8,8)=1.00                                                         THICK   249
              TR2(9,5)=1.00                                                         THICK   250
              TR2(10,10)=1.0                                                        THICK   251
          590 NPL=NDE+1                                                             THICK   252
          600 IBR=1                                                                 THICK   253
              ISTR=ISTK                                                             THICK   254
              NSTR=0                                                                THICK   255
              NFF=0                                                                 THICK   256
              IRS=0                                                                 THICK   257
              NFP=2                                                                 THICK   258
              NF=1                                                                  THICK   259
          610 I=IBR                                                                 THICK   260
              WRITE (6,1830)                                                        THICK   261
              WRITE (6,620) IBR,INXC                                                THICK   262
          620 FORMAT (1H0,20X,17HLOADS FOR PART NO,I3,12H  SUBCASE NO,I3)           THICK   263
              ICYL=0                                                                THICK   264
              ISH=ISS(I)                                                            THICK   265
              READ (5,140)  (DSC(I,J),J=2, K8,2)                                    THICK   266
              IF(KORTN) 629,628,629                                                 THICK   267
          629 WRITE(6,631)(DSC(I,J),J=2,K8,2)                                       THICK   268
          631 FORMAT(1H0,39HRING LOADS AT END OF THIS PART ARE    Q=,E12.5 ,        THICK   269
             17H  NPHI=, E12.5, 7H  MPHI=,E12.5, 7H NT P =    E12.5,7H  M TP=       THICK   270
             2   E12.5)                                                             THICK   271
              GO TO 627                                                             THICK   272
          628 WRITE (6,630)  (DSC(I,J),J=2,K8,2)                                    THICK   273
          630 FORMAT (1H0,39HRING LOADS AT END OF THIS PART ARE    Q=,E12.5,        THICK   274
             17H  NPHI=, E12.5, 7H  MPHI=,E12.5, 4H  N=,E12.5)                      THICK   275
          627 S=SI(I)                                                               THICK   276
              INDEX=2                                                               THICK   277
              CALL INPUT                                                            THICK   278
              INDEX=3                                                               THICK   279
              CALL INPUT                                                            THICK   280
              CALL ORTHO                                                            THICK   281
              INDEX=4                                                               THICK   282
              IF(NPRT) 730,730,640                                                  THICK   283
          640 CONTINUE                                                              THICK   284
              JJ=MLY(IBR)+1                                                         THICK   285
              WRITE (6,650) IBR                                                     THICK   286
          650 FORMAT (1H0, 20X, 28HAT BEGINNING AND END OF PART,I3,                 THICK   287
             115H PARAMETERS ARE  )                                                 THICK   288
              WRITE (6,1830)                                                        THICK   289
              DO 720 K=1,2                                                          THICK   290
              WRITE (6,660) R1,R2,R3,SXN,CXS                                        THICK   291
              WRITE (6,670)  PN,PL, PC,T0,T1                                        THICK   292
              WRITE (6,680)   C11,C12,C22,C66,E11,E12                               THICK   293
              WRITE (6,690)  E22,E66,D11,D12,D22,D66                                THICK   294
              WRITE (6,700)  H11,H12,H22,H21,G12,G21                                THICK   295
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      IF(KORTN) 651,652,651
  651 WRITE(6,701) XH11,XH12,XH22,F11,F12,F22
     1 ,XK11,XK12,XK22,H55,H66
  652 WRITE (6,710)    (ZLY(IBR,J), J=1,JJ)
  701 FORMAT(1H ,5HXH11= E12.4,5HXH12= E12.4,5HXH22= E12.4,
     1 5H F11= E12.4, 5H F12=E12.4, 5H F22= E12.4/1H ,5HXE11= E12.4,
     25HXE12=,E12.4,5HXE22=,E12.4,5H H55=,E12.4,5H H66= E12.4)
      WRITE (6,1830)
  660 FORMAT (1H ,5H  R1=,E12.4,5H  R2=, E12.4,5H  R3=,E12.4,
     15H SXN=, E12.4, 5H CXS=, E12.4)
  670 FORMAT (1H ,5H  PN=, E12.4,5H  PL=, E12.4,5H  PC=,E12.4,
     15H T0 =,E12.4,5H  T1=, E12.4)
  680 FORMAT (1H , 5H C11=,E12.4, 5H C12=,E12.4, 5H C22=, E12.4,
     15H C66=, E12.4, 5H E11=, E12.4, 5H E12=, E12.4)
  690 FORMAT (1H , 5H E22=, E12.4, 5H E66=, E12.4, 5H D11=, E12.4,
     15H D12=, E12.4, 5H D22=, E12.4, 5H D66=, E12.4)
  700 FORMAT (1H , 5H H11=, E12.4, 5H H12=, E12.4, 5H H22=, E12.4,
     15H H21=, E12.4, 5H G12=, E12.4, 5H G21=, E12.4)
  710 FORMAT (1H0, 7HZS ARE=,10E12.4)
      S=SX(I)
      CALL INPUT
      CALL ORTHO
  720 CONTINUE
  730 CONTINUE
      K=IPAR(I)+NF-1
      DO 740 J=NF,K
  740 ITP(J)=0
      IF(NTP(IBR))  780,780,750
  750 DO 760 J=NF,K
  760 ITP(J)=1
      IF(NTP(IBR)-1) 780,780,770
  770 ITP(K)=2
  780 CONTINUE
      PARTS=IPAR(IBR)
      SMXX=(SX(IBR) - SI(IBR))/PARTS
      SZERO=SI(IBR)
      XINT=ING(IBR)
      XPH(IBR)=SMXX/XINT
      NFF=NFF+IPAR(IBR)
      SMAX=SZERO+SMXX
      XOUT=SMAX
      IF(NPRT-1) 810,810,790
  790 WRITE (6,60)
      WRITE (6,800) IBR,IPAR(IBR)
  800 FORMAT(1H0,62HINITIAL VALUE INTEGRATIONS (COLUMNS OF Y(X) MATRIX)
     1OF PART NO,I3,5H OVER,I3,16H SEGMENTS FOLLOW)
  810 CONTINUE
  820 J=0
      XLD=0.0
  830 J=J+1
      DO 840 I=1,K8
  840 Y(I)=0.0
      IF(J-NDE) 850,850,860
  850 Y(J)=1.0
  860 IF(NPRT) 880,880,870
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 870 WRITE  (6,950)
    1          SZERO, (Y(I),I=1,NDE)
 880 CONTINUE
     S=SZERO
     HH=0.01*SMXX
     INIG=0
     IBCL=0
     IF(ICYL) 910,910,890
 890 DO 900 I=1,NDE
     K=I+K8
 900 D(NF,I,J)=DM(K,J)
     GO TO 930
 910 CALL RUNGE
     DO 920 I=1,NDE
     K=I+K8
     DM(K,J)=Y(I)
 920 D(NF,I,J)=Y(I)
 930 IF(NPRT-1) 970,970,940
 940 WRITE  (6,950)
    1SMAX,   (D(NF,I,J),I=1,NDE)
 950 FORMAT (1H0, F9.3,10E12.5)
     WRITE (6,960) IBCL
 960 FORMAT (1H ,7HPOINTS=,I5)
 970 CONTINUE
     IF(J-NDE) 830,980,990
 980 XLD=1.0
     ICYL=0
     GO TO 830
 990 IF(NF-NFF)  1010,1000,1000
1000 IF(IPAR(IBR)-1) 1010,1010,1110
1010 IF(IRS) 1080,1080,1020
1020 IRS=0
     S=SI(IBR)
     CALL INPUT
     TR2(1,1)=CXS
     TR2(1,2)=SXN
     TR2(3,1)=-SXN
     TR2(3,2)=CXS
     IF(NDE-8) 1030,1040,1041
1030 TR2(2,4)=CXS
     TR2(2,5)=SXN
     TR2(4,4)=-SXN
     TR2(4,5)=CXS
     GO TO 1050
1040 TR2(2,5)=CXS
     TR2(2,6)=SXN
     TR2(4,5)=-SXN
     TR2(4,6)=CXS
     GO TO 1050
1041 TR2(2,6)=CXS
     TR2(2,7)=SXN
     TR2(4,6)=-SXN
     TR2(4,7)=CXS
1050 DO 1060 I=1,NDE
     DO 1060 K=1,NDE
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SUBROUTINE  MAIN                              CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    8

            DM(I,K)=0.0                                                   THICK   406
            DO 1060 L=1,NDE                                               THICK   407
      1060  DM(I,K)=DM(I,K)+D(NF,I,L)*TR2(L,K)                            THICK   408
            DO 1070 I=1,NDE                                               THICK   409
            DO 1070 K=1,NDE                                               THICK   410
      1070  D(NF,I,K)=DM(I,K)                                             THICK   411
      1080  IF(IPAR(IBR)-1) 1110,1110,1090                                THICK   412
      1090  NF=NF+1                                                       THICK   413
            NFP=NF+1                                                      THICK   414
            SZERO=SMAX                                                    THICK   415
            SMAX=SMXX+SZERO                                               THICK   416
            XOUT=SMAX                                                     THICK   417
            IF(ISH-2)820,1100,820                                         THICK   418
      1100  ICYL=1                                                        THICK   419
            GO TO 820                                                     THICK   420
      1110  DO 1120 I=1,NDE                                               THICK   421
      1120  D(NF,I,NPL)=D(NF,I,NPL)-DSC(IBR,I)                            THICK   422
      1130  IF(IBR-IBRM) 1140,1220,1220                                   THICK   423
      1140  IF(ITP(NF)-2) 1150,1210,1210                                  THICK   424
      1150  S=SX(IBR)                                                     THICK   425
            CALL INPUT                                                    THICK   426
            TR1(1,1)=CXS                                                  THICK   427
            TR1(1,3)=-SXN                                                 THICK   428
            TR1(2,1)=SXN                                                  THICK   429
            TR1(2,3)=CXS                                                  THICK   430
            IF(NDE-8) 1160,1170,1171                                      THICK   431
      1160  TR1(4,2)=CXS                                                  THICK   432
            TR1(4,4)=-SXN                                                 THICK   433
            TR1(5,2)=SXN                                                  THICK   434
            TR1(5,4)=CXS                                                  THICK   435
            GO TO 1180                                                    THICK   436
      1170  TR1(5,2)=CXS                                                  THICK   437
            TR1(5,4)=-SXN                                                 THICK   438
            TR1(6,2)=SXN                                                  THICK   439
            TR1(6,4)=CXS                                                  THICK   440
            GO TO 1180                                                    THICK   441
      1171  TR1(6,2)=CXS                                                  THICK   442
            TR1(6,4)=-SXN                                                 THICK   443
            TR1(7,2)=SXN                                                  THICK   444
            TR1(7,4)=CXS                                                  THICK   445
      1180  DO 1190 I=1,NDE                                               THICK   446
            DO 1190 K=1,NPL                                               THICK   447
            DM(I,K)=0.0                                                   THICK   448
            DO 1190 L=1,NDE                                               THICK   449
      1190  DM(I,K)=DM(I,K)+TR1(I,L)*D(NF,L,K)                            THICK   450
            DO 1200 I=1,NDE                                               THICK   451
            DO 1200 K=1,NPL                                               THICK   452
      1200  D(NF,I,K)=DM(I,K)                                             THICK   453
      1210  IBR=IBR+1                                                     THICK   454
            NF=NF+1                                                       THICK   455
            NFP=NF+1                                                      THICK   456
            IRS=1                                                         THICK   457
            GO TO 610                                                     THICK   458
      1220  DO 1230 I=1,NDE                                               THICK   459
            DO 1230 J=1,NDE                                               THICK   460
```

```
          DM(I,J)=0.0                                                    THICK   461
          DO 1230 L=1,NDE                                                THICK   462
     1230 DM(I,J)=DM(I,J)  +D(1,I,L)*TLI(L,J)                            THICK   463
          DO1240 I=1,NDE                                                 THICK   464
          DO1240 J=1,NDE                                                 THICK   465
     1240 D(1,I,J)=DM(I,J)                                               THICK   466
          KF=1                                                           THICK   467
          IX=NF                                                          THICK   468
          DO 1290 K=1,NBR                                                THICK   469
          DO 1250 I=1,NDE                                                THICK   470
          DO 1250 J=1,NPL                                                THICK   471
          DM(I,J)=0.0                                                    THICK   472
          DO 1250 L=1,NDE                                                THICK   473
     1250 DM(I,J)=DM(I,J)+TR(I,L,K)*D(IX,L,J)                            THICK   474
          DO 1260 I=1,NDE                                                THICK   475
          DO 1260 J=1,NPL                                                THICK   476
     1260 D(IX,I,J)=DM(I,J)                                              THICK   477
          DO 1270 IX=KF,NF                                               THICK   478
          JJ=IX                                                          THICK   479
          IF(ITP(IX)-2) 1270,1280,1280                                   THICK   480
     1270 CONTINUE                                                       THICK   481
     1280 IX=JJ                                                          THICK   482
          KF=IX+1                                                        THICK   483
     1290 CONTINUE                                                       THICK   484
          IF(NPRT) 1320,1320,1300                                        THICK   485
     1300 CONTINUE                                                       THICK   486
          WRITE (6,1310)  (ITP(I),I=1,NF)                                THICK   487
     1310 FORMAT(1H0,50I2)                                               THICK   488
          WRITE (6,1830)                                                 THICK   489
     1320 CONTINUE                                                       THICK   490
          XLD=1.0                                                        THICK   491
          CALL TRIANG(D,IRC,JRC,KRC,DM,ISY,JSY)                          THICK   492
          IF(NPRT) 1370,1370,1330                                        THICK   493
     1330 CONTINUE                                                       THICK   494
          WRITE  (6,1340)                                                THICK   495
         1                          NFP,NFP,XN,  ERP                     THICK   496
     1340 FORMAT(1H0, 5X,4HNEXT,     I3, 41H ROWS ARE VARIABLES AT ENDPOINTS THICK   497
         1X1,....X, I2, 12H OF SEGMENTS,                                 THICK   498
         22X, 3HXN=, F5.1,2X,                        10H ACCURACY=,E8.1) THICK   499
          WRITE (6,1830)                                                 THICK   500
          DO 1350 I=1,NFP                                                THICK   501
     1350 WRITE  (6,1360)                                                THICK   502
         1                    I,(DM(I,J), J=1,NDE)                       THICK   503
     1360 FORMAT (1H ,3HX=X,I2,2X,10E12.5)                               THICK   504
     1370 CONTINUE                                                       THICK   505
          IST=0                                                          THICK   506
          DO 1440 K=1,NF                                                 THICK   507
          IF( ITP(K)-1) 1440,1380,1400                                   THICK   508
     1380 IF(IST) 1390,1390,1440                                         THICK   509
     1390 IST=2                                                          THICK   510
          I=K                                                            THICK   511
          GO TO 1440                                                     THICK   512
     1400 IF(IST) 1410,1410,1420                                         THICK   513
     1410 I=K                                                            THICK   514
     1420 CONTINUE                                                       THICK   515
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      DO 1430 J=1,NH
 1430 DM(K+1,J)=DM(I,J)
      IST=0
 1440 CONTINUE
      DO 1450 I=1,NDE
      Y(I)=0.0
      DO 1450 J=1,NDE
 1450 Y(I)=Y(I)+FLI(I,J)*DM(1,J)
      DO 1460 I=1,NDE
 1460 DM(1,I)=Y(I)
 1470 CONTINUE
      WRITE  (6,60)
      WRITE  (6,1480)      NX
 1480 FORMAT  (1H0,20X,60HSTATIC SOLUTION AT POINTS ALONG MERIDIAN FOR WA
     1VE NUMBER NX=,I3)
      IST=1
      KF=0
      IX=1
      JPA=IPAR(1)+1
      DO 1850 N=1,IBRM
      ISH=ISS(N)
      IBR=N
      L=ING(N)+1
      S=ST(N)
      KF=IPAR(N)+KF
      IF(ITP(KF)-1) 1540,1550,1550
 1540 IF(N-1) 1562,1562,1563
 1562 WRITE(6,1560)N
      GO TO 1564
 1563 WRITE(6,1561)N
 1564 IF(KORTN) 1488,1489,1488
 1488 IF(ISTR-1)1491,1511,1511
 1491 WRITE(6,1501)
 1501 FORMAT(1H0,3X,1HS,8X,1HW,8X,5HU PHI,5X,7HU THETA ,4X,8HBETA PHI,2X
     1,10HBETA THETA,9H LAYER NO,2X,7HSIG PHI,3X,9HSIG THETA,3X,7HSIG T
     2P,3X,9HTAU PHI Z,12H TAU THETA Z )
      GO TO 1530
 1511 WRITE(6,1502)
 1502 FORMAT(1H0,3X,1HS,9X,1HW,9X,5HU PHI,6X,7HU THETA,5X,8HBETA PHI,3X
     1,10HBETA THETA,3X,
     110HN PHI/QPHI,3X,16H N THETA/Q THETA,16H M PHI / N TPHI   ,
     216H M THETA/M T PHI )
      GO TO 1530
 1489 IF(ISTR-1) 1510,1490,1490
 1490 WRITE  (6,1500)
 1500 FORMAT (1H0,9H     S    ,2X,12H     W     , 12H     Q     ,
     112H    UPHI    , 12H    NPHI    , 12H    BPHI    , 12H    MPHI
     2, 12H   UTHETA   , 12H      N     , 12H   NTHETA   ,10H   MTHETA )
      GO TO 1530
 1510 WRITE  (6,1520)
 1520 FORMAT (1H0,9H     S    ,2X,12H     W     , 12H    UPHI    ,
     112H   UTHETA  ,  12H    BPHI    , 12H   SPHI IN  ,12H  SPHI OUT
     2,12H STHETA IN  ,12H STHETA OUT , 12H  SFITH IN  ,12H  SFITH OUT )
 1530 CONTINUE
      GO TO 1580
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SUBROUTINE  MAIN                       CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    11

      1550 WRITE    (6,1570) N                                        THICK    571
           IF(KORTN) 1541,1542,1541                                   THICK    572
      1541 IF(ISTR-1) 1543,1544,1544                                  THICK    573
      1544 WRITE(6,1502)                                              THICK    574
           GO TO 1559                                                 THICK    575
      1543 WRITE(6,1501)                                              THICK    576
           GO TO 1559                                                 THICK    577
      1542 IF(ISTR-1) 1547,1546,1546                                  THICK    578
      1546 WRITE(6,1500)                                              THICK    579
           GO TO 1559                                                 THICK    580
      1547 WRITE(6,1520)                                              THICK    581
      1559 IST=IST+1                                                  THICK    582
      1560 FORMAT (1H0, 20H  MAIN SHELL PART NO,I3)                   THICK    583
      1561 FORMAT (1H1, 20H  MAIN SHELL PART NO,I3)                   THICK    584
      1570 FORMAT (1H1, 20HBRANCH SHELL PART NO,I3)                   THICK    585
      1580 INDEX=3                                                    THICK    586
           CALL INPUT                                                 THICK    587
           CALL ORTHO                                                 THICK    588
           IF(N-1) 1660,1660,1590                                     THICK    589
      1590 IF(NSTH) 1600,1600,1660                                    THICK    590
      1600 TR2(1,1)=CXS                                               THICK    591
           TR2(1,2)=SXN                                               THICK    592
           TR2(3,1)=-SXN                                              THICK    593
           TR2(3,2)=CXS                                               THICK    594
           IF(NDE-8)1610,1620,1621                                    THICK    595
      1610 TR2(2,4)=CXS                                               THICK    596
           TR2(2,5)=SXN                                               THICK    597
           TR2(4,4)=-SXN                                              THICK    598
           TR2(4,5)=CXS                                               THICK    599
           GO TO 1630                                                 THICK    600
      1620 TR2(2,5)=CXS                                               THICK    601
           TR2(2,6)=SXN                                               THICK    602
           TR2(4,5)=-SXN                                              THICK    603
           TR2(4,6)=CXS                                               THICK    604
           GO TO 1630                                                 THICK    605
      1621 TR2(2,6)=CXS                                               THICK    606
           TR2(2,7)=SXN                                               THICK    607
           TR2(4,6)=-SXN                                              THICK    608
           TR2(4,7)=CXS                                               THICK    609
      1630 DO 1640 I=1,NDE                                            THICK    610
           Y(I)=0.0                                                   THICK    611
           DO 1640 J=1,NDE                                            THICK    612
      1640 Y(I)=Y(I)+TR2(I,J)*DM(JPA,J)                               THICK    613
           DO 1650 I=1,NDE                                            THICK    614
      1650 DM(JPA,I)=Y(I)                                             THICK    615
           JPA=JPA+IPAR(N)                                            THICK    616
      1660 XX=0.0                                                     THICK    617
           INDEX=4                                                    THICK    618
           S=IPAR(N)                                                  THICK    619
           DELS=0.01*(SX(N)-SI(N))/S                                  THICK    620
           SZERO=SI(N)                                                THICK    621
           IF(ISTR-1)   1700,1670,1670                                THICK    622
      1670 IF(NPCH) 1700,1700,1680                                    THICK    623
      1680 NTH= IPAR(N)*ING(N)+1                                      THICK    624
           I=1                                                        THICK    625
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      SUBROUTINE  MAIN                                         CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    12

      C     FOLLOWING STATEMENT IS INTENDED TO PUNCH CARDS FOR PRESTRESS STATE THICK    626
            WRITE (7,1690) N,NTR,I                                            THICK    627
       1690 FORMAT (3I5)                                                      THICK    628
       1700 CONTINUE                                                          THICK    629
            DO 1840 K=IX,KF                                                   THICK    630
            Z(7)=0.0                                                          THICK    631
            Z(8)=0.0                                                          THICK    632
            Z(9)=0.0                                                          THICK    633
            Z(10)=0.0                                                         THICK    634
            DO 1710 I=1,NDE                                                   THICK    635
            Z(I)=DM(K,I)                                                      THICK    636
       1710 Y(I)=DM(K,I)                                                      THICK    637
            HH=DELS                                                           THICK    638
            INIG=0                                                            THICK    639
            DO 1820 M=1,L                                                     THICK    640
            SZERO=SZERO+XPR(N)*XX                                             THICK    641
            S=SZERO                                                           THICK    642
            XX=1.0                                                            THICK    643
            CALL INPUT                                                        THICK    644
            CALL ORTHO                                                        THICK    645
            XNR=XN*R2                                                         THICK    646
            SXR=SXN*R2                                                        THICK    647
            CXR=CXS*R2                                                        THICK    648
            ELH=R1-SXR                                                        THICK    649
            ELJ=R1+SXR                                                        THICK    650
            IF(KORTN) 1728,1711,1728                                          THICK    651
       1711 ETH=XNR*Z(7)+ CXR*Z(3) +SXR*Z(1)                                  THICK    652
            BTH=XNR*Z(1) +SXR*Z(7)                                            THICK    653
            HTH=XNR*BTH+CXR*Z(5)                                              THICK    654
            EPS=-XNR*Z(3)-CXR*Z(7)                                            THICK    655
            HKA= -2.0*XNR*Z(5)-2.0*XNR*CXR*Z(1)+CXR*(ELH-SXR)*Z(7)+XNR*R1*Z(3) THICK    656
            DEL=C11*D11-E11*E11                                               THICK    657
            EN= Z(4)-C12*ETH-E12*HTH-(H11*T0+H12*T1)                          THICK    658
            EM= Z(6) -E12*ETH-D12*HTH-(H12*T0+G12*T1)                         THICK    659
            EFI= (EN*D11-EM*E11)/DEL                                          THICK    660
            HFI= (EM*C11-EN*E11)/DEL                                          THICK    661
            IF(ISTR-1) 1720,1750,1750                                         THICK    662
       1720 ZD=       (Z (8)-(C66+SXR*E66)*EPS-(E66+SXR*D66)*HKA)             THICK    663
           1/(C66+2.0*E66*SXR+D66*SXR*SXR)                                    THICK    664
            ETF = EPS+ZD                                                      THICK    665
            HTF=HKA+SXR*ZD                                                    THICK    666
            Z(2)=Z(3)                                                         THICK    667
            Z(3)=Z(7)                                                         THICK    668
            Z(4)=Z(5)                                                         THICK    669
            JJ=MLY(IBR)                                                       THICK    670
            DO 1740 I=1,JJ                                                    THICK    671
            J=I+I                                                             THICK    672
            Z(5)      =B11(N,I)*(EFI+ZLY(N,I)*HFI) +B12(N,I)*(ETH+ZLY(N,I)*HTH) THICK  673
           1-(B11(N,I)*AL1(N,I)+B12(N,I)*AL2(N,I))*(T0+ZLY(N,I)*T1)           THICK    674
            Z(6)      =B11(N,I)*(EFI+ZLY(N,J)*HFI) +B12(N,I)*(ETH+ZLY(N,J)*HTH) THICK  675
           1-(B11(N,I)*AL1(N,I)+B12(N,I)*AL2(N,I))*(T0+ZLY(N,J)*T1)           THICK    676
            Z(7)      =B12(N,I)*(EFI+ZLY(N,I)*HFI) +B22(N,I)*(ETH+ZLY(N,I)*HTH) THICK  677
           1-(B12(N,I)*AL1(N,I)+B22(N,I)*AL2(N,I))*(T0+ZLY(N,I)*T1)           THICK    678
            Z(8)      =B12(N,I)*(EFI+ZLY(N,J)*HFI) +B22(N,I)*(ETH+ZLY(N,J)*HTH) THICK  679
           1-(B12(N,I)*AL1(N,I)+B22(N,I)*AL2(N,I))*(T0+ZLY(N,J)*T1)           THICK    680
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          Z(9)      =B66(N,I)*(ETF+ZLY(N,I)*HTF)                            THICK    681
          Z(10)     =B66(N,J)*(ETF+ZLY(N,J)*HTF)                            THICK    682
          WRITE (6,1730) S, (Z(LLL),LLL=1,10)                               THICK    683
     1730 FORMAT (1X,1H ,F8.5,2X,10E12.5)                                   THICK    684
     1740 CONTINUE                                                          THICK    685
C   THE FOLLOWING CARD CAUSES STRESSES TO BE DOUBLE SPACED                  THICK    686
C         WRITE (6,1830)                                                    THICK    687
          GO TO 1790                                                        THICK    688
     1750 Z(9)=C12*EFI+C22*ETH+E12*HFI+E22*HTH+(H22*T0+H21*T1)              THICK    689
          Z(10)=                                                            THICK    690
         1      D12*HFI+D22*HTH+E12*EFI+E22*ETH+(H21*T0+G21*T1)             THICK    691
          WRITE (6,1730) S, (Z(I),I=1,10)                                   THICK    692
          IF(NPCH) 1790,1790,1760                                           THICK    693
     1760 IF(M-L) 1770,1790,1790                                            THICK    694
     1770 WRITE (7,1780) S, Z(4),Z(9),Z(8)                                  THICK    695
          GO TO  1790                                                       THICK    696
     1728 XLD=1.0                                                           THICK    697
          PN=0.0                                                            THICK    698
          PL=0.0                                                            THICK    699
          PC=0.0                                                            THICK    700
          CALL COEFF                                                        THICK    701
          Z(2)=Z(3)                                                         THICK    702
          Z(3)=Z(7)                                                         THICK    703
          Z(4)=Z(5)                                                         THICK    704
          Z(5)=Z(9)                                                         THICK    705
          IF(ISTR-1) 1722,1751,1751                                         THICK    706
     1722 JJ=MLY(IBR)                                                       THICK    707
          DO  1721 I=1,JJ                                                   THICK    708
          J=I+1                                                             THICK    709
          H=ZLY(N,I)                                                        THICK    710
          HP=ZLY(N,J)                                                       THICK    711
          S11= 1.0+H*R1                                                     THICK    712
          S12=1.0+H*SXR                                                     THICK    713
          S22=1.0+HP*R1                                                     THICK    714
          S21=1.0+HP*SXR                                                    THICK    715
          Z(6)=B11(N,I)*(EPP+H*CPP)/S11+B12(N,I)*(EPT+H*CPT)/S12            THICK    716
         1-(B11(N,I)*AL1(N,I)/S11                                           THICK    717
         2                     +B12(N,I)*AL2(N,I)/S12                       THICK    718
         3                                        )*(T0+ZLY(N,I)*T1)        THICK    719
          Z(11)=                                                            THICK    720
         1      B11(N,I)*(EPP+HP*CPP)/S22+B12(N,I)*(EPT+HP*CPT)/S21         THICK    721
         1-(B11(N,I)*AL1(N,I)/S22                                           THICK    722
         2                     +B12(N,I)*AL2(N,I)/S21                       THICK    723
         3                                        )*(T0+ZLY(N,J)*T1)        THICK    724
          Z(7)=B12(N,I)*(EPP+ H*CPP)/S11+B22(N,I)*(EPT+ H*CPT)/S12          THICK    725
         1-(B12(N,I)*AL1(N,I)/S11                                           THICK    726
         2                     +B22(N,I)*AL2(N,I)/S12                       THICK    727
         3                                        )*(T0+ZLY(N,I)*T1)        THICK    728
          Z(12)=B12(N,I)*(EPP+HP*CPP)/S22+B22(N,I)*(EPT+HP*CPT)/S21         THICK    729
         1-(B12(N,I)*AL1(N,I)/S22                                           THICK    730
         2                     +B22(N,I)*AL2(N,I)/S21                       THICK    731
         3                                        )*(T0+ZLY(N,J)*T1)        THICK    732
          Z( 8)=B66(N,I)*S12*(GMP+H*DLP)/S11+B66(N,I)*S11*(GMT+H*DLT)/S12   THICK    733
          Z(13)=B66(N,I)*(S21*(GMP+HP*DLP)/S22+S22*(GMT+HP*DLT)/S21)        THICK    734
          Z( 9)=B55(N,I)*GPZ/S11                                            THICK    735
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      Z(10)=B44(N,I)*GTZ/S12                                THICK   736
      Z(14)=B55(N,I)*GPZ/S22                                THICK   737
      Z(15)=B44(N,I)*GTZ/S21                                THICK   738
      IF(I.EQ.1) WRITE(6,1723)S,(Z(KKK),KKK=1,5),I,IN,(Z(LL),LL=6,10)   THICK   739
      IF(I.GT.1) WRITE(6,1782) I,IN,(Z(LL),LL=6,10)         FEB6     10
                 WRITE(6,1724)    IOUT,(Z(LL),LL=11,15)     THICK   741
 1721 CONTINUE                                              THICK   742
      GO TO 1790                                            THICK   743
 1751 Z(6)=Y(4)                                             THICK   744
      Z(7)=XNT                                              THICK   745
      Z(8)=Y(6)                                             THICK   746
      Z(9)=XMT                                              THICK   747
      Z(10)=Y(2)                                            THICK   748
      Z(11)=QT                                              THICK   749
      Z(12)=Y(8)                                            THICK   750
      Z(13)=Y(10)                                           THICK   751
      WRITE(6,1725) S,(Z(KK ),KK=1,  13)                    THICK   752
 1782 FORMAT(63X,I3,2X,A3,1X,5E11.4)                        FEB6     11
 1723 FORMAT(F8.4,5E11.4,I3,2X,A3,1X,5E11.4)                THICK   754
 1724 FORMAT(         68X      ,A3,1X,5E11.4)               THICK   755
 1725 FORMAT(F8.4,5E12.5,4(E14.5,2X)/68X,4(E14.5,2X))       THICK   756
 1780 FORMAT (4F20.8)                                       THICK   757
 1790 IF(M-L) 1800,1820,1820                                THICK   758
 1800 XOUT=XPR(I8R)+SZERO                                   THICK   759
      I8CL=0                                                THICK   760
      CALL RUNGE                                            THICK   761
      INIG=1                                                THICK   762
      Z(7)=0.0                                              THICK   763
      Z(8)=0.0                                              THICK   764
      Z(9)=0.0                                              THICK   765
      Z(10)=0.0                                             THICK   766
      DO 1810 I=1,NDE                                       THICK   767
 1810 Z(I)=Y(I)                                             THICK   768
 1820 CONTINUE                                              THICK   769
      XX=0.0                                                THICK   770
      WRITE  (6,1830)                                       THICK   771
 1830 FORMAT (1H )                                          THICK   772
 1840 CONTINUE                                              THICK   773
      IX=IX+IPAR(N)                                         THICK   774
 1850 CONTINUE                                              THICK   775
      IF(ISTR-1) 1870,1870,1860                             THICK   776
 1860 ISTR=0                                                THICK   777
      NNN=2                                                 THICK   778
      NSTR=2                                                THICK   779
      GO TO 1470                                            THICK   780
 1870 IF(INXC-NXT) 1880,1890,1890                           THICK   781
 1880 INXC=INXC+1                                           THICK   782
      GO TO 260                                             THICK   783
 1890 RETURN                                                THICK   784
      END                                                   THICK   785
MORE MEMORY WOULD HAVE RESULTED IN BETTER OPTIMIZATION
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SYMBOLIC REFERENCE MAP

ENTRY POINTS
2 MAIN

VARIABLES		SN TYPE		RELOCATION					
1332	ALFL	REAL		GEOM	2317	ALFR	REAL	ARRAY	GEOM
740	AL1	REAL	ARRAY	MATL	1060	AL2	REAL	ARRAY	MATL
4446	BTH	REAL			0	B11	REAL	ARRAY	MATL
120	B12	REAL	ARRAY	MATL	240	B22	REAL	ARRAY	MATL
500	B44	REAL	ARRAY	MATL	620	B55	REAL	ARRAY	MATL
360	B66	REAL	ARRAY	MATL	7	CPP	REAL		THICK
11	CPT	REAL		THICK	4442	CXR	REAL		
12	CXS	REAL		XMIT	25	C11	REAL		XMIT
26	C12	REAL		XMIT	27	C22	REAL		XMIT
30	C66	REAL		XMIT	0	D	REAL	ARRAY	F.P.
4452	DEL	REAL			4436	DELS	REAL		
12	DLP	REAL		THICK	15	DLT	REAL		THICK
0	DM	REAL	ARRAY	F.P.	550	DSC	REAL	ARRAY	GEOM
34	DUMM	REAL	ARRAY	RUN	35	D11	REAL		XMIT
36	D12	REAL		XMIT	37	D22	REAL		XMIT
40	D66	REAL		XMIT	4455	EFI	REAL		
4443	ELH	REAL			4444	ELJ	REAL		
4454	EM	REAL			56	EMFI	REAL		XMIT
57	EMTH	REAL		XMIT	4453	EN	REAL		
10	EPP	REAL		THICK	4450	EPS	REAL		
13	EPT	REAL		THICK	77	ERP	REAL		RUN
4460	ETF	REAL			4445	ETH	REAL		
31	E11	REAL		XMIT	32	E12	REAL		XMIT
33	E22	REAL		XMIT	34	E66	REAL		XMIT
50	F11	REAL		XMIT	51	F12	REAL		XMIT
52	F22	REAL		XMIT	0	GA	REAL	ARRAY	TRIA
5	GB	REAL	ARRAY	TRIA	14	GMP	REAL		THICK
16	GMT	REAL		THICK	4	GPZ	REAL		THICK
5	GTZ	REAL		THICK	64	G12	REAL		XMIT
65	G21	REAL		XMIT	4463	H	REAL		
0	HDMAX	REAL		ADAM	4456	HFI	REAL		
26	HH	REAL		RUN	4451	HKA	REAL		
4464	HP	REAL			4461	HTF	REAL		
4447	HTH	REAL			5	HTT	REAL		XMIT
60	H11	REAL		XMIT	61	H12	REAL		XMIT
63	H21	REAL		XMIT	62	H22	REAL		XMIT
41	H44	REAL		XMIT	42	H55	REAL		XMIT
43	H66	REAL		XMIT	4402	I	INTEGER		
1250	IA	INTEGER	ARRAY	GEOM	1262	IB	INTEGER	ARRAY	GEOM
75	IBCL	INTEGER		RUN	0	IBR	INTEGER		XMIT
1	IBRM	INTEGER		XDUM	4422	ICYL	INTEGER		
34	ID	INTEGER	ARRAY	RUN	33	IFREQ	INTEGER		RUN
4403	IGCT	INTEGER			4414	IK	INTEGER		
3536	IN	INTEGER			13	INDEX	INTEGER		XMIT
74	ING	INTEGER	ARRAY	GEOM	1	INTG	INTEGER		ADAM
4401	INXC	INTEGER			3537	IOR	INTEGER		
3540	IOUT	INTEGER			120	IPAR	INTEGER	ARRAY	GEOM
0	IRC	INTEGER		F.P.	4421	IRS	INTEGER		

