NASA CONTRACTOR REPORT

NASA CR-1801

NASA CR-
c. 1

COMPUTER PROGRAM FOR ANALYSIS OF IMPERFECTION SENSITIVITY OF RING-STIFFENED SHELLS OF REVOLUTION

by Gerald A. Cohen

Prepared by
PHILCO-FORD CORPORATION
Newport Beach, Calif. 92663
for Langley Research Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • OCTOBER 1971

1. Report No. NASA CR-1801	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Computer Program for Analysis of Imperfection Sensitivity of Ring-Stiffened Shells of Revolution		5. Report Date October 1971
		6. Performing Organization Code
7. Author(s) Gerald A. Cohen		8. Performing Organization Report No.
9. Performing Organization Name and Address Philco-Ford Corporation Newport Beach, California 92663		10. Work Unit No. 124-08-20-04
		11. Contract or Grant No. NAS1-5554 - 8
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		13. Type of Report and Period Covered Contractor Report
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

A FORTRAN IV digital computer program is presented for the initial postbuckling and imperfection sensitivity analysis of bifurcation buckling modes of ring-stiffened orthotropic multilayered shells of revolution. The boundary value problem for the second-order contribution to the buckled state is solved by the forward integration technique using the Runge-Kutta method. The effects of nonlinear prebuckling states and live pressure loadings are included.

17. Key Words (Suggested by Author(s)) Initial Imperfections, Ring-Stiffened Shells, Orthotropic Multilayered Shells, Buckling of Shells, Shell Analysis Computer Program	18. Distribution Statement Unclassified - Unlimited

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 195	22. Price* $3.00

*For sale by the National Technical Information Service, Springfield, Virginia 22151

PREFACE

This study was initiated while the author was employed by the Philco-Ford Corporation. Technical responsibility for the completion of the work and the preparation of this report resides in Structures Research Associates under subcontract to Philco-Ford.

CONTENTS

CONTENTS - (Continued)

COMPUTER PROGRAM

FOR ANALYSIS OF IMPERFECTION SENSITIVITY

OF RING-STIFFENED SHELLS OF REVOLUTION

By Gerald A. Cohen
Structures Research Associates, Newport Beach, California

SUMMARY

A FORTRAN IV digital computer program has been developed for the initial postbuckling and imperfection sensitivity analysis of unique bifurcation buckling modes of ring-stiffened orthotropic multilayered shells of revolution. The analysis for the second-order contribution to the buckled state is based on Novozhilov-type nonlinear moderate rotation shell and ring theory. In general, the second-order state consists of an axisymmetric component and an unsymmetric harmonic component, each of which are obtained by the forward integration method using the Runge-Kutta numerical technique. The imperfection analysis is based on a mean square angular imperfection measure, which includes imperfections of both shell and rings. Based on this measure, the imperfection which produces the greatest reduction in buckling load (for sufficiently small imperfections) and an imperfection proportional to the buckling mode shape are treated. From the results of the analysis, one can determine, for small values of the imperfection measure, the expected buckling load knockdown. In addition, the initial postbuckling stiffness of the perfect structure is obtained.

The computer program requires as input, prebuckling and buckling mode data. The prebuckling data consists of both a nonlinear state and a linear perturbation state about it. If a null nonlinear state is input, the results will be based simply on the linear prebuckling state. Only axisymmetric torsionless prebuckling states of axisymmetric structures are treated. Up to five orthotropic shell wall layers and thirty-four isotropic rings (including two edge rings) are treated. The effects of stringers (circumferentially smeared out), idealized elastic foundations, and live pressure fields are also treated.

INTRODUCTION

In the recent past, a fruitful area for research in shell buckling problems has been the application to specific shell geometries of the initial postbuckling and imperfection sensitivity theory, originally developed by Koiter (References 1 and 2) and further expounded by Budiansky and Hutchinson (References 3 and 4). Typical examples of such studies are afforded by References 5, 6, and 7, in which membrane prebuckling states and Donnell-type shell thories are used to study toroidal, cylindrical, and spheroidal shells. In References 8, 9, and 10 spherical shells and stiffened cylindrical shells are studied using nonlinear shallow shell theories. In each case recourse had to be made to the digital computer to obtain numerical results. In order to avoid a new programming effort each time a new problem is encountered, it is desirable to have a general program which can treat a whole class of technically important problems.

The general program presented here is based on a specialization of the general theory of References 11 and 12 to axisymmetric ring-stiffened shell structures under axisymmetric torsionless loads. In this specialization, the more complete Novozhilov-type nonlinear shell theory is used. In further contrast to previous studies, which assume an imperfection proportional to the buckling mode shape, the mean square value of angular deviations of both shell and rings is used as a measure of imperfections of arbitrary shape. The program gives results for the maximum possible buckling load reduction for an arbitrary imperfection as well as the buckling load reduction for an imperfection proportional to the buckling mode. Although the analysis is valid only for unique mode bifurcation buckling, this does not seriously limit the usefulness of the program, since simultaneous buckling modes are an unlikely occurrence for practical structures when real boundary conditions and nonlinear prebuckling states are considered.

The main body of this report presents the analytical formulation of the imperfect and perfect structure analysis, and the solution of several sample problems used to check out the program. In the appendices, more detailed information relating to the computer program is presented. Appendix A derives the boundary conditions used for dome closures. In Appendix B, the postbuckling and imperfection functionals, which are presented in generalized notation in References 11 and 12, are reduced to quadratures to be evaluated by Simpson's rule. Appendix C consists of a user's manual, including input and output listings for a sample problem. Appendix D consists of an overall logical flow chart of the program, brief descriptions of contractor-supplied subprograms, a glossary of the most important FORTRAN variables, and a source program listing.

SYMBOLS

A	shell surface area; also ring or stringer cross-sectional area
a	ring centroidal radius; also first postbuckling coefficient; also meridional radius of curvature of toroidal shell segment
b	second postbuckling coefficient

C	meridional stretching stiffness of shell wall
D	shell wall flexural rigidity
d	ring or stringer spacing
E	Young's modulus for a ring or stringer
E_1, E_2, E_{12}	meridional, circumferential, and shear shell elastic moduli, respectively
e	normal eccentricity of ring or stringer centroid from shell middle surface
e_1, e_2, e_{12}	meridional, circumferential, and shear linearized shell strain expressions, respectively
F_x, F_y, F_ϕ	external ring forces per unit of length in axial, radial, and circumferential directions, respectively
$F^{(1)}(u_1, u_1), F^{(2)}(u_1, u_1)$	buckling mode functionals (see Appendix B)
G	shear stiffness of shell wall; also shear modulus of rings or stringer
H	shallow spherical shell rise
h	layer half-thickness
I	ring or stringer centroidal moment of inertia
J	torsion constant for ring or stringer
K	generalized postbuckling stiffness
K_0	generalized prebuckling stiffness
k	proportionality constant for buckling mode imperfection
k_1, k_2, k_3	meridional, circumferential, and normal foundation moduli, respectively
L_1, L_2	external shell surface moments per unit of area about meridional and circumferential directions, respectively
ℓ	cylindrical on toroidal shell length; axial subinterval length
q	pressure applied to spherical cap

q_o	classical critical pressure for complete spherical shell
M_1, M_2, M_{12}	meridional, circumferential, and twisting shell stress couples, respectively
M_y	out-of-plane ring bending moment
N	number of stringers; also number of finite-difference stations
N_x, N_y, N_ϕ	external ring moments per unit of length in axial, radial, and circumferential directions, respectively
n	harmonic number
n_c	buckling mode harmonic number
P	total axial load for cylindrical shell
P, Q, S	effective shell forces per unit of circumferential length in axial, radial, and circumferential directions, respectively
p	pressure distribution assocated with normal pressure field $\lambda p(x,y)$, positive if acting in positive z-direction
R	spherical shell radius
R_2	circumferential radius of curvature
r	small circle radius
s	meridional arc distance
$\bar{s}$	meridional eccentricity of ring centroid from corresponding subdivision point
T_1, T_2, T_{12}	meridional, circumferential, and shear shell stress resultants, respectively
T_ϕ	ring hoop stress resultant
t	shell thickness
u, v	generalized displacement vectors; also meridional and circumferential shell displacements, respectively
u_y	radial ring displacement
w	normal shell displacement