SUBROUTINE MAIN CDC 6600 FTN V3.0-P243 OPT=1 06/19/71 13.01.44. PAGE 16

VARIABLES		SN	TYPE		RELOCATION					
1	ISH		INTEGER		XMIT	170	ISS	INTEGER	ARRAY	GEOM
4433	IST		INTEGER			4373	ISTK	INTEGER		
4416	ISTR		INTEGER			0	ISY	INTEGER		F.P.
31	ITP		INTEGER	ARRAY	TRIA	4375	IVB	INTEGER		
4432	IX		INTEGER			4411	J	INTEGER		
4423	JJ		INTEGER			30	JMAX	INTEGER		RUN
4434	JPA		INTEGER			0	JRC	INTEGER		F.P.
0	JSY		INTEGER		F.P.	0	JTYPE	INTEGER		XDUM
27	J9		INTEGER		RUN	4410	K	INTEGER		
4431	KF		INTEGER			4473	KK	INTEGER		
4471	KKK		INTEGER			76	KORTN	INTEGER		RUN
0	KHC		INTEGER		F.P.	4376	K100	INTEGER		
4377	K4		INTEGER			4400	K8	INTEGER		
4412	L		INTEGER			4404	LD	INTEGER		
4472	LL		INTEGER			4462	LLL	INTEGER		
4413	M		INTEGER			1060	MLY	INTEGER	ARRAY	GEOM
31	M9		INTEGER		RUN	4415	N	INTEGER		
24	NBR		INTEGER		XMIT	0	NDE	INTEGER		RUN
176	NF		INTEGER		TRIA	4420	NFF	INTEGER		
200	NFP		INTEGER		TRIA	175	NH	INTEGER		TRIA
4407	NNN		INTEGER			4406	NPCH	INTEGER		
177	NPL		INTEGER		TRIA	201	NPRT	INTEGER		TRIA
4417	NSTR		INTEGER			524	NTP	INTEGER	ARRAY	GEOM
4437	NTR		INTEGER			4405	NX	INTEGER		
4374	NXT		INTEGER			4	OMSQ	REAL		XMIT
4424	PARTS		REAL			16	PC	REAL		XMIT
15	PL		REAL		XMIT	14	PN	REAL		XMIT
6	QT		REAL		THICK	1200	RHO	REAL	ARRAY	MATL
21	RH1		REAL		XMIT	22	RH2	REAL		XMIT
23	RH3		REAL		XMIT	6	R1	REAL		XMIT
7	R2		REAL		XMIT	10	R3	REAL		XMIT
1	S		REAL		RUN	0	SI	REAL	ARRAY	GEOM
4430	SMAX		REAL			4425	SMXX	REAL		
24	SX		REAL	ARRAY	GEOM	11	SXN	REAL		XMIT
4441	SXR		REAL			4426	SZERO	REAL		
4465	S11		REAL			4466	S12	REAL		
4470	S21		REAL			4467	S22	REAL		
2153	TLI		REAL	ARRAY	GEOM	1333	TR	REAL	ARRAY	GEOM
214	TR1		REAL	ARRAY	GEOM	360	TR2	REAL	ARRAY	GEOM
17	T0		REAL		XMIT	20	T1	REAL		XMIT
47	XE66		REAL		XMIT	53	XH11	REAL		XMIT
54	XH12		REAL		XMIT	55	XH22	REAL		XMIT
4427	XINT		REAL			44	XK11	REAL		XMIT
45	XK12		REAL		XMIT	46	XK22	REAL		XMIT
2	XLAST		REAL		ADAM	3	XLD	REAL		XMIT
1	XMT		REAL		THICK	3	XMTP	REAL		THICK
2	XN		REAL		XMIT	4440	XNR	REAL		
0	XNT		REAL		THICK	2	XNTP	REAL		THICK
32	XOUT		REAL		RUN	50	XPR	REAL	ARRAY	GEOM
4435	XX		REAL			2	Y	REAL	ARRAY	RUN
14	YD		REAL	ARRAY	RUN	144	Z	REAL	ARRAY	GEOM
4457	ZD		REAL			1104	ZLY	REAL	ARRAY	GEOM

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        SUBROUTINE  MAIN                                             CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE     17

    FILE NAMES        MODE
          TAPE5       FMT               TAPE6        FMT                  TAPE7        FMT

    EXTERNALS           TYPE   ARGS
          BCOND                  0                        COEFF            0
          EOF         REAL       1                        EXIT             0
          INPUT                  0                        ORTHO            0
          RUNGE                  0                        TRIANG           7

    STATEMENT LABELS
        0  10         INACTIVE          3541  19     FMT                      3544  20     FMT
        0  30         INACTIVE          3546  40     FMT                       113  50
        0  51         INACTIVE           126  52                              3555  60     FMT
     3620  70      FMT                     0  80          INACTIVE            3632  90     FMT
      156  100                             0  110         INACTIVE            3640  120    FMT
      170  130                          3646  140    FMT                      3650  150    FMT
     3662  160     FMT                  3665  170    FMT                      3670  180    FMT
        0  190        INACTIVE          3704  200    FMT                       307  210
        0  220                             0  221         INACTIVE               0  222         INACTIVE
        0  230        INACTIVE          3713  240    FMT                       330  250
      330  260                             0  270         INACTIVE            3721  280    FMT
      356  290                          3731  300    FMT                       367  310
     3741  320     FMT                  3744  330    FMT                         0  339
        0  340        INACTIVE          3753  350    FMT                       474  360
     3762  370     FMT                   515  380                                0  390         INACTIVE
        0  400                           540  410                                0  411         INACTIVE
        0  412                           555  420                                0  430
      575  440                           600  450                                0  460
        0  470                           625  480                              630  490
        0  500                             0  510                                0  520
        0  530                             0  540                                0  550
        0  560                             0  570         INACTIVE             776  580
     1004  581                          1013  590                                0  600         INACTIVE
     1023  610                          3771  620    FMT                      1105  627
     1072  628                             0  629         INACTIVE            4014  630    FMT
     3777  631     FMT                     0  640         INACTIVE            4027  650    FMT
        0  651        INACTIVE          1276  652                             4056  660    FMT
     4066  670     FMT                  4076  680    FMT                      4110  690    FMT
     4122  700     FMT                  4036  701    FMT                      4134  710    FMT
        0  720                          1325  730                                0  740
        0  750        INACTIVE             0  760                                0  770         INACTIVE
     1346  780                             0  790         INACTIVE            4140  800    FMT
     1375  810                          1375  820                             1377  830
        0  840                             0  850         INACTIVE            1411  860
        0  870        INACTIVE          1422  880                                0  890         INACTIVE
        0  900                          1455  910                                0  920
     1477  930                             0  940         INACTIVE            4154  950    FMT
     4157  960     FMT                  1527  970                                0  980         INACTIVE
     1535  990                             0  1000        INACTIVE            1542  1010
        0  1020       INACTIVE             0  1030        INACTIVE            1563  1040
     1570  1041                         1574  1050                               0  1060
        0  1070                         1651  1080                               0  1090         INACTIVE
        0  1100       INACTIVE          1665  1110                               0  1120
        0  1130       INACTIVE             0  1140        INACTIVE               0  1150         INACTIVE
        0  1160       INACTIVE          1730  1170                            1735  1171
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STATEMENT LABELS

1741	1180			0	1190			0	1200		
2012	1210			2017	1220			0	1230		
0	1240			0	1250			0	1260		
0	1270			2161	1280			0	1290		
0	1300		INACTIVE	4162	1310	FMT		2200	1320		
0	1330		INACTIVE	4164	1340	FMT		0	1350		
4200	1360	FMT		2256	1370			0	1380		INACTIVE
0	1390		INACTIVE	2270	1400			0	1410		INACTIVE
2273	1420			0	1430			2305	1440		
0	1450			0	1460			2333	1470		
4204	1480	FMT		0	1488		INACTIVE	2411	1489		
0	1490		INACTIVE	0	1491		INACTIVE	4253	1500	FMT	
4215	1501	FMT		4234	1502	FMT		2417	1510		
2405	1511			4275	1520	FMT		2422	1530		
0	1540		INACTIVE	0	1541		INACTIVE	2443	1542		
2437	1543			0	1544		INACTIVE	0	1546		INACTIVE
2451	1547			2423	1550			2454	1559		
4317	1560	FMT		4323	1561	FMT		0	1562		INACTIVE
2371	1563			2376	1564			4327	1570	FMT	
2456	1580			0	1590		INACTIVE	0	1600		INACTIVE
0	1610		INACTIVE	2502	1620			2507	1621		
2513	1630			0	1640			0	1650		
2541	1660			0	1670		INACTIVE	0	1680		INACTIVE
4333	1690	FMT		2572	1700			0	1710		
0	1711		INACTIVE	0	1720		INACTIVE	0	1721		
0	1722		INACTIVE	4345	1723	FMT		4351	1724	FMT	
4354	1725	FMT		3137	1728			4335	1730	FMT	
0	1740			3067	1750			3413	1751		
0	1760		INACTIVE	0	1770		INACTIVE	4361	1780	FMT	
4341	1782	FMT		3435	1790			0	1800		INACTIVE
0	1810			3455	1820			4363	1830	FMT	
0	1840			0	1850			0	1860		INACTIVE
3500	1870			0	1880		INACTIVE	3505	1890		
0	3333		INACTIVE	102	3334						

COMMON BLOCKS	LENGTH
XDUM	2
RUN	64
MATL	720
XMIT	54
GEOM	1235
THICK	15
TRIA	130
ADAM	3

STATISTICS

PROGRAM LENGTH	4611B	2441
COMMON LENGTH	4257B	2223

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SUBROUTINE  ORTHO                                   CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.        PAGE     1

              SUBROUTINE ORTHO                                                          THICK    786
              COMMON/RUN/ NDE,S,Y(10),YD(10),HH,J9,JMAX,M9,XOUT,IFREQ,DUMM(33),        THICK    787
             1IBCL,KORTN,ERP                                                            THICK    788
              COMMON/MATL/ B11(20,4),B12(20,4),B22(20,4),B66(20,4),B44(20,4),          THICK    789
             1B55(20,4),AL1(20,4),AL2(20,4),RHO(20,4)                                  THICK    790
              COMMON/XMIT/ IBR,ISH,XN,XLD,OMSQ,HTT,R1,R2,R3,SXN,CXS,INDEX,PN,PL,       THICK    791
             1PC,T0,T1,RH1,RH2,RH3,NBR,C11,C12,C22,C66,E11,E12,E22,E66,D11,D12,        THICK    792
             2D22,D66,H44,H55,H66,XE11,XE12,XE22,XE66,F11,F12,F22,XH11,XH12,XH22      THICK    793
             3,EMFI,EMTH,H11,H12,H22,H21,G12,G21                                       THICK    794
              COMMON/GEOM/ SI(20),SX(20),XPR(20),ING(20),IPAR(20),Z(20),ISS(20),       THICK    795
             1TR1(10,10),TR2(10,10),NTP(20),DSC(20,10),MLY(20),ZLY(20,5),IA(10),       THICK    796
             2IB(10,4),ALFL          ,TR(10,10,4),TLI(10,10),ALFR(4)                   THICK    797
              DIMENSION IL1(20,4),IL2(20),PSR(20,4)                                     THICK    798
              GO TO (10,10,220,190),INDEX                                               THICK    799
           10 MK=MLY(IBR)                                                               THICK    800
              DO 60 I=1,MK                                                              THICK    801
              READ (5,20) B11(IBR,I),B12(IBR,I),B22(IBR,I),B66(IBR,I),                  THICK    802
             1AL1(IBR,I),AL2(IBR,I),RHO(IBR,I),IL1(IBR,I)                               THICK    803
           20 FORMAT (7F10.6, I5)                                                       THICK    804
              PSR(IBR,I)=B12(IBR,I)                                                     THICK    805
              IF(IL1(IBR,I)) 30,60,40                                                   THICK    806
           30 L3=-IL1(IBR,I)                                                            THICK    807
              DY=FGEN (L3,1)                                                            THICK    808
              GO TO 60                                                                  THICK    809
           40 L1=IL1(IBR,I)                                                             THICK    810
              K5=5                                                                      THICK    811
              IF(KORTN.NE.0) K5=7                                                       THICK    812
              L2=IL1(IBR,I)+K5                                                          THICK    813
              DO 50 J=L1,L2                                                             THICK    814
           50 DY=FGEN (J,1)                                                             THICK    815
           60 CONTINUE                                                                  THICK    816
              READ (5,70)  (ZLY(IBR,I),I=1, 5),IL2(IBR)                                 THICK    817
           70 FORMAT (5F10.6,I5)                                                        THICK    818
              IF(IL2(IBR)) 100,100,80                                                   THICK    819
           80 L2=IL2(IBR)+MK                                                            THICK    820
              L1=IL2(IBR)                                                               THICK    821
              DO 90 I=L1,L2                                                             THICK    822
           90 DY=FGEN (I,1)                                                             THICK    823
          100 CONTINUE                                                                  THICK    824
              MK=MLY(IBR)                                                               THICK    825
              DO 180 I=1,MK                                                             THICK    826
              J=I+1                                                                     THICK    827
              WRITE (6,110) I, ZLY(IBR,I),ZLY(IBR,J)                                    THICK    828
          110 FORMAT (1H0, 8HLAYER NO, I3, 9H  FROM Z=,E12.5,7H  TO Z=,E12.5)           THICK    829
              IF(B22(IBR,I)-1.0E-8) 120,120,140                                         THICK    830
          120 E=B11(IBR,I)                                                              THICK    831
              P=B12(IBR,I)                                                              THICK    832
              P1=1.0-P*P                                                                THICK    833
              B11(IBR,I)=E/P1                                                           THICK    834
              B12(IBR,I)=P*E/P1                                                         THICK    835
              B22(IBR,I)=B11(IBR,I)                                                     THICK    836
              B66(IBR,I)=E*0.5/(1.0+P)                                                  THICK    837
              B44(IBR,I)=B66(IBR,I)                                                     THICK    838
              B55(IBR,I)=B66(IBR,I)                                                     THICK    839
              WRITE (6,130) E,P                                                         THICK    840
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      130 FORMAT(1H ,5X,49HCONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= THICK  841
         1, E12.5, 20H  POISSONS RATIO NU=,E12.5)                            THICK  842
          GO TO 160                                                          THICK  843
      140 WRITE (6,150) B11(IBR,I),B12(IBR,I),B22(IBR,I),B66(IBR,I)          THICK  844
      150 FORMAT (1H ,5X,37HCONSISTS OF ORTHOTROPIC MATERIAL WITH,           THICK  845
         16H  B11=,E12.5,6H  B12=,E12.5,6H  B22=,E12.5,6H  B66=,E12.5)      THICK  846
      160 WRITE (6,170) AL1(IBR,I),AL2(IBR,I),RHO(IBR,I)                     THICK  847
      170 FORMAT (1H ,5X,33HCOEFFICIENTS OF THERMAL EXPANSION, 6H  AFI=,     THICK  848
         1E12.5, 9H  ATHETA=,E12.5, 19H  MASS DENSITY RHO=,E12.5)           THICK  849
      180 CONTINUE                                                           THICK  850
          RETURN                                                             THICK  851
      190 IF(IL2(IBR)) 200,200,230                                           THICK  852
      200 DO 210 I=1,MK                                                      THICK  853
          IF(IL1(IBR,I)) 250,210,250                                         THICK  854
      210 CONTINUE                                                           THICK  855
          RETURN                                                             THICK  856
      220 L1=IL2(IBR)                                                        THICK  857
          MK=MLY(IBR)                                                        THICK  858
          L2=IL2(IBR)+MK                                                     THICK  859
          IF(IL2(IBR)) 290,250,230                                           THICK  860
      230 J=0                                                                THICK  861
          DO 240 I=L1,L2                                                     THICK  862
          J=J+1                                                              THICK  863
      240 ZLY(IBR,J)=FGEN(I,2)                                               THICK  864
      250 DO 280 I=1,MK                                                      THICK  865
          IF(IL1(IBR,I)) 260,280,270                                         THICK  866
      260 L3=-IL1(IBR,I)                                                     THICK  867
          E=FGEN (L3,2)                                                      THICK  868
          P=PSR(IBR,I)                                                       THICK  869
          P1=1.0-P*P                                                         THICK  870
          B11(IBR,I)=E/P1                                                    THICK  871
          B22(IBR,I)=B11(IBR,I)                                              THICK  872
          B12(IBR,I)=P*B11(IBR,I)                                            THICK  873
          B66(IBR,I)=E*0.5/(1.0+P)                                           THICK  874
          B44(IBR,I)=B66(IBR,I)                                              THICK  875
          B55(IBR,I)=B66(IBR,I)                                              THICK  876
          GO TO 280                                                          THICK  877
      270 J=IL1(IBR,I)                                                       THICK  878
          B11(IBR,I)= FGEN (J  ,2)                                           THICK  879
          B12(IBR,I)= FGEN (J+1,2)                                           THICK  880
          B22(IBR,I)= FGEN (J+2,2)                                           THICK  881
          B66(IBR,I)= FGEN (J+3,2)                                           THICK  882
          AL1(IBR,I)= FGEN (J+4,2)                                           THICK  883
          AL2(IBR,I)= FGEN (J+5,2)                                           THICK  884
          IF(KORTN) 271,280,271                                              THICK  885
      271 B55(IBR,I)=FGEN(J+6,2)                                             THICK  886
          B44(IBR,I)=FGEN(J+7,2)                                             THICK  887
      280 CONTINUE                                                           THICK  888
      290 C11=0.0                                                            THICK  889
          S11=1.0                                                            THICK  890
          R11=1.0                                                            THICK  891
          H55=0.0                                                            THICK  892
          H66=0.0                                                            THICK  893
          F11=0.0                                                            THICK  894
          F12=0.0                                                            THICK  895
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      SUBROUTINE  ORTHO                        CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE    3

          F22=0.0                                                              THICK     896
          RHH=0.0                                                              THICK     897
          XE11=0.0                                                             THICK     898
          XE12=0.0                                                             THICK     899
          XE22=0.0                                                             THICK     900
          XH11=0.0                                                             THICK     901
          XH12=0.0                                                             THICK     902
          XH22=0.0                                                             THICK     903
          C12=0.0                                                              THICK     904
          C22=0.0                                                              THICK     905
          C66=0.0                                                              THICK     906
          E11=0.0                                                              THICK     907
          E12=0.0                                                              THICK     908
          E22=0.0                                                              THICK     909
          E66=0.0                                                              THICK     910
          D11=0.0                                                              THICK     911
          D12=0.0                                                              THICK     912
          D22=0.0                                                              THICK     913
          D66=0.0                                                              THICK     914
          H11=0.0                                                              THICK     915
          H12=0.0                                                              THICK     916
          H22=0.0                                                              THICK     917
          H21=0.0                                                              THICK     918
          G12=0.0                                                              THICK     919
          G21=0.0                                                              THICK     920
          RH1=0.0                                                              THICK     921
          RH2=0.0                                                              THICK     922
          RH3=0.0                                                              THICK     923
          H11=  ZLY(IBR,MK+1)-ZLY(IBR,1)                                       THICK     924
          R4=R2*SXN                                                            THICK     925
          DO 300 I=1,MK                                                        THICK     926
          J=I+1                                                                THICK     927
          Z1=ZLY(IBR,J) -ZLY(IBR,I)                                            THICK     928
          Z2=ZLY(IBR,J)*ZLY(IBR,J)-ZLY(IBR,I)*ZLY(IBR,I)                       THICK     929
          Z3=ZLY(IBR,J)*ZLY(IBR,J)*ZLY(IBR,J)-ZLY(IBR,I)*ZLY(IBR,I)*ZLY(IBR,   THICK     930
         1I)                                                                   THICK     931
          Z2=0.5*Z2                                                            THICK     932
          Z3=0.333333*Z3                                                       THICK     933
          S12=Z2                                                               THICK     934
          R12=Z2                                                               THICK     935
          IF(KORTN) 291,292,291                                                THICK     936
      291 S11=1.0-(R1-R4)*(Z2-Z3*R1)/Z1                                        THICK     937
          R11=1.0+(R1-R4)*(Z2-Z3*R4)/Z1                                        THICK     938
          XE11=XE11+B66(IBR,I)*Z1*S11                                          THICK     939
          XE12=XE12+B66(IBR,I)*Z1                                              THICK     940
          XE22=XE22+B66(IBR,I)*Z1*R11                                          THICK     941
          S12=Z2-(R1-R4)*Z3                                                    THICK     942
          R12=Z2+(R1-R4)*Z3                                                    THICK     943
          F11=F11+B66(IBR,I)*    S12                                           THICK     944
          F12=F12+B66(IBR,I)*Z2                                                THICK     945
          F22=F22+B66(IBR,I)*    R12                                           THICK     946
          XH11=XH11+B66(IBR,I)*Z3                                              THICK     947
          XH12=XH12+B66(IBR,I)*Z3                                              THICK     948
          XH22=XH22+B66(IBR,I)*Z3                                              THICK     949
          H55=H55+B55(IBR,I)*Z1*S11                                            THICK     950
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SUBROUTINE  ORTHO                          CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE     4
          H66=H66+B44(IBR,I)*Z1*R11                                          THICK     951
      292 C11=C11+B11(IBR,I)*Z1 *S11                                         THICK     952
          C12=C12+B12(IBR,I)*Z1                                              THICK     953
          C22=C22+B22(IBR,I)*Z1   *R11                                       THICK     954
          C66=C66+B66(IBR,I)*Z1                                              THICK     955
          E11=E11+B11(IBR,I)     *S12                                        THICK     956
          E12=E12+B12(IBR,I)*Z2                                              THICK     957
          E22=E22+B22(IBR,I)     *R12                                        THICK     958
          E66=E66+B66(IBR,I)*Z2                                              THICK     959
          D11=D11+B11(IBR,I)*Z3                                              THICK     960
          D12=D12+B12(IBR,I)*Z3                                              THICK     961
          D22=D22+B22(IBR,I)*Z3                                              THICK     962
          D66=D66+B66(IBR,I)*Z3                                              THICK     963
      294 A1=B11(IBR,I)*AL1(IBR,I)+B12(IBR,I)*AL2(IBR,I)                     THICK     964
          A2=B12(IBR,I)*AL1(IBR,I)+B22(IBR,I)*AL2(IBR,I)                     THICK     965
          H11=H11-A1*Z1                                                      THICK     966
          H12=H12-A1*Z2                                                      THICK     967
          H22=H22-A2*Z1                                                      THICK     968
          H21=H21-A2*Z2                                                      THICK     969
          G12=G12-A1*Z3                                                      THICK     970
          G21=G21-A2*Z3                                                      THICK     971
          RH1=RH1+RHO(IBR,I)*Z1                                              THICK     972
          RH2=RH2+RHO(IBR,I)*Z2                                              THICK     973
          RH3=RH3+RHO(IBR,I)*Z3                                              THICK     974
      300 CONTINUE                                                           THICK     975
          RETURN                                                             THICK     976
          END                                                                THICK     977
```

SUBROUTINE ORTHO   CDC 6600 FTN V3.0-P243 OPT=1   06/19/71   13.01.44.   PAGE 5

SYMBOLIC REFERENCE MAP

ENTRY POINTS
1 ORTHO

VARIABLES	SN	TYPE		RELOCATION					
1332	ALFL	REAL		GEOM	2317	ALFR	REAL	ARRAY	GEOM
740	AL1	REAL	ARRAY	MATL	1060	AL2	REAL	ARRAY	MATL
1032	A1	REAL			1033	A2	REAL		
0	B11	REAL	ARRAY	MATL	120	B12	REAL	ARRAY	MATL
240	B22	REAL	ARRAY	MATL	500	B44	REAL	ARRAY	MATL
620	B55	REAL	ARRAY	MATL	360	B66	REAL	ARRAY	MATL
12	CXS	REAL		XMIT	25	C11	REAL		XMIT
26	C12	REAL		XMIT	27	C22	REAL		XMIT
30	C66	REAL		XMIT	550	DSC	REAL	ARRAY	GEOM
34	DUMM	REAL	ARRAY	RUN	1011	DY	REAL		
35	D11	REAL		XMIT	36	D12	REAL		XMIT
37	D22	REAL		XMIT	40	D66	REAL		XMIT
1016	E	REAL			56	EMFI	REAL		XMIT
57	EMTH	REAL		XMIT	77	EXP	REAL		RUN
31	E11	REAL		XMIT	32	E12	REAL		XMIT
33	E22	REAL		XMIT	34	E66	REAL		XMIT
50	F11	REAL		XMIT	51	F12	REAL		XMIT
52	F22	REAL		XMIT	64	G12	REAL		XMIT
65	G21	REAL		XMIT	26	HH	REAL		RUN
5	HTT	REAL		XMIT	60	H11	REAL		XMIT
61	H12	REAL		XMIT	63	H21	REAL		XMIT
62	H22	REAL		XMIT	41	H44	REAL		XMIT
42	H55	REAL		XMIT	43	H66	REAL		XMIT
1007	I	INTEGER			1250	IA	INTEGER	ARRAY	GEOM
1262	IB	INTEGER	ARRAY	GEOM	75	IBCL	INTEGER		RUN
0	IBR	INTEGER		XMIT	33	IFREQ	INTEGER		RUN
1034	IL1	INTEGER	ARRAY		1154	IL2	INTEGER	ARRAY	
13	INDEX	INTEGER		XMIT	74	ING	INTEGER	ARRAY	GEOM
120	IPAR	INTEGER	ARRAY	GEOM	1	ISH	INTEGER		XMIT
170	ISS	INTEGER	ARRAY	GEOM	1015	J	INTEGER		
30	JMAX	INTEGER		RUN	27	J9	INTEGER		RUN
76	KORTN	INTEGER		RUN	1013	K5	INTEGER		
1012	L1	INTEGER			1014	L2	INTEGER		
1010	L3	INTEGER			1006	MK	INTEGER		
1060	MLY	INTEGER	ARRAY	GEOM	31	M9	INTEGER		RUN
24	NBR	INTEGER		XMIT	0	NDE	INTEGER		RUN
524	NTP	INTEGER	ARRAY	GEOM	4	OMSQ	REAL		XMIT
1017	P	REAL			16	PC	REAL		XMIT
15	PL	REAL		XMIT	14	PN	REAL		XMIT
1200	PSR	REAL	ARRAY		1020	P1	REAL		
1023	RHH	REAL			1200	RHO	REAL	ARRAY	MATL
21	RH1	REAL		XMIT	22	RH2	REAL		XMIT
23	RH3	REAL		XMIT	6	R1	REAL		XMIT
1022	R11	REAL			1031	R12	REAL		
7	R2	REAL		XMIT	10	R3	REAL		XMIT
1024	R4	REAL			1	S	REAL		RUN
0	SI	REAL	ARRAY	GEOM	24	SX	REAL	ARRAY	GEOM
11	SXN	REAL		XMIT	1021	S11	REAL		

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         SUBROUTINE  ORTHO                                            CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE      6

    VARIABLES      SN  TYPE              RELOCATION
     1030  S12         REAL                                 2153  TLI        REAL      ARRAY    GEOM
     1333  TR          REAL      ARRAY    GEOM               214  TR1        REAL      ARRAY    GEOM
      360  TR2         REAL      ARRAY    GEOM                17  TO         REAL               XMIT
       20  T1          REAL               XMIT                44  XE11       REAL               XMIT
       45  XE12        REAL               XMIT                46  XE22       REAL               XMIT
       47  XE66        REAL               XMIT                53  XH11       REAL               XMIT
       54  XH12        REAL               XMIT                55  XH22       REAL               XMIT
        3  XLD         REAL               XMIT                 2  XN         REAL               XMIT
       32  XOUT        REAL               RUN                 50  XPR        REAL      ARRAY    GEOM
        2  Y           REAL      ARRAY    RUN                 14  YD         REAL      ARRAY    RUN
      144  Z           REAL      ARRAY    GEOM              1104  ZLY        REAL      ARRAY    GEOM
     1025  Z1          REAL                                 1026  Z2         REAL
     1027  Z3          REAL

    FILE NAMES         MODE
           TAPE5        FMT                   TAPE6        FMT

    EXTERNALS           TYPE    ARGS
           FGEN         REAL      2

    STATEMENT LABELS
       12  10                                  721  20        FMT                          0  30              INACTIVE
       74  40                                    0  50                                   117  60
      724  70       FMT                          0  80            INACTIVE                 0  90
      153  100                                 727  110       FMT                          0  120             INACTIVE
      735  130      FMT                        233  140                                  750  150        FMT
      256  160                                 764  170       FMT                          0  180
      300  190                                   0  200           INACTIVE                 0  210
      314  220                                 321  230                                    0  240
      334  250                                   0  260           INACTIVE               370  270
        0  271          INACTIVE               455  280                                  460  290
        0  291          INACTIVE               601  292                                    0  294             INACTIVE
        0  300

    COMMON BLOCKS    LENGTH
           RUN          64
           MATL        720
           XMIT         54
           GEOM       1235

    STATISTICS
      PROGRAM LENGTH    1320B     720
       COMMON LENGTH    4031B    2073
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SUBROUTINE COEFF   CDC 6600 FTN V3.0-P243 OPT=1   06/19/71   13.01.44.   PAGE 1

```
      SUBROUTINE COEFF                                                  THICK 978
      COMMON/THICK/ XNT,XMT,XNTP,XMTP,GPZ,GTZ,QT,CPP,EPP,CPT,DLP,EPT,   THICK 979
     1GMP,DLT,GMT                                                       THICK 980
      COMMON/RUN/ NDE,S,Y(10),YD(10),HH,J9,JMAX,M9,XOUT,IFREQ,DUMM(33), THICK 981
     1IBCL,KORTN,ERP                                                    THICK 982
      COMMON/MATL/ B11(20,4),B12(20,4),B22(20,4),B66(20,4),B44(20,4),   THICK 983
     1B55(20,4),AL1(20,4),AL2(20,4),RHO(20,4)                           THICK 984
      COMMON/XMIT/ IBR,ISH,XN,XLD,OMSQ,HTT,R1,R2,R3,SXN,CXS,INDEX,PN,PL, THICK 985
     1PC,T0,T1,RH1,RH2,RH3,NBR,C11,C12,C22,C66,XK11,XK12,XK22,E66,D11,  THICK 986
     2D12,                                                              THICK 987
     2D22,D66,H44,H55,H66, E11, E12, E22,XE66,F11,F12,F22,XH11,XH12,XH22 THICK 988
     3,EMFI,EMTH,H11,H12,H22,H21,G12,G21                                THICK 989
C                                                                       THICK 990
      ENQ=XN*XN                                                         THICK 991
      RSQ=R2*R2                                                         THICK 992
      CXSR = CXS*R2                                                     THICK 993
      SXNR = SXN*R2                                                     THICK 994
      XNR  = XN*R2                                                      THICK 995
      B 2 = -PN*XLD                                                     THICK 996
      B 4 = -PL*XLD                                                     THICK 997
      B 8 = -PC*XLD                                                     THICK 998
      YD(1)=1.0/H55*Y(2)  +R1*Y(3)- Y(5)                                THICK 999
      EPT = XNR*Y(7)  + CXSR*Y(3)  + SXNR*Y(1)                          THICK 1000
      CPT = XNR*Y(9)  + CXSR*Y(5)                                       THICK 1001
      GMT = -XNR*Y(3)  - CXSR*Y(7)                                      THICK 1002
      DLT = -XNR*Y(5)  - CXSR*Y(9)                                      THICK 1003
      THN=(H11*T0+H12*T1)*XLD                                           THICK 1004
      THM=(H12*T0+G12*T1)*XLD                                           THICK 1005
      EPP = 1.0/(C11*D11 - XK11*XK11)*((Y(4) - C12*EPT-XK12*CPT-THN)*D11 THICK 1006
     1 - (Y(6) - XK12*EPT - D12*CPT-THM)*XK11)                          THICK 1007
      CPP = -1.0/(C11*D11 - XK11*XK11)*((Y(4) - C12*EPT-XK12*CPT-THN)*XK THICK 1008
     111- (Y(6) - XK12*EPT - D12*CPT-THM)*C11 )                         THICK 1009
      YD(5) = CPP                                                       THICK 1010
      GMP=1.0/(E11*XH11-F11*F11)*((Y(8)-E12*GMT-F12*DLT)*XH11           THICK 1011
     1 - (Y(10) - F12*GMT-X H12*DLT)*F11)                               THICK 1012
      YD(7) = GMP                                                       THICK 1013
      DLP = -1.0/(E11*XH11- F11*F11)*((Y(8) - E12*GMT - F12*DLT)*F11    THICK 1014
     1 - (Y(10) - F12*GMT-X H12*DLT)*E11)                               THICK 1015
      YD(9) = DLP                                                       THICK 1016
      YD(3) = EPP - R1*Y(1)                                             THICK 1017
      XNT =  C12*EPP  +  C22*EPT  + XK12*CPP  + XK22*CPT+(H22*T0+H21*T1) THICK 1018
     1*XLD                                                              THICK 1019
      XMT = XK12*EPP  + XK22*EPT  +  D12*CPP  +  D22*CPT+(H21*T0+G21*T1) THICK 1020
     1*XLD                                                              THICK 1021
      XNTP=  E12*GMP  +  E22*GMT  +  F12*DLP  +  F22*DLT                THICK 1022
      XMTP=  F12*GMP  +  F22*GMT  + XH12*DLP  + XH22*DLT                THICK 1023
      GTZ=        -XNR*Y(1) - SXNR*Y(7) + Y(9)                          THICK 1024
      QT=GTZ*H66                                                        THICK 1025
      YD(2) = - CXSR*Y(2) - XNR*QT + R1*Y(4) + SXNR*XNT + B 2           THICK 1026
      YD(4) = - CXSR*Y(4) - XNR*XNTP + CXSR*XNT - R1*Y(2) + B 4         THICK 1027
      YD(8) = - CXSR*Y(8) + XNR*XNT - CXSR*XNTP - SXNR*QT + B 8         THICK 1028
      YD(6) = - CXSR*Y(6) - XNR*XMTP + CXSR*XMT + Y(2)                  THICK 1029
      YD(10) = - CXSR*Y(10) + XNR*XMT - CXSR*XMTP + QT                  THICK 1030
      GPZ=YD(1)-Y(3)*R1+Y(5)                                            THICK 1031
      RETURN                                                            THICK 1032
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      SUBROUTINE  COEFF                               CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    2
                END                                                  THICK    1033
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SUBROUTINE COEFF   CDC 6600 FTN V3.0-P243 OPT=1 06/19/71 13.01.44.   PAGE 3

SYMBOLIC REFERENCE MAP

ENTRY POINTS
1 COEFF

VARIABLES SN		TYPE		RELOCATION					
740	AL1	REAL	ARRAY	MATL	1060	AL2	REAL	ARRAY	MATL
0	B11	REAL	ARRAY	MATL	120	B12	REAL	ARRAY	MATL
307	B2	REAL			240	B22	REAL	ARRAY	MATL
310	B4	REAL			500	B44	REAL	ARRAY	MATL
620	B55	REAL	ARRAY	MATL	360	B66	REAL	ARRAY	MATL
311	B8	REAL			7	CPP	REAL		THICK
11	CPT	REAL		THICK	12	CXS	REAL		XMIT
304	CXSR	REAL			25	C11	REAL		XMIT
26	C12	REAL		XMIT	27	C22	REAL		XMIT
30	C66	REAL		XMIT	12	DLP	REAL		THICK
15	DLT	REAL		THICK	34	DUMM	REAL	ARRAY	RUN
35	D11	REAL		XMIT	36	D12	REAL		XMIT
37	D22	REAL		XMIT	40	D66	REAL		XMIT
56	EMFI	REAL		XMIT	57	EMIH	REAL		XMIT
302	ENQ	REAL			10	EPP	REAL		THICK
13	EPT	REAL		THICK	77	ERP	REAL		RUN
44	E11	REAL		XMIT	45	E12	REAL		XMIT
46	E22	REAL		XMIT	34	E66	REAL		XMIT
50	F11	REAL		XMIT	51	F12	REAL		XMIT
52	F22	REAL		XMIT	14	GMP	REAL		THICK
16	GMT	REAL		THICK	4	GPZ	REAL		THICK
5	GTZ	REAL		THICK	64	G12	REAL		XMIT
65	G21	REAL		XMIT	26	HH	REAL		RUN
5	HTT	REAL		XMIT	60	H11	REAL		XMIT
61	H12	REAL		XMIT	63	H21	REAL		XMIT
62	H22	REAL		XMIT	41	H44	REAL		XMIT
42	H55	REAL		XMIT	43	H66	REAL		XMIT
75	IBCL	INTEGER		RUN	0	IBR	INTEGER		XMIT
33	IFREQ	INTEGER		RUN	13	INDEX	INTEGER		XMIT
1	ISH	INTEGER		XMIT	30	JMAX	INTEGER		RUN
27	J9	INTEGER		RUN	76	KORTN	INTEGER		RUN
31	M9	INTEGER		RUN	24	NBR	INTEGER		XMIT
0	NDE	INTEGER		RUN	4	OMSQ	REAL		XMIT
16	PC	REAL		XMIT	15	PL	REAL		XMIT
14	PN	REAL		XMIT	6	QT	REAL		THICK
1200	RHO	REAL	ARRAY	MATL	21	RH1	REAL		XMIT
22	RH2	REAL		XMIT	23	RH3	REAL		XMIT
303	RSQ	REAL			6	R1	REAL		XMIT
7	R2	REAL		XMIT	10	R3	REAL		XMIT
1	S	REAL		RUN	11	SXN	REAL		XMIT
305	SXNR	REAL			313	THM	REAL		
312	THN	REAL			17	T0	REAL		XMIT
20	T1	REAL		XMIT	47	XE66	REAL		XMIT
53	XH11	REAL		XMIT	54	XH12	REAL		XMIT
55	XH22	REAL		XMIT	31	XK11	REAL		XMIT
32	XK12	REAL		XMIT	33	XK22	REAL		XMIT
3	XLD	REAL		XMIT	1	XMT	REAL		THICK
3	XMTP	REAL		THICK	2	XN	REAL		XMIT

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      SUBROUTINE  COEFF                                         CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      4

VARIABLES     SN  TYPE              RELOCATION
  306  XNR         REAL                                  0  XNT        REAL                 THICK
    2  XNTP        REAL                 THICK           32  XOUT       REAL                 RUN
    2  Y           REAL       ARRAY     RUN             14  YD         REAL       ARRAY     RUN

COMMON BLOCKS   LENGTH
       THICK        15
       RUN          64
       MATL        720
       XMIT         54

STATISTICS
  PROGRAM LENGTH    314B      204
   COMMON LENGTH   1525B      853
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SUBROUTINE  DIFFEQ                                        CDC 6600 FTN V3.0-P243 OPT=1  06/19/71   13.01.44.       PAGE     1

      SUBROUTINE DIFFEQ                                                    THICK   1034
      COMMON/THICK/ XNT,XMT,XNTP,XMTP,GPZ,GTZ,QT,CPP,EPP,CPT,DLP,EPT,      THICK   1035
     1GMP,DLT,GMT                                                          THICK   1036
      COMMON/RUN/ NDE,S,Y(10),YD(10),HH,J9,JMAX,M9,XOUT,IFREQ,DUMM(33),    THICK   1037
     1IBCL,KORTN,ERP                                                       THICK   1038
      COMMON/MAIL/ B11(20,4),B12(20,4),B22(20,4),B66(20,4),B44(20,4),      THICK   1039
     1B55(20,4),AL1(20,4),AL2(20,4),RHO(20,4)                              THICK   1040
      COMMON/XMIT/ IBR,ISH,XN,XLD,OMSQ,HTT,R1,R2,R3,SXN,CXS,INDEX,PN,PL,   THICK   1041
     1PC,T0,T1,RH1,RH2,RH3,NBR,C11,C12,C22,C66,E11,E12,E22,E66,D11,D12,    THICK   1042
     2D22,D66,H44,H55,H66,XK11,XK12,XK22,XE66,F11,F12,F22,XH11,XH12,XH22   THICK   1043
     3,EMFI,EMTH,H11,H12,H22,H21,G12,G21                                   THICK   1044
      COMMON/GEOM/ SI(20),SX(20),XPR(20),ING(20),IPAR(20),Z(20),ISS(20),   THICK   1045
     1TR1(10,10),TR2(10,10),NTP(20),DSC(20,10),MLY(20),ZLY(20,5),IA(10),   THICK   1046
     2IB(10,4),ALFL        ,TR(10,10,4),TLI(10,10),ALFR(4)                 THICK   1047
      IBCL=IBCL+1                                                          THICK   1048
      IF(IBCL-750) 130,130,10                                              THICK   1049
   10 WRITE (6,20)                                                         THICK   1050
   20 FORMAT (1H0, 96HTHERE IS SOMETHING WRONG IN THIS SEGMENT. MORE THA  THICK   1051
     1N 750 POINTS HAVE BEEN USED IN INTEGRATION      )                    THICK   1052
      WRITE (6,30)                                                         THICK   1053
   30 FORMAT (1H0, 28HAT THIS POINT PARAMETERS ARE)                        THICK   1054
      WRITE (6,40) S,HH,XOUT                                               THICK   1055
   40 FORMAT (1H0,2HX=,E12.4, 5H  HH=, E12.4, 7H  XOUT=, E12.4)            THICK   1056
      WRITE (6,50)   (Y(I),I=1,NDE)                                        THICK   1057
   50 FORMAT (1H0, 2HY=,10E12.5)                                           THICK   1058
      WRITE (6,60)   (YD(I),I=1,NDE)                                       THICK   1059
   60 FORMAT (1H0, 3HDY=, 10E12.5)                                         THICK   1060
      WRITE (6,70) R1,R2,R3,SXN,CXS                                        THICK   1061
   70 FORMAT (1H0, 4H R1=,E12.4, 4H R2=, E12.4,4H R3=, E12.4,              THICK   1062
     15H SXN=, E12.4, 5H CXS=, E12.4)                                      THICK   1063
      WRITE (6,80)   PN,PL, PC,T0,T1                                       THICK   1064
   80 FORMAT (1H0, 4H PN=, E12.4, 4H PL=, E12.4,4H PC=, E12.4,             THICK   1065
     14H T0=, E12.4, 4H T1=, E12.4)                                        THICK   1066
      WRITE (6,90)    C11,C12,C22,C66,E11,E12                              THICK   1067
   90 FORMAT (1H0, 5H C11=,E12.4, 5H C12=,E12.4, 5H C22=, E12.4,           THICK   1068
     15H C66=, E12.4, 5H E11=, E12.4, 5H E12=, E12.4)                      THICK   1069
      WRITE (6,100)   E22,E66,D11,D12,D22,D66                              THICK   1070
  100 FORMAT (1H0, 5H E22=, E12.4, 5H E66=, E12.4, 5H D11=, E12.4,         THICK   1071
     15H D12=, E12.4, 5H D22=, E12.4, 5H D66=, E12.4)                      THICK   1072
      WRITE (6,110)   H11,H12,H22,H21,G12,G21                              THICK   1073
  110 FORMAT (1H0, 5H H11=, E12.4, 5H H12=, E12.4, 5H H22=, E12.4,         THICK   1074
     15H H21=, E12.4, 5H G12=, E12.4, 5H G21=, E12.4)                      THICK   1075
      JJ=MLY(IBR)+1                                                        THICK   1076
      WRITE (6,120)     (ZLY(IBR,J), J=1,JJ)                               THICK   1077
  120 FORMAT (1H0, 7HZS ARE=,10E12.4)                                      THICK   1078
      CALL EXIT                                                            THICK   1079
  130 CONTINUE                                                             THICK   1080
      CALL INPUT                                                           THICK   1081
      CALL ORTHO                                                           THICK   1082
      CXR=CXS*R2                                                           THICK   1083
      SXR=SXN*R2                                                           THICK   1084
      IF(KORTN) 141,139,141                                                THICK   1085
  139 IF(NDE-7) 140,140,150                                                THICK   1086
  140 ETH=          CXR*Y(3)  +SXR*Y(1)                                    THICK   1087
      HTH=        CXR*Y(5)                                                 THICK   1088
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SUBROUTINE DIFFEQ CDC 6600 FTN V3.0-P243 OPT=1 06/19/71 13.01.44. PAGE 2

```
      DEL=C11*D11-E11*E11
      EN= Y(4)-C12*ETH-E12*HTH-(H11*T0+H12*T1)*XLD
      EM= Y(6) -E12*ETH-D12*HTH-(H12*T0+G12*T1)*XLD
      EFI= (EN*D11-EM*E11)/DEL
      HFI= (EM*C11-EN*E11)/DEL
      YD(1)=R1*Y(3)-Y(5)
      YD(3)= EFI-R1*Y(1)
      YD(5)=HFI
      THN= C12*EFI+C22*ETH+E12*HFI+E22*HTH+(H22*T0+H21*T1)*XLD
      THM= D12*HFI+D22*HTH+E12*EFI+E22*ETH+(H21*T0+G21*T1)*XLD
      YD(2)=-CXR*Y(2)+SXR*THN+R1*Y(4)-PN*XLD
      YD(4)=CXR*(THN-Y(4))-R1*Y(2)-PL*XLD
      YD(6)= CXR*(THM-Y(6))+Y(2)-EMFI*XLD
      GO TO 160
  150 XNR=XN*R2
      ELH=R1-SXR
      ELJ=R1+SXR
      ETH=XNR*Y(7)+ CXR*Y(3) +SXR*Y(1)
      BTH=XNR*Y(1) +SXR*Y(7)
      HTH=XNR*BTH+CXR*Y(5)
      EPS=-XNR*Y(3)-CXR*Y(7)
      HKA= -2.0*XNR*Y(5)-2.0*XNR*CXR*Y(1)+CXR*(ELH-SXR)*Y(7)+XNR*R1*Y(3)
      DEL=C11*D11-E11*E11
      EN= Y(4)-C12*ETH-E12*HTH-(H11*T0+H12*T1)*XLD
      EM= Y(6) -E12*ETH-D12*HTH-(H12*T0+G12*T1)*XLD
      EFI= (EN*D11-EM*E11)/DEL
      HFI= (EM*C11-EN*E11)/DEL
      YD(1)=R1*Y(3)-Y(5)
      YD(3)= EFI-R1*Y(1)
      YD(5)=HFI
      YD(7)=    ( Y(8)-(C66+SXR*E66)*EPS-(E66+SXR*D66)*HKA)
     1/(C66+2.0*E66*SXR+D66*SXR*SXR)
      THN= C12*EFI+C22*ETH+E12*HFI+E22*HTH+(H22*T0+H21*T1)*XLD
      THM= D12*HFI+D22*HTH+E12*EFI+E22*ETH+(H21*T0+G21*T1)*XLD
      TFM= E66*(EPS+YD(7))+ D66*(HKA+SXR*YD(7))
      YD(2)= -2.0*XNR*CXR*TFM- CXR*Y(2)+SXR*THN+ R1*Y(4)+ XNR*XNR*THM-
     1PN*XLD
      YD(4)=  -XNR*Y(8)+XNR*ELJ*TFM+CXR*(THN-Y(4))   -R1*Y(2)-PL*XLD
      YD(6)=  -2.0*XNR*TFM+CXR*(THM-Y(6)) +Y(2)
      YD(8)= ELH*CXR*TFM -2.0*CXR*Y(8) +XNR*THN+ XNR*SXR*THM-PC*XLD
      GO TO 160
  141 CALL COEFF
  160 IF(R3-1.0) 170,190,170
  170 DO 180 I=1,NDE
  180 YD(I)=YD(I)/R3
  190 RETURN
      END
```

SUBROUTINE DIFFEQ CDC 6600 FTN V3.0-P243 OPT=1 06/19/71 13.01.44. PAGE 3

SYMBOLIC REFERENCE MAP

ENTRY POINTS
1 DIFFEQ

VARIABLES		SN TYPE		RELOCATION					
1332	ALFL	REAL		GEOM	2317	ALFR	REAL	ARRAY	GEOM
740	AL1	REAL	ARRAY	MATL	1060	AL2	REAL	ARRAY	MATL
714	BTH	REAL			0	B11	REAL	ARRAY	MATL
120	B12	REAL	ARRAY	MATL	240	B22	REAL	ARRAY	MATL
500	B44	REAL	ARRAY	MATL	620	B55	REAL	ARRAY	MATL
360	B66	REAL	ARRAY	MATL	7	CPP	REAL		THICK
11	CPT	REAL		THICK	676	CXR	REAL		
12	CXS	REAL		XMIT	25	C11	REAL		XMIT
26	C12	REAL		XMIT	27	C22	REAL		XMIT
30	C66	REAL		XMIT	702	DEL	REAL		
12	DLP	REAL		THICK	15	DLT	REAL		THICK
550	DSC	REAL	ARRAY	GEOM	34	DUMM	REAL	ARRAY	RUN
35	D11	REAL		XMIT	36	D12	REAL		XMIT
37	D22	REAL		XMIT	40	D66	REAL		XMIT
705	EFI	REAL			712	ELH	REAL		
713	ELJ	REAL			704	EM	REAL		
56	EMFI	REAL		XMIT	57	EMTH	REAL		XMIT
703	EN	REAL			10	EPP	REAL		THICK
715	EPS	REAL			13	EPT	REAL		THICK
77	ERP	REAL		RUN	700	ETH	REAL		
31	E11	REAL		XMIT	32	E12	REAL		XMIT
33	E22	REAL		XMIT	34	E66	REAL		XMIT
50	F11	REAL		XMIT	51	F12	REAL		XMIT
52	F22	REAL		XMIT	14	GMP	REAL		THICK
16	GMT	REAL		THICK	4	GPZ	REAL		THICK
5	GTZ	REAL		THICK	64	G12	REAL		XMIT
65	G21	REAL		XMIT	706	HFI	REAL		
26	HH	REAL		RUN	716	HKA	REAL		
701	HTH	REAL			5	HTT	REAL		XMIT
60	H11	REAL		XMIT	61	H12	REAL		XMIT
63	H21	REAL		XMIT	62	H22	REAL		XMIT
41	H44	REAL		XMIT	42	H55	REAL		XMIT
43	H66	REAL		XMIT	673	I	INTEGER		
1250	IA	INTEGER	ARRAY	GEOM	1262	IB	INTEGER	ARRAY	GEOM
75	IBCL	INTEGER		RUN	0	IBR	INTEGER		XMIT
33	IFREQ	INTEGER		RUN	13	INDEX	INTEGER		XMIT
74	ING	INTEGER	ARRAY	GEOM	120	IPAR	INTEGER	ARRAY	GEOM
1	ISH	INTEGER		XMIT	170	ISS	INTEGER	ARRAY	GEOM
675	J	INTEGER			674	JJ	INTEGER		
30	JMAX	INTEGER		RUN	27	J9	INTEGER		RUN
76	KORTN	INTEGER		RUN	1060	MLY	INTEGER	ARRAY	GEOM
31	M9	INTEGER		RUN	24	NBR	INTEGER		XMIT
0	NUE	INTEGER		RUN	524	NTP	INTEGER	ARRAY	GEOM
4	OMSQ	REAL		XMIT	16	PC	REAL		XMIT
15	PL	REAL		XMIT	14	PN	REAL		XMIT
6	QT	REAL		THICK	1200	RHO	REAL	ARRAY	MATL
21	RH1	REAL		XMIT	22	RH2	REAL		XMIT
23	RH3	REAL		XMIT	6	R1	REAL		XMIT

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     SUBROUTINE  DIFFEQ                                     CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      4

VARIABLES     SN  TYPE            RELOCATION
     7  R2            REAL                XMIT           10  R3       REAL                XMIT
     1  S             REAL                RUN             0  SI       REAL        ARRAY   GEOM
    24  SX            REAL      ARRAY     GEOM           11  SXN      REAL                XMIT
   677  SXR           REAL                              717  TFM      REAL
   710  THM           REAL                              707  THN      REAL
  2153  TLI           REAL      ARRAY     GEOM         1333  TR       REAL        ARRAY   GEOM
   214  TRI           REAL      ARRAY     GEOM          360  TR2      REAL        ARRAY   GEOM
    17  T0            REAL                XMIT           20  T1       REAL                XMIT
    47  XE66          REAL                XMIT           53  XH11     REAL                XMIT
    54  XH12          REAL                XMIT           55  XH22     REAL                XMIT
    44  XK11          REAL                XMIT           45  XK12     REAL                XMIT
    46  XK22          REAL                XMIT            3  XLD      REAL                XMIT
     1  XMT           REAL                THICK           3  XMTP     REAL                THICK
     2  XN            REAL                XMIT          711  XNR      REAL
     0  XNT           REAL                THICK           2  XNTP     REAL                THICK
    32  XOUT          REAL                RUN            50  XPR      REAL        ARRAY   GEOM
     2  Y             REAL      ARRAY     RUN            14  YD       REAL        ARRAY   RUN
   144  Z             REAL      ARRAY     GEOM         1104  ZLY      REAL        ARRAY   GEOM

FILE NAMES          MODE
        TAPE6        FMT

EXTERNALS            TYPE   ARGS
        COEFF                0                        EXIT                0
        INPUT                0                        ORTHO               0

STATEMENT LABELS
     0  10          INACTIVE            551   20      FMT                        565   30      FMT
   572  40      FMT                     600   50      FMT                        603   60      FMT
   606  70      FMT                     616   80      FMT                        626   90      FMT
   640  100     FMT                     652  110      FMT                        664  120      FMT
   165  130                               0  139          INACTIVE                 0  140          INACTIVE
   537  141                             321  150                                 541  160
     0  170         INACTIVE              0  180                                 550  190

COMMON BLOCKS   LENGTH
        THICK        15
        RUN          64
        MATL        720
        XMIT         54
        GEOM       1235

STATISTICS
   PROGRAM LENGTH    720B      464
   COMMON LENGTH    4050B     2088
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      SUBROUTINE  BCOND                          CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE    1

              SUBROUTINE BCOND                                                    THICK    1136
              COMMON/RUN/ NDE,S,Y(10),YD(10),HH,J9,JMAX,M9,XOUT,IFREQ,DUMM(33),   THICK    1137
             1IBCL,KORTN,ERP                                                      THICK    1138
              COMMON/MATL/ B11(20,4),B12(20,4),B22(20,4),B66(20,4),B44(20,4),     THICK    1139
             1B55(20,4),AL1(20,4),AL2(20,4),RHO(20,4)                             THICK    1140
              COMMON/XMIT/ IBR,ISH,XN,XLD,OMSQ,HTT,R1,R2,R3,SXN,CXS,INDEX,PN,PL,  THICK    1141
             1PC,T0,T1,RH1,RH2,RH3,NBR,C11,C12,C22,C66,E11,E12,E22,E66,D11,D12,   THICK    1142
             2D22,D66,H44,H55,H66,XK11,XK12,XK22,XE66,F11,F12,F22,XH11,XH12,XH22  THICK    1143
             3,EMFI,EMTH,H11,H12,H22,H21,G12,G21                                  THICK    1144
              COMMON/GEOM/ SI(20),SX(20),XPR(20),ING(20),IPAR(20),Z(20),ISS(20),  THICK    1145
             1TR1(10,10),TR2(10,10),NTP(20),DSC(20,10),MLY(20),ZLY(20,5),IA(10),  THICK    1146
             2IB(10,4),ALFL         ,TR(10,10,4),TLI(10,10),ALFR(4)               THICK    1147
      C       NOTE THAT MATRIX TLI HERE IS Y(A)=TLI*U(A)                          THICK    1148
      C       TR MATRIX IS U(B)=TR*Y(B)                                           THICK    1149
              DO 10 I=1,NDE                                                       THICK    1150
              DO 10 J=1,NDE                                                       THICK    1151
              TLI(I,J)=0.0                                                        THICK    1152
              DO 10 K=1,NBR                                                       THICK    1153
           10 TR (I,J,K)=0.0                                                      THICK    1154
              DO 20 I=1,NDE                                                       THICK    1155
              TLI(I,I)=1.0                                                        THICK    1156
              DO 20 K=1,NBR                                                       THICK    1157
           20 TR (I,I,K)=1.0                                                      THICK    1158
              ALFA=ALFL*1.74533E-02                                               THICK    1159
              SIL=SIN (ALFA)                                                      THICK    1160
              COL=COS (ALFA)                                                      THICK    1161
              TLI(1,1)=  COL                                                      THICK    1162
              TLI(1,3)=  SIL                                                      THICK    1163
              TLI(2,2)=  COL                                                      THICK    1164
              TLI(2,4)=  SIL                                                      THICK    1165
              TLI(3,1)= -SIL                                                      THICK    1166
              TLI(3,3)=  COL                                                      THICK    1167
              TLI(4,2)= -SIL                                                      THICK    1168
              TLI(4,4)=  COL                                                      THICK    1169
              DO 30 K=1,NBR                                                       THICK    1170
              ALFA=ALFR(K)*1.74533E-02                                            THICK    1171
              SIR=SIN (ALFA)                                                      THICK    1172
              COR=COS (ALFA)                                                      THICK    1173
              TR(1,1,K)=COR                                                       THICK    1174
              TR(1,3,K)=-SIR                                                      THICK    1175
              TR(2,2,K)=COR                                                       THICK    1176
              TR(2,4,K)=-SIR                                                      THICK    1177
              TR(3,1,K)=SIR                                                       THICK    1178
              TR(3,3,K)=COR                                                       THICK    1179
              TR(4,2,K)=SIR                                                       THICK    1180
           30 TR(4,4,K)=COR                                                       THICK    1181
           40 RETURN                                                              THICK    1182
              END                                                                 THICK    1183
```

SUBROUTINE BCOND CDC 6600 FTN V3.0-P243 OPT=1 06/19/71 13.01.44. PAGE 2

SYMBOLIC REFERENCE MAP

ENTRY POINTS
1 BCOND

VARIABLES		TYPE		RELOCATION					
101	ALFA	REAL			1332	ALFL	REAL		GEOM
2317	ALFR	REAL	ARRAY	GEOM	740	ALI	REAL	ARRAY	MATL
1060	AL2	REAL	ARRAY	MATL	0	B11	REAL	ARRAY	MATL
120	B12	REAL	ARRAY	MATL	240	B22	REAL	ARRAY	MATL
500	B44	REAL	ARRAY	MATL	620	B55	REAL	ARRAY	MATL
360	B66	REAL	ARRAY	MATL	103	COL	REAL		
105	COR	REAL			12	CXS	REAL		XMIT
25	C11	REAL		XMIT	26	C12	REAL		XMIT
27	C22	REAL		XMIT	30	C66	REAL		XMIT
550	DSC	REAL	ARRAY	GEOM	34	DUMM	REAL	ARRAY	RUN
35	D11	REAL		XMIT	36	D12	REAL		XMIT
37	D22	REAL		XMIT	40	D66	REAL		XMIT
56	EMFI	REAL		XMIT	57	EMTH	REAL		XMIT
77	EXP	REAL		RUN	31	E11	REAL		XMIT
32	E12	REAL		XMIT	33	E22	REAL		XMIT
34	E66	REAL		XMIT	50	F11	REAL		XMIT
51	F12	REAL		XMIT	52	F22	REAL		XMIT
64	G12	REAL		XMIT	65	G21	REAL		XMIT
26	HH	REAL		RUN	5	HTT	REAL		XMIT
60	H11	REAL		XMIT	61	H12	REAL		XMIT
63	H21	REAL		XMIT	62	H22	REAL		XMIT
41	H44	REAL		XMIT	42	H55	REAL		XMIT
43	H66	REAL		XMIT	76	I	INTEGER		
1250	IA	INTEGER	ARRAY	GEOM	1262	IB	INTEGER	ARRAY	GEOM
75	IBCL	INTEGER		RUN	0	IBR	INTEGER		XMIT
33	IFREQ	INTEGER		RUN	13	INDEX	INTEGER		XMIT
74	ING	INTEGER	ARRAY	GEOM	120	IPAR	INTEGER	ARRAY	GEOM
1	ISH	INTEGER		XMIT	170	ISS	INTEGER	ARRAY	GEOM
77	J	INTEGER			30	JMAX	INTEGER		RUN
27	J9	INTEGER		RUN	100	K	INTEGER		
76	KORTN	INTEGER		RUN	1060	MLY	INTEGER	ARRAY	GEOM
31	M9	INTEGER		RUN	24	NBR	INTEGER		XMIT
0	NOE	INTEGER		RUN	524	NTP	INTEGER	ARRAY	GEOM
4	OMSQ	REAL		XMIT	16	PC	REAL		XMIT
15	PL	REAL		XMIT	14	PN	REAL		XMIT
1200	RHO	REAL	ARRAY	MATL	21	RH1	REAL		XMIT
22	RH2	REAL		XMIT	23	RH3	REAL		XMIT
6	R1	REAL		XMIT	7	R2	REAL		XMIT
10	R3	REAL		XMIT	1	S	REAL		RUN
0	SI	REAL	ARRAY	GEOM	102	SIL	REAL		
104	SIR	REAL			24	SX	REAL	ARRAY	GEOM
11	SXN	REAL		XMIT	2153	TLI	REAL	ARRAY	GEOM
1333	TR	REAL	ARRAY	GEOM	214	TR1	REAL	ARRAY	GEOM
360	TR2	REAL	ARRAY	GEOM	17	T0	REAL		XMIT
20	T1	REAL		XMIT	47	XE66	REAL		XMIT
53	XH11	REAL		XMIT	54	XH12	REAL		XMIT
55	XH22	REAL		XMIT	44	XK11	REAL		XMIT
45	XK12	REAL		XMIT	46	XK22	REAL		XMIT

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         SUBROUTINE  BCOND                                           CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      3

 VARIABLES      SN  TYPE              RELOCATION
       3  XLD       REAL                     XMIT            2  XN         REAL                XMIT
      32  XOUT      REAL                     RUN            50  XPR        REAL      ARRAY     GEOM
       2  Y         REAL         ARRAY       RUN            14  YD         REAL      ARRAY     RUN
     144  Z         REAL         ARRAY       GEOM         1104  ZLY        REAL      ARRAY     GEOM

 EXTERNALS          TYPE    ARGS
         COS        REAL      1 LIBRARY                        SIN        REAL      1 LIBRARY

 STATEMENT LABELS
       0  10                                    0  20                                     0  30
       0  40          INACTIVE

 COMMON BLOCKS    LENGTH
         RUN          64
         MATL        720
         XMIT         54
         GEOM       1235

 STATISTICS
   PROGRAM LENGTH     106B        70
    COMMON LENGTH    4031B      2073
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102311

SUBROUTINE INPUT CDC 6600 FTN V3.0-P243 OPT=1 06/19/71 13.01.44. PAGE 1

```
      SUBROUTINE INPUT                                                  THICK    1184
      COMMON/MATL/ B11(20,4),B12(20,4),B22(20,4),B66(20,4),B44(20,4),   THICK    1185
     1B55(20,4),AL1(20,4),AL2(20,4),RHO(20,4)                           THICK    1186
      COMMON/RUN/ NDE,S,Y(10),YD(10),HH,J9,JMAX,M9,XOUT,IFREQ,DUMM(33), THICK    1187
     1IBCL,KORTN,ERP                                                    THICK    1188
      COMMON/XMIT/ IBR,ISH,XN,XLD,OMSQ,HIT,R1,R2,R3,SXN,CXS,INDEX,PN,PL, THICK    1189
     1PC,T0,T1,RH1,RH2,RH3,NBR,C11,C12,C22,C66,E11,E12,E22,E66,D11,D12, THICK    1190
     2D22,D66,H44,H55,H66,XK11,XK12,XK22,XE66,F11,F12,F22,XH11,XH12,XH22 THICK    1191
     3,EMF1,EMTH,H11,H12,H22,H21,G12,G21                                THICK    1192
      COMMON/GEOM/ SI(20),SX(20),XPR(20),ING(20),IPAR(20),Z(20),ISS(20), THICK    1193
     1TR1(10,10),TR2(10,10),NTP(20),DSC(20,10),MLY(20),ZLY(20,5),IA(10), THICK    1194
     2IB(10,4),ALFL       ,TR(10,10,4),TLI(10,10),ALFR(4)               THICK    1195
      DIMENSION VN(10,4),IL1(10),IL2(10),IFG(10,4)                      THICK    1196
      DIMENSION VK(10,5),IK2(10),IK1(10),IKG(10,5),INORM(10)            THICK    1197
      GO TO (10,260,390,480),INDEX                                      THICK    1198
   10 READ  (5,20)  (VN(IBR,I), I=1,4),  IL2(IBR)                       THICK    1199
   20 FORMAT  (4F10.5,I5)                                               THICK    1200
      IF(IL2(IBR))  70,70,30                                            THICK    1201
   30 READ  (5,40)  (IFG(IBR,I),I=1,3),  IL1(IBR)                       THICK    1202
   40 FORMAT  (10I5)                                                    THICK    1203
      WRITE  (6,50)   (IFG(IBR,I),I=1,3)                                THICK    1204
   50 FORMAT  (1H0, 29HVARIABLE SHELL PARAMETERS ARE,  4I5)             THICK    1205
      L1=IL1(IBR)                                                       THICK    1206
      L2=IL2(IBR)+IL1(IBR)-1                                            THICK    1207
      DO 60 I=L1,L2                                                     THICK    1208
   60 DY=FGEN (I,1)                                                     THICK    1209
   70 GO TO  (80,100,120,140,160,200,220,240,180), ISH                  THICK    1210
   80 WRITE  (6,90)                                                     THICK    1211
   90 FORMAT  (1H0,  30HNO SHELL NO. 1 IN THIS PROGRAM)                 THICK    1212
      CALL EXIT                                                         THICK    1213
  100 WRITE   (6,110)  ISH,VN(IBR,1),VN(IBR,2), VN(IBR,3)               THICK    1214
  110 FORMAT  (1H0,       20HCYLINDRICAL SHELL NO,I3,2X,                THICK    1215
     1 4H  H=,E12.5,2X,4H  R=,E12.5,  2X, 4HPHI=, F10.3, 9H  DEGREES)   THICK    1216
      RETURN                                                            THICK    1217
  120 WRITE  (6,130)   ISH,VN(IBR,1),VN(IBR,2), VN(IBR,4)               THICK    1218
  130 FORMAT  (1H0,       18HSPHERICAL SHELL NO,I3,4X,                  THICK    1219
     1 4H  H=,E12.5,2X,4H  R=,E12.5, 12H  DIRECTION=, F3.0 )            THICK    1220
      RETURN                                                            THICK    1221
  140 WRITE  (6,150)   ISH,VN(IBR,1),VN(IBR,2), VN(IBR,4)               THICK    1222
  150 FORMAT  (1H0,      21HPARABOLOIDAL SHELL NO,I3,3X,                THICK    1223
     1 4H  H=,E12.5,2X,5H  2P=,E12.5,  12H  DIRECTION=, F3.0)           THICK    1224
      RETURN                                                            THICK    1225
  160 WRITE  (6,170)   ISH,VN(IBR,1),VN(IBR,2),VN(IBR,3),VN(IBR,4)      THICK    1226
  170 FORMAT  (1H0,       20HELLIPSOIDAL SHELL NO,I3,3X,                THICK    1227
     1 4H  H=,E12.5,2X,4H  A=,E12.5, 2X,4H  B=,E12.5,10H  DIRECTN=,F3.0) THICK   1228
      RETURN                                                            THICK    1229
  180 WRITE(6,190)    ISH,VN(IBR,1),VN(IBR,2),VN(IBR,3),VN(IBR,4)       THICK    1230
  190 FORMAT  (1H0,       20HHYPERBOLIC  SHELL NO,I3,3X,                THICK    1231
     1 4H  H=,E12.5,2X,4H  A=,E12.5, 2X,4H  B=,E12.5,10H  DIRECTN=,F3.0) THICK   1232
      RETURN                                                            THICK    1233
  200 WRITE   (6,210)  ISH,VN(IBR,1),VN(IBR,2),VN(IBR,3)                THICK    1234
  210 FORMAT  (1H0,       16HCONICAL SHELL NO,I3,2X,    4H  H=,F10.6, 2X, THICK   1235
     14HPHI=,F10.3, 8H DEGREES, 2X,4H  A=,E12.5)                        THICK    1236
      RETURN                                                            THICK    1237
  220 WRITE  (6,230)   ISH,VN(IBR,1),VN(IBR,2),VN(IBR,3),VN(IBR,4)      THICK    1238
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SUBROUTINE  INPUT                                  CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    2