X, Y, Z	shell variables defined by Equations (6)
X_1, X_2, X_3	external shell surface forces per unit of area in meridional, circumferential, and normal directions, respectively.
x, y, z	axial, radial, and normal coordinates, respectively
Z	curvature parameter for cylindrical or toroidal shell, $(\ell^2/rt)(1-\nu^2)^{1/2}$
$\bar{z}$	ring or stringer normal centroidal eccentricity from shell inner surface
α, β	first and second imperfection parameters, respectively
Δ	work deflection; also incremental value
$\bar{\delta}$	maximum normal displacement of buckling mode imperfection
γ	meridion orientation angle
$\epsilon_1, \epsilon_2, \epsilon_{12}$	meridional, circumferential, and shear shell stretching strains, respectively
ϵ_ϕ	ring hoop strain
$\kappa_1, \kappa_2, \kappa_{12}$	meridional, circumferential, and shear shell bending strains, respectively
λ	load factor; also shallow spherical shell parameter, $2[3(1-\nu^2)]^{1/4}(H/t)^{1/2}$
λ_c	critical load factor for bifurcation buckling of perfect structure
λ_s	buckling load for imperfect structure (snapping load)
λ_o	load level of nonlinear prebuckling state
λ_{ij} $(i,j = 1,2,3,4)$	orthotropic shell wall normal moduli defined by Equation (7) of Reference 14
μ	buckling mode functional defined by Equation (8)
μ_{ij} $(i,j = 1,2)$	orthotropic shell wall shear moduli defined by Equation (7) of Reference 14
ν	Poisson's ratio
Θ	postbuckling slope angle of axial load-deflection curve of cylindrical shell, $=$ arctan $[d(P/P_c)/d(\Delta/\Delta_c)]$

Θ_o	prebuckling slope angle of axial load-deflection curve of cylindrical shell
ν_1	orthotropic Poisson contraction ratio with meridional stress acting
ξ	normal amplitude of the contribution of the buckling mode to the postbuckling state
ξ, η, v	shell displacements in axial, radial, and circumferential directions, respectively
$\bar{\xi}$	root-mean-square angular imperfection amplitude
$\Phi(\bar{u})$	imperfection functional defined by Equation (B-21)
ϕ	circumferential angle
χ, ψ, θ	shell elemental rotations about circumferential, meridional, and normal directions, respectively
Ω_x, Ω_y	ring variables defined by Equations (6)
$\omega_x, \omega_y, \omega_\phi$	ring elemental rotations about axial, radial, circumferential directions, respectively

Subscripts:

av	average value
c	critical value
cl	classical value
mode	pertaining to imperfection shape proportional to buckling mode
$_0(\ )$	pertaining to the axisymmetric component of the second-order postbuckling state
$_2(\ )$	pertaining to the unsymmetric harmonic component of the second-order postbuckling state

Superscripts:

$(\ )^{(e)}$	nonhomogeneous part
$(\ )^{(0)}$	pertaining to the prebuckling state (generally evaluated at $\lambda = \lambda_c$)

$(\ )^{(1)}$	pertaining to the buckling mode
$(\ )^{(2)}$	pertaining to the second-order postbuckling state
$(\tilde{\ })$	pertaining to an arbitrary imperfection
$(\bar{\ })$	pertaining to a normalized imperfection shape
$(\hat{\ })$	pertaining to the worst imperfection shape
$(\ )^*$	evaluated at $\lambda = \lambda_c$
$(\ )'$	$\partial(\ )/\partial s$
$(\ )^{\cdot}$	$\partial(\ )/\partial\phi$
$(\dot{\ })$	$\partial(\ )/\partial r$

Generalized field variables and operators:

$H(\varepsilon)$	linear operator relating generalized stresses and strains
$L_1(u)$	linear operator representing linear part of the strain-displacement relations
$L_2(u)$	quadratic operator representing the nonlinear part of the strain-displacement relations
$L_{11}(u,v)$	bilinear operator defined by the identity $L_2(u+v) = L_2(u)+2L_{11}(u,v)+L_2(v)$
$q_1(u)$	perturbation load vector associated with a (live) normal pressure field
u	displacement
ε	strain
σ	stress

Generalized variable subscripts:

0	associated with the prebuckling state
1	associated with the buckling mode

2	associated with the second-order postbuckling state

Generalized variable superscripts:

(1)	$\partial(\ )/\partial\lambda$
(2)	$\partial^2(\ )/\partial\lambda^2$

Matrices:

[B],[D]	4x4 boundary conditions matrices
[e]	4x4 ring eccentricity matrix defined by Equation (A8) of Reference 15
[k]	4x4 ring stiffness matrix defined by Equation (A5) of Reference 15 (in which k is denoted by κ)
{L}	4x1 boundary condition load matrix
{y}	4x1 internal shell force matrix
{z}	4x1 shell displacement matrix
[κ]	4x4 ring prestress matrix defined by Equation (A5) of Reference 13.

Matrix superscripts:

$(\ )^T$	transpose

ANALYTICAL FORMULATION

The general theory upon which this study is based has been presented in References 11 and 12. In the general development presented there, no restrictions on the structural geometry are imposed. In this study attention is restricted to ring-stiffened shells of revolution subjected to axisymmetric torsionless loads, and consequently the analytical formulation is, in a sense, a specialization of the equations of References 11 and 12 to this class of structures.

Imperfection Analysis

Imperfection measure. - A primary goal of this study was to develop a capability to assess the snapping loads of stiffened shells of revolution as a function of a mean imperfection amplitude or measure $\bar{\xi}$. For this purpose it is convenient to consider geometrical imperfections as angular deviations of either shell or ring elements from the desired geometrical orientation, and $\bar{\xi}^2$ as a mean square imperfection amplitude given by*

$$\bar{\xi}^2 = (1/A) \int_s \int_0^{2\pi} (\tilde{\chi}^2+\tilde{\psi}^2+\tilde{\theta}^2) r\,d\phi\,ds + [1/(2\pi \sum_k a)] \sum_k a \int_0^{2\pi} (\tilde{\omega}_x^2+\tilde{\omega}_y^2) d\phi \qquad (1)$$

where the integral over s ranges over the whole shell meridian, and the summations over k range over all rings. With this definition of the imperfection amplitude, the relation $\tilde{u} = \bar{\xi}\bar{u}$ between the imperfection $\tilde{u}$ and the normalized imperfection shape $\bar{u}$ yields the normalization condition

$$(1/A) \int_s \int_0^{2\pi} (\bar{\chi}^2+\bar{\psi}^2+\bar{\theta}^2) r\,d\phi\,ds + [1/(2\pi \sum_k a)] \sum_k a) \int_0^{2\pi} (\bar{\omega}_x^2+\bar{\omega}_y^2) d\phi = 1 \qquad (2)$$

Except for Equation (2) and conditions of continuity, the normalized imperfection angles, $\bar{\chi},\bar{\psi},\bar{\theta}$ for the shell and $\bar{\omega}_x,\bar{\omega}_y$ for the rings, are arbitrary functions of s and ϕ.

Snapping load. - For a given imperfection shape, Equation (35) of Reference 11 gives the snapping load λ_s in the case where the first postbuckling coefficient a is nonzero, and Equation (36) of Reference 11 gives λ_s when a = 0 and the second postbuckling coefficient b is negative. Since for axisymmetric structures having a unique (unsymmetrical) harmonic buckling mode, a is identically zero, the latter of these two equations is of primary importance here. This equation is reproduced here as Equation (3) and displayed graphically in Figure 1.

$$(1-\lambda_s/\lambda_c)^{3/2}+3(-3b\alpha^2\bar{\xi}^2)^{1/2}[(\beta/\alpha)(1-\lambda_s/\lambda_c)-1]/2 = 0 \qquad (3)$$

Equation (3) reduces to the original Koiter relation [Equation 45.10) with n = 4 of Reference 1] if β is set to zero. On the other hand, for a linear prebuckling state neglecting prebuckling deformations, $\beta = \alpha$. Therefore, β is included in an attempt to improve the accuracy of Equation (3); however, as noted in Reference 11, Equation (3) is not a complete second approximation since other terms of the same order as β-terms have been neglected. It should be noted further that b, α, and β do not have unique values but depend on the normalization of the buckling mode. If the buckling mode is changed by the multiplicative factor C_1, then b changes by the factor C_1^2 and α and β change by the factor $1/C_1$. It therefore follows, as it should, that the quantities which determine the physical load knockdown λ_s/λ_c, viz. $b\alpha^2$ and β/α, have unique values. In order to use Figure 1 to determine the snapping load λ_s as a function of the root-mean-square imperfection amplitude $\bar{\xi}$, it

*The ring angular deviation $\tilde{\omega}_\phi$ does not enter into the theory and therefore is omitted from Equation (1).

is necessary to know in addition to these quantities the corresponding critical load λ_c of the perfect structure. All these quantities must be determined for each bifurcation buckling mode of the perfect structure, each of which has a λ_s-$\bar{\xi}$ relationship. The theory, to obtain each buckling mode of ring-stiffened shells of revolution has been presented in Reference 8, and it is assumed henceforth that λ_c and other details of the buckling mode, along with the prebuckling state at λ_c, are known inputs to the imperfection analysis.