  230 FORMAT (1H0,      17HTOROIDAL SHELL NO,I3,3X,                          THICK    1239
     1 4H  H=,E12.5,2X,4H  A=,E12.5, 2X,4H  B=,E12.5,10H  DIRECTN=,F3.0)     THICK    1240
      RETURN                                                                 THICK    1241
  240 WRITE  (6,250) ISH, (VN(IBR,I),I=1,4)                                  THICK    1242
  250 FORMAT (1H0,  16HGENERAL SHELL NO, I3, 4H  H=,E12.5,                   THICK    1243
     17H 1/RFI=,E12.5, 5H   R=, E12.5, 4H FI=, F10.3,  4H DEG)               THICK    1244
      RETURN                                                                 THICK    1245
  260 READ (5,270)   (VK(IBR,I),I=1,5), IK2(IBR),INORM(IBR),RPM              THICK    1246
  270 FORMAT (5F10.5,2I5,F10.5)                                              THICK    1247
      RPS=6.28318*RPM/60.0                                                   THICK    1248
      RPQ=RPS*RPS                                                            THICK    1249
      EMIH=0.0                                                               THICK    1250
      EMFI=0.0                                                               THICK    1251
      IF(INORM(IBR)/100) 300,280,300                                         FEB6       12
  280 WRITE  (6,290)  (VK(IBR,I),I=1,5)                                      THICK    1253
  290 FORMAT (1H0,30HSURFACE AND TEMP LOADS ARE  P=,E12.5,6H  PFI=,E12.5     THICK    1254
     1,9H  PTHETA=,E12.5,5H  TL=,E12.5,5H  TU=,E12.5)                        THICK    1255
      GO TO 340                                                              THICK    1256
  300 WRITE(6,310)(VK(IBR,I),I=1,5)                                          THICK    1257
  310 FORMAT (1H0,30HSURFACE AND TEMP LOADS ARE P1=,E12.5,6H   P2=,E12.5     THICK    1258
     1,9H  PTHETA=,E12.5,5H  TL=,E12.5,5H  TU=,E12.5)                        THICK    1259
      IF(RPM) 340,340,320                                                    THICK    1260
  320 WRITE  (6,330)  RPM                                                    THICK    1261
  330 FORMAT (1H0, 45HSHELL IS SPINNING ABOUT AXIS OF SYMMETRY WITH,         THICK    1262
     1E12.5, 5H  RPM)                                                        THICK    1263
  340 CONTINUE                                                               THICK    1264
      IF(IK2(IBR)) 380,380,350                                               THICK    1265
  350 READ   (5,40)  (IKG(IBR,I),I=1,5), IK1(IBR)                            THICK    1266
      WRITE  (6,360)     (IKG(IBR,I),I=1,5)                                  THICK    1267
  360 FORMAT (1H0,  28HVARIABLE LOAD PARAMETERS ARE,  5I5)                   THICK    1268
      K1=IK1(IBR)                                                            THICK    1269
      K2=IK2(IBR)+IK1(IBR)-1                                                 THICK    1270
      DO 370 I=K1,K2                                                         THICK    1271
  370 DY= FGEN(I,1)                                                          THICK    1272
  380 RETURN                                                                 THICK    1273
  390 CONTINUE                                                               THICK    1274
      L1=IL1(IBR)                                                            THICK    1275
      L2=IL2(IBR)+IL1(IBR)-1                                                 THICK    1276
      K1=IK1(IBR)                                                            THICK    1277
      K2=IK2(IBR)+IK1(IBR)-1                                                 THICK    1278
      MK=MLY(IBR)                                                            THICK    1279
      GO TO(80,400,410,420,430,450,460,470,440), ISH                         THICK    1280
  400 R2=ABS (1.0/VN(IBR,2))                                                 THICK    1281
      RT=VN(IBR,2)                                                           FEB6       13
      R1=0.0                                                                 THICK    1282
      R3=1.0                                                                 THICK    1283
      CXS=0.0                                                                THICK    1284
      ALFA=VN(IBR,3)*1.745329E-02                                            THICK    1285
      SAN=SIN (ALFA)                                                         THICK    1286
      GO TO 480                                                              THICK    1287
  410 R1=1.0/VN(IBR,2)                                                       THICK    1288
      RT=VN(IBR,2)                                                           FEB6       14
      R3=ABS (R1)                                                            THICK    1289
  420 GO TO 480                                                              THICK    1290
  430 BSQ= (VN(IBR,3)/VN(IBR,2))*(VN(IBR,3)/VN(IBR,2))                       THICK    1291
```

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SUBROUTINE  INPUT                           CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    3

          GO TO 480                                                    THICK   1292
      440 BSQ= (VN(IBR,3)/VN(IBR,2))*(VN(IBR,3)/VN(IBR,2))             THICK   1293
          GO TO 480                                                    THICK   1294
      450 R1=0.0                                                       THICK   1295
          R3=1.0                                                       THICK   1296
          ALFA = VN(IBR,2)*0.1745329E-01                               THICK   1297
          SXN=SIN (ALFA)                                               THICK   1298
          CXS=COS (ALFA)                                               THICK   1299
          GO TO 480                                                    THICK   1300
      460 R1=1.0/VN(IBR,3)                                             THICK   1301
          RT=VN(IBR,3)                                                 FEB6      15
          R3=ABS (R1)                                                  THICK   1302
          GO TO 480                                                    THICK   1303
      470 R3=1.0                                                       THICK   1304
          RT=VN(IBR,3)                                                 JUN16      6
      480 IF(IL2(IBR)) 510,510,490                                     THICK   1305
      490 IK=0                                                         THICK   1306
          DO 500 I=L1,L2                                               THICK   1307
          IK=IK+1                                                      THICK   1308
          J=IFG(IBR,IK)                                                THICK   1309
      500 VN(IBR,J)=FGEN (I,2)                                         THICK   1310
      510 IF(IK2(IBR)) 540,540,520                                     THICK   1311
      520 IK=0                                                         THICK   1312
          DO 530 I=K1,K2                                               THICK   1313
          IK=IK+1                                                      THICK   1314
          J=IKG(IBR,IK)                                                THICK   1315
      530 VK(IBR,J)=FGEN (I,2)                                         THICK   1316
      540 PN=VK(IBR,1)                                                 THICK   1317
          PL=VK(IBR,2)                                                 THICK   1318
          PC=VK(IBR,3)                                                 THICK   1319
          HTT=ZLY(IBR,MK+1)-ZLY(IBR,1)                                 FEB6      16
          T0= (VK(IBR,4)*ZLY(IBR,MK+1) -VK(IBR,5)*ZLY(IBR,1))/HTT      THICK   1320
          T1= (VK(IBR,5)-VK(IBR,4))/HTT                                THICK   1321
          GO TO(80,620,550,560,570,590,600,610,580), ISH               THICK   1322
      550 ARG=S*VN(IBR,4)                                              THICK   1323
          SXN=SIN (ARG)                                                THICK   1324
          CXS=COS (ARG)                                                THICK   1325
          R2=ABS (R1/SXN)                                              THICK   1326
          GO TO 620                                                    THICK   1327
      560 ARG=S*VN(IBR,4)                                              THICK   1328
          SXN=SIN (ARG)                                                THICK   1329
          CXS=COS (ARG)                                                THICK   1330
          R2=ABS (CXS/(SXN*VN(IBR,2)))                                 THICK   1331
          R1= ABS(CXS*CXS*CXS)/VN(IBR,2)                               THICK   1332
          R3=ABS (R1)                                                  THICK   1333
          RT=1.0/R2                                                    FEB6      18
          GO TO 620                                                    THICK   1334
      570 ARG=S*VN(IBR,4)                                              THICK   1335
          SXN=SIN (ARG)                                                THICK   1336
          CXS=COS (ARG)                                                THICK   1337
          R=SQRT (BSQ+(1.-BSQ)*SXN*SXN)                                THICK   1338
          R1=R*R*R/(BSQ*VN(IBR,2))                                     THICK   1339
          R2=ABS (R  /(SXN*VN(IBR,2)))                                 THICK   1340
          R3=ABS (R1)                                                  THICK   1341
          RT=1.0/R2                                                    FEB6      19
```

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SUBROUTINE  INPUT                          CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE     4
           GO TO 620                                                        THICK    1342
       580 ARG=S*VN(IBR,4)                                                  THICK    1343
           SXN=SIN (ARG)                                                    THICK    1344
           CXS=COS (ARG)                                                    THICK    1345
           R=SQRT (SXN*SXN +BSQ*CXS*CXS)                                    THICK    1346
           R1= -VN(IBR,2)*R*R*R/(VN(IBR,3)*VN(IBR,3))                       THICK    1347
           R2=ABS (R  /(SXN*VN(IBR,2)))                                     THICK    1348
           R3=ABS (R1)                                                      THICK    1349
           RT=1.0/R2                                                        FEB6       20
           GO TO 620                                                        THICK    1350
       590 R2= ABS (1.0/((VN(IBR,3)+S)*CXS))                                THICK    1351
           RT=1.0/R2                                                        FEB6       21
           GO TO 620                                                        THICK    1352
       600 ARG=S*VN(IBR,4)                                                  THICK    1353
           SXN=SIN (ARG)                                                    THICK    1354
           CXS=COS (ARG)                                                    THICK    1355
           R2=ABS (1.0/(VN(IBR,2)+VN(IBR,3)*SXN))                           THICK    1356
           GO TO 620                                                        THICK    1357
       610 R1=VN(IBR,2)                                                     THICK    1358
           R2=ABS (1.0/VN(IBR,3))                                           THICK    1359
           ARG=  VN(IBR,4)*0.1745329E-01                                    THICK    1360
           CXS=COS(ARG)                                                     THICK    1361
           SXN=SIN(ARG)                                                     THICK    1362
       620 IF(XLD-0.5) 650,650,630                                          THICK    1363
       630 IF(INORM(IBR)/100)  650,650,640                                  FEB6       22
       640 PHR= VK(IBR,2)+RPQ*(RH1/R2+     SXN*RH2)                         THICK    1365
           EMFI=RPQ*CXS*(RH2/R2+SXN*RH3)                                    THICK    1366
           PN=VK(IBR,1)*CXS+PHR*SXN                                         THICK    1367
           PL=-VK(IBR,1)*SXN+PHR*CXS                                        THICK    1368
       650 IF(MOD(INORM(IBR),100).EQ.0) RETURN                              FEB6       23
           IF(MOD(INORM(IBR),10 ).EQ.0) GO TO 651                           FEB6       24
           BN=(RT+ZLY(IBR,1))/RT                                            FEB6       25
       652 PN=BN*PN                                                         FEB6       26
           PL=BN*PL                                                         FEB6       27
           PC=BN*PC                                                         FEB6       28
           RETURN                                                           FEB6       29
       651 BN=(RT+ZLY(IBR,MK+1))/RT                                         FEB6       30
           GO TO 652                                                        FEB6       31
           END                                                              THICK    1370
```

SUBROUTINE INPUT CDC 6600 FTN V3.0-P243 OPT=1 06/19/71 13.01.44. PAGE 5

SYMBOLIC REFERENCE MAP

ENTRY POINTS
1 INPUT

VARIABLES		TYPE		RELOCATION					
1271	ALFA	REAL			1332	ALFL	REAL	ARRAY	GEOM
2317	ALFR	REAL	ARRAY	GEOM	740	AL1	REAL	ARRAY	MATL
1060	AL2	REAL	ARRAY	MATL	1275	ARG	REAL		
1300	RN	REAL			1272	BSQ	REAL		
0	B11	REAL	ARRAY	MATL	120	B12	REAL	ARRAY	MATL
240	B22	REAL	ARRAY	MATL	500	B44	REAL	ARRAY	MATL
620	B55	REAL	ARRAY	MATL	360	B66	REAL	ARRAY	MATL
12	CAS	REAL		XMIT	25	C11	REAL		XMIT
26	C12	REAL		XMIT	27	C22	REAL		XMIT
30	C66	REAL		XMIT	550	DSC	REAL	ARRAY	GEOM
34	DUMM	REAL	ARRAY	RUN	1261	DY	REAL		
35	D11	REAL		XMIT	36	D12	REAL		XMIT
37	D22	REAL		XMIT	40	D66	REAL		XMIT
56	EMFI	REAL		XMIT	57	EMTH	REAL		XMIT
77	ERF	REAL		RUN	31	E11	REAL		XMIT
32	E12	REAL		XMIT	33	E22	REAL		XMIT
34	E66	REAL		XMIT	50	F11	REAL		XMIT
51	F12	REAL		XMIT	52	F22	REAL		XMIT
64	G12	REAL		XMIT	65	G21	REAL		XMIT
26	HH	REAL		RUN	5	HTT	REAL		XMIT
60	H11	REAL		XMIT	61	H12	REAL		XMIT
63	H21	REAL		XMIT	62	H22	REAL		XMIT
41	H44	REAL		XMIT	42	H55	REAL		XMIT
43	H66	REAL		XMIT	1256	I	INTEGER		
1250	IA	INTEGER	ARRAY	GEOM	1262	IB	INTEGER	ARRAY	GEOM
75	IBCL	INTEGER		RUN	0	IBR	INTEGER		XMIT
1375	IFG	INTEGER	ARRAY		33	IFREQ	INTEGER		RUN
1273	IK	INTEGER			1553	IKG	INTEGER	ARRAY	
1541	IK1	INTEGER	ARRAY		1527	IK2	INTEGER	ARRAY	
1351	IL1	INTEGER	ARRAY		1363	IL2	INTEGER	ARRAY	
13	INDEX	INTEGER		XMIT	74	ING	INTEGER	ARRAY	GEOM
1635	INORM	INTEGER	ARRAY		120	IPAR	INTEGER	ARRAY	GEOM
1	ISH	INTEGER		XMIT	170	ISS	INTEGER	ARRAY	GEOM
1274	J	INTEGER			30	JMAX	INTEGER		RUN
27	J9	INTEGER		RUN	76	KORTN	INTEGER		RUN
1265	K1	INTEGER			1266	K2	INTEGER		
1257	L1	INTEGER			1260	L2	INTEGER		
1267	MK	INTEGER			1060	MLY	INTEGER	ARRAY	GEOM
31	M9	INTEGER		RUN	24	NBR	INTEGER		XMIT
0	NDE	INTEGER		RUN	524	NTP	INTEGER	ARRAY	GEOM
4	OMSQ	REAL		XMIT	16	PC	REAL		XMIT
1277	PHR	REAL			15	PL	REAL		XMIT
14	PN	REAL		XMIT	1276	R	REAL		
1200	RHO	REAL	ARRAY	MATL	21	RH1	REAL		XMIT
22	RH2	REAL		XMIT	23	RH3	REAL		XMIT
1262	RPM	REAL			1264	RPQ	REAL		
1263	RPS	REAL			1270	RT	REAL		
6	R1	REAL		XMIT	7	R2	REAL		XMIT

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```
      SUBROUTINE  INPUT                                       CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      6

 VARIABLES      SN  TYPE               RELOCATION
     10  R3         REAL                  XMIT          1  S         REAL                RUN
      0  SI         REAL       ARRAY      GEOM         24  SX        REAL       ARRAY    GEOM
     11  SXN        REAL                  XMIT       2153  TLI       REAL       ARRAY    GEOM
   1333  TR         REAL       ARRAY      GEOM        214  TR1       REAL       ARRAY    GEOM
    360  TR2        REAL       ARRAY      GEOM         17  T0        REAL                XMIT
     20  T1         REAL                  XMIT       1445  VK        REAL       ARRAY
   1301  VN         REAL       ARRAY                   47  XE66      REAL                XMIT
     53  XH11       REAL                  XMIT         54  XH12      REAL                XMIT
     55  XH22       REAL                  XMIT         44  XK11      REAL                XMIT
     45  XK12       REAL                  XMIT         46  XK22      REAL                XMIT
      3  XLD        REAL                  XMIT          2  XN        REAL                XMIT
     32  XOUT       REAL                  RUN          50  XPR       REAL       ARRAY    GEOM
      2  Y          REAL       ARRAY      RUN          14  YD        REAL       ARRAY    RUN
    144  Z          REAL       ARRAY      GEOM       1104  ZLY       REAL       ARRAY    GEOM

 FILE NAMES          MODE
         TAPE5        FMT                 TAPE6        FMT

 EXTERNALS           TYPE    ARGS
         COS        REAL       1 LIBRARY                    EXIT               0
         FGEN       REAL       2                            SIN      REAL      1 LIBRARY
         SQRT       REAL       1 LIBRARY

 INLINE FUNCTIONS    TYPE    ARGS
         ABS        REAL       1  INTRIN                    MOD      INTEGER   2  INTRIN

 STATEMENT LABELS
     12  10                            1044  20        FMT                       0  30           INACTIVE
   1047  40      FMT                   1051  50        FMT                       0  60
     74  70                             111  80                               1056  90       FMT
    116  100                           1063  110       FMT                     132  120
   1075  130     FMT                    146  140                              1106  150      FMT
    142  160                           1117  170       FMT                     200  180
   1131  190     FMT                    216  200                              1143  210      FMT
    232  220                           1154  230       FMT                     250  240
   1166  250     FMT                    266  260                              1200  270      FMT
      0  280         INACTIVE          1203  290       FMT                     334  300
   1216  310     FMT                      0  320           INACTIVE           1231  330      FMT
    356  340                              0  350           INACTIVE           1241  360      FMT
      0  370                            423  380                               424  390
    451  400                            463  410                               470  420
    471  430                            474  440                               477  450
    510  460                            515  470                               520  480
      0  490         INACTIVE             0  500                               542  510
      0  520         INACTIVE             0  530                               564  540
    622  550                            634  560                               653  570
    676  580                            722  590                               730  600
    744  610                            756  620                                 0  630          INACTIVE
      0  640         INACTIVE          1004  650                              1030  651
   1024  652

 COMMON BLOCKS    LENGTH
         MATL       720
         RUN         64
```

```
      SUBROUTINE  INPUT                               CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      7

 COMMON BLOCKS   LENGTH
       XMIT          54
       GEOM        1235

 STATISTICS
   PROGRAM LENGTH   16478      935
    COMMON LENGTH   40318     2073
```

```
      FUNCTION FGEN (NM,N1)
      DIMENSION XP(30,20),YP(30,20),SL(30,20),M(30)
      COMMON/RUN/ NDE,S,Y(10),YD(10),HH,J9,JMAX,M9,XOUT,IFREQ,DUMM(33),
     1IBCL,KORTN,ERP
      IF(NM-30) 30,30,10
   10 WRITE (6,20)
   20 FORMAT(1H0,50HMAXIMUM NUMBER OF 30 FGEN SETS HAVE BEEN EXCEEDED )
      CALL EXIT
   30 CONTINUE
      GO TO (40,120),N)
   40 READ  (5,50) NAMEG,  M(NM)
   50 FORMAT  (A5,I5)
      WRITE  (6,60) NAMEG, NM,M(NM)
   60 FORMAT (1H0,  10X, A5,  32H  LINEAR FUNCTION GENERATOR NO. ,
     1I3, 5H FROM, I4, 7H POINTS)
      MK=M(NM)
      READ  (5,70) (XP(NM,I),  YP(NM,I), I=1,MK)
   70 FORMAT (8F10.5)
      MU=0
      MZ=10
      MX= (M(NM)-1)/10+1
      DO 100 J=1,MX
      L=AMIN0 (MK,   MZ)
      L1=MU+1
      WRITE  (6,80)  (YP(NM,I), I=L1,L)
      WRITE  (6,90)   (XP(NM,I), I=L1,L)
   80 FORMAT (1H0, 13HY COORDINATES,3X,10F10.5)
   90 FORMAT (1H0, 13HX COORDINATES,3X,10F10.5)
      MZ=MZ+10
  100 MU=MU+10
      MM=M(NM)-1
      DO 110 I=1,MM
      SL(NM,I)= (YP(NM,I+1)-YP(NM,I))/ (XP(NM,I+1)-XP(NM,I))
  110 YP(NM,I)=YP(NM,I) -SL(NM,I)*XP(NM,I)
      RETURN
  120 MK=M(NM)
      DO 130 I=1,MK
      J=I
      IF(XP(NM,I)-S) 130,130,140
  130 CONTINUE
  140 IF(J-1) 150,150,160
  150 J=2
  160 FGEN= SL(NM,J-1)*S +YP(NM,J-1)
      RETURN
      END
```

```
        FUNCTION    FGEN                                   CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE     2

        SYMBOLIC REFERENCE MAP

ENTRY POINTS
    2  FGEN

VARIABLES       SN  TYPE            RELOCATION
   34  DUMM         REAL        ARRAY    RUN                  77  ERP       REAL                 RUN
  252  FGEN         REAL                                      26  HH        REAL                 RUN
  255  I            INTEGER                                   75  IBCL      INTEGER              RUN
   33  IFREQ        INTEGER              RUN                 261  J         INTEGER
   30  JMAX         INTEGER              RUN                  27  J9        INTEGER              RUN
   76  KORIN        INTEGER              RUN                 262  L         INTEGER
  263  L1           INTEGER                                 3675  M         INTEGER    ARRAY
  254  MK           INTEGER                                  264  MM        INTEGER
  256  MU           INTEGER                                  260  MX        INTEGER
  257  MZ           INTEGER                                   31  M9        INTEGER              RUN
  253  NAMEG        INTEGER                                    0  NDE       INTEGER              RUN
    0  NM           INTEGER               F.P.                 0  N1        INTEGER               F.P.
    1  S            REAL                 RUN                2545  SL        REAL       ARRAY
   32  XOUT         REAL                 RUN                 265  XP        REAL       ARRAY
    2  Y            REAL        ARRAY    RUN                  14  YD        REAL       ARRAY     RUN
 1415  YP           REAL        ARRAY

FILE NAMES          MODE
        TAPE5       FMT                  TAPE6       FMT

EXTERNALS           TYPE    ARGS
        EXIT                  0

INLINE FUNCTIONS    TYPE    ARGS
        AMIN0       REAL      0   INTRIN

STATEMENT LABELS
    0  10           INACTIVE             216  20       FMT                      24  30
   33  40                                225  50       FMT                     227  60       FMT
  237  70       FMT                      241  80       FMT                     245  90       FMT
    0  100                                 0  110                              165  120
    0  130                               202  140                                0  150          INACTIVE
  205  160

COMMON BLOCKS   LENGTH
        RUN         64

STATISTICS
  PROGRAM LENGTH    3742B    2018
   COMMON LENGTH     100B      64
```

102303

```
SUBROUTINE  RUNGE                               CDC 6600 FTN V3.0-P24? OPT=1  06/19/71  13.01.44.      PAGE     1

                 SUBROUTINE RUNGE                                          THICK    1416
                 COMMON/RUN/N,X,Y(10),DY(10),HH,J,JMAX,M,XOUT,IFREQ,X1,X2,X3,   THICK    1417
                1Y1(10),Y2(10),Y3(10),IBCL,KORTN ,ERP                      THICK    1418
                 J=1                                                       THICK    1419
      05         JMAX=1                                                    THICK    1420
                 IFREQ=3                                                   THICK    1421
                 M=1                                                       THICK    1422
                 CALL RUNKUT                                               THICK    1423
                 RETURN                                                    THICK    1424
      10         END                                                       THICK    1425
```

```
SUBROUTINE  RUNGE                                   CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      2

SYMBOLIC REFERENCE MAP

ENTRY POINTS
    1  RUNGE

VARIABLES      SN  TYPE             RELOCATION
   14  DY          REAL      ARRAY      RUN          77  ERP      REAL               RUN
   26  HH          REAL                 RUN          75  IBCL     INTEGER            RUN
   33  IFREQ       INTEGER              RUN          27  J        INTEGER            RUN
   30  JMAX        INTEGER              RUN          76  KORTN    INTEGER            RUN
   31  M           INTEGER              RUN           0  N        INTEGER            RUN
    1  X           REAL                 RUN          32  XOUT     REAL               RUN
   34  X1          REAL                 RUN          35  X2       REAL               RUN
   36  X3          REAL                 RUN           2  Y        REAL      ARRAY    RUN
   37  Y1          REAL      ARRAY      RUN          51  Y2       REAL      ARRAY    RUN
   63  Y3          REAL      ARRAY      RUN

EXTERNALS           TYPE    ARGS
      RUNKUT                  0

COMMON BLOCKS    LENGTH
      RUN          64

STATISTICS
  PROGRAM LENGTH      11B       9
   COMMON LENGTH     100B      64
```

```
      SUBROUTINE  RUNKUT                       CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE    1

                SUBROUTINE RUNKUT                                                    THICK     1426
                COMMON/RUN/N,X,Y(10),DY(10),HH,J,JMAX,M,XOUT,IFREQ,X1,X2,X3,         THICK     1427
               1Y1(10),Y2(10),Y3(10),IBCL,KORIN ,ERP                                 THICK     1428
                INDE9       = 0                                                      THICK     1429
                CALL        ADJSTP                                                   THICK     1430
                IF(J-JMAX) 10,10,50                                                  THICK     1431
             10 INDE9 = INDE9 + 1                                                    THICK     1432
                CALL INTPOL                                                          THICK     1433
                IF(J-JMAX) 20,20,50                                                  THICK     1434
             20 CALL STEP                                                            THICK     1435
                X1          = X2                                                     THICK     1436
                X2          = X3                                                     THICK     1437
                X3          = X                                                      THICK     1438
                DO 30 I = 1, N                                                       THICK     1439
                Y1(I)       = Y2(I)                                                  THICK     1440
                Y2(I)       = Y3(I)                                                  THICK     1441
             30 Y3(I)       = Y(I)                                                   THICK     1442
                IF (INDE9 - IFREQ) 10,40,40                                          THICK     1443
             40 INDE9       = 0                                                      THICK     1444
                CALL        ADJSTP                                                   THICK     1445
                IF(J-JMAX) 10,10,50                                                  THICK     1446
             50 RETURN                                                               THICK     1447
                END                                                                  THICK     1448
```

```
      SUBROUTINE  RUNKUT                                   CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      2

      SYMBOLIC REFERENCE MAP

ENTRY POINTS
    1  RUNKUT

VARIABLES      SN  TYPE              RELOCATION
   14  DY          REAL      ARRAY     RUN               77  ERP        REAL                RUN
   26  HH          REAL                RUN               44  I          INTEGER
   75  IBCL        INTEGER             RUN               33  IFREQ      INTEGER             RUN
   43  INDE9       INTEGER                               27  J          INTEGER             RUN
   30  JMAX        INTEGER             RUN               76  KORTN      INTEGER             RUN
   31  M           INTEGER             RUN                0  N          INTEGER             RUN
    1  X           REAL                RUN               32  XOUT       REAL                RUN
   34  X1          REAL                RUN               35  X2         REAL                RUN
   36  X3          REAL                RUN                2  Y          REAL      ARRAY     RUN
   37  Y1          REAL      ARRAY     RUN               51  Y2         REAL      ARRAY     RUN
   63  Y3          REAL      ARRAY     RUN

EXTERNALS           TYPE   ARGS
      ADJSTP                 0                          INTPOL                0
      STEP                   0

STATEMENT LABELS
   10  10                                    0  20        INACTIVE              0  30
    0  40           INACTIVE                41  50

COMMON BLOCKS    LENGTH
      RUN          64

STATISTICS
  PROGRAM LENGTH      45B        37
   COMMON LENGTH     100B        64
```


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```
SUBROUTINE  ADJSTP                                   CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    1

          SUBROUTINE ADJSTP                                                    THICK   1449
          COMMON/RUN/N,X,Y(10),DY(10),HH,J,JMAX,M,XOUT,IFREQ,X1,X2,X3,         THICK   1450
         1Y1(10),Y2(10),Y3(10),IBCL,KORTN ,ERP                                 THICK   1451
          KSL=0                                                                THICK   1452
          HFACT      = 1.0 E+31                                                THICK   1453
          HFACT1     = 1.0E+30                                                 THICK   1454
          GO TO (30,10), M                                                     THICK   1455
       10 H1         = HH                                                      THICK   1456
          HH         = 2.0 * HH                                                THICK   1457
          X          = X1                                                      THICK   1458
          DO 20 I = 1, N                                                       THICK   1459
       20 Y(I)       = Y1(I)                                                   THICK   1460
          GO TO 100                                                            THICK   1461
       30 KSL=1                                                                THICK   1462
       40 H1         = HH                                                      THICK   1463
          XXX        = X                                                       THICK   1464
          DO 50 I = 1, N                                                       THICK   1465
       50 Y1(I)      = Y(I)                                                    THICK   1466
          X1         = X                                                       THICK   1467
          CALL INTPOL                                                          THICK   1468
          IF(J-JMAX) 60,60,250                                                 THICK   1469
       60 CALL STEP                                                            THICK   1470
          DO 70 I = 1, N                                                       THICK   1471
       70 Y2(I)      = Y(I)                                                    THICK   1472
          X2         = X                                                       THICK   1473
          CALL INTPOL                                                          THICK   1474
          IF(J-JMAX) 80,80,250                                                 THICK   1475
       80 CALL STEP                                                            THICK   1476
          DO 90 I = 1, N                                                       THICK   1477
          Y3(I)      = Y(I)                                                    THICK   1478
       90 Y(I)       = Y1(I)                                                   THICK   1479
          X3         = X                                                       THICK   1480
          X          = XXX                                                     THICK   1481
          HH         = 2.0 * HH                                                THICK   1482
      100 CALL STEP                                                            THICK   1483
          DO 150 I = 1, N                                                      THICK   1484
          DELY    = ABS ( Y(I)-Y3(I))/30.0                                     THICK   1485
          IF(DELY  -ABS (Y2(I))*ERP    )120,110,110                            THICK   1486
      110 IF( ABS (Y2(I))-ERP     ) 120,130,130                                THICK   1487
      120 HFIRST     = 1.0E+30                                                 THICK   1488
          GO TO 140                                                            THICK   1489
      130 HFIRST=   (ABS (Y2(I))* ERP     /DELY    ) **0.2                     THICK   1490
      140 CONTINUE                                                             THICK   1491
      150 HFACT=AMIN1 (HFACT, HFIRST    )                                      THICK   1492
          IF (HFACT1 - HFACT) 160,160,170                                      THICK   1493
      160 HH            = 2.0 * H1                                             THICK   1494
          GO TO (40,230), M                                                    THICK   1495
      170 HH            = H1 * HFACT                                           THICK   1496
          GO TO (180,230), M                                                   THICK   1497
      180 IF(KSL) 220,220,190                                                  THICK   1498
      190 KSL=0                                                                THICK   1499
          IF(ABS (HH)-ABS (H1)) 200,220,220                                    THICK   1500
      200 DO 210 I = 1, N                                                      THICK   1501
      210 Y(I)          = Y1(I)                                                THICK   1502
          X             = XXX                                                  THICK   1503
```

```
SUBROUTINE  ADJSTP                    CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE    2

          GO TO 40                                                       THICK     1504
      220 KSL=0                                                          THICK     1505
          M           = 2                                                THICK     1506
      230 DO 240 I = 1, N                                                THICK     1507
      240 Y(I)        = Y3(I)                                            THICK     1508
      250 RETURN                                                         THICK     1509
          END                                                            THICK     1510
```

```
         SUBROUTINE  ADJSTP                                  CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    3

         SYMBOLIC REFERENCE MAP

     ENTRY POINTS
         1  ADJSTP

     VARIABLES     SN  TYPE           RELOCATION
       211  DELY       REAL                                  14  DY        REAL       ARRAY     RUN
        77  EHP        REAL                   RUN           204  HFACT     REAL
       205  HFACT1     REAL                                 212  HFIRST    REAL
        26  HH         REAL                   RUN           206  H1        REAL
       207  I          INTEGER                               75  IBCL      INTEGER              RUN
        33  IFREQ      INTEGER                RUN            27  J         INTEGER              RUN
        30  JMAX       INTEGER                RUN            76  KORTN     INTEGER              RUN
       203  KSL        INTEGER                               31  M         INTEGER              RUN
         0  N          INTEGER                RUN             1  X         REAL                 RUN
        32  XOUT       REAL                   RUN           210  XXX       REAL
        34  X1         REAL                   RUN            35  X2        REAL                 RUN
        36  X3         REAL                   RUN             2  Y         REAL       ARRAY     RUN
        37  Y1         REAL          ARRAY    RUN            51  Y2        REAL       ARRAY     RUN
        63  Y3         REAL          ARRAY    RUN

     EXTERNALS           TYPE   ARGS
         INTPOL                  0                                STEP                0

     INLINE FUNCTIONS    TYPE   ARGS
         ABS         REAL        1  INTRIN                        AMIN1     REAL        0  INTRIN

     STATEMENT LABELS
        14  10                                0  20                                25  30
        26  40                                0  50                                 0  60           INACTIVE
         0  70                                0  80          INACTIVE               0  90
        72  100                               0  110         INACTIVE             110  120
       112  130                             120  140                                0  150
         0  160          INACTIVE           140  170                              150  180
         0  190          INACTIVE             0  200         INACTIVE               0  210
       165  220                             167  230                                0  240
       174  250

     COMMON BLOCKS    LENGTH
         RUN            64

     STATISTICS
       PROGRAM LENGTH   213B      139
        COMMON LENGTH   100B       64
```

```
      SUBROUTINE  STEP                          CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    1

            SUBROUTINE STEP                                                       THICK    1511
            COMMON/RUN/N,X,Y(10),DY(10),HH,J,JMAX,M,XOUT,IFREQ,X1,X2,X3,          THICK    1512
           1Y1(10),Y2(10),Y3(10),IBCL,KORTN ,ERP                                  THICK    1513
            DIMENSION Y0(10),P1(10)                                               THICK    1514
            DO 10 I = 1, N                                                        THICK    1515
         10 Y0(I)      = Y(I)                                                     THICK    1516
            X0         =X                                                         THICK    1517
            CALL DIFFEQ                                                           THICK    1518
            DO 20 I = 1, N                                                        THICK    1519
            P1(I)      = DY(I) * HH                                               THICK    1520
         20 Y(I)       = Y0(I) + P1(I)*0.5                                        THICK    1521
            X          = X0 + HH*0.5                                              THICK    1522
            CALL DIFFEQ                                                           THICK    1523
            DO 30 I = 1, N                                                        THICK    1524
            P1(I)= P1(I)+2.0*HH*DY(I)                                             THICK    1525
         30 Y(I)       = Y0(I) + 0.5*HH*DY(I)                                     THICK    1526
            CALL DIFFEQ                                                           THICK    1527
            DO 40 I = 1, N                                                        THICK    1528
            P1(I)= P1(I)+2.0*HH*DY(I)                                             THICK    1529
         40 Y(I)       = Y0(I) + HH*DY(I)                                         THICK    1530
            X          = X0 + HH                                                  THICK    1531
            CALL DIFFEQ                                                           THICK    1532
            DO 50 I = 1, N                                                        THICK    1533
         50 Y(I)=Y0(I) + (P1(I)+HH*DY(I))*0.1666667                               THICK    1534
            RETURN                                                                THICK    1535
            END                                                                   THICK    1536
```


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```
        SUBROUTINE  STEP                                         CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.       PAGE      2

        SYMBOLIC REFERENCE MAP

ENTRY POINTS
     1  STEP

VARIABLES      SN  TYPE              RELOCATION
     14  DY          REAL       ARRAY    RUN               77  ERP         REAL                RUN
     26  HH          REAL                RUN               74  I           INTEGER
     75  IBCL        INTEGER             RUN               33  IFREQ       INTEGER             RUN
     27  J           INTEGER             RUN               30  JMAX        INTEGER             RUN
     76  KORTN       INTEGER             RUN               31  M           INTEGER             RUN
      0  N           INTEGER             RUN              110  P1          REAL       ARRAY
      1  X           REAL                RUN               32  XOUT        REAL                RUN
     75  X0          REAL                                  34  X1          REAL                RUN
     35  X2          REAL                RUN               36  X3          REAL                RUN
      2  Y           REAL       ARRAY    RUN               76  Y0          REAL       ARRAY
     37  Y1          REAL       ARRAY    RUN               51  Y2          REAL       ARRAY    RUN
     63  Y3          REAL       ARRAY    RUN

EXTERNALS          TYPE    ARGS
        DIFFEQ               0

STATEMENT LABELS
      0  10                          0  20                          0  30
      0  40                          0  50

COMMON BLOCKS    LENGTH
        RUN          64

STATISTICS
   PROGRAM LENGTH    122B      82
    COMMON LENGTH    100B      64
```

```
SUBROUTINE  INTPOL                         CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE    1

                  SUBROUTINE INTPOL                                               THICK    1537
                  COMMON/RUN/N,X,Y(10),DY(10),HH,J,JMAX,M,XOUT,IFREQ,X1,X2,X3,   THICK    1538
                 1Y1(10),Y2(10),Y3(10),IBCL,KORTN ,ERP                           THICK    1539
                  IF(ABS (XOUT    - X)-ABS (HH)) 10,10,20                        THICK    1540
 05            10 HH=XOUT-X                                                       THICK    1541
                  CALL STEP                                                       THICK    1542
                  J          = J + 1                                              THICK    1543
               20 RETURN                                                          THICK    1544
                  END                                                             THICK    1545
```

```
        SUBROUTINE  INTPOL                                        CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      2
        SYMBOLIC REFERENCE MAP

ENTRY POINTS
     1  INTPOL

VARIABLES      SN  TYPE            RELOCATION
     14  DY         REAL       ARRAY    RUN              77  ERP        REAL                RUN
     26  HH         REAL                RUN              75  IBCL       INTEGER             RUN
     33  IFREQ      INTEGER             RUN              27  J          INTEGER             RUN
     30  JMAX       INTEGER             RUN              76  KORTN      INTEGER             RUN
     31  M          INTEGER             RUN               0  N          INTEGER             RUN
      1  X          REAL                RUN              32  XOUT       REAL                RUN
     34  X1         REAL                RUN              35  X2         REAL                RUN
     36  X3         REAL                RUN               2  Y          REAL       ARRAY    RUN
     37  Y1         REAL       ARRAY    RUN              51  Y2         REAL       ARRAY    RUN
     63  Y3         REAL       ARRAY    RUN

EXTERNALS           TYPE    ARGS
        STEP                  0

INLINE FUNCTIONS    TYPE    ARGS
        ABS         REAL      1  INTRIN

STATEMENT LABELS
     0  10          INACTIVE                 15  20

COMMON BLOCKS   LENGTH
        RUN           64

STATISTICS
  PROGRAM LENGTH     17B        15
   COMMON LENGTH    100B        64
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$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
          SUBROUTINE  TRIANG     TRACE                     CDC 6600 FTN V3.0-P243 OPT=0  06/23/71  02.12.12.      PAGE      1

                        SUBROUTINE TRIANG(D,IRC,JRC,KRC,DM,ISY,JSY)                         THICK    1546
                        DIMENSION D(IRC,JRC,KRC),DM(ISY,JSY)                                THICK    1547
                        COMMON/RUN/ NDE,S,Y(10),YD(10),HH,J9,JMAX,M9,XOUT,IFREQ,DUMM(33),   THICK    1548
                       1IBCL,KORTN,ERP                                                      THICK    1549
                        COMMON/MATL/ B11(20,4),B12(20,4),B22(20,4),B66(20,4),B44(20,4),     THICK    1550
                       1B55(20,4),AL1(20,4),AL2(20,4),RHO(20,4)                             THICK    1551
                        COMMON/XMIT/ IBR,ISH,XN,XLD,OMSQ,HTT,R1,R2,R3,SXN,CXS,INDEX,PN,PL,  THICK    1552
                       1PC,T0,T1,RH1,RH2,RH3,NBR,C11,C12,C22,C66,E11,E12,E22,E66,D11,D12,   THICK    1553
                       2D22,D66,H44,H55,H66,XK11,XK12,XK22,XE66,F11,F12,F22,XH11,XH12,XH22  THICK    1554
                       3,EMFI,EMTH,H11,H12,H22,H21,G12,G21                                  THICK    1555
                        COMMON/GEOM/ SI(20),SX(20),XPR(20),ING(20),IPAR(20),Z(20),ISS(20),  THICK    1556
                       1TR1(10,10),TR2(10,10),NTP(20),DSC(20,10),MLY(20),ZLY(20,5),IA(10),  THICK    1557
                       2IB(10,4),ALFL         ,TR(10,10,4),TLI(10,10),ALFR(4)               THICK    1558
                        COMMON/TRIA/GA(5),GB(5,4),ITP(100),NH,NE,NPL,NEP,NPRT               FEB6       32
                        COMMON/XDUM/JTYPE,IBRM                                              FEB6       35
                        DIMENSION D1(5,5),D2(5,5),U1(5,5),U2(5,5)                           JUN16       1
                        DATA IOR/8HTORSION   /                                              JUN16       2
                         IF(JTYPE.NE.IOR) GO TO 4                                           FEB6       36
                        JF=1                                                                FEB6       37
                        DO 2 K=1,IBRM                                                       FEB6       38
                        IX=IPAR(K)+JF-2                                                     FEB6       39
                        DO 3 L=JF,IX                                                        FEB6       40
                        DO 3 I=1,NPL                                                        FEB6       41
                        TEMP=D(L,4,I)                                                       FEB6       42
                             D(L,4,I)=D(L,7,I)                                              FEB6       43
                      3 D(L,7,I)=TEMP                                                       FEB6       44
                        IX=IX+1                                                             FEB6       45
                        JF=JF+1                                                             FEB6       46
                        DO 7 L=JF,IX                                                        FEB6       47
                        DO 7 I=1,NDE                                                        FEB6       48
                        TEMP=D(L,I,4)                                                       FEB6       49
                        D(L,I,4)=D(L,I,7)                                                   FEB6       50
                      7 D(L,I,7)=TEMP                                                       FEB6       51
                      2 JF=IX+1                                                             FEB6       52
                      4 CONTINUE                                                            FEB6       53
                        IST=0                                                               THICK    1560
                        IRR=1                                                               THICK    1561
                        DO 10 I=1,NH                                                        THICK    1562
                        DO 10 J=1,NH                                                        THICK    1563
                        JJ=J+NH                                                             THICK    1564
                     10 U1(I,J) =   D(1,I,JJ)                                               THICK    1565
                        CALL INVERT (U1,NH,DET)                                             THICK    1566
                        DO 20 I=1,NH                                                        THICK    1567
                        II=I+NH                                                             THICK    1568
                        DO 20 J=1,NH                                                        THICK    1569
                        U2(I,J) = 0.0                                                       THICK    1570
                        DO 20 L=1,NH                                                        THICK    1571
                        LL=L+NH                                                             THICK    1572
                     20 U2(I,J) = U2(I,J) + D(1,II,LL) * U1(L,J)                            THICK    1573
                        DM(1,1)=DET                                                         THICK    1574
                        DO 30 I=1,NH                                                        THICK    1575
                        II=I+NH                                                             THICK    1576
                        D1(1,I) = - D(1,I,NPL)                                              THICK    1577
                        D1(2,I) = - D(1,II,NPL)                                             THICK    1578
                        DO 30 J=1,NH                                                        THICK    1579
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SUBROUTINE  TRIANG    TRACE                 CDC 6600 FTN V3.0-P243 OPT=0  06/23/71  02.12.12.    PAGE    2

          D1(1,I) = D1(1,I) - D(1,I,J) * GA(J)                     THICK  1580
       30 D1(2,I) = D1(2,I) - D(1,II,J) * GA(J)                    THICK  1581
          DO 40 I=1,NH                                             THICK  1582
          DO 40 J=1,NH                                             THICK  1583
       40 D1(2,I) = D1(2,I) - U2(I,J) * D1(1,J)                    THICK  1584
          DO 50 I=1,NH                                             THICK  1585
          II = I+NH                                                THICK  1586
          D(1,I,NPL) = D1(1,I)                                     THICK  1587
          D(1,II,NPL) = D1(2,I)                                    THICK  1588
          DO 50 J=1,NH                                             THICK  1589
       50 D(1,II,J) = U1(I,J)                                      THICK  1590
          IF(NF-1) 520,520,60                                      THICK  1591
       60 CALL INVERT (U2,NH,DET)                                  THICK  1592
          DM(1,2) = DET                                            THICK  1593
          DO 70 I=1,NH                                             THICK  1594
          II=I+NH                                                  THICK  1595
          DO 70 J=1,NH                                             THICK  1596
          JJ=J+NH                                                  THICK  1597
       70 D(1,II,JJ) = U2(I,J)                                     THICK  1598
          DO 510 K=2,NF                                            THICK  1599
          DO 80 I=1,NH                                             THICK  1600
          DO 80 J=1,NH                                             THICK  1601
          JJ=J+NH                                                  THICK  1602
          D2(I,J) = 0.0                                            THICK  1603
          DO 80 L=1,NH                                             THICK  1604
          LL= L+NH                                                 THICK  1605
       80 D2(I,J) = D2(I,J) + D(K,I,L) * D(K-1,LL,JJ)              THICK  1606
          IF(ITP(K-1)-2) 110,90,90                                 THICK  1607
       90 DO 100 I=1,NH                                            THICK  1608
          DO 100 J=1,NH                                            THICK  1609
          JJ=J+NH                                                  THICK  1610
          U1(I,J) = D(K,I,JJ)                                      THICK  1611
          DO 100 L=1,NH                                            THICK  1612
      100 U1(I,J) = U1(I,J) - D2(I,L) *D(K-1,L,JJ)                 THICK  1613
          GO TO 130                                                THICK  1614
      110 DO 120 I=1,NH                                            THICK  1615
          DO 120 J=1,NH                                            THICK  1616
          JJ=J+NH                                                  THICK  1617
      120 U1(I,J) = D(K,I,JJ) + D2(I,J)                            THICK  1618
      130 IF( ITP(K)-1) 200,140,140                                THICK  1619
      140 IF(IST  -1) 150,150,180                                  THICK  1620
      150 IRR=IRR+1                                                THICK  1621
          IST=K                                                    THICK  1622
          DO 170 I=1,NH                                            THICK  1623
          II=I+NH                                                  THICK  1624
          DO 160 J=1,NH                                            THICK  1625
          JJ=J+NH                                                  THICK  1626
          D(K=1,I,JJ)=0.0                                          THICK  1627
      160 D(K-1,I,J )=0.0                                          THICK  1628
      170 D(K=1,I,II)=-1.0                                         THICK  1629
      180 DO 190 I=1,NH                                            THICK  1630
          DO 190 J=1,NH                                            THICK  1631
          JJ=J+NH                                                  THICK  1632
          D(K,I,J)=0.0                                             THICK  1633
          DO 190 L=1,NH                                            THICK  1634
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190 D(K,I,J) = D(K,I,J) - D2(I,L) * D(K-1,L,JJ)                    THICK 1635
200 CALL INVERT (U1,NH,DET)                                        THICK 1636
    DM(K,1)=DET                                                    THICK 1637
    DO 210 I=1,NH                                                  THICK 1638
    D1(1,I) = - D(K,I,NPL)                                         THICK 1639
    DO 210 J=1,NH                                                  THICK 1640
    JJ=J+NH                                                        THICK 1641
210 D1(1,I) = D1(1,I) - D2(I,J) * D(K-1,JJ,NPL)                    THICK 1642
    DO 220 I=1,NH                                                  THICK 1643
    II=I+NH                                                        THICK 1644
    DO 220 J=1,NH                                                  THICK 1645
    JJ = J + NH                                                    THICK 1646
    D2(I,J) = 0.0                                                  THICK 1647
    DO 220 L=1,NH                                                  THICK 1648
    LL = L + NH                                                    THICK 1649
220 D2(I,J) = D2(I,J) + D(K,II,L) * D(K-1,LL,JJ)                   THICK 1650
    IF( ITP(K)-1) 250,230,230                                      THICK 1651
230 DO 240 I=1,NH                                                  THICK 1652
    DO 240 J=1,NH                                                  THICK 1653
    JJ=J+NH                                                        THICK 1654
    D(K,I,JJ)=0.0                                                  THICK 1655
    DO 240 L=1,NH                                                  THICK 1656
240 D(K,I,JJ) = D(K,I,JJ) - D2(I,L) * D(K-1,L,JJ)                  THICK 1657
250 DO 260 I=1,NH                                                  THICK 1658
    II=I+NH                                                        THICK 1659
    D1(2,I) = -D(K,II,NPL)                                         THICK 1660
    DO 260 J=1,NH                                                  THICK 1661
    JJ=J+NH                                                        THICK 1662
260 D1(2,I) = D1(2,I) - D2(I,J) * D(K-1,JJ,NPL)                    THICK 1663
    IF(ITP(K-1)-2) 300,270,270                                     THICK 1664
270 DO 280 I=1,NH                                                  THICK 1665
    DO 280 J=1,NH                                                  THICK 1666
    JJ=J+NH                                                        THICK 1667
    U2(I,J) = 0.0                                                  THICK 1668
    DO 280 L=1,NH                                                  THICK 1669
280 U2(I,J) = U2(I,J) - D2(I,L) * D(K-1,L,JJ)                      THICK 1670
    DO 290 I=1,NH                                                  THICK 1671
    DO 290 J=1,NH                                                  THICK 1672
290 D2(I,J) = U2(I,J)                                              THICK 1673
300 DO 310 I=1,NH                                                  THICK 1674
    II=I+NH                                                        THICK 1675
    DO 310 J=1,NH                                                  THICK 1676
    JJ=J+NH                                                        THICK 1677
310 D2(I,J) = D(K,II,JJ) + D2(I,J)                                 THICK 1678
    DO 320 I=1,NH                                                  THICK 1679
    DO 320 J=1,NH                                                  THICK 1680
    U2(I,J) = 0.0                                                  THICK 1681
    DO 320 L=1,NH                                                  THICK 1682
320 U2(I,J) = U2(I,J) + D2(I,L) * U1(L,J)                          THICK 1683
    IF( ITP(K)-1) 350,330,330                                      THICK 1684
330 DO 340 I=1,NH                                                  THICK 1685
    DO 340 J=1,NH                                                  THICK 1686
    JJ=J+NH                                                        THICK 1687
    DO 340 L=1,NH                                                  THICK 1688
340 D(K,I,JJ) = D(K,I,JJ) - U2(I,L) * D(K,L,J)                     THICK 1689
```

221085


```
SUBROUTINE  TRIANG     TRACE                   CDC 6600 FTN V3.0-P243 OPT=0  06/23/71  02.12.12.    PAGE    4
            350 DO 360I=1,NH                                                  THICK    1690
                DO 360J=1,NH                                                  THICK    1691
            360 D1(2,I) = D1(2,I)- U2(I,J) * D1(1,J)                          THICK    1692
                DO 370 I=1,NH                                                 THICK    1693
                II=I+NH                                                       THICK    1694
                D(K,I,NPL) = D1(1,I)                                          THICK    1695
                D(K,II,NPL) = D1(2,I)                                         THICK    1696
                DO 370 J=1,NH                                                 THICK    1697
            370 D(K,II,J) = U1(I,J)                                           THICK    1698
                IF(K-NF) 380,520,520                                          THICK    1699
            380 CALL INVERT (U2,NH,DET)                                       THICK    1700
                DM(K,2) = DET                                                 THICK    1701
                DO 390 I=1,NH                                                 THICK    1702
                II=I+NH                                                       THICK    1703
                DO 390 J=1,NH                                                 THICK    1704
                JJ=J+NH                                                       THICK    1705
            390 D(K,II,JJ) = U2(I,J)                                          THICK    1706
                IF( ITP(K)-1) 510,510,400                                     THICK    1707
            400 DO 410 I=1,NH                                                 THICK    1708
                II=I+NH                                                       THICK    1709
            410 D(K,II,NPL) = D(K,II,NPL) + GB(I,IRR)                         THICK    1710
                DO 420 I=1,NH                                                 THICK    1711
                II=I+NH                                                       THICK    1712
                DO 420 J=1,NH                                                 THICK    1713
                U1(I,J)=D(K+1,I,J)                                            THICK    1714
            420 D1(I,J)=D(K+1,II,J)                                           THICK    1715
                DO 490 N=IST,K                                                THICK    1716
                DO 430 I=1,NH                                                 THICK    1717
                DO 430 J=1,NH                                                 THICK    1718
                JJ=J+NH                                                       THICK    1719
                U2(I,J)=0.0                                                   THICK    1720
                D2(I,J)=0.0                                                   THICK    1721
                DO 430 L=1,NH                                                 THICK    1722
                LL=L+NH                                                       THICK    1723
                U2(I,J) = U2(I,J) + U1(I,L) * D(N-1,LL,JJ)                    THICK    1724
            430 D2(I,J) = D2(I,J) + D1(I,L) * D(N-1,LL,JJ)                    THICK    1725
                DO 440 I=1,NH                                                 THICK    1726
                II=I+NH                                                       THICK    1727
                DO 440 J=1,NH                                                 THICK    1728
                JJ=J+NH                                                       THICK    1729
                DO 440 L=1,NH                                                 THICK    1730
                D(K+1,I,JJ )= D(K+1,I ,JJ)- U2(I,L)*D(N-1,L,JJ)               THICK    1731
            440 D(K+1,II,JJ)= D(K+1,II,JJ)- D2(I,L)*D(N-1,L,JJ)               THICK    1732
                DO 450 I=1,NH                                                 THICK    1733
                II=I+NH                                                       THICK    1734
                DO 450 J=1,NH                                                 THICK    1735
                JJ=J+NH                                                       THICK    1736
                D(K+1,I,NPL) = D(K+1, I,NPL)+ U2(I,J) * D(N-1,JJ,NPL)         THICK    1737
            450 D(K+1,II,NPL) = D(K+1,II,NPL) + D2(I,J) * D(N-1,JJ,NPL)       THICK    1738
                DO 460 I=1,NH                                                 THICK    1739
                DO 460 J=1,NH                                                 THICK    1740
                U1(I,J)=0.0                                                   THICK    1741
                D1(I,J)=0.0                                                   THICK    1742
                DO 460 L=1,NH                                                 THICK    1743
                LL=L+NH                                                       THICK    1744
```

```
SUBROUTINE  TRIANG    TRACE                     CDC 6600 FTN V3.0-P243 OPT=0  06/23/71  02.12.12.     PAGE     5

            U1(I,J) = U1(I,J) + U2(I,L) * D(N,LL,J)                             THICK   1745
        460 D1(I,J) = D1(I,J) + D2(I,L) * D(N,LL,J)                             THICK   1746
            DO 470 I=1,NH                                                       THICK   1747
            II=I+NH                                                             THICK   1748
            DO 470 J=1,NH                                                       THICK   1749
            JJ=J+NH                                                             THICK   1750
            DO 470 L=1,NH                                                       THICK   1751
            D(K+1,I ,JJ)= D(K+1,I ,JJ) -U1(I,L)*D(N,L,J)                        THICK   1752
        470 D(K+1,II,JJ)= D(K+1,II,JJ) -D1(I,L)*D(N,L,J)                        THICK   1753
            DO 480 I=1,NH                                                       THICK   1754
            II=I+NH                                                             THICK   1755
            DO 480 J=1,NH                                                       THICK   1756
            D(K+1,I, NPL) = D(K+1,I, NPL) + U1(I,J) * D(N,J,NPL)                THICK   1757
        480 D(K+1,II,NPL) = D(K+1,II,NPL) + D1(I,J) * D(N,J,NPL)                THICK   1758
        490 CONTINUE                                                            THICK   1759
            DO 500 I=1,NH                                                       THICK   1760
            II=I+NH                                                             THICK   1761
            DO 500 J=1,NH                                                       THICK   1762
            D(K+1,I ,J )= U1(I,J)                                               THICK   1763
        500 D(K+1,II,J )= D1(I,J)                                               THICK   1764
            IST=0                                                               THICK   1765
        510 CONTINUE                                                            THICK   1766
        520 DO 530 I=1,NH                                                       THICK   1767
            II=I+NH                                                             THICK   1768
        530 D(NF,II,NPL) = D(NF,II,NPL) + GB(I,1)                               THICK   1769
            CALL INVERT (U2,NH,DET)                                             THICK   1770
            IF(NPRT) 610,610,540                                                THICK   1771
        540 CONTINUE                                                            THICK   1772
            WRITE (6,550)                                                       THICK   1773
        550 FORMAT (1H0,40X,45HSOLUTION IS BASED ON FOLLOWING C-SUB-M MATRIX)   THICK   1774
            DO 561 I=1,NH                                                       THICK   1775
        561 WRITE(6,560)(U2(I,J),J=1,NH)                                        THICK   1776
        560 FORMAT (1H , 22X,5E18.8)                                            THICK   1777
            WRITE (6,570)                                                       THICK   1778
           1              (DM(I,1),I=1,NF )                                     THICK   1779
        570 FORMAT(1H ,8HDET(UF)=,8E15.7)                                       THICK   1780
            J=NF-1                                                              THICK   1781
            WRITE (6,580)                                                       THICK   1782
           1             (DM(I,2),I=1,J)                                        THICK   1783
        580 FORMAT(1H ,8HDET(UC)=,8E15.7)                                       THICK   1784
            DIAG=1.0                                                            THICK   1785
            DO 590 I=1,NH                                                       THICK   1786
        590 DIAG=DIAG*U2(I,I)                                                   THICK   1787
            WRITE (6,600) DET,DIAG                                              THICK   1788
        600 FORMAT (1H0, 12HDETERMINANT=,E16.8,7H  DIAG=,E14.7)                 THICK   1789
        610 CONTINUE                                                            THICK   1790
            DO 620 I=1,NH                                                       THICK   1791
            II=I+NH                                                             THICK   1792
            DM(NFP,II)=0.0                                                      THICK   1793
            DO 620 J=1,NH                                                       THICK   1794
            JJ=J+NH                                                             THICK   1795
        620 D(NF,II,JJ)=U2(I,J)                                                 THICK   1796
            IST=0                                                               THICK   1797
            DO 760 N=1,NF                                                       THICK   1798
            K=NFP-N                                                             THICK   1799
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SUBROUTINE TRIANG   TRACE                    CDC 6600 FTN V3.0-P243 OPT=0  06/23/71  02.12.12.   PAGE   6

      IF( ITP(K)-1) 630,660,650                                          THICK  1800
  630 IF(IST-1) 680,680,640                                              THICK  1801
  640 IST=0                                                              THICK  1802
      GO TO 660                                                          THICK  1803
  650 IK=K+1                                                             THICK  1804
      IST=2                                                              THICK  1805
  660 DO 670 I=1,NH                                                      THICK  1806
      II=I+NH                                                            THICK  1807
      DO 670 J=1,NH                                                      THICK  1808
      JJ=J+NH                                                            THICK  1809
  670 D(K,II,NPL) = D(K,II,NPL) - D(K,I,JJ) * DM(IK,JJ)                  THICK  1810
      IF(ITP(K)-1) 680,680,700                                           THICK  1811
  680 DO 690 I=1,NH                                                      THICK  1812
      II=I+NH                                                            THICK  1813
  690 D(K,II,NPL) = D(K,II,NPL) + DM(K+1,II)                             THICK  1814
  700 DO 710 I=1,NH                                                      THICK  1815
      II=I+NH                                                            THICK  1816
      DM(K+1,I) =0.0                                                     THICK  1817
      DO 710 L=1,NH                                                      THICK  1818
      LL=L+NH                                                            THICK  1819
  710 DM(K+1,I) = DM(K+1,I) + D(K,II,LL) * D(K,LL,NPL)                   THICK  1820
      IF(ITP(K)-1) 740,720,720                                           THICK  1821
  720 DO 730 I=1,NH                                                      THICK  1822
      DO 730 J=1,NH                                                      THICK  1823
      JJ=J+NH                                                            THICK  1824
  730 D(K,I,NPL) = D(K,I,NPL) - D(K,I,JJ) * DM(IK,JJ)                    THICK  1825
  740 DO 750 I=1,NH                                                      THICK  1826
  750 D(K,I,NPL) = D(K,I,NPL) + DM(K+1,I)                                THICK  1827
      DO 760 I=1,NH                                                      THICK  1828
      II=I+NH                                                            THICK  1829
      DM(K,II)=0.0                                                       THICK  1830
      DO 760 L=1,NH                                                      THICK  1831
  760 DM(K,II) = DM(K,II) + D(K,II,L) * D(K,L,NPL)                       THICK  1832
      DO 770 I=1,NH                                                      THICK  1833
  770 DM(1,I)=GA(I)                                                      THICK  1834
      IF(JTYPE.NE.IOR) RETURN                                            FEB6     54
      JF=2                                                               FEB6     55
      DO 771 K=1,IBRM                                                    FEB6     56
      IX=IPAR(K)+JF-2                                                    FEB6     57
      DO 772 L=JF,IX                                                     FEB6     58
      TEMP=DM(L,4)                                                       FEB6     59
      DM(L,4)=DM(L,7)                                                    FEB6     60
  772 DM(L,7)=TEMP                                                       FEB6     61
  771 JF=IX+2                                                            FEB6     62
      RETURN                                                             THICK  1835
      END                                                                THICK  1836
```

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        SUBROUTINE  TRIANG    TRACE                          CDC 6600 FTN V3.0-P243 OPT=0  06/23/71  02.12.12.      PAGE      7

        SYMBOLIC REFERENCE MAP

   ENTRY POINTS
      2  TRIANG

   VARIABLES      SN   TYPE              RELOCATION
     1332  ALFL        REAL                 GEOM          2317  ALFR        REAL       ARRAY     GEOM
      740  AL1         REAL       ARRAY     MATL          1060  AL2         REAL       ARRAY     MATL
        0  B11         REAL       ARRAY     MATL           120  B12         REAL       ARRAY     MATL
      240  B22         REAL       ARRAY     MATL           500  B44         REAL       ARRAY     MATL
      620  B55         REAL       ARRAY     MATL           360  B66         REAL       ARRAY     MATL
       12  CXS         REAL                 XMIT            25  C11         REAL                 XMIT
       26  C12         REAL                 XMIT            27  C22         REAL                 XMIT
       30  C66         REAL                 XMIT             0  D           REAL       ARRAY     F.P.
     3462  DET         REAL                               3466  DIAG        REAL
        0  DM          REAL       ARRAY     F.P.           550  DSC         REAL       ARRAY     GEOM
       34  DUMM        REAL       ARRAY     RUN           3470  D1          REAL       ARRAY
       35  D11         REAL                 XMIT            36  D12         REAL                 XMIT
     3521  D2          REAL       ARRAY                     37  D22         REAL                 XMIT
       40  D66         REAL                 XMIT            56  EMET        REAL                 XMIT
       57  EMTH        REAL                 XMIT            77  ERP         REAL                 RUN
       31  E11         REAL                 XMIT            32  E12         REAL                 XMIT
       33  E22         REAL                 XMIT            34  E66         REAL                 XMIT
       50  F11         REAL                 XMIT            51  F12         REAL                 XMIT
       52  F22         REAL                 XMIT             0  GA          REAL       ARRAY     TRIA
        5  GB          REAL       ARRAY     TRIA            64  G12         REAL                 XMIT
       65  G21         REAL                 XMIT            26  HH          REAL                 RUN
        5  HTT         REAL                 XMIT            60  H11         REAL                 XMIT
       61  H12         REAL                 XMIT            63  H21         REAL                 XMIT
       62  H22         REAL                 XMIT            41  H44         REAL                 XMIT
       42  H55         REAL                 XMIT            43  H66         REAL                 XMIT
     3454  I           INTEGER                            1250  IA          INTEGER    ARRAY     GEOM
     1262  IB          INTEGER    ARRAY     GEOM            75  IBCL        INTEGER              RUN
        0  IBR         INTEGER              XMIT             1  IBRM        INTEGER              XDUM
       33  IFREQ       INTEGER              RUN           3463  II          INTEGER
     3467  IK          INTEGER                              13  INDEX       INTEGER              XMIT
       74  ING         INTEGER    ARRAY     GEOM          3416  IOR         INTEGER
      120  IPAR        INTEGER    ARRAY     GEOM             0  IRC         INTEGER              F.P.
     3457  IRR         INTEGER                               1  ISH         INTEGER              XMIT
      170  ISS         INTEGER    ARRAY     GEOM          3456  IST         INTEGER
        0  ISY         INTEGER              F.P.            31  ITP         INTEGER    ARRAY     TRIA
     3452  IX          INTEGER                            3460  J           INTEGER
     3450  JF          INTEGER                            3461  JJ          INTEGER
       30  JMAX        INTEGER              RUN              0  JRC         INTEGER              F.P.
        0  JSY         INTEGER              F.P.             0  JTYPE       INTEGER              XDUM
       27  J9          INTEGER              RUN           3451  K           INTEGER
       76  KORTN       INTEGER              RUN              0  KRC         INTEGER              F.P.
     3453  L           INTEGER                            3464  LL          INTEGER
     1060  MLY         INTEGER    ARRAY     GEOM            31  M9          INTEGER              RUN
     3465  N           INTEGER                              24  NBR         INTEGER              XMIT
        0  NDE         INTEGER              RUN            176  NF          INTEGER              TRIA
      200  NFP         INTEGER              TRIA           175  NH          INTEGER              TRIA
      177  NPL         INTEGER              TRIA           201  NPRT        INTEGER              TRIA
      524  NTP         INTEGER    ARRAY     GEOM             4  OMSQ        REAL                 XMIT
```

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        SUBROUTINE  TRIANG     TRACE                          CDC 6600 FTN V3.0-P243 OPT=0  06/23/71  02.12.12.     PAGE     8

  VARIABLES       SN  TYPE              RELOCATION
       16  PC         REAL                    XMIT          15  PL         REAL                XMIT
       14  PN         REAL                    XMIT        1200  RHO        REAL       ARRAY    MATL
       21  RH1        REAL                    XMIT          22  RH2        REAL                XMIT
       23  RH3        REAL                    XMIT           6  R1         REAL                XMIT
        7  R2         REAL                    XMIT          10  R3         REAL                XMIT
        1  S          REAL                    RUN            0  SI         REAL       ARRAY    GEOM
       24  SX         REAL          ARRAY     GEOM          11  SXN        REAL                XMIT
     3455  TEMP       REAL                                2153  TLI        REAL       ARRAY    GEOM
     1333  TR         REAL          ARRAY     GEOM         214  TR1        REAL       ARRAY    GEOM
      360  TR2        REAL          ARRAY     GEOM          17  T0         REAL                XMIT
       20  T1         REAL                    XMIT        3552  U1         REAL       ARRAY
     3603  U2         REAL          ARRAY                   47  XE66       REAL                XMIT
       53  XH11       REAL                    XMIT          54  XH12       REAL                XMIT
       55  XH22       REAL                    XMIT          44  XK11       REAL                XMIT
       45  XK12       REAL                    XMIT          46  XK22       REAL                XMIT
        3  XLD        REAL                    XMIT           2  XN         REAL                XMIT
       32  XOUT       REAL                    RUN           50  XPR        REAL       ARRAY    GEOM
        2  Y          REAL          ARRAY     RUN           14  YD         REAL       ARRAY    RUN
      144  Z          REAL          ARRAY     GEOM        1104  ZLY        REAL       ARRAY    GEOM

  FILE NAMES          MODE
          TAPE6        FMT

  EXTERNALS            TYPE    ARGS
          INVERT                 3

  STATEMENT LABELS
        0  2                                  0  3                                  162  4
        0  7                                  0  10                                   0  20
        0  30                                 0  40                                   0  50
        0  60        INACTIVE                 0  70                                   0  80
        0  90        INACTIVE                 0  100                                703  110
        0  120                              736  130                                  0  140      INACTIVE
        0  150       INACTIVE                 0  160                                  0  170
     1017  180                                0  190                               1067  200
        0  210                                0  220                                  0  230      INACTIVE
        0  240                             1276  250                                  0  260
        0  270       INACTIVE                 0  280                                  0  290
     1444  300                                0  310                                  0  320
        0  330       INACTIVE                 0  340                               1603  350
        0  360                                0  370                                  0  380      INACTIVE
        0  390                                0  400       INACTIVE                   0  410
        0  420                                0  430                                  0  440
        0  450                                0  460                                  0  470
        0  480                                0  490                                  0  500
     2607  510                             2612  520                                  0  530
        0  540       INACTIVE              3417  550       FMT                     3426  560   FMT
        0  561                             3431  570       FMT                     3435  580   FMT
        0  590                             3441  600       FMT                     2744  610
        0  620                                0  630       INACTIVE                   0  640      INACTIVE
     3014  650                             3017  660                                  0  670
     3054  680                                0  690                               3107  700
        0  710                                0  720       INACTIVE                   0  730
     3214  740                                0  750                                  0  760
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      SUBROUTINE  TRIANG    TRACE                         CDC 6600 FTN V3.0-P243 OPT=0  06/23/71  02.12.12.      PAGE      9

   STATEMENT LABELS
      0  770                               0  771                               0  772

   COMMON BLOCKS   LENGTH
          RUN          64
          MATL        720
          XMIT         54
          GEOM       1235
          TRIA        130
          XDUM          2

   STATISTICS
     PROGRAM LENGTH   40308    2072
      COMMON LENGTH   42358    2205
```

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SUBROUTINE  INVERT                              CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.     PAGE     1

          SUBROUTINE INVERT (DP,MAX,DETERM)                            THICK   1837
          DIMENSION DP(5,5),M(5),C(5)                                  THICK   1838
          DETERM = 1.                                                  THICK   1839
          DO 10 I = 1, MAX                                             THICK   1840
          M(I) = - I                                                   THICK   1841
       10 CONTINUE                                                     THICK   1842
          DO 140 II = 1, MAX                                           THICK   1843
          D = 0.0                                                      THICK   1844
          DO 60 K = 1, MAX                                             THICK   1845
          IF (M(K)) 20,20,60                                           THICK   1846
       20 DO 50 L = 1, MAX                                             THICK   1847
          IF (M(L)) 30,30,50                                           THICK   1848
       30 IF ( ABS(D)- ABS(DP(K,L))) 40,40,50                          THICK   1849
       40 LD = L                                                       THICK   1850
          KD = K                                                       THICK   1851
          D = DP(K,L)                                                  THICK   1852
       50 CONTINUE                                                     THICK   1853
       60 CONTINUE                                                     THICK   1854
          IF(KD-LD) 70,80,70                                           THICK   1855
       70 DETERM =-DETERM                                              THICK   1856
       80 IF(D.NE.0.0) DETERM=DETERM*D                                 FEB6      63
          NEMP = -M(LD)                                                THICK   1858
          M(LD)=M(KD)                                                  THICK   1859
          M(KD)= NEMP                                                  THICK   1860
          DO 90 I = 1, MAX                                             THICK   1861
          C(I) = DP(I,LD)                                              THICK   1862
          DP(I,LD) = DP(I,KD)                                          THICK   1863
          DP(I,KD) = 0.0                                               THICK   1864
       90 CONTINUE                                                     THICK   1865
          DP(KD,KD) = 1.                                               THICK   1866
          DO 100 J = 1, MAX                                            THICK   1867
          DR=0.0                                                       FEB6      64
          IF(D.NE.0.0) DR=DP(KD,J)/D                                   FEB6      65
          DP(KD,J)=DR                                                  FEB6      66
      100 CONTINUE                                                     THICK   1869
          DO 130 I = 1, MAX                                            THICK   1870
          IF (I-KD) 110,130,110                                        THICK   1871
      110 DO 120 J = 1, MAX                                            THICK   1872
          DP(I,J) = DP(I,J) - C(I)*DP(KD,J)                            THICK   1873
      120 CONTINUE                                                     THICK   1874
      130 CONTINUE                                                     THICK   1875
      140 CONTINUE                                                     THICK   1876
          DO 170 I = 1, MAX                                            THICK   1877
          L=0                                                          THICK   1878
      150 L=L+1                                                        THICK   1879
          IF (M(L)-I) 150,160,150                                      THICK   1880
      160 M(L)=M(I)                                                    THICK   1881
          M(I)=I                                                       THICK   1882
          DO 170 J = 1, MAX                                            THICK   1883
          TEMP = DP(L,J)                                               THICK   1884
          DP(L,J) = DP(I,J)                                            THICK   1885
          DP(I,J) = TEMP                                               THICK   1886
      170 CONTINUE                                                     THICK   1887
          RETURN                                                       THICK   1888
          END                                                          THICK   1889
```

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        SUBROUTINE  INVERT                                    CDC 6600 FTN V3.0-P243 OPT=1  06/19/71  13.01.44.      PAGE      2

        SYMBOLIC REFERENCE MAP

ENTRY POINTS
    2  INVERT

VARIABLES       SN  TYPE            RELOCATION
  203  C            REAL        ARRAY                      165  D        REAL
    0  DETERM       REAL                  F.P.               0  DP       REAL       ARRAY     F.P.
  174  DR           REAL                                   163  I        INTEGER
  164  II           INTEGER                                173  J        INTEGER
  166  K            INTEGER                                171  KD       INTEGER
  167  L            INTEGER                                170  LD       INTEGER
  176  M            INTEGER     ARRAY                        0  MAX      INTEGER              F.P.
  172  NEMP         INTEGER                                175  TEMP     REAL

INLINE FUNCTIONS    TYPE    ARGS
       ABS          REAL      1  INTRIN

STATEMENT LABELS
    0  10                            0  20       INACTIVE           0  30        INACTIVE
    0  40          INACTIVE         47  50                         52  60
    0  70          INACTIVE         60  80                          0  90
    0  100                           0  110      INACTIVE           0  120
  130  130                           0  140                       137  150
    0  160         INACTIVE          0  170

STATISTICS
  PROGRAM LENGTH     243B      163
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APPENDIX B
EXAMPLE PROBLEMS
COMPUTER OUTPUT

TORSIONAL PROBLEM RESULTS
CASE I

```
                  STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
            WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
         MODIFIED PROGRAM TO ACCOUNT FOR TRANSVERSE SHEAR DEFORMATION --WRITTEN BY R.L. CITERLEY
                  ANAMET LABORATORIES INC.     BERKELEY, CALIFORNIA          1 OCT.1969

            STATIC ANALYSIS      PARTS=  2  BRANCHES=  0  NUMBER OF SUBCASES=  0

NGLES OF ROTATION OF BOUNDARY CONDITIONS ARE ALFL=-0.          ALFRS=-0.

       PART NO  1

I= 0.            SX= 1.00000E-01   IPAR=  4   ING=  1    SHELL TYPE 2   NTP= 0   LAYERS MLY= 4

YLINDRICAL SHELL NO  2    H= 6.65000E-01    R= 1.66750E+00  PHI=    90.000  DEGREES

AYER NO  1  FROM Z=-3.30000E-03  TO Z=-1.60000E-03
   CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E-01  POISSONS RATIO NU= 3.50000E-01
   COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.

AYER NO  2  FROM Z=-1.60000E-03  TO Z= 0.
   CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E-01  POISSONS RATIO NU= 3.50000E-01
   COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.