On the other hand, if a = 0 and b>0, Equation (3) does not apply and the structure may carry loads greater than λ_c. In order to assess this additional load carrying capacity, it is desirable to compute the ratio of initial postbuckling stiffness K* to the prebuckling stiffness at bifurcation K_0^*. Formulas for the functionals b, K_0, K*, α, and β are presented in References 11 and 12, and it is the basic purpose of this study to develop the capability to evaluate these quantities for each buckling mode and imperfection shape of interest.

Worst imperfection shape. - As is evident from Figure 1, for sufficiently small imperfection amplitudes the value of β is relatively unimportant. For this reason, the worst imperfection shape, which for a given (sufficiently small) value of $\bar{\xi}$ tends to produce the greatest reduction in critical load, is defined as those particular imperfection angles, denoted here by $\hat{\chi}, \hat{\psi}, \hat{\theta}, \hat{\omega}_x, \hat{\omega}_y$, which maximize the value of α subject to the normalization condition (2).

From Reference 12, the general expression for α is

$$\alpha = [\sigma_o^* \cdot L_{11}(\bar{u}, u_1) + \sigma_1 \cdot L_{11}(\bar{u}, u_o^*) - \lambda_c q_1(\bar{u}) \cdot u_1] / \lambda_c F^{(1)}(u_1, u_1) \tag{4}$$

Since the denominator of this expression is independent of the imperfection, it is only necessary to find the imperfection shape which maximizes the numerator. For ring-stiffened shells of revolution, the numerator, denoted here as I, is given by†

$$I \equiv \int_s \int_0^{2\pi} (X\bar{\chi} + Y\bar{\psi} + Z\bar{\theta}) r \, d\phi \, ds + \sum_k a \int_0^{2\pi} (\Omega_x \bar{\omega}_x + \Omega_y \bar{\omega}_y) d\phi \tag{5}$$

†For clarity, the asterisk is omitted from explicit prebuckling variables, it being understood that they are evaluated at λ_c. In obtaining Equation (5), normal pressure field terms associated with surface dilatation and pressure gradients have been neglected. For dead loading, the terms in Equations (6) with the factor p should be omitted.

where

$$X = T_1^{(0)}\chi^{(1)}+T_1^{(1)}\chi^{(0)}-\lambda_c pu^{(1)}$$

$$Y = T_2^{(0)}\psi^{(1)}+T_{12}^{(1)}\chi^{(0)}-\lambda_c pv^{(1)}$$

$$Z = [T_1^{(0)}+T_2^{(0)}]\theta^{(1)} \tag{6}$$

$$\Omega_x = T_\phi^{(0)}\omega_x^{(1)}$$

$$\Omega_y = T_\phi^{(0)}\omega_y^{(1)}$$

From Equation (2) and the following Schwarz inequality

$$I^2 \le \mu^2[(1/A)\int_s\int_0^{2\pi}(\bar{\chi}^2+\bar{\psi}^2+\bar{\theta}^2)r\,d\phi\,ds+[1/(2\pi\sum_k a)]\sum_k a\int_0^{2\pi}(\bar{\omega}_x^2+\bar{\omega}_y^2)d\phi] \tag{7}$$

where

$$\mu^2 = A\int_s\int_0^{2\pi}(X^2+Y^2+Z^2)r\,d\phi\,ds+(2\pi\sum_k a)\sum_k a\int_0^{2\pi}(\Omega_x^2+\Omega_y^2)d\phi \tag{8}$$

it follows that the maximum value of α is

$$\hat{\alpha} = \mu/\lambda_c F^{(1)}(u_1,u_1) \tag{9}$$

Furthermore, this value is reached only for the special imperfection angles given by

$$\hat{\chi} = AX/\mu$$

$$\hat{\psi} = AY/\mu$$

$$\hat{\theta} = AZ/\mu \tag{10}$$

$$\hat{\omega}_x = (2\pi\sum_k a)\Omega_x/\mu$$

$$\hat{\omega}_y = (2\pi\sum_k a)\Omega_y/\mu$$

Perfect Structure Analysis

Whereas the imperfection parameters α and β depend only on the prebuckling state and buckling mode (which may be called the first-order postbuckling state) of the perfect structure, b and K* depend, in addition, on the second-order postbuckling state. The equations for this state are given in Reference 11 in variational form. However, for numerical purposes, the corresponding differential equations are more convenient to use and they are most easily derived by applying the perturbation procedure directly to the nonlinear field equations.

Field equations for shells of revolution. - A suitable form of the nonlinear field equations for shells of revolution is given in Section II of Reference 13. Before applying the perturbation procedure, it is convenient to transform these equations to a set of eight basic differential equations in the eight basic shell variables $P,Q,S,M_1,\xi,\eta,v,\chi$, plus a set of supplemental equations, as has been done previously for the linearized shell equations (Reference 14) and the corresponding perturbation equations (Reference 13). The transformation of the equations is accomplished with the help of the Gauss-Codazzi surface compatibility relations. The resulting equilibrium equations are

$$(rP)'+(r/R_2)\dot{S}-(2/r)\dot{M}_{12}-(r'/r)\ddot{M}_2-(r/R_2)[(T_1+T_2)\theta]^{\cdot}+r'(T_2\psi+T_{12}\chi)^{\cdot}$$
$$+r[(r/R_2)X_1-r'X_3]+r'\dot{L}_1 = 0$$

$$(rQ)'+r'\dot{S}-T_2+\ddot{M}_2/R_2-r'[(T_1+T_2)\theta]^{\cdot}-(r/R_2)(T_2\psi+T_{12}\chi)^{\cdot}+r[r'X_1+(r/R_2)X_3]$$
$$-(r/R_2)\dot{L}_1 = 0 \qquad (11)$$

$$(rS)'+r'S+\dot{T}_2+\dot{M}_2/R_2-r'(T_1+T_2)\theta-(r/R_2)(T_2\psi+T_{12}\chi)+rX_2-(r/R_2)L_1 = 0$$

$$(rM_1)'+r[r'P-(r/R_2)Q]-r'M_2+2\dot{M}_{12}-r(T_1\chi+T_{12}\psi)+rL_2=0$$

where the primes indicate partial derivatives with respect to s and the dots indicate partial derivatives with respect to ϕ. The nonlinear terms in Equations (11) can be conveniently thought of as the following additional load terms applied to the linearized equations.

$$X_1 = -[(T_1+T_2)\theta]^{\bullet}/r$$

$$X_2 = -(r'/r)(T_1+T_2)\theta$$

$$X_3 = 0 \tag{12}$$

$$L_1 = T_2\psi+T_{12}\chi$$

$$L_2 = -(T_1\chi+T_{12}\psi)$$

This isolation of the nonlinear terms is desirable since linear terms will pass through the perturbation procedure unaffected.

The four basic kinematic equations may be written in the form

$$\xi' = r'\chi+(r/R_2)e_1$$

$$\eta' = -(r/R_2)\chi+r'e_1 \tag{13}$$

$$v' = -\dot{\xi}/R_2-(r'/r)(\dot{\eta}-v)+e_{12}$$

$$\chi' = \kappa_1$$

Equations (13) are linear since they do not involve the strains $\varepsilon_1,\varepsilon_{12}$ but rather the linearized strain expressions e_1,e_{12}. In addition to the nonlinear strain-rotation equations, given by Equations (1) of Reference 13, and the partially inverted constitutive relations, given by Equations (6) of Reference 14 with S replaced by $S-(T_1+T_2)\theta/2$, the following equations complete the transformed system of field equations

$$T_{12} = S-2M_{12}/R_2-(T_1+T_2)\theta/2 \tag{14a}$$

$$T_1 = (r/R_2)P + r'Q$$

$$e_2 = (\eta + \dot{v})/r$$

$$\kappa_2 = [r'(\chi + \ddot{\xi}/r) + (\dot{v} - \ddot{\eta})/R_2]/r$$

$$\kappa_{12} - e_{12}/R_2 = (\chi - \xi/r)^{\bullet}/r \tag{14b}$$

$$\psi = (v - \dot{\eta})/R_2 + (r'/r)\dot{\xi}$$

$$\theta = (r'/r)(v - \dot{\eta}) - \dot{\xi}/R_2$$

Equations for second-order postbuckling state. - In deriving the equations for the second-order contribution to the postbuckling state, all response variables of the postbuckling state are expanded in a power series in a parameter ξ about the corresponding variables of the prebuckling state at the same load level λ. These expansions are then substituted directly into each of the field equations. Terms of the same order in ξ are collected after subtracting off the corresponding equations satisfied by the prebuckling state variables. Terms of order ξ then yield the buckling mode (eigenvalue) equations and terms of order ξ^2 yield the second-order equations.