AYER NO  3  FROM Z= 0.            TO Z= 1.60000E-03
   CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E-01  POISSONS RATIO NU= 3.50000E-01
   COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.

AYER NO  4  FROM Z= 1.60000E-03  TO Z= 3.30000E-03
   CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E-01  POISSONS RATIO NU= 3.50000E-01
   COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.

       PART NO  2

I= 0.            SX= 1.00000E-01   IPAR=  4   ING=  1    SHELL TYPE 2   NTP= 0   LAYERS MLY= 4

YLINDRICAL SHELL NO  2    H= 6.65000E-01    R= 1.66750E+00  PHI=    90.000  DEGREES

AYER NO  1  FROM Z=-3.30000E-03  TO Z=-1.60000E-03
   CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E-01  POISSONS RATIO NU= 3.50000E-01
   COEFFICIENTS OF THERMAL EXPANSION. AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.

AYER NO  2  FROM Z=-1.60000E-03  TO Z= 0.
   CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E-01  POISSONS RATIO NU= 3.50000E-01
   COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.

AYER NO  3  FROM Z= 0.            TO Z= 1.60000E-03
   CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E-01  POISSONS RATIO NU= 3.50000E-01
   COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.

AYER NO  4  FROM Z= 1.60000E-03  TO Z= 3.30000E-03
   CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E-01  POISSONS RATIO NU= 3.50000E-01
   COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.
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                 STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
              WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
        MODIFIED PROGRAM TO ACCOUNT FOR TRANSVERSE SHEAR DEFORMATION --WRITTEN BY R.L. CITERLEY
                 ANAMET LABORATORIES INC.     BERKELEY, CALIFORNIA        1 OCT.1969

                    SUBCASE NO  1   FOR FOURIER HARMONIC COS=0 THETA

IOUNDARY CONDITIONS AT STARTING EDGE      1=0.          3=0.          5=0.          7=0.

IOUNDARY CONDITIONS AT FINAL    EDGE      2=0.          4=0.          6=0.          8 1.00000E+03


               LOADS FOR PART NO  1  SURCASE NO  1

IING LOADS AT END OF THIS PART ARE   Q=-0.        NPHI=-0.        MPHI=-0.        N=-0.

IURFACE AND TEMP LOADS ARE  P=-0.        PFI=-0.        PTHETA=-0.        TL=-0.        TU=-0.

               AT BEGINNING AND END OF PART  1 PARAMETERS ARE

  RI=  0.          R2=  5.9970E-01  R3=  1.0000E+00 SXN=  1.0000E+00 CXS=  0.
  PN= -0.          PL= -0.          PC= -0.         T0 =  0.          T1=  0.
 C11=  3.3846E-03 C12=  1.1846E-03 C22=  3.3846E-03 C66=  1.1000E-03 E11=  1.3553E-20 E12=  1.0164E-20
 E22=  1.3553E-20 E66=  3.3881E-21 D11=  1.2286E-08 D12=  4.3001E-09 D22=  1.2286E-08 D66=  3.9930E-09
 H11=  0.         H12=  0.        H22=  0.         H21=  0.         G12=  0.         G21=  0.

!S ARE= -3.3000E-03 -1.6000E-03  0.          1.6000E-03  3.3000E-03

  RI=  0.          R2=  5.9970E-01  R3=  1.0000E+00 SXN=  1.0000E+00 CXS=  0.
  PN= -0.          PL= -0.          PC= -0.         T0 =  0.          T1=  0.
 C11=  3.3846E-03 C12=  1.1846E-03 C22=  3.3846E-03 C66=  1.1000E-03 E11=  1.3553E-20 E12=  1.0164E-20
 E22=  1.3553E-20 E66=  3.3881E-21 D11=  1.2286E-08 D12=  4.3001E-09 D22=  1.2286E-08 D66=  3.9930E-09
 H11=  0.         H12=  0.        H22=  0.         H21=  0.         G12=  0.         G21=  0.

!S ARE= -3.3000E-03 -1.6000E-03  0.          1.6000E-03  3.3000E-03
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STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
MODIFIED PROGRAM TO ACCOUNT FOR TRANSVERSE SHEAR DEFORMATION --WRITTEN BY R.L. CITERLEY
ANAMET LABORATORIES INC. BERKELEY, CALIFORNIA 1 OCT.1969

STATIC SOLUTION AT POINTS ALONG MERIDIAN FOR WAVE NUMBER NX= -0

MAIN SHELL PART NO 1

S	W	Q	UPHI	NPHI	RPHI	MPHI	UTHETA	N	NTHETA	MTHETA
0.00000	0.	0.	0.	0.	0.	0.	0.	1.00000E+03	0.	0.
.02500	0.	0.	0.	0.	0.	0.	2.27272E+04	1.00000E+03	0.	0.
.02500	0.	0.	0.	0.	0.	0.	2.27272E+04	1.00000E+03	0.	0.
.05000	0.	0.	0.	0.	0.	0.	4.54545E+04	1.00000E+03	0.	0.
.05000	0.	0.	0.	0.	0.	0.	4.54545E+04	1.00000E+03	0.	0.
.07500	0.	0.	0.	0.	0.	0.	6.81817E+04	1.00000E+03	0.	0.
.07500	0.	0.	0.	0.	0.	0.	6.81817E+04	1.00000E+03	0.	0.
.10000	0.	0.	0.	0.	0.	0.	9.09090E+04	1.00000E+03	0.	0.

MAIN SHELL PART NO 2

S	W	Q	UPHI	NPHI	QPHI	MPHI	UTHETA	N	NTHETA	MTHETA
0.00000	0.	0.	0.	0.	0.	0.	9.09090E+04	1.00000E+03	0.	0.
.02500	0.	0.	0.	0.	0.	0.	1.13636E+05	1.00000E+03	0.	0.
.02500	0.	0.	0.	0.	0.	0.	1.13636E+05	1.00000E+03	0.	0.
.05000	0.	0.	0.	0.	0.	0.	1.36363E+05	1.00000E+03	0.	0.
.05000	0.	0.	0.	0.	0.	0.	1.36363E+05	1.00000E+03	0.	0.
.07500	0.	0.	0.	0.	0.	0.	1.59091E+05	1.00000E+03	0.	0.
.07500	0.	0.	0.	0.	0.	0.	1.59091E+05	1.00000E+03	0.	0.
.10000	0.	0.	0.	0.	0.	0.	1.81818E+05	1.00000E+03	0.	0.

STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
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ANAMET LABORATORIES INC. BERKELEY, CALIFORNIA 1 OCT,1969

STATIC SOLUTION AT POINTS ALONG MERIDIAN FOR WAVE NUMBER NX= -0

MAIN SHELL PART NO 1

S	W	UPHI	UTHETA	BPHI	SPHI IN	SPHI OUT	STHETA IN	STHETA OUT	SEITH IN	SEITH OUT
0.00000	0.	0.	0.	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
0.00000	0.	0.	0.	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
0.00000	0.	0.	0.	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
0.00000	0.	0.	0.	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.02500	0.	0.	2.27272E+04	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.02500	0.	0.	2.27272E+04	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.02500	0.	0.	2.27272E+04	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.02500	0.	0.	2.27272E+04	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.02500	0.	0.	2.27272E+04	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.02500	0.	0.	2.27272E+04	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.02500	0.	0.	2.27272E+04	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.02500	0.	0.	2.27272E+04	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.05000	0.	0.	4.54545E+04	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.05000	0.	0.	4.54545E+04	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.05000	0.	0.	4.54545E+04	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.05000	0.	0.	4.54545E+04	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.05000	0.	0.	4.54545E+04	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.05000	0.	0.	4.54545E+04	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.05000	0.	0.	4.54545E+04	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.05000	0.	0.	4.54545E+04	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.07500	0.	0.	6.81817E+04	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.07500	0.	0.	6.81817E+04	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.07500	0.	0.	6.81817E+04	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.07500	0.	0.	6.81817E+04	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.07500	0.	0.	6.81817E+04	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.07500	0.	0.	6.81817E+04	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.07500	0.	0.	6.81817E+04	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.07500	0.	0.	6.81817E+04	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.10000	0.	0.	9.09090E+04	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.10000	0.	0.	9.09090E+04	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.10000	0.	0.	9.09090E+04	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.10000	0.	0.	9.09090E+04	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05

MAIN SHELL PART NO 2

S	W	UPHI	UTHETA	RPHI	SPHI IN	SPHI OUT	STHETA IN	STHETA OUT	SFITH IN	SFITH OUT
0.00000	0.	0.	9.09090E+04	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
0.00000	0.	0.	9.09090E+04	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
0.00000	0.	0.	9.09090E+04	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
0.00000	0.	0.	9.09090E+04	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.02500	0.	0.	1.13636E+05	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.02500	0.	0.	1.13636E+05	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.02500	0.	0.	1.13636E+05	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.02500	0.	0.	1.13636E+05	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.02500	0.	0.	1.13636E+05	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.02500	0.	0.	1.13636E+05	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.02500	0.	0.	1.13636E+05	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.02500	0.	0.	1.13636E+05	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.05000	0.	0.	1.36363E+05	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.05000	0.	0.	1.36363E+05	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.05000	0.	0.	1.36363E+05	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.05000	0.	0.	1.36363E+05	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.05000	0.	0.	1.36363E+05	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.05000	0.	0.	1.36363E+05	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.05000	0.	0.	1.36363E+05	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.05000	0.	0.	1.36363E+05	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.07500	0.	0.	1.59091E+05	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.07500	0.	0.	1.59091E+05	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.07500	0.	0.	1.59091E+05	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.07500	0.	0.	1.59091E+05	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.07500	0.	0.	1.59091E+05	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.07500	0.	0.	1.59091E+05	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.07500	0.	0.	1.59091E+05	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.07500	0.	0.	1.59091E+05	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05
.10000	0.	0.	1.81818E+05	0.	0.	0.	0.	0.	1.51215E+05	1.51370E+05
.10000	0.	0.	1.81818E+05	0.	0.	0.	0.	0.	1.51370E+05	1.51515E+05
.10000	0.	0.	1.81818E+05	0.	0.	0.	0.	0.	1.51515E+05	1.51660E+05
.10000	0.	0.	1.81818E+05	0.	0.	0.	0.	0.	1.51660E+05	1.51815E+05

INTERNAL PRESSURE LOADING
CASE II

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----UNSATISFIED EXTERNALS-----                                REFERENCES
   THICK
                       STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
                 WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
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                       ANAMET LABORATORIES INC.    BERKELEY, CALIFORNIA        1 OCT,1969

                  STATIC ANALYSIS    PARTS=  1  BRANCHES=  0  NUMBER OF SUBCASES=  0

ANGLES OF ROTATION OF BOUNDARY CONDITIONS ARE ALFL=-0.            ALFRS=-0.

         PART NO  1

SI= 0.          SX= 7.00000E+00   IPAR= 28   ING=  1   SHELL TYPE 2   NTP= 0   LAYERS MLY= 4

CYLINDRICAL SHELL NO  2    H= 6.65000E-01    R= 1.66750E+00  PHI=    90.000  DEGREES

LAYER NO  1  FROM Z=-3.32500E-01  TO Z=-1.66250E-01
     CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E+05  POISSONS RATIO NU= 3.50000E-01
     COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.
LAYER NO  2  FROM Z=-1.66250E-01  TO Z= 0.
     CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E+05  POISSONS RATIO NU= 3.50000E-01
     COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.
LAYER NO  3  FROM Z= 0.           TO Z= 1.66250E-01
     CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E+05  POISSONS RATIO NU= 3.50000E-01
     COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.
LAYER NO  4  FROM Z= 1.66250E-01  TO Z= 3.32500E-01
     CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E+05  POISSONS RATIO NU= 3.50000E-01
     COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.          ATHETA=-0.          MASS DENSITY RHO=-0.
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              STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
          WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
        MODIFIED PROGRAM TO ACCOUNT FOR TRANSVERSE SHEAR DEFORMATION --WRITTEN BY R.L. CITERLEY
              ANAMET LABORATORIES INC.    BERKELEY, CALIFORNIA        1 OCT,1969

                SUBCASE NO  1   FOR FOURIER HARMONIC COS-0 THETA

BOUNDARY CONDITIONS AT STARTING EDGE      2 0.          4 0.          6 0.

BOUNDARY CONDITIONS AT FINAL    EDGE      2 0.          3 0.          5 0.

            LOADS FOR PART NO  1  SUBCASE NO  1

RING LOADS AT END OF THIS PART ARE   Q=-0.         NPHI=-0.         MPHI=-0.        NT P =-0.        M TP=-0.

SURFACE AND TEMP LOADS ARE  P= 3.00000E+02  PFI=-0.        PTHETA=-0.        TL=-0.         TU=-0.
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STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
MODIFIED PROGRAM TO ACCOUNT FOR TRANSVERSE SHEAR DEFORMATION --WRITTEN BY R.L. CITERLEY
ANAMET LABORATORIES INC. BERKELEY, CALIFORNIA 1 OCT,1969

STATIC SOLUTION AT POINTS ALONG MERIDIAN FOR WAVE NUMBER NX= =0

MAIN SHELL PART NO 1

S	W	U PHI	U THETA	BETA PHI	BETA THETA	LAYER NO		SIG PHI	SIG THETA	SIG T P	TAU PHI Z	TAU THETA Z
0.0000	2.0701E-03	1.0930E-04	0.	7.5086E-05	0.	1	IN	7.4766E+00	7.0041E+02	0.	0.	0.
							OUT	-8.3108E-01	6.2023E+02	0.	0.	0.
						2	IN	-8.3108E-01	6.2023E+02	0.	0.	0.
							OUT	-2.9929E+00	5.5761E+02	0.	0.	0.
						3	IN	-2.9929E+00	5.5761E+02	0.	0.	0.
							OUT	-6.8038E-01	5.0777E+02	0.	0.	0.
						4	IN	-6.8038E-01	5.0777E+02	0.	0.	0.
							OUT	4.9906E+00	4.6753E+02	0.	0.	0.
.2500	2.0390E-03	-2.1413E-18	0.	1.3751E-04	0.	1	IN	1.4393E+01	6.9234E+02	0.	-5.9749E+00	0.
							OUT	2.9146E+00	6.1221E+02	0.	-5.9749E+00	0.
						2	IN	2.9146E+00	6.1221E+02	0.	-5.9749E+00	0.
							OUT	-2.5099E+00	5.4938E+02	0.	-5.9749E+00	0.
						3	IN	-2.5099E+00	5.4938E+02	0.	-5.9749E+00	0.
							OUT	-3.5273E+00	4.9914E+02	0.	-5.9749E+00	0.
						4	IN	-3.5273E+00	4.9914E+02	0.	-5.9749E+00	0.
							OUT	-1.2367E+00	4.5834E+02	0.	-5.9749E+00	0.
.2500	2.0390E-03	0.	0.	1.3751E-04	0.	1	IN	2.6760E+02	7.0097E+02	0.	-5.9749E+00	0.
							OUT	2.3507E+02	6.9347E+02	0.	-5.9749E+00	0.
						2	IN	2.3507E+02	6.9347E+02	0.	-5.9749E+00	0.
							OUT	2.0860E+02	6.2327E+02	0.	-5.9749E+00	0.
						3	IN	2.0860E+02	6.2327E+02	0.	-5.9749E+00	0.
							OUT	1.8653E+02	5.6566E+02	0.	-5.9749E+00	0.
						4	IN	1.8653E+02	5.6566E+02	0.	-5.9749E+00	0.
							OUT	1.6778E+02	5.1750E+02	0.	-5.9749E+00	0.
.5000	2.0001E-03	-4.0552E-06	0.	1.2272E-04	0.	1	IN	2.7733E+02	7.7126E+02	0.	-2.3888E+00	0.
							OUT	2.4033E+02	6.8365E+02	0.	-2.3888E+00	0.
						2	IN	2.4033E+02	6.8365E+02	0.	-2.3888E+00	0.
							OUT	2.0927E+02	6.1300E+02	0.	-2.3888E+00	0.
						3	IN	2.0927E+02	6.1300E+02	0.	-2.3888E+00	0.
							OUT	1.8253E+02	5.5471E+02	0.	-2.3888E+00	0.
						4	IN	1.8253E+02	5.5471E+02	0.	-2.3888E+00	0.
							OUT	1.5904E+02	5.0569E+02	0.	-2.3888E+00	0.
.5000	2.0001E-03	-4.0552E-06	0.	1.2272E-04	0.	1	IN	2.7733E+02	7.7126E+02	0.	-2.3888E+00	0.
							OUT	2.4033E+02	6.8365E+02	0.	-2.3888E+00	0.
						2	IN	2.4033E+02	6.8365E+02	0.	-2.3888E+00	0.
							OUT	2.0927E+02	6.1300E+02	0.	-2.3888E+00	0.
						3	IN	2.0927E+02	6.1300E+02	0.	-2.3888E+00	0.
							OUT	1.8253E+02	5.5471E+02	0.	-2.3888E+00	0.
						4	IN	1.8253E+02	5.5471E+02	0.	-2.3888E+00	0.
							OUT	1.5904E+02	5.0569E+02	0.	-2.3888E+00	0.
.7500	1.9706E-03	-6.1040E-06	0.	9.8445E-05	0.	1	IN	2.8012E+02	7.6228E+02	0.	-1.8659E-01	0.
							OUT	2.4188E+02	6.7534E+02	0.	-1.8659E-01	0.
						2	IN	2.4188E+02	6.7534E+02	0.	-1.8659E-01	0.
							OUT	2.0949E+02	6.0511E+02	0.	-1.8659E-01	0.
						3	IN	2.0949E+02	6.0511E+02	0.	-1.8659E-01	0.
							OUT	1.8136E+02	5.4705E+02	0.	-1.8659E-01	0.
						4	IN	1.8136E+02	5.4705E+02	0.	-1.8659E-01	0.
							OUT	1.5643E+02	4.9813E+02	0.	-1.8659E-01	0.
.7500	1.9706E-03	-6.1040E-06	0.	9.8445E-05	0.	1	IN	2.8012E+02	7.6228E+02	0.	-1.8659E-01	0.
							OUT	2.4188E+02	6.7534E+02	0.	-1.8659E-01	0.

					2	IN	2.4188E+02	6.7534E+02	0.	-1.8659E-01	0.
						OUT	2.0949E+02	6.0511E+02	0.	-1.8659E-01	0.
					3	IN	2.0949E+02	6.0511E+02	0.	-1.8659E-01	0.
						OUT	1.8136E+02	5.4705E+02	0.	-1.8659E-01	0.
					4	IN	1.8136E+02	5.4705E+02	0.	-1.8659E-01	0.
						OUT	1.5643E+02	4.9813E+02	0.	-1.8659E-01	0.
1.0000	1.9499E-03	-6.8038E-06	0.	7.2464E-05	0.	1	IN	2.7889E+02	7.5489E+02	0.	9.9347E-01	0.
						OUT	2.4128E+02	6.6894E+02	0.	9.9347E-01	0.
					2	IN	2.4128E+02	6.6894E+02	0.	9.9347E-01	0.
						OUT	2.0945E+02	5.9953E+02	0.	9.9347E-01	0.
					3	IN	2.0945E+02	5.9953E+02	0.	9.9347E-01	0.
						OUT	1.8184E+02	5.4216E+02	0.	9.9347E-01	0.
					4	IN	1.8184E+02	5.4216E+02	0.	9.9347E-01	0.
						OUT	1.5739E+02	4.9382E+02	0.	9.9347E-01	0.
1.0000	1.9499E-03	-6.8038E-06	0.	7.2464E-05	0.	1	IN	2.7889E+02	7.5489E+02	0.	9.9347E-01	0.
						OUT	2.4128E+02	6.6894E+02	0.	9.9347E-01	0.
					2	IN	2.4128E+02	6.6894E+02	0.	9.9347E-01	0.
						OUT	2.0945E+02	5.9953E+02	0.	9.9347E-01	0.
					3	IN	2.0945E+02	5.9953E+02	0.	9.9347E-01	0.
						OUT	1.8184E+02	5.4216E+02	0.	9.9347E-01	0.
					4	IN	1.8184E+02	5.4216E+02	0.	9.9347E-01	0.
						OUT	1.5739E+02	4.9382E+02	0.	9.9347E-01	0.
1.2500	1.9367E-03	-6.6812E-06	0.	4.9085E-05	0.	1	IN	2.7572E+02	7.4934E+02	0.	1.4786E+00	0.
						OUT	2.3962E+02	6.6441E+02	0.	1.4786E+00	0.
					2	IN	2.3962E+02	6.6441E+02	0.	1.4786E+00	0.
						OUT	2.0928E+02	5.9591E+02	0.	1.4786E+00	0.
					3	IN	2.0928E+02	5.9591E+02	0.	1.4786E+00	0.
						OUT	1.8312E+02	5.3937E+02	0.	1.4786E+00	0.
					4	IN	1.8312E+02	5.3937E+02	0.	1.4786E+00	0.
						OUT	1.6010E+02	4.9190E+02	0.	1.4786E+00	0.
1.2500	1.9367E-03	-6.6812E-06	0.	4.9085E-05	0.	1	IN	2.7572E+02	7.4934E+02	0.	1.4786E+00	0.
						OUT	2.3962E+02	6.6441E+02	0.	1.4786E+00	0.
					2	IN	2.3962E+02	6.6441E+02	0.	1.4786E+00	0.
						OUT	2.0928E+02	5.9591E+02	0.	1.4786E+00	0.
					3	IN	2.0928E+02	5.9591E+02	0.	1.4786E+00	0.
						OUT	1.8312E+02	5.3937E+02	0.	1.4786E+00	0.
					4	IN	1.8312E+02	5.3937E+02	0.	1.4786E+00	0.
						OUT	1.6010E+02	4.9180E+02	0.	1.4786E+00	0.
1.5000	1.9292E-03	-6.1230E-06	0.	3.0217E-05	0.	1	IN	2.7195E+02	7.4549E+02	0.	1.5340E+00	0.
						OUT	2.3764E+02	6.6146E+02	0.	1.5340E+00	0.
					2	IN	2.3764E+02	6.6146E+02	0.	1.5340E+00	0.
						OUT	2.0905E+02	5.9380E+02	0.	1.5340E+00	0.
					3	IN	2.0905E+02	5.9380E+02	0.	1.5340E+00	0.
						OUT	1.8464E+02	5.3806E+02	0.	1.5340E+00	0.
					4	IN	1.8464E+02	5.3806E+02	0.	1.5340E+00	0.
						OUT	1.6335E+02	4.9125E+02	0.	1.5340E+00	0.
1.5000	1.9292E-03	-6.1230E-06	0.	3.0217E-05	0.	1	IN	2.7195E+02	7.4549E+02	0.	1.5340E+00	0.
						OUT	2.3764E+02	6.6146E+02	0.	1.5340E+00	0.
					2	IN	2.3764E+02	6.6146E+02	0.	1.5340E+00	0.
						OUT	2.0905E+02	5.9380E+02	0.	1.5340E+00	0.
					3	IN	2.0905E+02	5.9380E+02	0.	1.5340E+00	0.
						OUT	1.8464E+02	5.3806E+02	0.	1.5340E+00	0.
					4	IN	1.8464E+02	5.3806E+02	0.	1.5340E+00	0.
						OUT	1.6335E+02	4.9125E+02	0.	1.5340E+00	0.
1.7500	1.9257E-03	-5.3906E-06	0.	1.6255E-05	0.	1	IN	2.6839E+02	7.4305E+02	0.	1.3566E+00	0.
						OUT	2.3575E+02	6.5975E+02	0.	1.3566E+00	0.
					2	IN	2.3575E+02	6.5975E+02	0.	1.3566E+00	0.
						OUT	2.0884E+02	5.9278E+02	0.	1.3566E+00	0.
					3	IN	2.0884E+02	5.9278E+02	0.	1.3566E+00	0.
						OUT	1.8608E+02	5.3770E+02	0.	1.3566E+00	0.
					4	IN	1.8608E+02	5.3770E+02	0.	1.3566E+00	0.
						OUT	1.6645E+02	4.9155E+02	0.	1.3566E+00	0.
1.7500	1.9257E-03	-5.3906E-06	0.	1.6255E-05	0.	1	IN	2.6839E+02	7.4305E+02	0.	1.3566E+00	0.
						OUT	2.3575E+02	6.5975E+02	0.	1.3566E+00	0.
					2	IN	2.3575E+02	6.5975E+02	0.	1.3566E+00	0.
						OUT	2.0884E+02	5.9278E+02	0.	1.3566E+00	0.
					3	IN	2.0884E+02	5.9278E+02	0.	1.3566E+00	0.
						OUT	1.8608E+02	5.3770E+02	0.	1.3566E+00	0.
					4	IN	1.8608E+02	5.3770E+02	0.	1.3566E+00	0.
						OUT	1.6645E+02	4.9155E+02	0.	1.3566E+00	0.
2.0000	1.9248E-03	-4.6446E-06	0.	6.7441E-06	0.	1	IN	2.6540E+02	7.4169E+02	0.	1.0810E+00	0.
						OUT	[illegible]	[illegible]	0.	1.0810E+00	0.

1.7500	1.9257E-03	-5.3906E-06	0.	1.6255E-05	0.	1	IN	2.6839E+02	7.4305E+02	0.	1.3566E+00	0.
							OUT	2.3575E+02	6.5975E+02	0.	1.3566E+00	0.
						2	IN	2.3575E+02	6.5975E+02	0.	1.3566E+00	0.
							OUT	2.0884E+02	5.9278E+02	0.	1.3566E+00	0.
						3	IN	2.0884E+02	5.9278E+02	0.	1.3566E+00	0.
							OUT	1.8608E+02	5.3770E+02	0.	1.3566E+00	0.
						4	IN	1.8608E+02	5.3770E+02	0.	1.3566E+00	0.
							OUT	1.6645E+02	4.9155E+02	0.	1.3566E+00	0.
2.0000	1.9248E-03	-4.6446E-06	0.	6.7441E-06	0.	1	IN	2.6540E+02	7.4169E+02	0.	1.0810E+00	0.
							OUT	2.3417E+02	6.5891E+02	0.	1.0810E+00	0.
						2	IN	2.3417E+02	6.5891E+02	0.	1.0810E+00	0.
							OUT	2.0865E+02	5.9245E+02	0.	1.0810E+00	0.
						3	IN	2.0865E+02	5.9245E+02	0.	1.0810E+00	0.
							OUT	1.8730E+02	5.3789E+02	0.	1.0810E+00	0.
						4	IN	1.8730E+02	5.3789E+02	0.	1.0810E+00	0.
							OUT	1.6906E+02	4.9224E+02	0.	1.0810E+00	0.
2.0000	1.9248E-03	-4.6446E-06	0.	6.7441E-06	0.	1	IN	2.6540E+02	7.4169E+02	0.	1.0810E+00	0.
							OUT	2.3417E+02	6.5891E+02	0.	1.0810E+00	0.
						2	IN	2.3417E+02	6.5891E+02	0.	1.0810E+00	0.
							OUT	2.0865E+02	5.9245E+02	0.	1.0810E+00	0.
						3	IN	2.0865E+02	5.9245E+02	0.	1.0810E+00	0.
							OUT	1.8730E+02	5.3789E+02	0.	1.0810E+00	0.
						4	IN	1.8730E+02	5.3789E+02	0.	1.0810E+00	0.
							OUT	1.6906E+02	4.9224E+02	0.	1.0810E+00	0.
2.2500	1.9253E-03	-3.9711E-06	0.	8.4869E-07	0.	1	IN	2.6313E+02	7.4106E+02	0.	7.9091E-01	0.
							OUT	2.3296E+02	6.5864E+02	0.	7.9091E-01	0.
						2	IN	2.3296E+02	6.5864E+02	0.	7.9091E-01	0.
							OUT	2.0851E+02	5.9254E+02	0.	7.9091E-01	0.
						3	IN	2.0851E+02	5.9254E+02	0.	7.9091E-01	0.
							OUT	1.8822E+02	5.3834E+02	0.	7.9091E-01	0.
						4	IN	1.8822E+02	5.3834E+02	0.	7.9091E-01	0.
							OUT	1.7106E+02	4.9306E+02	0.	7.9091E-01	0.
2.2500	1.9253E-03	-3.9711E-06	0.	8.4869E-07	0.	1	IN	2.6313E+02	7.4106E+02	0.	7.9091E-01	0.
							OUT	2.3296E+02	6.5864E+02	0.	7.9091E-01	0.
						2	IN	2.3296E+02	6.5864E+02	0.	7.9091E-01	0.
							OUT	2.0851E+02	5.9254E+02	0.	7.9091E-01	0.
						3	IN	2.0851E+02	5.9254E+02	0.	7.9091E-01	0.
							OUT	1.8822E+02	5.3834E+02	0.	7.9091E-01	0.
						4	IN	1.8822E+02	5.3834E+02	0.	7.9091E-01	0.
							OUT	1.7106E+02	4.9306E+02	0.	7.9091E-01	0.
2.5000	1.9265E-03	-3.4055E-06	0.	-2.3574E-06	0.	1	IN	2.6153E+02	7.4092E+02	0.	5.3233E-01	0.
							OUT	2.3211E+02	6.5871E+02	0.	5.3233E-01	0.
						2	IN	2.3211E+02	6.5871E+02	0.	5.3233E-01	0.
							OUT	2.0841E+02	5.9284E+02	0.	5.3233E-01	0.
						3	IN	2.0841E+02	5.9284E+02	0.	5.3233E-01	0.
							OUT	1.8887E+02	5.3887E+02	0.	5.3233E-01	0.
						4	IN	1.8887E+02	5.3887E+02	0.	5.3233E-01	0.
							OUT	1.7246E+02	4.9383E+02	0.	5.3233E-01	0.
2.5000	1.9265E-03	-3.4055E-06	0.	-2.3574E-06	0.	1	IN	2.6153E+02	7.4092E+02	0.	5.3233E-01	0.
							OUT	2.3211E+02	6.5871E+02	0.	5.3233E-01	0.
						2	IN	2.3211E+02	6.5871E+02	0.	5.3233E-01	0.
							OUT	2.0841E+02	5.9284E+02	0.	5.3233E-01	0.
						3	IN	2.0841E+02	5.9284E+02	0.	5.3233E-01	0.
							OUT	1.8887E+02	5.3887E+02	0.	5.3233E-01	0.
						4	IN	1.8887E+02	5.3887E+02	0.	5.3233E-01	0.
							OUT	1.7246E+02	4.9383E+02	0.	5.3233E-01	0.
2.7500	1.9279E-03	-2.9517E-06	0.	-3.7215E-06	0.	1	IN	2.6050E+02	7.4104E+02	0.	3.2507E-01	0.
							OUT	2.3156E+02	6.5894E+02	0.	3.2507E-01	0.
						2	IN	2.3156E+02	6.5894E+02	0.	3.2507E-01	0.
							OUT	2.0834E+02	5.9320E+02	0.	3.2507E-01	0.
						3	IN	2.0834E+02	5.9320E+02	0.	3.2507E-01	0.
							OUT	1.8929E+02	5.3936E+02	0.	3.2507E-01	0.
						4	IN	1.8929E+02	5.3936E+02	0.	3.2507E-01	0.

							OUT	1.7337E+02	4.9446E+02	0.	3.2507E-01	0.
2.7500	1.9279E-03	-2.9517E-06	0.	-3.7215E-06	0.	1	IN	2.6050E+02	7.4104E+02	0.	3.2507E-01	0.
							OUT	2.3156E+02	6.5894E+02	0.	3.2507E-01	0.
						2	IN	2.3156E+02	6.5894E+02	0.	3.2507E-01	0.
							OUT	2.0834E+02	5.9320E+02	0.	3.2507E-01	0.
						3	IN	2.0834E+02	5.9320E+02	0.	3.2507E-01	0.
							OUT	1.8929E+02	5.3936E+02	0.	3.2507E-01	0.
						4	IN	1.8929E+02	5.3936E+02	0.	3.2507E-01	0.
							OUT	1.7337E+02	4.9446E+02	0.	3.2507E-01	0.
3.0000	1.9293E-03	-2.5968E-06	0.	-3.9360E-06	0.	1	IN	2.5991E+02	7.4128E+02	0.	1.7263E-01	0.
							OUT	2.3124E+02	6.5923E+02	0.	1.7263E-01	0.
						2	IN	2.3124E+02	6.5923E+02	0.	1.7263E-01	0.
							OUT	2.0830E+02	5.9355E+02	0.	1.7263E-01	0.
						3	IN	2.0830E+02	5.9355E+02	0.	1.7263E-01	0.
							OUT	1.8954E+02	5.3978E+02	0.	1.7263E-01	0.
						4	IN	1.8954E+02	5.3978E+02	0.	1.7263E-01	0.
							OUT	1.7390E+02	4.9495E+02	0.	1.7263E-01	0.
3.0000	1.9293E-03	-2.5968E-06	0.	-3.9360E-06	0.	1	IN	2.5991E+02	7.4128E+02	0.	1.7263E-01	0.
							OUT	2.3124E+02	6.5923E+02	0.	1.7263E-01	0.
						2	IN	2.3124E+02	6.5923E+02	0.	1.7263E-01	0.
							OUT	2.0830E+02	5.9355E+02	0.	1.7263E-01	0.
						3	IN	2.0830E+02	5.9355E+02	0.	1.7263E-01	0.
							OUT	1.8954E+02	5.3978E+02	0.	1.7263E-01	0.
						4	IN	1.8954E+02	5.3978E+02	0.	1.7263E-01	0.
							OUT	1.7390E+02	4.9495E+02	0.	1.7263E-01	0.
3.2500	1.9304E-03	-2.3208E-06	0.	-3.5187E-06	0.	1	IN	2.5962E+02	7.4156E+02	0.	6.9445E-02	0.
							OUT	2.3109E+02	6.5951E+02	0.	6.9445E-02	0.
						2	IN	2.3109E+02	6.5951E+02	0.	6.9445E-02	0.
							OUT	2.0828E+02	5.9384E+02	0.	6.9445E-02	0.
						3	IN	2.0828E+02	5.9384E+02	0.	6.9445E-02	0.
							OUT	1.8965E+02	5.4009E+02	0.	6.9445E-02	0.
						4	IN	1.8965E+02	5.4009E+02	0.	6.9445E-02	0.
							OUT	1.7415E+02	4.9529E+02	0.	6.9445E-02	0.
3.2500	1.9304E-03	-2.3208E-06	0.	-3.5187E-06	0.	1	IN	2.5962E+02	7.4156E+02	0.	6.9445E-02	0.
							OUT	2.3109E+02	6.5951E+02	0.	6.9445E-02	0.
						2	IN	2.3109E+02	6.5951E+02	0.	6.9445E-02	0.
							OUT	2.0828E+02	5.9384E+02	0.	6.9445E-02	0.
						3	IN	2.0828E+02	5.9384E+02	0.	6.9445E-02	0.
							OUT	1.8965E+02	5.4009E+02	0.	6.9445E-02	0.
						4	IN	1.8965E+02	5.4009E+02	0.	6.9445E-02	0.
							OUT	1.7415E+02	4.9529E+02	0.	6.9445E-02	0.
3.5000	1.9312E-03	-2.1024E-06	0.	-2.8262E-06	0.	1	IN	2.5954E+02	7.4182E+02	0.	5.9898E-03	0.
							OUT	2.3104E+02	6.5975E+02	0.	5.9898E-03	0.
						2	IN	2.3104E+02	6.5975E+02	0.	5.9898E-03	0.
							OUT	2.0828E+02	5.9407E+02	0.	5.9898E-03	0.
						3	IN	2.0828E+02	5.9407E+02	0.	5.9898E-03	0.
							OUT	1.8969E+02	5.4031E+02	0.	5.9898E-03	0.
						4	IN	1.8969E+02	5.4031E+02	0.	5.9898E-03	0.
							OUT	1.7423E+02	4.9551E+02	0.	5.9898E-03	0.
3.5000	1.9312E-03	-2.1024E-06	0.	-2.8262E-06	0.	1	IN	2.5954E+02	7.4182E+02	0.	5.9898E-03	0.
							OUT	2.3104E+02	6.5975E+02	0.	5.9898E-03	0.
						2	IN	2.3104E+02	6.5975E+02	0.	5.9898E-03	0.
							OUT	2.0828E+02	5.9407E+02	0.	5.9898E-03	0.
						3	IN	2.0828E+02	5.9407E+02	0.	5.9898E-03	0.
							OUT	1.8969E+02	5.4031E+02	0.	5.9898E-03	0.
						4	IN	1.8969E+02	5.4031E+02	0.	5.9898E-03	0.
							OUT	1.7423E+02	4.9551E+02	0.	5.9898E-03	0.
3.7500	1.9318E-03	-1.9229E-06	0.	-2.0825E-06	0.	1	IN	2.5958E+02	7.4203E+02	0.	-2.8089E-02	0.
							OUT	2.3106E+02	6.5994E+02	0.	-2.8089E-02	0.
						2	IN	2.3106E+02	6.5994E+02	0.	-2.8089E-02	0.
							OUT	2.0828E+02	5.9423E+02	0.	-2.8089E-02	0.
						3	IN	2.0828E+02	5.9423E+02	0.	-2.8089E-02	0.
							OUT	1.8967E+02	5.4045E+02	0.	-2.8089E-02	0.
						4	IN	1.8967E+02	5.4045E+02	0.	-2.8089E-02	0.
							OUT	1.7420E+02	4.9563E+02	0.	-2.8089E-02	0.
3.7500	1.9318E-03	-1.9229E-06	0.	-2.0825E-06	0.	1	IN	2.5958E+02	7.4203E+02	0.	-2.8089E-02	0.
							OUT	2.3106E+02	6.5994E+02	0.	-2.8089E-02	0.
						2	IN	2.3106E+02	6.5994E+02	0.	-2.8089E-02	0.
							OUT	2.0828E+02	5.9423E+02	0.	-2.8089E-02	0.
						3	IN	2.0828E+02	5.9423E+02	0.	-2.8089E-02	0.
							OUT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

							OUT	1.8967E+02	5.4045E+02	0.	-2.8089E-02	0.
						4	IN	1.8967E+02	5.4045E+02	0.	-2.8089E-02	0.
							OUT	1.7420E+02	4.9563E+02	0.	-2.8089E-02	0.
3.7500	1.9318E-03	-1.9229E-06	0.	-2.0825E-06	0.	1	IN	2.5958E+02	7.4203E+02	0.	-2.8089E-02	0.
							OUT	2.3106E+02	6.5994E+02	0.	-2.8089E-02	0.
						2	IN	2.3106E+02	6.5994E+02	0.	-2.8089E-02	0.
							OUT	2.0828E+02	5.9423E+02	0.	-2.8089E-02	0.
						3	IN	2.0828E+02	5.9423E+02	0.	-2.8089E-02	0.
							OUT	1.8967E+02	5.4045E+02	0.	-2.8089E-02	0.
						4	IN	1.8967E+02	5.4045E+02	0.	-2.8089E-02	0.
							OUT	1.7420E+02	4.9563E+02	0.	-2.8089E-02	0.
4.0000	1.9322E-03	-1.7670E-06	0.	-1.4120E-06	0.	1	IN	2.5967E+02	7.4219E+02	0.	-4.2174E-02	0.
							OUT	2.3111E+02	6.6007E+02	0.	-4.2174E-02	0.
						2	IN	2.3111E+02	6.6007E+02	0.	-4.2174E-02	0.
							OUT	2.0828E+02	5.9433E+02	0.	-4.2174E-02	0.
						3	IN	2.0828E+02	5.9433E+02	0.	-4.2174E-02	0.
							OUT	1.8964E+02	5.4053E+02	0.	-4.2174E-02	0.
						4	IN	1.8964E+02	5.4053E+02	0.	-4.2174E-02	0.
							OUT	1.7412E+02	4.9569E+02	0.	-4.2174E-02	0.
4.0000	1.9322E-03	-1.7670E-06	0.	-1.4120E-06	0.	1	IN	2.5967E+02	7.4219E+02	0.	-4.2174E-02	0.
							OUT	2.3111E+02	6.6007E+02	0.	-4.2174E-02	0.
						2	IN	2.3111E+02	6.6007E+02	0.	-4.2174E-02	0.
							OUT	2.0828E+02	5.9433E+02	0.	-4.2174E-02	0.
						3	IN	2.0828E+02	5.9433E+02	0.	-4.2174E-02	0.
							OUT	1.8964E+02	5.4053E+02	0.	-4.2174E-02	0.
						4	IN	1.8964E+02	5.4053E+02	0.	-4.2174E-02	0.
							OUT	1.7412E+02	4.9569E+02	0.	-4.2174E-02	0.
4.2500	1.9324E-03	-1.6238E-06	0.	-8.7000E-07	0.	1	IN	2.5977E+02	7.4230E+02	0.	-4.3880E-02	0.
							OUT	2.3116E+02	6.6015E+02	0.	-4.3880E-02	0.
						2	IN	2.3116E+02	6.6015E+02	0.	-4.3880E-02	0.
							OUT	2.0829E+02	5.9440E+02	0.	-4.3880E-02	0.
						3	IN	2.0829E+02	5.9440E+02	0.	-4.3880E-02	0.
							OUT	1.8959E+02	5.4057E+02	0.	-4.3880E-02	0.
						4	IN	1.8959E+02	5.4057E+02	0.	-4.3880E-02	0.
							OUT	1.7403E+02	4.9571E+02	0.	-4.3880E-02	0.
4.2500	1.9324E-03	-1.6238E-06	0.	-8.7000E-07	0.	1	IN	2.5977E+02	7.4230E+02	0.	-4.3880E-02	0.
							OUT	2.3116E+02	6.6015E+02	0.	-4.3880E-02	0.
						2	IN	2.3116E+02	6.6015E+02	0.	-4.3880E-02	0.
							OUT	2.0829E+02	5.9440E+02	0.	-4.3880E-02	0.
						3	IN	2.0829E+02	5.9440E+02	0.	-4.3880E-02	0.
							OUT	1.8959E+02	5.4057E+02	0.	-4.3880E-02	0.
						4	IN	1.8959E+02	5.4057E+02	0.	-4.3880E-02	0.
							OUT	1.7403E+02	4.9571E+02	0.	-4.3880E-02	0.
4.5000	1.9325E-03	-1.4856E-06	0.	-4.6831E-07	0.	1	IN	2.5988E+02	7.4237E+02	0.	-3.8867E-02	0.
							OUT	2.3122E+02	6.6020E+02	0.	-3.8867E-02	0.
						2	IN	2.3122E+02	6.6020E+02	0.	-3.8867E-02	0.
							OUT	2.0830E+02	5.9443E+02	0.	-3.8867E-02	0.
						3	IN	2.0830E+02	5.9443E+02	0.	-3.8867E-02	0.
							OUT	1.8955E+02	5.4058E+02	0.	-3.8867E-02	0.
						4	IN	1.8955E+02	5.4058E+02	0.	-3.8867E-02	0.
							OUT	1.7394E+02	4.9570E+02	0.	-3.8867E-02	0.
4.5000	1.9325E-03	-1.4856E-06	0.	-4.6831E-07	0.	1	IN	2.5988E+02	7.4237E+02	0.	-3.8867E-02	0.
							OUT	2.3122E+02	6.6020E+02	0.	-3.8867E-02	0.
						2	IN	2.3122E+02	6.6020E+02	0.	-3.8867E-02	0.
							OUT	2.0830E+02	5.9443E+02	0.	-3.8867E-02	0.
						3	IN	2.0830E+02	5.9443E+02	0.	-3.8867E-02	0.
							OUT	1.8955E+02	5.4058E+02	0.	-3.8867E-02	0.
						4	IN	1.8955E+02	5.4058E+02	0.	-3.8867E-02	0.
							OUT	1.7394E+02	4.9570E+02	0.	-3.8867E-02	0.
4.7500	1.9326E-03	-1.3478E-06	0.	-1.9413E-07	0.	1	IN	2.5996E+02	7.4241E+02	0.	-3.1013E-02	0.
							OUT	2.3126E+02	6.6023E+02	0.	-3.1013E-02	0.
						2	IN	2.3126E+02	6.6023E+02	0.	-3.1013E-02	0.

							OUT	2.0830E+02	5.9443E+02	0.	-3.1013E-02	0.
						3	IN	2.0830E+02	5.9443E+02	0.	-3.1013E-02	0.
							OUT	1.8952E+02	5.4058E+02	0.	-3.1013E-02	0.
						4	IN	1.8952E+02	5.4058E+02	0.	-3.1013E-02	0.
							OUT	1.7387E+02	4.9568E+02	0.	-3.1013E-02	0.
4.7500	1.9326E-03	-1.3478E-06	0.	-1.9413E-07	0.	1	IN	2.5996E+02	7.4241E+02	0.	-3.1013E-02	0.
							OUT	2.3126E+02	6.6023E+02	0.	-3.1013E-02	0.
						2	IN	2.3126E+02	6.6023E+02	0.	-3.1013E-02	0.
							OUT	2.0830E+02	5.9443E+02	0.	-3.1013E-02	0.
						3	IN	2.0830E+02	5.9443E+02	0.	-3.1013E-02	0.
							OUT	1.8952E+02	5.4058E+02	0.	-3.1013E-02	0.
						4	IN	1.8952E+02	5.4058E+02	0.	-3.1013E-02	0.
							OUT	1.7387E+02	4.9568E+02	0.	-3.1013E-02	0.
5.0000	1.9325E-03	-1.2080E-06	0.	-2.3658E-08	0.	1	IN	2.6003E+02	7.4243E+02	0.	-2.2739E-02	0.
							OUT	2.3130E+02	6.6023E+02	0.	-2.2739E-02	0.
						2	IN	2.3130E+02	6.6023E+02	0.	-2.2739E-02	0.
							OUT	2.0831E+02	5.9443E+02	0.	-2.2739E-02	0.
						3	IN	2.0831E+02	5.9443E+02	0.	-2.2739E-02	0.
							OUT	1.8949E+02	5.4056E+02	0.	-2.2739E-02	0.
						4	IN	1.8949E+02	5.4056E+02	0.	-2.2739E-02	0.
							OUT	1.7381E+02	4.9565E+02	0.	-2.2739E-02	0.
5.0000	1.9325E-03	-1.2080E-06	0.	-2.3658E-08	0.	1	IN	2.6003E+02	7.4243E+02	0.	-2.2739E-02	0.
							OUT	2.3130E+02	6.6023E+02	0.	-2.2739E-02	0.
						2	IN	2.3130E+02	6.6023E+02	0.	-2.2739E-02	0.
							OUT	2.0831E+02	5.9443E+02	0.	-2.2739E-02	0.
						3	IN	2.0831E+02	5.9443E+02	0.	-2.2739E-02	0.
							OUT	1.8949E+02	5.4056E+02	0.	-2.2739E-02	0.
						4	IN	1.8949E+02	5.4056E+02	0.	-2.2739E-02	0.
							OUT	1.7381E+02	4.9565E+02	0.	-2.2739E-02	0.
5.2500	1.9325E-03	-1.0650E-06	0.	6.9487E-08	0.	1	IN	2.6007E+02	7.4243E+02	0.	-1.5377E-02	0.
							OUT	2.3132E+02	6.6023E+02	0.	-1.5377E-02	0.
						2	IN	2.3132E+02	6.6023E+02	0.	-1.5377E-02	0.
							OUT	2.0831E+02	5.9442E+02	0.	-1.5377E-02	0.
						3	IN	2.0831E+02	5.9442E+02	0.	-1.5377E-02	0.
							OUT	1.8947E+02	5.4055E+02	0.	-1.5377E-02	0.
						4	IN	1.8947E+02	5.4055E+02	0.	-1.5377E-02	0.
							OUT	1.7377E+02	4.9563E+02	0.	-1.5377E-02	0.
5.2500	1.9325E-03	-1.0650E-06	0.	6.9487E-08	0.	1	IN	2.6007E+02	7.4243E+02	0.	-1.5377E-02	0.
							OUT	2.3132E+02	6.6023E+02	0.	-1.5377E-02	0.
						2	IN	2.3132E+02	6.6023E+02	0.	-1.5377E-02	0.
							OUT	2.0831E+02	5.9442E+02	0.	-1.5377E-02	0.
						3	IN	2.0831E+02	5.9442E+02	0.	-1.5377E-02	0.
							OUT	1.8947E+02	5.4055E+02	0.	-1.5377E-02	0.
						4	IN	1.8947E+02	5.4055E+02	0.	-1.5377E-02	0.
							OUT	1.7377E+02	4.9563E+02	0.	-1.5377E-02	0.
5.5000	1.9325E-03	-9.1880E-07	0.	1.0941E-07	0.	1	IN	2.6010E+02	7.4243E+02	0.	-9.5125E-03	0.
							OUT	2.3134E+02	6.6022E+02	0.	-9.5125E-03	0.
						2	IN	2.3134E+02	6.6022E+02	0.	-9.5125E-03	0.
							OUT	2.0831E+02	5.9441E+02	0.	-9.5125E-03	0.
						3	IN	2.0831E+02	5.9441E+02	0.	-9.5125E-03	0.
							OUT	1.8946E+02	5.4053E+02	0.	-9.5125E-03	0.
						4	IN	1.8946E+02	5.4053E+02	0.	-9.5125E-03	0.
							OUT	1.7374E+02	4.9561E+02	0.	-9.5125E-03	0.
5.5000	1.9325E-03	-9.1880E-07	0.	1.0941E-07	0.	1	IN	2.6010E+02	7.4243E+02	0.	-9.5125E-03	0.
							OUT	2.3134E+02	6.6022E+02	0.	-9.5125E-03	0.
						2	IN	2.3134E+02	6.6022E+02	0.	-9.5125E-03	0.
							OUT	2.0831E+02	5.9441E+02	0.	-9.5125E-03	0.
						3	IN	2.0931E+02	5.9441E+02	0.	-9.5125E-03	0.
							OUT	1.8946E+02	5.4053E+02	0.	-9.5125E-03	0.
						4	IN	1.8946E+02	5.4053E+02	0.	-9.5125E-03	0.
							OUT	1.7374E+02	4.9561E+02	0.	-9.5125E-03	0.
5.7500	1.9324E-03	-7.6969E-07	0.	1.1568E-07	0.	1	IN	2.6012E+02	7.4242E+02	0.	-5.2569E-03	0.
							OUT	2.3135E+02	6.6022E+02	0.	-5.2569E-03	0.
						2	IN	2.3135E+02	6.6022E+02	0.	-5.2569E-03	0.
							OUT	2.0831E+02	5.9440E+02	0.	-5.2569E-03	0.
						3	IN	2.0831E+02	5.9440E+02	0.	-5.2569E-03	0.
							OUT	1.8945E+02	5.4052E+02	0.	-5.2569E-03	0.
						4	IN	1.8945E+02	5.4052E+02	0.	-5.2569E-03	0.
							OUT	1.7373E+02	4.9560E+02	0.	-5.2569E-03	0.

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							OUT	2.3135E+02	6.6022E+02	0.	-5.2569E-03	0.
						2	IN	2.3135E+02	6.6022E+02	0.	-5.2569E-03	0.
							OUT	2.0831E+02	5.9440E+02	0.	-5.2569E-03	0.
						3	IN	2.0831E+02	5.9440E+02	0.	-5.2569E-03	0.
							OUT	1.8945E+02	.4052E+02	0.	-5.2569E-03	0.
						4	IN	1.8945E+02	5.4052E+02	0.	-5.2569E-03	0.
							OUT	1.7373E+02	4.9560E+02	0.	-5.2569E-03	0.
5.7500	1.9324E-03	-7.6969E-07	0.	1.1568E-07	0.	1	IN	2.6012E+02	7.4242E+02	0.	-5.2569E-03	0.
							OUT	2.3135E+02	6.6022E+02	0.	-5.2569E-03	0.
						2	IN	2.3135E+02	6.6022E+02	0.	-5.2569E-03	0.
							OUT	2.0831E+02	5.9440E+02	0.	-5.2569E-03	0.
						3	IN	2.0831E+02	5.9440E+02	0.	-5.2569E-03	0.
							OUT	1.8945E+02	5.4052E+02	0.	-5.2569E-03	0.
						4	IN	1.8945E+02	5.4052E+02	0.	-5.2569E-03	0.
							OUT	1.7373E+02	4.9560E+02	0.	-5.2569E-03	0.
6.0000	1.9324E-03	-6.1824E-07	0.	1.0277E-07	0.	1	IN	2.6013E+02	7.4241E+02	0.	-2.4586E-03	0.
							OUT	2.3135E+02	6.6021E+02	0.	-2.4586E-03	0.
						2	IN	2.3135E+02	6.6021E+02	0.	-2.4586E-03	0.
							OUT	2.0831E+02	5.9439E+02	0.	-2.4586E-03	0.
						3	IN	2.0831E+02	5.9439E+02	0.	-2.4586E-03	0.
							OUT	1.8945E+02	5.4051E+02	0.	-2.4586E-03	0.
						4	IN	1.8945E+02	5.4051E+02	0.	-2.4586E-03	0.
							OUT	1.7372E+02	4.9559E+02	0.	-2.4586E-03	0.
6.0000	1.9324E-03	-6.1824E-07	0.	1.0277E-07	0.	1	IN	2.6013E+02	7.4241E+02	0.	-2.4586E-03	0.
							OUT	2.3135E+02	6.6021E+02	0.	-2.4586E-03	0.
						2	IN	2.3135E+02	6.6021E+02	0.	-2.4586E-03	0.
							OUT	2.0831E+02	5.9439E+02	0.	-2.4586E-03	0.
						3	IN	2.0831E+02	5.9439E+02	0.	-2.4586E-03	0.
							OUT	1.8945E+02	5.4051E+02	0.	-2.4586E-03	0.
						4	IN	1.8945E+02	5.4051E+02	0.	-2.4586E-03	0.
							OUT	1.7372E+02	4.9559E+02	0.	-2.4586E-03	0.
6.2500	1.9324E-03	-4.6504E-07	0.	8.0340E-08	0.	1	IN	2.6013E+02	7.4241E+02	0.	-8.4246E-04	0.
							OUT	2.3135E+02	6.6020E+02	0.	-8.4246E-04	0.
						2	IN	2.3135E+02	6.6020E+02	0.	-8.4246E-04	0.
							OUT	2.0831E+02	5.9439E+02	0.	-8.4246E-04	0.
						3	IN	2.0831E+02	5.9439E+02	0.	-8.4246E-04	0.
							OUT	1.8945E+02	5.4051E+02	0.	-8.4246E-04	0.
						4	IN	1.8945E+02	5.4051E+02	0.	-8.4246E-04	0.
							OUT	1.7372E+02	4.9558E+02	0.	-8.4246E-04	0.
6.2500	1.9324E-03	-4.6504E-07	0.	8.0340E-08	0.	1	IN	2.6013E+02	7.4241E+02	0.	-8.4246E-04	0.
							OUT	2.3135E+02	6.6020E+02	0.	-8.4246E-04	0.
						2	IN	2.3135E+02	6.6020E+02	0.	-8.4246E-04	0.
							OUT	2.0831E+02	5.9439E+02	0.	-8.4246E-04	0.
						3	IN	2.0831E+02	5.9439E+02	0.	-8.4246E-04	0.
							OUT	1.8945E+02	5.4051E+02	0.	-8.4246E-04	0.
						4	IN	1.8945E+02	5.4051E+02	0.	-8.4246E-04	0.
							OUT	1.7372E+02	4.9558E+02	0.	-8.4246E-04	0.
6.5000	1.9323E-03	-3.1064E-07	0.	5.4167E-08	0.	1	IN	2.6013E+02	7.4240E+02	0.	-9.5594E-05	0.
							OUT	2.3136E+02	6.6020E+02	0.	-9.5594E-05	0.
						2	IN	2.3136E+02	6.6020E+02	0.	-9.5594E-05	0.
							OUT	2.0831E+02	5.9438E+02	0.	-9.5594E-05	0.
						3	IN	2.0831E+02	5.9438E+02	0.	-9.5594E-05	0.
							OUT	1.8945E+02	5.4050E+02	0.	-9.5594E-05	0.
						4	IN	1.8945E+02	5.4050E+02	0.	-9.5594E-05	0.
							OUT	1.7372E+02	4.9558E+02	0.	-9.5594E-05	0.
6.5000	1.9323E-03	-3.1064E-07	0.	5.4167E-08	0.	1	IN	2.6013E+02	7.4240E+02	0.	-9.5594E-05	0.
							OUT	2.3136E+02	6.6020E+02	0.	-9.5594E-05	0.
						2	IN	2.3136E+02	6.6020E+02	0.	-9.5594E-05	0.
							OUT	2.0831E+02	5.9438E+02	0.	-9.5594E-05	0.
						3	IN	2.0831E+02	5.9438E+02	0.	-9.5594E-05	0.
							OUT	1.8945E+02	5.4050E+02	0.	-9.5594E-05	0.
						4	IN	1.8945E+02	5.4050E+02	0.	-9.5594E-05	0.

6.7500	1.9323E-03	-1.5549E-07	0.	2.7079E-08	0.		OUT	1.7372E+02	4.9558E+02	0.	-4.5594E-05	0.
						1	IN	2.6013E+02	7.4240E+02	0.	8.9210E-05	0.
							OUT	2.3136E+02	6.6019E+02	0.	8.9210E-05	0.
						2	IN	2.3136E+02	6.6019E+02	0.	8.9210E-05	0.
							OUT	2.0831E+02	5.9438E+02	0.	8.9210E-05	0.
						3	IN	2.0831E+02	5.9438E+02	0.	8.9210E-05	0.
							OUT	1.8945E+02	5.4050E+02	0.	8.9210E-05	0.
						4	IN	1.8945E+02	5.4050E+02	0.	8.9210E-05	0.
							OUT	1.7372E+02	4.9558E+02	0.	8.9210E-05	0.
6.7500	1.9323E-03	-1.5549E-07	0.	2.7079E-08	0.	1	IN	2.6013E+02	7.4240E+02	0.	8.9210E-05	0.
							OUT	2.3136E+02	6.6019E+02	0.	8.9210E-05	0.
						2	IN	2.3136E+02	6.6019E+02	0.	8.9210E-05	0.
							OUT	2.0831E+02	5.9438E+02	0.	8.9210E-05	0.
						3	IN	2.0831E+02	5.9438E+02	0.	8.9210E-05	0.
							OUT	1.8945E+02	5.4050E+02	0.	8.9210E-05	0.
						4	IN	1.8945E+02	5.4050E+02	0.	8.9210E-05	0.
							OUT	1.7372E+02	4.9558E+02	0.	8.9210E-05	0.
7.0000	1.9323E-03	-3.9680E-17	0.	6.9042E-17	0.	1	IN	2.6013E+02	7.4240E+02	0.	1.6735E-11	0.
							OUT	2.3136E+02	6.6019E+02	0.	1.6735E-11	0.
						2	IN	2.3136E+02	6.6019E+02	0.	1.6735E-11	0.
							OUT	2.0831E+02	5.9438E+02	0.	1.6735E-11	0.
						3	IN	2.0831E+02	5.9438E+02	0.	1.6735E-11	0.
							OUT	1.8945E+02	5.4050E+02	0.	1.6735E-11	0.
						4	IN	1.8945E+02	5.4050E+02	0.	1.6735E-11	0.
							OUT	1.7372E+02	4.9558E+02	0.	1.6735E-11	0.

IBRM=0 WHICH INDICATES END OF JOB. EXIT IS CALLED

EXTERNAL PRESSURE LOADING
CASE III

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----UNSATISFIED EXTERNALS-----                                   REFERENCES
    THICK
                     STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
                 WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
              MODIFIED PROGRAM TO ACCOUNT FOR TRANSVERSE SHEAR DEFORMATION --WRITTEN BY R.L. CITERLEY
                     ANAMET LABORATORIES INC.     BERKELEY, CALIFORNIA        1 OCT,1969

                STATIC ANALYSIS     PARTS=  1  BRANCHES=  0  NUMBER OF SUBCASES=  0

ANGLES OF ROTATION OF BOUNDARY CONDITIONS ARE ALFL=-0.          ALFRS=-0.

      PART NO  1

SI= 0.           SX= 7.00000E+00   IPAR= 28   ING=  1    SHELL TYPE 2   NTP= 0   LAYERS NLY= 4

CYLINDRICAL SHELL NO  2    H= 6.65000E-01    R= 1.66750E+00  PHI=    90.000  DEGREES

LAYER NO  1  FROM Z=-3.32500E-01   TO Z=-1.66250E-01
    CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E+05  POISSONS RATIO NU= 3.50000E-01
    COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.            ATHETA=-0.              MASS DENSITY RHO=-0.

LAYER NO  2  FROM Z=-1.66250E-01   TO Z= 0.
    CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E+05  POISSONS RATIO NU= 3.50000E-01
    COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.            ATHETA=-0.              MASS DENSITY RHO=-0.

LAYER NO  3  FROM Z= 0.            TO Z= 1.66250E-01
    CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E+05  POISSONS RATIO NU= 3.50000E-01
    COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.            ATHETA=-0.              MASS DENSITY RHO=-0.

LAYER NO  4  FROM Z= 1.66250E-01   TO Z= 3.32500E-01
    CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= 4.50000E+05  POISSONS RATIO NU= 3.50000E-01
    COEFFICIENTS OF THERMAL EXPANSION  AFI=-0.            ATHETA=-0.              MASS DENSITY RHO=-0.
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            STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
        WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
    MODIFIED PROGRAM TO ACCOUNT FOR TRANSVERSE SHEAR DEFORMATION --WRITTEN BY R.L. CITERLEY
            ANAMET LABORATORIES INC.     BERKELEY, CALIFORNIA          1 OCT,1969
                SUBCASE NO  1   FOR FOURIER HARMONIC COS=0 THETA

BOUNDARY CONDITIONS AT STARTING EDGE       2 0.              4 0.              6 0.

BOUNDARY CONDITIONS AT FINAL    EDGE       2 0.              3 0.              5 0.

            LOADS FOR PART NO  1  SUBCASE NO  1
RING LOADS AT END OF THIS PART ARE    Q=-0.           NPHI=-0.          MPHI=-0.          NT P =-0.          M TP=-0.
SURFACE AND TEMP LOADS ARE  P= 3.00000E+02  PFI=-0.          PTHETA=-0.          TL=-0.          TU=-0.
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REFERENCES

STRESS ANALYSIS PROGRAM OF SHELLS OF REVOLUTION UNDER STATIC LOADS
WRIGHT PATTERSON AIR FORCE BASE FLIGHT DYNAMICS LABORATORY VERSION, 22 JULY 1968
MODIFIED PROGRAM TO ACCOUNT FOR TRANSVERSE SHEAR DEFORMATION --WRITTEN BY R.L. CITERLEY
ANAMET LABORATORIES INC. BERKELEY, CALIFORNIA 1 OCT,1969

STATIC SOLUTION AT POINTS ALONG MERIDIAN FOR WAVE NUMBER NX= =0

MAIN SHELL PART NO 1

S	W	U PHI	U THETA	BETA PHI	BETA THETA	LAYER NO		SIG PHI	SIG THETA	SIG T P	TAU PHI Z	TAU THETA Z
0.0000	3.1013E-03	1.9374E-04	0.	1.1249E-04	0.	1	IN	1.1201E+01	1.0493E+03	0.	0.	0.
							OUT	-1.2451E+00	9.2919E+02	0.	0.	0.
						2	IN	-1.2451E+00	9.2919E+02	0.	0.	0.
							OUT	-4.4837E+00	8.3537E+02	0.	0.	0.
						3	IN	-4.4837E+00	8.3537E+02	0.	0.	0.
							OUT	-1.0193E+00	7.6070E+02	0.	0.	0.
						4	IN	-1.0193E+00	7.6070E+02	0.	0.	0.
							OUT	7.4766E+00	7.0041E+02	0.	0.	0.
.2500	3.0547E-03	-4.9873E-18	0.	2.0600E-04	0.	1	IN	2.1562E+01	1.0372E+03	0.	-8.9511E+00	0.
							OUT	4.3665E+00	9.1718E+02	0.	-8.9511E+00	0.
						2	IN	4.3665E+00	9.1718E+02	0.	-8.9511E+00	0.
							OUT	-3.7601E+00	8.2304E+02	0.	-8.9511E+00	0.
						3	IN	-3.7601E+00	8.2304E+02	0.	-8.9511E+00	0.
							OUT	-5.2843E+00	7.4777E+02	0.	-8.9511E+00	0.
						4	IN	-5.2843E+00	7.4777E+02	0.	-8.9511E+00	0.
							OUT	-1.8527E+00	6.8666E+02	0.	-8.9511E+00	0.
.2500	3.0547E-03	0.	0.	2.0600E-04	0.	1	IN	4.0089E+02	1.1700E+03	0.	-8.9511E+00	0.
							OUT	3.5217E+02	1.0369E+03	0.	-8.9511E+00	0.
						2	IN	3.5217E+02	1.0369E+03	0.	-8.9511E+00	0.
							OUT	3.1251E+02	9.3373E+02	0.	-8.9511E+00	0.
						3	IN	3.1251E+02	9.3373E+02	0.	-8.9511E+00	0.
							OUT	2.7945E+02	8.4743E+02	0.	-8.9511E+00	0.
						4	IN	2.7945E+02	8.4743E+02	0.	-8.9511E+00	0.
							OUT	2.5135E+02	7.7528E+02	0.	-8.9511E+00	0.
.5000	2.9964E-03	-6.0753E-06	0.	1.8385E-04	0.	1	IN	4.1548E+02	1.1554E+03	0.	-3.5787E+00	0.
							OUT	3.6005E+02	1.0242E+03	0.	-3.5787E+00	0.
						2	IN	3.6005E+02	1.0242E+03	0.	-3.5787E+00	0.
							OUT	3.1351E+02	9.1835E+02	0.	-3.5787E+00	0.
						3	IN	3.1351E+02	9.1835E+02	0.	-3.5787E+00	0.
							OUT	2.7346E+02	8.3102E+02	0.	-3.5787E+00	0.
						4	IN	2.7346E+02	8.3102E+02	0.	-3.5787E+00	0.
							OUT	2.3826E+02	7.5758E+02	0.	-3.5787E+00	0.
.5000	2.9964E-03	-6.0753E-06	0.	1.8385E-04	0.	1	IN	4.1548E+02	1.1554E+03	0.	-3.5787E+00	0.
							OUT	3.6005E+02	1.0242E+03	0.	-3.5787E+00	0.
						2	IN	3.6005E+02	1.0242E+03	0.	-3.5787E+00	0.
							OUT	3.1351E+02	9.1835E+02	0.	-3.5787E+00	0.
						3	IN	3.1351E+02	9.1835E+02	0.	-3.5787E+00	0.
							OUT	2.7346E+02	8.3102E+02	0.	-3.5787E+00	0.
						4	IN	2.7346E+02	8.3102E+02	0.	-3.5787E+00	0.
							OUT	2.3826E+02	7.5758E+02	0.	-3.5787E+00	0.
.7500	2.9522E-03	-9.1445E-06	0.	1.4748E-04	0.	1	IN	4.1966E+02	1.1420E+03	0.	-2.7953E-01	0.
							OUT	3.6237E+02	1.0117E+03	0.	-2.7953E-01	0.
						2	IN	3.6237E+02	1.0117E+03	0.	-2.7953E-01	0.
							OUT	3.1385E+02	9.0653E+02	0.	-2.7953E-01	0.
						3	IN	3.1385E+02	9.0653E+02	0.	-2.7953E-01	0.
							OUT	2.7171E+02	8.1956E+02	0.	-2.7953E-01	0.
						4	IN	2.7171E+02	8.1956E+02	0.	-2.7953E-01	0.
							OUT	2.3436E+02	7.4626E+02	0.	-2.7953E-01	0.
.7500	2.9522E-03	-9.1445E-06	0.	1.4748E-04	0.	1	IN	4.1966E+02	1.1420E+03	0.	-2.7953E-01	0.
							OUT	3.6237E+02	1.0117E+03	0.	-2.7953E-01	0.