In order to illustrate the perturbation procedure, consider the strain-rotation equation

$$\varepsilon_1 = e_1 + (\chi^2 + \theta^2)/2 \tag{15}$$

Substituting the expansions for each of these variables and dropping terms of order ξ^3 and higher gives

$$\varepsilon_1^{(0)} + \xi\varepsilon_1^{(1)} + \xi^2\varepsilon_1^{(2)} = e_1^{(0)} + \xi e_1^{(1)} + \xi^2 e_1^{(2)} + [\chi^{(0)} + \xi\chi^{(1)} + \xi^2\chi^{(2)}]^2/2 + [\xi\theta^{(1)} + \xi^2\theta^{(2)}]^2/2 \tag{16}$$

In Equation (16) the prebuckling rotation about the normal direction $\theta^{(0)}$ has been omitted since it is identically zero for an axisymmetric torsionless prebuckling state. The prebuckling rotation $\chi^{(0)}$ is also a function of ξ through its dependence on λ. However, since $a = 0$, it follows that the difference between $\chi^{(0)}(\lambda)$ and $\chi^{(0)}(\lambda_c)$ is $O(\xi^2)$. Consequently, up to the order considered, no error is incurred if $\chi^{(0)}$ is evaluated at $\lambda = \lambda_c$. Subtracting the prebuckling relation $\varepsilon_1^{(0)} = e_1^{(0)}+\chi^{(0)2}/2$ from Equation (16) and equating terms of the same order in ξ gives

$$\varepsilon_1^{(1)}-e_1^{(1)}-\chi^{(0)}\chi^{(1)} = 0 \tag{17a}$$

$$\varepsilon_1^{(2)}-e_1^{(2)}-\chi^{(0)}\chi^{(2)} = [\chi^{(1)2}+\theta^{(1)2}]/2 \tag{17b}$$

Equation (17a) is one of the field equations for the buckling mode, and Equation (17b) is one of the field equations for the second-order postbuckling state. It should be observed that the homogeneous parts (i.e., the left-hand sides) of these two equations are identical, the only difference being the addition in Equation (17b) of a nonhomogeneous term quadratically dependent on the buckling mode. This difference is typical of all equations arising from field equations with nonlinear terms. Linear field equations give rise to equations which are identical in form to the original field equation from which they are derived.

Applying this procedure to all of the field equations given in the preceding section yields the following equations for the second-order postbuckling state. The equilibrium equations are identical to the linearized form of Equations (11) if the load terms are identified as*

$$\begin{aligned}
X_1 &= \lambda_c p\chi-[T_1^{(0)}+T_2^{(0)}]\theta^{\bullet}/r-\{[T_1^{(1)}+T_2^{(1)}]\theta^{(1)}\}^{\bullet}/r \\
X_2 &= \lambda_c p\psi-r'[T_1^{(0)}+T_2^{(0)}]\theta/r-r'[T_1^{(1)}+T_2^{(1)}]\theta^{(1)}/r \\
X_3 &= \lambda_c[p(e_1+e_2)+\xi\partial p/\partial x+\eta\partial p/\partial y] \\
L_1 &= T_2^{(0)}\psi+T_{12}\chi^{(0)}+T_2^{(1)}\psi^{(1)}+T_{12}^{(1)}\chi^{(1)} \\
L_2 &= -T_1^{(0)}\chi-T_1\chi^{(0)}-T_1^{(1)}\chi^{(1)}-T_{12}^{(1)}\psi^{(1)}
\end{aligned} \tag{18}$$

---

*For clarity, the superscript (2) is henceforth omitted from the second-order postbuckling state variables. Terms of Equations (18) with the factor p are associated with a normal pressure field $\lambda p(x,y)$ and are omitted for dead loading.

The kinematic equations (13), being linear, apply unaltered to the second-order postbuckling state. The strain-rotation equations become

$$\varepsilon_1 = e_1+\chi^{(0)}\chi+[\chi^{(1)2}+\theta^{(1)2}]/2$$

$$\varepsilon_2 = e_2+[\psi^{(1)2}+\theta^{(1)2}]/2 \tag{19}$$

$$\varepsilon_{12} = e_{12}+\chi^{(0)}\psi+\chi^{(1)}\psi^{(1)}$$

The constitutive equations become

$$T_2 = \lambda_{11}\varepsilon_2+\lambda_{12}\kappa_2+\lambda_{13}T_1+\lambda_{14}M_1$$

$$M_2 = \lambda_{21}\varepsilon_2+\lambda_{22}\kappa_2+\lambda_{23}T_1+\lambda_{24}M_1$$

$$\varepsilon_1 = \lambda_{31}\varepsilon_2+\lambda_{32}\kappa_2+\lambda_{33}T_1+\lambda_{34}M_1 \tag{20}$$

$$\kappa_1 = \lambda_{41}\varepsilon_2+\lambda_{42}\kappa_2+\lambda_{43}T_1+\lambda_{44}M_1$$

$$2M_{12} = \mu_{11}\kappa_{12}^{\dagger}+\mu_{12}S^{\dagger}$$

$$\varepsilon_{12} = \mu_{21}\kappa_{12}^{\dagger}+\mu_{22}S^{\dagger}$$

where $\kappa_{12}^{\dagger} = \kappa_{12}-\varepsilon_{12}/R_2$

$$S^{\dagger} = S-[T_1^{(0)}+T_2^{(0)}]\theta/2-[T_1^{(1)}+T_2^{(1)}]\theta^{(1)}/2$$

Equation (14a) becomes

$$T_{12} = S-2M_{12}/R_2-[T_1^{(0)}+T_2^{(0)}]\theta/2-[T_1^{(1)}+T_2^{(1)}]\theta^{(1)}/2 \tag{21}$$

whereas Equations (14b), being linear, remain unaltered in form.

A similar analysis can be made on the differential equations for elastic rings. In analogy with Equations (18), the resulting equations are identical in form to the linearized ring equations if the applied moments and forces per unit of length are identified as

$$\begin{aligned}
F_x &= 0 \\
F_y &= -EA[\omega_x^{(1)2}+\omega_y^{(1)2}]/2a \\
F_\phi &= EA[\omega_x^{(1)2}+\omega_y^{(1)2}]^{\bullet}/2a \\
N_x &= -T_\phi^{(0)}\omega_x-T_\phi^{(1)}\omega_x^{(1)} \\
N_y &= -T_\phi^{(0)}\omega_y-T_\phi^{(1)}\omega_y^{(1)} \\
N_\phi &= 0
\end{aligned} \tag{22}$$

<u>Method of solution</u>. - Examination of the equations of the preceding section shows that all nonhomogeneous terms are quadratic functions of buckling mode variables. Since, in general, these variables are pure harmonic functions of the circumferential coordinate ϕ, the nonhomogeneous terms may be decomposed into an axisymmetric component and a sinusoidal component. This is accomplished by use of the trigonometric identities

$$\begin{aligned}
\cos^2 x &= (1+\cos 2x)/2 \\
\sin^2 x &= (1-\cos 2x)/2 \\
\sin x \cos x &= \sin 2x/2
\end{aligned} \tag{23}$$