						2	IN	3.6237E+02	1.0117E+03	0.	-2.7953E-01	0.
							OUT	3.1385E+02	9.0653E+02	0.	-2.7953E-01	0.
						3	IN	3.1385E+02	9.0653E+02	0.	-2.7953E-01	0.
							OUT	2.7171E+02	8.1996E+02	0.	-2.7953E-01	0.
						4	IN	2.7171E+02	8.1996E+02	0.	-2.7953E-01	0.
							OUT	2.3436E+02	7.4626E+02	0.	-2.7953E-01	0.
1.0000	2.9213E-03	-1.0193E-05	0.	1.0856E-04	0.	1	IN	4.1782E+02	1.1309E+03	0.	1.4883E+00	0.
							OUT	3.6146E+02	1.0022E+03	0.	1.4883E+00	0.
						2	IN	3.6146E+02	1.0022E+03	0.	1.4883E+00	0.
							OUT	3.1379E+02	8.9817E+02	0.	1.4883E+00	0.
						3	IN	3.1379E+02	8.9817E+02	0.	1.4883E+00	0.
							OUT	2.7242E+02	8.1222E+02	0.	1.4883E+00	0.
						4	IN	2.7242E+02	8.1222E+02	0.	1.4883E+00	0.
							OUT	2.3580E+02	7.3981E+02	0.	1.4883E+00	0.
1.0000	2.9213E-03	-1.0193E-05	0.	1.0856E-04	0.	1	IN	4.1782E+02	1.1309E+03	0.	1.4883E+00	0.
							OUT	3.6146E+02	1.0022E+03	0.	1.4883E+00	0.
						2	IN	3.6146E+02	1.0022E+03	0.	1.4883E+00	0.
							OUT	3.1379E+02	8.9817E+02	0.	1.4883E+00	0.
						3	IN	3.1379E+02	8.9817E+02	0.	1.4883E+00	0.
							OUT	2.7242E+02	8.1222E+02	0.	1.4883E+00	0.
						4	IN	2.7242E+02	8.1222E+02	0.	1.4883E+00	0.
							OUT	2.3580E+02	7.3981E+02	0.	1.4883E+00	0.
1.2500	2.9015E-03	-1.0009E-05	0.	7.3539E-05	0.	1	IN	4.1306E+02	1.1226E+03	0.	2.2152E+00	0.
							OUT	3.5899E+02	9.9537E+02	0.	2.2152E+00	0.
						2	IN	3.5899E+02	9.9537E+02	0.	2.2152E+00	0.
							OUT	3.1352E+02	8.9275E+02	0.	2.2152E+00	0.
						3	IN	3.1352E+02	8.9275E+02	0.	2.2152E+00	0.
							OUT	2.7433E+02	8.0804E+02	0.	2.2152E+00	0.
						4	IN	2.7433E+02	8.0804E+02	0.	2.2152E+00	0.
							OUT	2.3985E+02	7.3678E+02	0.	2.2152E+00	0.
1.2500	2.9015E-03	-1.0009E-05	0.	7.3539E-05	0.	1	IN	4.1306E+02	1.1226E+03	0.	2.2152E+00	0.
							OUT	3.5899E+02	9.9537E+02	0.	2.2152E+00	0.
						2	IN	3.5899E+02	9.9537E+02	0.	2.2152E+00	0.
							OUT	3.1352E+02	8.9275E+02	0.	2.2152E+00	0.
						3	IN	3.1352E+02	8.9275E+02	0.	2.2152E+00	0.
							OUT	2.7433E+02	8.0804E+02	0.	2.2152E+00	0.
						4	IN	2.7433E+02	8.0804E+02	0.	2.2152E+00	0.
							OUT	2.3985E+02	7.3678E+02	0.	2.2152E+00	0.
1.5000	2.8902E-03	-9.1730E-06	0.	4.5269E-05	0.	1	IN	4.0742E+02	1.1168E+03	0.	2.2982E+00	0.
							OUT	3.5602E+02	9.9096E+02	0.	2.2982E+00	0.
						2	IN	3.5602E+02	9.9096E+02	0.	2.2982E+00	0.
							OUT	3.1319E+02	8.8959E+02	0.	2.2982E+00	0.
						3	IN	3.1319E+02	8.8959E+02	0.	2.2982E+00	0.
							OUT	2.7661E+02	8.0608E+02	0.	2.2982E+00	0.
						4	IN	2.7661E+02	8.0608E+02	0.	2.2982E+00	0.
							OUT	2.4472E+02	7.3596E+02	0.	2.2982E+00	0.
1.5000	2.8902E-03	-9.1730E-06	0.	4.5269E-05	0.	1	IN	4.0742E+02	1.1168E+03	0.	2.2982E+00	0.
							OUT	3.5602E+02	9.9096E+02	0.	2.2982E+00	0.
						2	IN	3.5602E+02	9.9096E+02	0.	2.2982E+00	0.
							OUT	3.1319E+02	8.8959E+02	0.	2.2982E+00	0.
						3	IN	3.1319E+02	8.8959E+02	0.	2.2982E+00	0.
							OUT	2.7661E+02	8.0608E+02	0.	2.2982E+00	0.
						4	IN	2.7661E+02	8.0608E+02	0.	2.2982E+00	0.
							OUT	2.4472E+02	7.3596E+02	0.	2.2982E+00	0.
1.7500	2.8850E-03	-8.0758E-06	0.	2.4351E-05	0.	1	IN	4.0208E+02	1.1132E+03	0.	2.0324E+00	0.
							OUT	3.5319E+02	9.8839E+02	0.	2.0324E+00	0.
						2	IN	3.5319E+02	9.8839E+02	0.	2.0324E+00	0.
							OUT	3.1287E+02	8.8806E+02	0.	2.0324E+00	0.
						3	IN	3.1287E+02	8.8806E+02	0.	2.0324E+00	0.
							OUT	2.7878E+02	8.0554E+02	0.	2.0324E+00	0.
						4	IN	2.7878E+02	8.0554E+02	0.	2.0324E+00	0.
							OUT	2.4937E+02	7.3640E+02	0.	2.0324E+00	0.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	IN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1.7500	2.8850E-03	-4.0750E-06	0.	2.4391E-05	0.	1	IN	4.0208E+02	1.1132E+03	0.	2.0324E+00 0.
							OUT	3.5319E+02	9.8839E+02	0.	2.0324E+00 0.
						2	IN	3.5319E+02	9.8839E+02	0.	2.0324E+00 0.
							OUT	3.1287E+02	8.8806E+02	0.	2.0324E+00 0.
						3	IN	3.1287E+02	8.8806E+02	0.	2.0324E+00 0.
							OUT	2.7878E+02	8.0554E+02	0.	2.0324E+00 0.
						4	IN	2.7878E+02	8.0554E+02	0.	2.0324E+00 0.
							OUT	2.4937E+02	7.3640E+02	0.	2.0324E+00 0.
2.0000	2.8835E-03	-6.9583E-06	0.	1.0104E-05	0.	1	IN	3.9761E+02	1.1111E+03	0.	1.6194E+00 0.
							OUT	3.5082E+02	9.8713E+02	0.	1.6194E+00 0.
						2	IN	3.5082E+02	9.8713E+02	0.	1.6194E+00 0.
							OUT	3.1259E+02	8.8757E+02	0.	1.6194E+00 0.
						3	IN	3.1259E+02	8.8757E+02	0.	1.6194E+00 0.
							OUT	2.8059E+02	8.0582E+02	0.	1.6194E+00 0.
						4	IN	2.8059E+02	8.0582E+02	0.	1.6194E+00 0.
							OUT	2.5328E+02	7.3744E+02	0.	1.6194E+00 0.
2.0000	2.8835E-03	-6.9583E-06	0.	1.0104E-05	0.	1	IN	3.9761E+02	1.1111E+03	0.	1.6194E+00 0.
							OUT	3.5082E+02	9.8713E+02	0.	1.6194E+00 0.
						2	IN	3.5082E+02	9.8713E+02	0.	1.6194E+00 0.
							OUT	3.1259E+02	8.8757E+02	0.	1.6194E+00 0.
						3	IN	3.1259E+02	8.8757E+02	0.	1.6194E+00 0.
							OUT	2.8059E+02	8.0582E+02	0.	1.6194E+00 0.
						4	IN	2.8059E+02	8.0582E+02	0.	1.6194E+00 0.
							OUT	2.5328E+02	7.3744E+02	0.	1.6194E+00 0.
2.2500	2.8843E-03	-5.9493E-06	0.	1.2714E-06	0.	1	IN	3.9420E+02	1.1102E+03	0.	1.1849E+00 0.
							OUT	3.4900E+02	9.8673E+02	0.	1.1849E+00 0.
						2	IN	3.4900E+02	9.8673E+02	0.	1.1849E+00 0.
							OUT	3.1238E+02	8.8771E+02	0.	1.1849E+00 0.
						3	IN	3.1238E+02	8.8771E+02	0.	1.1849E+00 0.
							OUT	2.8198E+02	8.0650E+02	0.	1.1849E+00 0.
						4	IN	2.8198E+02	8.0650E+02	0.	1.1849E+00 0.
							OUT	2.5627E+02	7.3866E+02	0.	1.1849E+00 0.
2.2500	2.8843E-03	-5.9493E-06	0.	1.2714E-06	0.	1	IN	3.9420E+02	1.1102E+03	0.	1.1849E+00 0.
							OUT	3.4900E+02	9.8673E+02	0.	1.1849E+00 0.
						2	IN	3.4900E+02	9.8673E+02	0.	1.1849E+00 0.
							OUT	3.1238E+02	8.8771E+02	0.	1.1849E+00 0.
						3	IN	3.1238E+02	8.8771E+02	0.	1.1849E+00 0.
							OUT	2.8198E+02	8.0650E+02	0.	1.1849E+00 0.
						4	IN	2.8198E+02	8.0650E+02	0.	1.1849E+00 0.
							OUT	2.5627E+02	7.3866E+02	0.	1.1849E+00 0.
2.5000	2.8861E-03	-5.1018E-06	0.	-3.5317E-06	0.	1	IN	3.9180E+02	1.1100E+03	0.	7.9750E-01 0.
							OUT	3.4773E+02	9.8683E+02	0.	7.9750E-01 0.
						2	IN	3.4773E+02	9.8683E+02	0.	7.9750E-01 0.
							OUT	3.1222E+02	8.8815E+02	0.	7.9750E-01 0.
						3	IN	3.1222E+02	8.8815E+02	0.	7.9750E-01 0.
							OUT	2.8296E+02	8.0729E+02	0.	7.9750E-01 0.
						4	IN	2.8296E+02	8.0729E+02	0.	7.9750E-01 0.
							OUT	2.5837E+02	7.3981E+02	0.	7.9750E-01 0.
2.5000	2.8861E-03	-5.1018E-06	0.	-3.5317E-06	0.	1	IN	3.9180E+02	1.1100E+03	0.	7.9750E-01 0.
							OUT	3.4773E+02	9.8683E+02	0.	7.9750E-01 0.
						2	IN	3.4773E+02	9.8683E+02	0.	7.9750E-01 0.
							OUT	3.1222E+02	8.8815E+02	0.	7.9750E-01 0.
						3	IN	3.1222E+02	8.8815E+02	0.	7.9750E-01 0.
							OUT	2.8296E+02	8.0729E+02	0.	7.9750E-01 0.
						4	IN	2.8296E+02	8.0729E+02	0.	7.9750E-01 0.
							OUT	2.5837E+02	7.3981E+02	0.	7.9750E-01 0.
2.7500	2.8883E-03	-4.4220E-06	0.	-5.5753E-06	0.	1	IN	3.9026E+02	1.1102E+03	0.	4.8700E-01 0.
							OUT	3.4690E+02	9.8718E+02	0.	4.8700E-01 0.
						2	IN	3.4690E+02	9.8718E+02	0.	4.8700E-01 0.
							OUT	3.1212E+02	8.8849E+02	0.	4.8700E-01 0.
						3	IN	3.1212E+02	8.8849E+02	0.	4.8700E-01 0.
							OUT	2.8359E+02	8.0804E+02	0.	4.8700E-01 0.
						4	IN	2.8359E+02	8.0804E+02	0.	4.8700E-01 0.

							OUT	2.5973E+02	7.4077E+02	0.	4.8700E-01	0.
2.7500	2.8883E-03	-4.4220E-06	0.	-5.5793E-06	0.	1	IN	3.9026E+02	1.1102E+03	0.	4.8700E-01	0.
							OUT	3.4690E+02	9.8718E+02	0.	4.8700E-01	0.
						2	IN	3.4690E+02	9.8718E+02	0.	4.8700E-01	0.
							OUT	3.1212E+02	8.8869E+02	0.	4.8700E-01	0.
						3	IN	3.1212E+02	8.8869E+02	0.	4.8700E-01	0.
							OUT	2.8359E+02	8.0804E+02	0.	4.8700E-01	0.
						4	IN	2.8359E+02	8.0804E+02	0.	4.8700E-01	0.
							OUT	2.5973E+02	7.4077E+02	0.	4.8700E-01	0.
3.0000	2.8903E-03	-3.8903E-06	0.	-5.8966E-06	0.	1	IN	3.8937E+02	1.1105E+03	0.	2.5862E-01	0.
							OUT	3.4643E+02	9.8762E+02	0.	2.5862E-01	0.
						2	IN	3.4643E+02	9.8762E+02	0.	2.5862E-01	0.
							OUT	3.1207E+02	8.8921E+02	0.	2.5862E-01	0.
						3	IN	3.1207E+02	8.8921E+02	0.	2.5862E-01	0.
							OUT	2.8395E+02	8.0866E+02	0.	2.5862E-01	0.
						4	IN	2.8395E+02	8.0866E+02	0.	2.5862E-01	0.
							OUT	2.6052E+02	7.4150E+02	0.	2.5862E-01	0.
3.0000	2.8903E-03	-3.8903E-06	0.	-5.8966E-06	0.	1	IN	3.8937E+02	1.1105E+03	0.	2.5862E-01	0.
							OUT	3.4643E+02	9.8762E+02	0.	2.5862E-01	0.
						2	IN	3.4643E+02	9.8762E+02	0.	2.5862E-01	0.
							OUT	3.1207E+02	8.8921E+02	0.	2.5862E-01	0.
						3	IN	3.1207E+02	8.8921E+02	0.	2.5862E-01	0.
							OUT	2.8395E+02	8.0866E+02	0.	2.5862E-01	0.
						4	IN	2.8395E+02	8.0866E+02	0.	2.5862E-01	0.
							OUT	2.6052E+02	7.4150E+02	0.	2.5862E-01	0.
3.2500	2.8920E-03	-3.4768E-06	0.	-5.2714E-06	0.	1	IN	3.8895E+02	1.1110E+03	0.	1.0404E-01	0.
							OUT	3.4620E+02	9.8804E+02	0.	1.0404E-01	0.
						2	IN	3.4620E+02	9.8804E+02	0.	1.0404E-01	0.
							OUT	3.1204E+02	8.8965E+02	0.	1.0404E-01	0.
						3	IN	3.1204E+02	8.8965E+02	0.	1.0404E-01	0.
							OUT	2.8412E+02	8.0913E+02	0.	1.0404E-01	0.
						4	IN	2.8412E+02	8.0913E+02	0.	1.0404E-01	0.
							OUT	2.6090E+02	7.4201E+02	0.	1.0404E-01	0.
3.2500	2.8920E-03	-3.4768E-06	0.	-5.2714E-06	0.	1	IN	3.8895E+02	1.1110E+03	0.	1.0404E-01	0.
							OUT	3.4620E+02	9.8804E+02	0.	1.0404E-01	0.
						2	IN	3.4620E+02	9.8804E+02	0.	1.0404E-01	0.
							OUT	3.1204E+02	8.8965E+02	0.	1.0404E-01	0.
						3	IN	3.1204E+02	8.8965E+02	0.	1.0404E-01	0.
							OUT	2.8412E+02	8.0913E+02	0.	1.0404E-01	0.
						4	IN	2.8412E+02	8.0913E+02	0.	1.0404E-01	0.
							OUT	2.6090E+02	7.4201E+02	0.	1.0404E-01	0.
3.5000	2.8932E-03	-3.1497E-06	0.	-4.2339E-06	0.	1	IN	3.8883E+02	1.1113E+03	0.	8.9734E-03	0.
							OUT	3.4613E+02	9.8839E+02	0.	8.9734E-03	0.
						2	IN	3.4613E+02	9.8839E+02	0.	8.9734E-03	0.
							OUT	3.1203E+02	8.8999E+02	0.	8.9734E-03	0.
						3	IN	3.1203E+02	8.8999E+02	0.	8.9734E-03	0.
							OUT	2.8417E+02	8.0946E+02	0.	8.9734E-03	0.
						4	IN	2.8417E+02	8.0946E+02	0.	8.9734E-03	0.
							OUT	2.6101E+02	7.4233E+02	0.	8.9734E-03	0.
3.5000	2.8932E-03	-3.1497E-06	0.	-4.2339E-06	0.	1	IN	3.8883E+02	1.1113E+03	0.	8.9734E-03	0.
							OUT	3.4613E+02	9.8839E+02	0.	8.9734E-03	0.
						2	IN	3.4613E+02	9.8839E+02	0.	8.9734E-03	0.
							OUT	3.1203E+02	8.8999E+02	0.	8.9734E-03	0.
						3	IN	3.1203E+02	8.8999E+02	0.	8.9734E-03	0.
							OUT	2.8417E+02	8.0946E+02	0.	8.9734E-03	0.
						4	IN	2.8417E+02	8.0946E+02	0.	8.9734E-03	0.
							OUT	2.6101E+02	7.4233E+02	0.	8.9734E-03	0.
3.7500	2.8941E-03	-2.8807E-06	0.	-3.1198E-06	0.	1	IN	3.8888E+02	1.1117E+03	0.	-4.2081E-02	0.
							OUT	3.4616E+02	9.8867E+02	0.	-4.2081E-02	0.
						2	IN	3.4616E+02	9.8867E+02	0.	-4.2081E-02	0.
							OUT	3.1203E+02	8.9023E+02	0.	-4.2081E-02	0.
						3	IN	3.1203E+02	8.9023E+02	0.	-4.2081E-02	0.

			OUT	2.8415E+02	8.0967E+02	0.	-4.2081E-02	0.
		4	IN	2.8415E+02	8.0967E+02	0.	-4.2081E-02	0.
			OUT	2.6097E+02	7.4252E+02	0.	-4.2081E-02	0.
3.7500 2.8941E-03-2.8807E-06 0.	-3.1198E-06 0.	1	IN	3.8888E+02	1.1117E+03	0.	-4.2081E-02	0.
			OUT	3.4616E+02	9.8867E+02	0.	-4.2081E-02	0.
		2	IN	3.4616E+02	9.8867E+02	0.	-4.2081E-02	0.
			OUT	3.1203E+02	8.9023E+02	0.	-4.2081E-02	0.
		3	IN	3.1203E+02	8.9023E+02	0.	-4.2081E-02	0.
			OUT	2.8415E+02	8.0967E+02	0.	-4.2081E-02	0.
		4	IN	2.8415E+02	8.0967E+02	0.	-4.2081E-02	0.
			OUT	2.6097E+02	7.4252E+02	0.	-4.2081E-02	0.
4.0000 2.8947E-03-2.6472E-06 0.	-2.1153E-06 0.	1	IN	3.8901E+02	1.1119E+03	0.	-6.3183E-02	0.
			OUT	3.4623E+02	9.8886E+02	0.	-6.3183E-02	0.
		2	IN	3.4623E+02	9.8886E+02	0.	-6.3183E-02	0.
			OUT	3.1204E+02	8.9039E+02	0.	-6.3183E-02	0.
		3	IN	3.1204E+02	8.9039E+02	0.	-6.3183E-02	0.
			OUT	2.8410E+02	8.0979E+02	0.	-6.3183E-02	0.
		4	IN	2.8410E+02	8.0979E+02	0.	-6.3183E-02	0.
			OUT	2.6086E+02	7.4261E+02	0.	-6.3183E-02	0.
4.0000 2.8947E-03-2.6472E-06 0.	-2.1153E-06 0.	1	IN	3.8901E+02	1.1119E+03	0.	-6.3183E-02	0.
			OUT	3.4623E+02	9.8886E+02	0.	-6.3183E-02	0.
		2	IN	3.4623E+02	9.8886E+02	0.	-6.3183E-02	0.
			OUT	3.1204E+02	8.9039E+02	0.	-6.3183E-02	0.
		3	IN	3.1204E+02	8.9039E+02	0.	-6.3183E-02	0.
			OUT	2.8410E+02	8.0979E+02	0.	-6.3183E-02	0.
		4	IN	2.8410E+02	8.0979E+02	0.	-6.3183E-02	0.
			OUT	2.6086E+02	7.4261E+02	0.	-6.3183E-02	0.
4.2500 2.8950E-03-2.4326E-06 0.	-1.3034E-06 0.	1	IN	3.8918E+02	1.1121E+03	0.	-6.5738E-02	0.
			OUT	3.4631E+02	9.8899E+02	0.	-6.5738E-02	0.
		2	IN	3.4631E+02	9.8899E+02	0.	-6.5738E-02	0.
			OUT	3.1204E+02	8.9048E+02	0.	-6.5738E-02	0.
		3	IN	3.1204E+02	8.9048E+02	0.	-6.5738E-02	0.
			OUT	2.8403E+02	8.0985E+02	0.	-6.5738E-02	0.
		4	IN	2.8403E+02	8.0985E+02	0.	-6.5738E-02	0.
			OUT	2.6072E+02	7.4263E+02	0.	-6.5738E-02	0.
4.2500 2.8950E-03-2.4326E-06 0.	-1.3034E-06 0.	1	IN	3.8918E+02	1.1121E+03	0.	-6.5738E-02	0.
			OUT	3.4631E+02	9.8899E+02	0.	-6.5738E-02	0.
		2	IN	3.4631E+02	9.8897E+02	0.	-6.5738E-02	0.
			OUT	3.1204E+02	8.9048E+02	0.	-6.5738E-02	0.
		3	IN	3.1204E+02	8.9048E+02	0.	-6.5738E-02	0.
			OUT	2.8403E+02	8.0985E+02	0.	-6.5738E-02	0.
		4	IN	2.8403E+02	8.0985E+02	0.	-6.5738E-02	0.
			OUT	2.6072E+02	7.4263E+02	0.	-6.5738E-02	0.
4.5000 2.8952E-03-2.2256E-06 0.	-7.0158E-07 0.	1	IN	3.8933E+02	1.1122E+03	0.	-5.8227E-02	0.
			OUT	3.4639E+02	9.8907E+02	0.	-5.8227E-02	0.
		2	IN	3.4639E+02	9.8907E+02	0.	-5.8227E-02	0.
			OUT	3.1205E+02	8.9052E+02	0.	-5.8227E-02	0.
		3	IN	3.1205E+02	8.9052E+02	0.	-5.8227E-02	0.
			OUT	2.8397E+02	8.0986E+02	0.	-5.8227E-02	0.
		4	IN	2.8397E+02	8.0986E+02	0.	-5.8227E-02	0.
			OUT	2.6059E+02	7.4262E+02	0.	-5.8227E-02	0.
4.5000 2.8952E-03-2.2256E-06 0.	-7.0158E-07 0.	1	IN	3.8933E+02	1.1122E+03	0.	-5.8227E-02	0.
			OUT	3.4639E+02	9.8907E+02	0.	-5.8227E-02	0.
		2	IN	3.4639E+02	9.8907E+02	0.	-5.8227E-02	0.
			OUT	3.1205E+02	8.9052E+02	0.	-5.8227E-02	0.
		3	IN	3.1205E+02	8.9052E+02	0.	-5.8227E-02	0.
			OUT	2.8397E+02	8.0986E+02	0.	-5.8227E-02	0.
		4	IN	2.8397E+02	8.0986E+02	0.	-5.8227E-02	0.
			OUT	2.6059E+02	7.4262E+02	0.	-5.8227E-02	0.
4.7500 2.8952E-03-2.0192E-06 0.	-2.9083E-07 0.	1	IN	3.8946E+02	1.1122E+03	0.	-4.6461E-02	0.
			OUT	3.4646E+02	9.8910E+02	0.	-4.6461E-02	0.
		2	IN	3.4646E+02	9.8910E+02	0.	-4.6461E-02	0.

							OUT	3.1206E+02	8.9054E+02	0.	-4.6461E-02	0.
						3	IN	3.1206E+02	8.9054E+02	0.	-4.6461E-02	0.
							OUT	2.8392E+02	8.0985E+02	0.	-4.6461E-02	0.
						4	IN	2.8392E+02	8.0985E+02	0.	-4.6461E-02	0.
							OUT	2.6048E+02	7.4259E+02	0.	-4.6461E-02	0.
4.7500	2.8952E-03	-2.0192E-06	0.	-2.9683E-07	0.	1	IN	3.8948E+02	1.1122E+03	0.	-4.6461E-02	0.
							OUT	3.4646E+02	9.8910E+02	0.	-4.6461E-02	0.
						2	IN	3.4646E+02	9.8910E+02	0.	-4.6461E-02	0.
							OUT	3.1206E+02	8.9054E+02	0.	-4.6461E-02	0.
						3	IN	3.1206E+02	8.9054E+02	0.	-4.6461E-02	0.
							OUT	2.8392E+02	8.0985E+02	0.	-4.6461E-02	0.
						4	IN	2.8392E+02	8.0985E+02	0.	-4.6461E-02	0.
							OUT	2.6048E+02	7.4259E+02	0.	-4.6461E-02	0.
5.0000	2.8952E-03	-1.8097E-06	0.	-3.5442E-08	0.	1	IN	3.8955E+02	1.1123E+03	0.	-3.4065E-02	0.
							OUT	3.4651E+02	9.8911E+02	0.	-3.4065E-02	0.
						2	IN	3.4651E+02	9.8911E+02	0.	-3.4065E-02	0.
							OUT	3.1207E+02	8.9053E+02	0.	-3.4065E-02	0.
						3	IN	3.1207E+02	8.9053E+02	0.	-3.4065E-02	0.
							OUT	2.8388E+02	8.0983E+02	0.	-3.4065E-02	0.
						4	IN	2.8388E+02	8.0983E+02	0.	-3.4065E-02	0.
							OUT	2.6039E+02	7.4255E+02	0.	-3.4065E-02	0.
5.0000	2.8952E-03	-1.8097E-06	0.	-3.5442E-08	0.	1	IN	3.8955E+02	1.1123E+03	0.	-3.4065E-02	0.
							OUT	3.4651E+02	9.8911E+02	0.	-3.4065E-02	0.
						2	IN	3.4651E+02	9.8911E+02	0.	-3.4065E-02	0.
							OUT	3.1207E+02	8.9053E+02	0.	-3.4065E-02	0.
						3	IN	3.1207E+02	8.9053E+02	0.	-3.4065E-02	0.
							OUT	2.8388E+02	8.0983E+02	0.	-3.4065E-02	0.
						4	IN	2.8388E+02	8.0983E+02	0.	-3.4065E-02	0.
							OUT	2.6039E+02	7.4255E+02	0.	-3.4065E-02	0.
5.2500	2.8951E-03	-1.5955E-06	0.	1.0410E-07	0.	1	IN	3.8962E+02	1.1123E+03	0.	-2.3037E-02	0.
							OUT	3.4655E+02	9.8911E+02	0.	-2.3037E-02	0.
						2	IN	3.4655E+02	9.8911E+02	0.	-2.3037E-02	0.
							OUT	3.1207E+02	8.9052E+02	0.	-2.3037E-02	0.
						3	IN	3.1207E+02	8.9052E+02	0.	-2.3037E-02	0.
							OUT	2.8385E+02	8.0981E+02	0.	-2.3037E-02	0.
						4	IN	2.8385E+02	8.0981E+02	0.	-2.3037E-02	0.
							OUT	2.6033E+02	7.4252E+02	0.	-2.3037E-02	0.
5.2500	2.8951E-03	-1.5955E-06	0.	1.0410E-07	0.	1	IN	3.8962E+02	1.1123E+03	0.	-2.3037E-02	0.
							OUT	3.4655E+02	9.8911E+02	0.	-2.3037E-02	0.
						2	IN	3.4655E+02	9.8911E+02	0.	-2.3037E-02	0.
							OUT	3.1207E+02	8.9052E+02	0.	-2.3037E-02	0.
						3	IN	3.1207E+02	8.9052E+02	0.	-2.3037E-02	0.
							OUT	2.8385E+02	8.0981E+02	0.	-2.3037E-02	0.
						4	IN	2.8385E+02	8.0981E+02	0.	-2.3037E-02	0.
							OUT	2.6033E+02	7.4252E+02	0.	-2.3037E-02	0.
5.5000	2.8951E-03	-1.3765E-06	0.	1.6391E-07	0.	1	IN	3.8967E+02	1.1123E+03	0.	-1.4251E-02	0.
							OUT	3.4657E+02	9.8910E+02	0.	-1.4251E-02	0.
						2	IN	3.4657E+02	9.8910E+02	0.	-1.4251E-02	0.
							OUT	3.1208E+02	8.9051E+02	0.	-1.4251E-02	0.
						3	IN	3.1208E+02	8.9051E+02	0.	-1.4251E-02	0.
							OUT	2.8383E+02	8.0979E+02	0.	-1.4251E-02	0.
						4	IN	2.8383E+02	8.0979E+02	0.	-1.4251E-02	0.
							OUT	2.6029E+02	7.4249E+02	0.	-1.4251E-02	0.
5.5000	2.8951E-03	-1.3765E-06	0.	1.6391E-07	0.	1	IN	3.8967E+02	1.1123E+03	0.	-1.4251E-02	0.
							OUT	3.4657E+02	9.8910E+02	0.	-1.4251E-02	0.
						2	IN	3.4657E+02	9.8910E+02	0.	-1.4251E-02	0.
							OUT	3.1208E+02	8.9051E+02	0.	-1.4251E-02	0.
						3	IN	3.1208E+02	8.9051E+02	0.	-1.4251E-02	0.
							OUT	2.8383E+02	8.0979E+02	0.	-1.4251E-02	0.
						4	IN	2.8383E+02	8.0979E+02	0.	-1.4251E-02	0.
							OUT	2.6029E+02	7.4249E+02	0.	-1.4251E-02	0.
5.7500	2.8950E-03	-1.1531E-06	0.	1.7331E-07	0.	1	IN	3.8969E+02	1.1122E+03	0.	-7.8755E-03	0.

							OUT	3.4659E+02	9.8909E+02	0.	-7.8755E-03	0.
						2	IN	3.4659E+02	9.8909E+02	0.	-7.8755E-03	0.
							OUT	3.1208E+02	8.9049E+02	0.	-7.8755E-03	0.
						3	IN	3.1208E+02	8.9049E+02	0.	-7.8755E-03	0.
							OUT	2.8382E+02	8.0977E+02	0.	-7.8755E-03	0.
						4	IN	2.8382E+02	8.0977E+02	0.	-7.8755E-03	0.
							OUT	2.6027E+02	7.4247E+02	0.	-7.8755E-03	0.
5.7500	2.8950E-03	-1.1531E-08	0.	1.7331E-07	0.	1	IN	3.8969E+02	1.1122E+03	0.	-7.8755E-03	0.
							OUT	3.4659E+02	9.8909E+02	0.	-7.8755E-03	0.
						2	IN	3.4659E+02	9.8909E+02	0.	-7.8755E-03	0.
							OUT	3.1208E+02	8.9049E+02	0.	-7.8755E-03	0.
						3	IN	3.1208E+02	8.9049E+02	0.	-7.8755E-03	0.
							OUT	2.8382E+02	8.0977E+02	0.	-7.8755E-03	0.
						4	IN	2.8382E+02	8.0977E+02	0.	-7.8755E-03	0.
							OUT	2.6027E+02	7.4247E+02	0.	-7.8755E-03	0.
6.0000	2.8950E-03	-9.2621E-07	0.	1.5396E-07	0.	1	IN	3.8971E+02	1.1122E+03	0.	-3.6833E-03	0.
							OUT	3.4660E+02	9.8908E+02	0.	-3.6833E-03	0.
						2	IN	3.4660E+02	9.8908E+02	0.	-3.6833E-03	0.
							OUT	3.1208E+02	8.9048E+02	0.	-3.6833E-03	0.
						3	IN	3.1208E+02	8.9048E+02	0.	-3.6833E-03	0.
							OUT	2.8382E+02	8.0976E+02	0.	-3.6833E-03	0.
						4	IN	2.8382E+02	8.0976E+02	0.	-3.6833E-03	0.
							OUT	2.6025E+02	7.4246E+02	0.	-3.6833E-03	0.
6.0000	2.8950E-03	-9.2621E-07	0.	1.5396E-07	0.	1	IN	3.8971E+02	1.1122E+03	0.	-3.6833E-03	0.
							OUT	3.4660E+02	9.8908E+02	0.	-3.6833E-03	0.
						2	IN	3.4660E+02	9.8908E+02	0.	-3.6833E-03	0.
							OUT	3.1208E+02	8.9048E+02	0.	-3.6833E-03	0.
						3	IN	3.1208E+02	8.9048E+02	0.	-3.6833E-03	0.
							OUT	2.8382E+02	8.0976E+02	0.	-3.6833E-03	0.
						4	IN	2.8382E+02	8.0976E+02	0.	-3.6833E-03	0.
							OUT	2.6025E+02	7.4246E+02	0.	-3.6833E-03	0.
6.2500	2.8949E-03	-6.9669E-07	0.	1.2036E-07	0.	1	IN	3.8971E+02	1.1122E+03	0.	-1.2621E-03	0.
							OUT	3.4660E+02	9.8906E+02	0.	-1.2621E-03	0.
						2	IN	3.4660E+02	9.8906E+02	0.	-1.2621E-03	0.
							OUT	3.1208E+02	8.9047E+02	0.	-1.2621E-03	0.
						3	IN	3.1208E+02	8.9047E+02	0.	-1.2621E-03	0.
							OUT	2.8382E+02	8.0975E+02	0.	-1.2621E-03	0.
						4	IN	2.8382E+02	8.0975E+02	0.	-1.2621E-03	0.
							OUT	2.6025E+02	7.4245E+02	0.	-1.2621E-03	0.
6.2500	2.8949E-03	-6.9669E-07	0.	1.2036E-07	0.	1	IN	3.8971E+02	1.1122E+03	0.	-1.2621E-03	0.
							OUT	3.4660E+02	9.8906E+02	0.	-1.2621E-03	0.
						2	IN	3.4660E+02	9.8906E+02	0.	-1.2621E-03	0.
							OUT	3.1208E+02	8.9047E+02	0.	-1.2621E-03	0.
						3	IN	3.1208E+02	8.9047E+02	0.	-1.2621E-03	0.
							OUT	2.8382E+02	8.0975E+02	0.	-1.2621E-03	0.
						4	IN	2.8382E+02	8.0975E+02	0.	-1.2621E-03	0.
							OUT	2.6025E+02	7.4245E+02	0.	-1.2621E-03	0.
6.5000	2.8949E-03	-4.6538E-07	0.	8.1149E-08	0.	1	IN	3.8972E+02	1.1122E+03	0.	-1.4321E-04	0.
							OUT	3.4660E+02	9.8906E+02	0.	-1.4321E-04	0.
						2	IN	3.4660E+02	9.8906E+02	0.	-1.4321E-04	0.
							OUT	3.1208E+02	8.9046E+02	0.	-1.4321E-04	0.
						3	IN	3.1208E+02	8.9046E+02	0.	-1.4321E-04	0.
							OUT	2.8381E+02	8.0974E+02	0.	-1.4321E-04	0.
						4	IN	2.8381E+02	8.0974E+02	0.	-1.4321E-04	0.
							OUT	2.6025E+02	7.4244E+02	0.	-1.4321E-04	0.
6.5000	2.8949E-03	-4.6538E-07	0.	8.1149E-08	0.	1	IN	3.8972E+02	1.1122E+03	0.	-1.4321E-04	0.
							OUT	3.4660E+02	9.8906E+02	0.	-1.4321E-04	0.
						2	IN	3.4660E+02	9.8906E+02	0.	-1.4321E-04	0.
							OUT	3.1208E+02	8.9046E+02	0.	-1.4321E-04	0.
						3	IN	3.1208E+02	8.9046E+02	0.	-1.4321E-04	0.
							OUT	2.8381E+02	8.0974E+02	0.	-1.4321E-04	0.
						4	IN	2.8381E+02	8.0974E+02	0.	-1.4321E-04	0.

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                                                          OUT  2.6025E+02 7.4244E+02 0.        -1.4321E-04 0.
6.7500 2.8949E-03-2.3295E-07 0.        4.0567E-08 0.    1  IN  3.8971E+02 1.1122E+03 0.         1.3365E-04 0.
                                                          OUT  3.4660E+02 9.8905E+02 0.         1.3365E-04 0.
                                                        2  IN  3.4660E+02 9.8905E+02 0.         1.3365E-04 0.
                                                          OUT  3.1208E+02 8.9046E+02 0.         1.3365E-04 0.
                                                        3  IN  3.1208E+02 8.9046E+02 0.         1.3365E-04 0.
                                                          OUT  2.8381E+02 8.0974E+02 0.         1.3365E-04 0.
                                                        4  IN  2.8381E+02 8.0974E+02 0.         1.3365E-04 0.
                                                          OUT  2.6025E+02 7.4244E+02 0.         1.3365E-04 0.
6.7500 2.8949E-03-2.3295E-07 0.        4.0567E-08 0.    1  IN  3.8971E+02 1.1122E+03 0.         1.3365E-04 0.
                                                          OUT  3.4660E+02 9.8905E+02 0.         1.3365E-04 0.
                                                        2  IN  3.4660E+02 9.8905E+02 0.         1.3365E-04 0.
                                                          OUT  3.1208E+02 8.9046E+02 0.         1.3365E-04 0.
                                                        3  IN  3.1208E+02 8.9046E+02 0.         1.3365E-04 0.
                                                          OUT  2.8381E+02 8.0974E+02 0.         1.3365E-04 0.
                                                        4  IN  2.8381E+02 8.0974E+02 0.         1.3365E-04 0.
                                                          OUT  2.6025E+02 7.4244E+02 0.         1.3365E-04 0.
7.0000 2.8949E-03-1.2353E-16 0.        1.3223E-16 0.    1  IN  3.8971E+02 1.1122E+03 0.         3.1480E-11 0.
                                                          OUT  3.4660E+02 9.8905E+02 0.         3.1480E-11 0.
                                                        2  IN  3.4660E+02 9.8905E+02 0.         3.1480E-11 0.
                                                          OUT  3.1208E+02 8.9045E+02 0.         3.1480E-11 0.
                                                        3  IN  3.1208E+02 8.9045E+02 0.         3.1480E-11 0.
                                                          OUT  2.8381E+02 8.0974E+02 0.         3.1480E-11 0.
                                                        4  IN  2.8381E+02 8.0974E+02 0.         3.1480E-11 0.
                                                          OUT  2.6025E+02 7.4243E+02 0.         3.1480E-11 0.

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13. ABSTRACT
This report describes the results of an investigation for the numerical analysis procedures of shells of revolution and consultation on the execution of shell problems at the Air Force Flight Dynamics Laboratory Facilities. A computer program for the analysis of the thick shells of revolution, the analysis of thin shells subjected to torsion and the theory upon which it is based is presented. This computer program is tailored to an existing program previously written by Dr. Kalnins under Air Force Contract No. 33 (615)-3870. Detailed input instructions and three example problems are included to illustrate the added capabilities of the computer program. In addition, numerical procedures and subroutines that effect an improvement in numerical integration procedures and efficient eigenvalue search techniques are discussed.

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1. Structural shells						
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