Denoting the nonhomogeneous parts of the load terms of Equations (18) with the superscript (e), and the amplitudes of the buckling mode variables by the same symbols as used previously for total quantities, one obtains,

$$X_1^{(e)} = -(n_c/r)[T_1^{(1)}+T_2^{(1)}]\theta^{(1)}\cos 2n_c\phi$$

$$X_2^{(e)} = -(r'/2r)[T_1^{(1)}+T_2^{(1)}]\theta^{(1)}\sin 2n_c\phi$$

$$X_3^{(e)} = 0 \tag{24}$$

$$L_1^{(e)} = (1/2)[T_2^{(1)}\psi^{(1)}+T_{12}^{(1)}\chi^{(1)}]\sin 2n_c\phi$$

$$L_2^{(e)} = -(1/2)[T_1^{(1)}\chi^{(1)}+T_{12}^{(1)}\psi^{(1)}]$$

$$-(1/2)[T_1^{(1)}\chi^{(1)}-T_{12}^{(1)}\psi^{(1)}]\cos 2n_c\phi$$

Similarly, the nonhomogeneous parts of the strain expressions, Equations (19) may be decomposed to

$$\varepsilon_1^{(e)} = (1/4)[\chi^{(1)2}+\theta^{(1)2}]+(1/4)[\chi^{(1)2}-\theta^{(1)2}]\cos 2n_c\phi$$

$$\varepsilon_2^{(e)} = (1/4)[\psi^{(1)2}+\theta^{(1)2}]-(1/4)[\psi^{(1)2}+\theta^{(1)2}]\cos 2n_c\phi \tag{25}$$

$$\varepsilon_{12}^{(e)} = (1/2)\chi^{(1)}\psi^{(1)}\sin 2n_c\phi$$

The nonhomogeneous term $[T_1^{(1)}+T_2^{(1)}]\theta^{(1)}/2$ in Equations (20) and (21) becomes $(1/4)[T_1^{(1)}+T_2^{(1)}]\theta^{(1)}\sin 2n_c\phi$, and the nonhomogeneous ring loads become, from Equations (22),

$$F_x^{(e)} = 0$$

$$F_y^{(e)} = -(EA/4a)[\omega_x^{(1)2}+\omega_y^{(1)2}]+(EA/4a)[\omega_x^{(1)2}+\omega_y^{(1)2}]\cos 2n_c\phi$$

$$F_\phi^{(e)} = (n_c EA/2a)[\omega_x^{(1)2}+\omega_y^{(1)2}]\sin 2n_c\phi \tag{26}$$

$$N_x^{(e)} = -(1/2)T_\phi^{(1)}\omega_x^{(1)}\sin 2n_c\phi$$

$$N_y^{(e)} = -(1/2)T_\phi^{(1)}\omega_y^{(1)}\sin 2n_c\phi$$

$$N_\phi^{(e)} = 0$$

It follows, therefore, that the response variables for the second-order postbuckling state are composed of the two harmonics $n = 0$ and $n = 2n_c$, which are uncoupled and may be solved for individually, one after the other. Each of these problems is analogous to a linear shell statics problem with pure sinusoidal loading so that the method of solution presented in Reference 14 can be used.

For each harmonic, the boundary conditions at meridional stations at which elastic rings are attached may be written in the matrix notation of References 13 and 15 as

$$r\Delta\{y\}-[k-\kappa(\lambda_c)]\{z\} = -[e]^T\{L\} \tag{27}$$

where

$$\{L\} = \begin{Bmatrix} aF_x^{(e)} + nN_y^{(e)} \\ aF_y^{(e)} - nN_x^{(e)} \\ aF_\phi^{(e)} - N_x^{(e)} \\ aN_\phi^{(e)} \end{Bmatrix} \tag{28}$$

Here $F^{(e)}$ and $N^{(e)}$ are either the axisymmetric or sinusoidal amplitudes of the corresponding total quantities given by Equations (26). Other boundary conditions for the second-order postbuckling state are either homogeneous versions of general linear conditions imposed on the actual shell (e.g., external line loads) or conditions at the initial and/or terminal shell edge representing a spherical dome closure (see Appendix A). After the response variables of the second-order postbuckling state are determined, they are used in the evaluation of the postbuckling coefficient b and the initial postbuckling stiffness K* as shown in Appendix B.

EXAMPLES

Results for the following examples are presented and compared to independently obtained published results: (1) a simply supported toroidal shell (equatorial) segment subjected to uniform lateral pressure (Reference 5), (2) a clamped spherical cap subjected to uniform pressure (Reference 9), (3) unstiffened and ring-stiffened simply supported cylinders subjected to uniform hydrostatic pressure (Reference 6), and (4) a simply supported stringer-stiffened cylinder subjected to axial compression (Reference 10). In addition, results are presented for a cylindrical shell under axial compression with simply supported and ring-stiffened edges, since in these cases an independent verification of the postbuckling stiffness calculation can be made.

Toroidal Shell Segment

A six-degree toroidal shell segment of positive Gaussian curvature with $r/a = 0.5$, $t/r = 0.008265$, and $\nu = 1/3$ was considered. Here r is the equatorial radius and a the meridional radius of curvature. These values correspond to the curvature parameter $Z = 5$. Based on a uniform membrane prebuckling state (as in Reference 5), the computer results are, for $n_c = 20$, $p/E = 6.120 \times 10^{-5}$ and $b = -0.496$ (with the buckling mode normalized to have a normal deflection amplitude equal to the shell thickness). Hutchinson's Fourier series solution [Equation (36) of Reference 5] gives for this shell $b = -0.501$ (and $p/E = 6.125 \times 10^{-5}$). The small difference between these two results may be attributed to the use of a Donnell-type shell theory and the treatment of n as a continuous variable in Reference 5.

Spherical Cap

A twenty-degree spherical cap with $t/R = 0.01094$ and $\nu = 1/3$ was considered. These values correspond to the shallow shell parameter $\lambda = 6$. Based on a nonlinear prebuckling state, the computer results are, for $n_c = 2$, $q_c/q_o = 0.783$, $b = -0.790$, and $K^*/K_0^* = 4.195$, which in the notation of Reference 9 corresponds to the value $\alpha = -0.585$. These results are in good agreement with Fitch and Budiansky's finite-difference solution of the shallow shell equations given in Figure 8 of Reference 9. Small discrepancies with the results of that reference may be attributed to the use of shallow shell theory and dead pressure loading in Reference 9.

Ring-Stiffened Cylinders

The only previously published results for ring-stiffened shells are those of Hutchinson and Amazigo for ring-stiffened cylinders (Reference 6). In that paper the stretching and in-plane bending ring stiffnesses are uniformly distributed over the shell, and the torsional and out-of-plane bending stiffnesses are neglected. In order to compare their results with the results of the present computer program, which treats rings discretely, it is necessary to choose a cylindrical shell with many rings of uniform size and spacing.

For this purpose, a shell was chosen with $r/t = 100$, $\ell/r = 0.724$, and $\nu = 0.3$*, resulting in the curvature parameter $Z = (\ell^2/rt)(1-\nu^2)^{1/2} = 50$. For the stiffened cylinder, 11 equally spaced rings were chosen with the centroid to centroid spacing $d = \ell/11$, the two outermost rings being spaced a distance $d/2$ from the simply supported edges. The section properties used for the rings are: $A/r^2 = 1.318 \times 10^{-4}$, $I_x/r^4 = 6.02 \times 10^{-8}$, $I_y = I_{xy} = J = \bar{s} = 0$, and $\bar{z}/r = 0.025$ and -0.015. Assuming that the shell and rings have the same Young's modulus, these values correspond to what is referred to in Reference 6 as light stiffening, i.e., $A/dt = 0.2$, $EI/Dd = 10$, $e/t = \pm 2$, to which Figure 8 of Reference 6 applies. The table below gives the buckling pressures obtained, and the corresponding values

*After the calculations were made, it was discovered that the value $\nu = 1/3$ was used in Reference 6.

of the second postbuckling coefficient in the case of live pressure loading. The values in parentheses are the buckling mode harmonic numbers.

	Reference 6 (Figure 8, $\nu = 1/3$)		Present ($\nu = 0.3$)	
	$p_c/E \times 10^4$	b	$p_c/E \times 10^4$	b
Unstiffened cylinder[a]	0.13	-0.2	0.140 (9)	-0.222
Internal stiffening[a]	0.73	-0.1+	0.753 (6)	-0.0750
Internal stiffening[b]	--	--	0.671 (6)	-0.0676
External stiffening[a]	0.73+	-0.12	0.779 (6)	-0.0830

Aside from the noted difference in Poisson's ratio, the only reason for discrepancy in the case of the unstiffened cylinder is the use of Novozhilov shell theory here as opposed to Donnell theory in Reference 6. For the stiffened cylinders, the smearing-out of the ring stiffness in Reference 6 is a further difference, which apparently causes the greater discrepancy in these cases.

In order to obtain a better correlation with the results of Reference 6, the shell was reconsidered with its radius increased by a factor of 5, but with all other properties unchanged. Since this is, in effect, a shorter shell, the assumption of smeared out rings should be more accurate. In order to obtain the best possible agreement, the calculation was made only for a membrane prebuckling state, as was done in Reference 6. The table below gives the buckling pressures and the corresponding values of the second postbuckling coefficient.

	Reference 6 (Figure 8, $\nu = 1/3$)		Present ($\nu = 0.3$)	
	$p_c/E \times 10^6$	b	$p_c/E \times 10^6$	b
Internal rings	3.75	-0.22	3.77 (15)	-0.214
External rings	4.85	-0.33	4.80 (16)	-0.319

As expected, in this case the agreement is much better.

---

[a]Based on membrane prebuckling state

[b]Based on nonlinear prebuckling state

Stringer-Stiffened Cylinder

A cylindrical shell was chosen with $t/r = 0.001343$, $\ell/r = 0.65$, and $\nu = 0.3$, corresponding to the curvature parameter $Z = 300$. In addition, the following stringer properties were chosen: $EI/Dd = 100$, $A/dt = 1$, and $e/t = 6$ (external stringers). In order to compare with the results of Reference 10, in which stringer torsional stiffness is neglected, GJ/Dd was set to zero. From Table 2 of Reference 10, it is seen that the predicted critical harmonic for this shell is exactly $n_c = 10$, so that no error can be attributed to the treatment in that reference of n as a continuous variable. The table below compares the present results to those of Reference 10.

	$(P_c)_{stiff}/(P_c)_{unstiff}$	b	$\alpha^2 b$	Θ_0^*	Θ^*
Present results	8.74	-0.0114	-0.00360	36.4°	-141.1°
Reference 10	8.79	-0.012	-0.0042	36.	-142.

Here, b-values are based on the buckling mode normalized to have a normal deflection amplitude equal to the shell thickness, and α-values on an imperfection shape identical to the normalized buckling mode deflections.

As seen, the agreement between the finite-difference results of Reference 10 and the present results is good except for the imperfection parameter α. In Reference 16, however, it is noted that this discrepancy is primarily the result of truncation error in the finite-difference solution associated with the use of only 60 finite-difference stations. The convergence of the finite-difference solution for b and $\alpha^2 b$ as the number of stations N increases is shown in the following table taken from Reference 16.

N	b	$\alpha^2 b$
30	-0.0130	-0.0052
60	-0.0121	-0.00425
95	-0.0119	-0.00395

These results show that as the number of stations increases, the corresponding finite-difference solution tends to better agreement with the present results. Complete numerical agreement, however, can not be expected because of differences between the Donnell shell theory used in References 10 and 16 and the Novozhilov theory used here.

Cylindrical Shell Under Axial Compression

As a final example, the case of a cylinder under axial compression is presented. Since under uniform axial compression the work deflection Δ is simply the average end shortening, an independent calculation of K* can be made to check the program. The formula for this is

$$K^* = (1/K_0^* + \Delta^{(2)}/bP_c)^{-1} \tag{29}$$

where $\Delta^{(2)}$ is the average end shortening in the second-order postbuckling component and P_c is the critical load. Calculations were made for a monocoque cylinder ($r/t = 100$, $\ell/r = 0.7$, and $\nu = 0.3$) with both simply supported and ring-stiffened edges.

Simply supported edges. - The computer results for this case are $P_c/P_{cl} = 0.801$ ($n_c = 8$) where P_{cl} is the classical critical load, $K_0^*/Er = 0.0724$, $b = -4.95 \times 10^3$ (for the buckling mode normalized to have maximum normal deflection of one shell radius), and $K^*/Er = 0.0880$. Note that the prebuckling stiffness for the cylinder with free edges is $K_0/Er = 2\pi t/\ell = 0.0898$, so that simple supports make the prebuckled cylinder less stiff with respect to axial load. Secondly, since b is negative, the postbuckling load-deflection curve is falling at a somewhat greater slope than the prebuckling curve is rising. This is the classical picture of the postbuckling equilibrium path doubling back under the prebuckling path. The computation of K* was verified since the hand calculation of K* using Equation (29) checked the printed value to at least four significant digits.

Ring-stiffened edges. - In this case the shell edges are supported by internal square rings of width 3t and the axial load is applied at the ring centroid. The computer results for this case are $P_c/P_{cl} = 0.0167$ ($n_c = 2$), $K_0^*/Er = 0.0118$, $b = -3.93$, and $K^*/Er = -1.357 \times 10^{-5}$. In this case, the work deflection is not the end shortening of the shell but rather the relative axial shortening of the distance between the (eccentric) ring centroids. As a result of the out-of-plane bending flexibility of the rings, the prebuckling stiffness is drastically reduced. On the other hand, the ring eccentricity increases the buckling load of the essentially inextensional mode by causing ring stretching to occur during buckling. With no eccentricity the inextensional buckling theory gives [see Equation (22) of Reference 7] $P_c/P_{cl} = 0.0108$. The postbuckling load-deflection curve again falls (negative b) but this time at a small negative slope. The hand calculation of K* again checked the printed value to at least four significant digits.

CONCLUDING REMARKS

A digital computer program has been developed for the initial post-buckling and imperfection sensitivity analysis of buckling modes of general ring-stiffened shells of revolution. This program treats nonlinear prebuckling states and live pressure loading, and compares for a given mean square angular imperfection amplitude the worst imperfection shape with the buckling mode imperfection shape. The range of amplitudes treated is extended to imperfections of moderate size by computing both the first and second imperfection parameters. Assuming that the mean square imperfection measure used characterizes a particular type of shell structure and a particular type of construction, correlation of the computer results with experiment should provide a basis for realistic prediction of buckling loads of practical structures.

APPENDIX A

SHELLS WITH DOME CLOSURES

Solution for Second-Order Postbuckling State

Shells with dome closures are treated by deleting a small spherical cap containing the pole and generating appropriate boundary conditions in terms of the eight basic shell variables $(P,Q,S,M_1,\xi,\eta,v,\chi)$ for the artificial edge so created. These boundary conditions, which represent the deleted cap to first order in the edge radius, are derived in this appendix.

Based on the finitness of the linearized strain expressions one can derive, in a manner similar to that in Reference 8, the following results valid at a pole

$$\begin{aligned} n^2\xi &= 0 \\ \eta + nv &= 0 \\ n\eta + v &= 0 \\ (n^2-1)\chi &= 0 \\ \psi &= \mp\chi \end{aligned} \tag{A-1}$$

$$\begin{aligned} e_1 &= \dot{\eta} \\ e_2 &= \dot{\eta} + n\dot{v} \\ e_{12} &= \mp n\dot{\eta} \\ \kappa_1 &= \pm\dot{\chi} \\ \dot{\xi} &= \chi \\ \ddot{\xi} &= \dot{\chi} \pm \eta/R_2 \end{aligned} \tag{A-2}$$

For the terms with ambiguous signs in Equations (A-2), the upper signs apply at an initial pole, at which $r' = 1$, and the lower signs apply at a final pole, at which $r' = -1$. The dots above the symbols denote differentiation with respect to the radius r. From Equations (A-1) and (A-2) boundary conditions are derived for the axisymmetric and the sinusoidal problems of the second-order postbuckling state.

Axisymmetric problem. - From Equations (A-1) and (A-2), the following relations hold to first order in r at the artificial edge

$$\begin{aligned} \eta &= r\dot{\eta} = re_1 \\ \chi &= r\dot{\chi} = \pm r\,\kappa_1 \end{aligned} \qquad \text{(A-3)}$$

Using the last of Equations (A-1) and Equations (14b), (19), (20), and (25), Equations (A-3) become

$$\begin{aligned} &\pm r\lambda_{33}Q+r\lambda_{34}M_1-(1+\lambda_{13})\eta\mp\lambda_{23}\chi = r(1+\lambda_{13})[\chi^{(1)2}+\theta^{(1)2}]/4 \\ &\pm r\lambda_{34}Q+r\lambda_{44}M_1-\lambda_{14}\eta\mp(1+\lambda_{24})\chi = r\lambda_{14}[\chi^{(1)2}+\theta^{(1)2}]/4 \end{aligned} \qquad \text{(A-4)}$$

It can be shown that at a pole the rotation θ is the order of strain and hence negligible in Equations (19), so that the $\theta^{(1)}$-terms in Equations (A-4) are also negligible. In fact, the right-hand sides of Equations (A-4) are negligible unless $n_c = 1$, since for $n_c \neq 1$, $\chi^{(1)} = 0$ at a pole.

Since the axisymmetric problem is torsionless, a third boundary condition is simply $S = 0$. The fourth condition may be derived from the first of the equilibrium equations (11), which for the axisymmetric problem reduces to

$$(r\dot{P}) = rX_3\big|_{r=0}+0(r^2) \qquad \text{(A-5)}$$

Integration of Equation (A-5) between the limits $r = 0$ and $r = r$ gives at the edge

$$P = (r/2)X_3\big|_{r=0}+0(r^2) \qquad \text{(A-6)}$$

From the third of Equations (18) and the first of Equations (A-3), it follows that

$$X_3\big|_{r=0} = \lambda_c[2pe_2+\xi\partial p/\partial x]+O(r) \qquad \text{(A-7)}$$

Combination of Equations (A-6) and (A-7) gives the desired boundary condition, which, in view of the relation $e_2 = \eta/r$, may be written as

$$P - \lambda_c p\eta-(r/2)\lambda_c\xi\partial p/\partial x = 0 \qquad \text{(A-8)}$$

The second and third terms of Equation (A-8) arise only in the case of a live pressure field.

Sinusoidal problem. - In this case, all four boundary conditions are derivable from the first-order relations obtainable from Equations (A-1) and (A-2), viz.

$$\begin{aligned} \xi &= 0 \\ \eta &= re_1 \\ v &= r(ne_2\pm e_{12})/n^2 \\ \chi &= \pm r\kappa_1 \end{aligned} \qquad \text{(A-9)}$$

The first of Equations (A-9) is already a suitable boundary condition. The remaining three are transformed in a fashion similar to that in obtaining Equations (A-4) to give [neglecting $\theta^{(1)}$]

$$\begin{aligned} &\pm r\lambda_{33}Q+r\lambda_{34}M_1-(1+\lambda_{13}+n^2\lambda_{23}/2R_2)\eta-n(\lambda_{13}+\lambda_{23}/R_2)v\mp(1-n^2/2)\lambda_{23}\chi = r(1-\lambda_{13})\chi^{(1)2}/4 \\ &r\mu_{22}S\pm n(1-\mu_{12}/2R_2)\eta+n\mu_{12}\chi/2 = \mp r(1-\mu_{12}/R_2)\chi^{(1)2}/2 \qquad \text{(A-10)} \\ &\pm r\lambda_{34}Q+r\lambda_{44}M_1-(\lambda_{14}+n^2\lambda_{24}/2R_2)\eta-n(\lambda_{14}+\lambda_{24}/R_2)v\mp[1+(1-n^2/2)\lambda_{24}]\chi = -r\lambda_{14}\chi^{(1)2}/4 \end{aligned}$$

Correction of Integrals

In addition to employing the above boundary conditions at an artificial edge created by deleting the small polar cap, a first-order correction is made to the integrals required in the functional evaluation (Appendix B) to account for the neglect of the integral over the deleted cap. These integrals are of the form $\int_s \Psi r ds$, and the contribution over a deleted cap of edge radius r is

$$\int_{cap} \Psi r ds = \pm \int_0^r (r/r')\Psi dr \qquad \text{(A-11)}$$

In either case, one obtains

$$\int_{cap} \Psi r ds = \int_0^r [\Psi|_{r=0} + O(r)] r dr = r^2\Psi/2 + O(r^3) \qquad \text{(A-12)}$$

Thus the correction is $r^2\Psi/2$, where the integrand Ψ is evaluated at the artificial edge.

APPENDIX B

EVALUATION OF FUNCTIONALS

The general formulas for the functionals b, K_0, K^*, α, and β are given in References 11 and 12. In this appendix, these formulas are specialized to ring-stiffened shells of revolution with an axisymmetric torsionless prebuckling state. These specialized formulas can be simplified to single integrals over the shell meridian plus algebraic sums over all rings by making use of the trigonometric identities, valid for $n \neq 0$,

$$\int_0^{2\pi} \cos^2 n\phi d\phi = \int_0^{2\pi} \sin^2 n\phi d\phi = \pi$$
$$\int_0^{2\pi} \cos 2n\phi \cos^2 n\phi d\phi = -\int_0^{2\pi} \cos 2n\phi \sin^2 n\phi d\phi = \pi/2 \qquad \text{(B-1)}$$

In all cases the variables shown for the buckling mode and the sinusoidal component of the second-order postbuckling state are harmonic amplitudes of the corresponding total quantities. Since for this study axisymmetric buckling modes are uninteresting, all formulas shown are for the case $n_c \neq 0$.

Second Postbuckling Coefficient, b

The general formula for b is given by Equation (22b) of Reference 11. This formula, simplified by setting a to zero, is

$$b = -[\sigma_2 \cdot L_2(u_1) + 2\sigma_1 \cdot L_{11}(u_1, u_2)]/\lambda_c F^{(1)}(u_1, u_1) \qquad \text{(B-2)}$$

To evaluate b, the three functionals shown in Equation (B-2) must be computed.

$\underline{F^{(1)}(u_1,u_1)}$. - For shells of revolution one obtains from the definition of $F^{(1)}(u,v)$ given in Reference 11

$$(1/\pi)F^{(1)}(u_1,u_1) = \int_s \{2[T_1^{(1)}\chi^{(1)}+T_{12}^{(1)}\psi^{(1)}]\partial\chi^{(0)}/\partial\lambda+[\chi^{(1)2}+\theta^{(1)2}]\partial T_1^{(0)}/\partial\lambda$$

$$+[\psi^{(1)2}+\theta^{(1)2}]\partial T_2^{(0)}/\partial\lambda-X_1^{(1)}u^{(1)}-X_2^{(1)}v^{(1)}-X_3^{(1)}w^{(1)}\}rds$$

$$+\sum_k a[\omega_x^{(1)2}+\omega_y^{(1)2}]\partial T_\phi^{(0)}/\partial\lambda \tag{B-3}$$

where

$$X_1^{(1)} = p\chi^{(1)}$$

$$X_2^{(1)} = p\psi^{(1)} \tag{B-4}$$

$$X_3^{(1)} = p[e_1^{(1)}+e_2^{(1)}]+\xi^{(1)}\partial p/\partial x+\eta^{(1)}\partial p/\partial y$$

The terms given by Equations (B-4) represent live pressure loading and are set to zero for dead loading. It may be noted that except for two small differences $(1/\pi)F^{(1)}(u_1,u_1)$ is minus the inner product of the buckling mode with itself, as defined by Equation (32) of Reference 13. These differences are: (1) in the inner product, the derivatives of the prebuckling state variables with respect to λ are generally evaluated at λ_o, whereas in Equation (B-3) they are evaluated at λ_c; and (2) the terms depending on the prebuckling state in the formula for $T_{12}^{(1)}$, viz.

$$T_{12}^{(1)} = (1-\mu_{12}/R_2)\{S^{(1)}-[T_1^{(0)}+T_2^{(0)}]\theta^{(1)}/2\}+\mu_{11}\{n_c[\chi^{(1)}-\xi^{(1)}/r]/r$$

$$+\chi^{(0)}\psi^{(1)}/R_2\}/R_2 \tag{B-5}$$

have been neglected in the inner product. Since the partial derivatives with respect to λ of Equation (B-3) input to the program are evaluated at λ_o, the value of $F^{(1)}(u_1,u_1)$ computed by the program contains in general an error which diminishes with the difference $\lambda_c - \lambda_o$. This approximate value, divided by $-\pi$, is printed out and denoted as the inner product. If the optional prebuckling data, which contains the corresponding second partial derivatives with respect to λ evaluated a λ_o is input (see page 43), then a first-order correction in $\lambda_c - \lambda_o$ is made to $-F^{(1)}(u_1,u_1)/\pi$, and the corrected value is printed out and denoted as the corrected inner product.

$\underline{\sigma_2 \cdot L_2(u_1)}$. - Denoting the axisymmetric components of the second-order state variables by the preceding subscript 0, and the amplitudes of the sinusoidal components by the preceding subscript 2, one has

$$\begin{aligned}
\sigma_2 \cdot L_2(u_1) = \int_s \int_0^{2\pi} \{ & [{}_0T_1 + {}_2T_1 \cos 2n_c\phi][\chi^{(1)2}\cos^2 n_c\phi + \theta^{(1)2}\sin^2 n_c\phi] \\
& + [{}_0T_2 + {}_2T_2 \cos 2n_c\phi][\psi^{(1)2} + \theta^{(1)2}]\sin^2 n_c\phi \\
& + 2\,{}_2T_{12}\chi^{(1)}\psi^{(1)} \sin 2n_c\phi \cos n_c\phi \sin n_c\phi \} r\,d\phi\,ds \\
& + \sum_k a \int_0^{2\pi} [{}_0T_\phi + {}_2T_\phi \cos 2n_c\phi][\omega_x^{(1)2} + \omega_y^{(1)2}]\sin^2 n_c\phi\,d\phi \qquad \text{(B-6)}
\end{aligned}$$

Employing Equations (B-1), Equation (B-6) simplifies to

$$\begin{aligned}
(1/\pi)\sigma_2 \cdot L_2(u_1) = \int_s \{ & {}_0T_1[\chi^{(1)2} + \theta^{(1)2}] + {}_2T_1[\chi^{(1)2} - \theta^{(1)2}]/2 \\
& + [{}_0T_2 - {}_2T_2/2][\psi^{(1)2} + \theta^{(1)2}] + {}_2T_{12}\chi^{(1)}\psi^{(1)} \} r\,ds \\
& + \sum_k a[{}_0T_\phi - {}_2T_\phi/2][\omega_x^{(1)2} + \omega_y^{(1)2}] \qquad \text{(B-7)}
\end{aligned}$$

$\underline{\sigma_1 \cdot L_{11}(u_1,u_2)}$. - In a fashion similar to that for $\sigma_2 \cdot L_2(u_1)$ one can show

$$(1/\pi)\sigma_1 \cdot L_{11}(u_1,u_2) = \int_s \{T_1^{(1)}\chi^{(1)}[{}_0\chi + {}_2\chi/2] + [T_1^{(1)}+T_2^{(1)}]\theta^{(1)}{}_2\theta/2$$

$$+T_2^{(1)}\psi^{(1)}{}_2\psi/2 + T_{12}^{(1)}[\chi^{(1)}{}_2\psi/2 - \psi^{(1)}{}_2\chi/2 + \psi^{(1)}{}_o\chi]\}rds$$

$$+\sum_k aT_\phi^{(1)}[\omega_x^{(1)}{}_2\omega_x + \omega_y^{(1)}{}_2\omega_y]/2 \qquad \text{(B-8)}$$

Prebuckling Stiffness, K_0

Although the value of K_0 is input to the postbuckling program, rather than computed by it, for the sake of completeness it is also discussed here. The general formula for K_0 is given by Equation (25) of Reference 11, viz.

$$K_0 = \lambda/\sigma_0 \cdot \varepsilon_0^{(1)} \qquad \text{(B-9)}$$

The functional $\sigma_0 \cdot \varepsilon_0^{(1)}$ is given by

$$(1/2\pi)\sigma_0 \cdot \varepsilon_0^{(1)} = \int_s (T_1\partial\varepsilon_1/\partial\lambda + T_2\partial\varepsilon_2/\partial\lambda + M_1\partial\kappa_1/\partial\lambda + M_2\partial\kappa_2/\partial\lambda)rds$$

$$+\sum_k (T_\phi \partial u_y/\partial\lambda - M_y\partial\omega_\phi/\partial\lambda) \qquad \text{(B-10)}$$

In Equation (B-10) the prebuckling superscript (0) has been omitted since all response variables pertain to the prebuckling state.

Initial Postbuckling Stiffness, K*

The general formula for K* is given by Equation (31) of Reference 11, viz.

$$K^* = K_0^*/[1+(K_0^*/2b\lambda_c^2)(\sigma_1 \cdot \varepsilon_1 + 2\sigma_0^* \cdot \varepsilon_2)] \qquad \text{(B-11)}$$

To evaluate K*, two new functionals must be computed.

$\underline{\sigma_1 \cdot \varepsilon_1}$. - This functional is most easily obtained from the following relation, which follows from Equation (8c) of Reference 11.

$$\sigma_1 \cdot \varepsilon_1 = \lambda_c q_1(u_1) \cdot u_1 - \sigma_0^* \cdot L_2(u_1) \tag{B-12}$$

For shells of revolution, this specializes to

$$(1/\pi)\sigma_1 \cdot \varepsilon_1 = \lambda_c \int_s [X_1^{(1)} u^{(1)} + X_2^{(1)} v^{(1)} + X_3^{(1)} w^{(1)}] rds$$

$$- \int_s \{T_1^{(0)} [\chi^{(1)2} + \theta^{(1)2}] + T_2^{(0)} [\psi^{(1)2} + \theta^{(1)2}]\} rds$$

$$- \sum_k aT_\phi^{(0)} [\omega_x^{(1)2} + \omega_y^{(1)2}] \tag{B-13}$$

where $X_1^{(1)}$, $X_2^{(1)}$, and $X_3^{(1)}$ are live pressure terms given by Equation (B-4).

$\underline{\sigma_0^* \cdot \varepsilon_2}$. - Although ε_2 has both a symmetric and sinusoidal component, the sinusoidal component contributes nothing to this functional because of the trigonometric identities $\int_0^{2\pi} \sin n\phi d\phi = \int_0^{2\pi} \cos n\phi d\phi = 0$. Consequently, the formula reduces to

$$(1/2\pi)\sigma_0^* \cdot \varepsilon_2 = \int_s [T_1^{(0)}\,{}_0\varepsilon_1 + T_2^{(0)}\,{}_0\varepsilon_2 + M_1^{(0)}\,{}_0\kappa_1 + M_2^{(0)}\,{}_0\kappa_2] rds$$

$$+ \sum_k [T_\phi^{(0)}\,{}_0u_y - M_y^{(0)}\,{}_0\omega_\phi] \tag{B-14}$$

First Imperfection Parameter, α

Worst imperfection shape. - The maximum value of α is given by Equations (8) and (9). If the buckling mode variables in Equations (6) are interpreted as harmonic amplitudes, then Equation (8) becomes

$$\mu^2 = \pi [A \int_s (X^2+Y^2+Z^2) rds + (2\pi \sum_k a) \sum_k a(\Omega_x^2 + \Omega_y^2)] \tag{B-15}$$

Imperfection shape proportional to the buckling mode. - In this case, [cf. Equation (39) of Reference 12]

$$\alpha = -k\sigma_1 \cdot L_1(u_1)/\lambda_c F^{(1)}(u_1,u_1) \tag{B-16}$$

where k is the constant of proportionality given by

$$k = \pi^{-1/2}\{(1/A)\int_s[\chi^{(1)2}+\psi^{(1)2}+\theta^{(1)2}]rds+(2\pi\sum_k a)^{-1}\sum_k a[\omega_x^{(1)2}+\omega_y^{(1)2}]\}^{-1/2} \tag{B-17}$$

With the buckling mode normalized to have a unit maximum normal deflection, k represents the ratio of the maximum normal imperfection to the rms value of the angular imperfection. From the definition of ε_1 given by Equation (8a) of Reference 11, it follows that

$$\sigma_1 \cdot L_1(u_1) = \sigma_1 \cdot \varepsilon_1 - \sigma_1 \cdot L_{11}(u_0^*,u_1) \tag{B-18}$$

where $\sigma_1 \cdot \varepsilon_1$ is given by Equation (B-13) and

$$\sigma_1 \cdot L_{11}(u_0^*,u_1) = \pi\int_s(T_1^{(1)}\chi^{(1)}+T_{12}^{(1)}\psi^{(1)})\chi^{(0)}rds \tag{B-19}$$

Second Imperfection Parameter, β

The second imperfection parameter β is given by Equation (34b) of Reference 12, viz.

$$\beta = \{\Phi(\bar{u})-\alpha\lambda_c H[L_{11}(u_0^{(1)}*,u_1)]\cdot L_{11}(u_0^{(1)}*,u_1)-(1/2)\alpha\lambda_c F^{(2)}(u_1,u_1)\}/F^{(1)}(u_1,u_1) \tag{B-20}$$

where

$$\Phi(\bar{u}) \equiv \sigma_0^{(1)}*\cdot L_{11}(\bar{u},u_1)+\sigma_1\cdot L_{11}(\bar{u},u_0^{(1)}*)-q_1(\bar{u})\cdot u_1+H[L_{11}(u_0^{(1)}*,u_1)]\cdot L_{11}(\bar{u},u_0^*) \tag{B-21}$$

Note that the last two terms of the numerator do not depend on the imperfection shape $\bar{u}$. One obtains for these terms, from their definitions,

$$(1/\pi)F^{(2)}(u_1,u_1) = \int_s \{2[T_1^{(1)}\chi^{(1)}+T_{12}^{(1)}\psi^{(1)}]\partial^2\chi^{(0)}/\partial\lambda^2$$

$$+[\chi^{(1)2}+\theta^{(1)2}]\partial^2 T_1^{(0)}/\partial\lambda^2+[\psi^{(1)2}+\theta^{(1)2}]\partial^2 T_2^{(0)}/\partial\lambda^2\}rds$$

$$+\sum_k a[\omega_x^{(1)2}+\omega_y^{(1)2}]\partial^2 T_\phi^{(0)}/\partial\lambda^2 \qquad \text{(B-22)}$$

and

$$H[L_{11}(u_0^{(1)}*,u_1)]\cdot L_{11}(u_0^{(1)}*,u_1) = \pi\int_s [C\chi^{(1)2}+G\psi^{(1)2}][\partial\chi^{(0)}/\partial\lambda]^2 rds \qquad \text{(B-23)}$$

where C and G are the shell wall meridional stretching and shear stiffnesses denoted by $C_1^{(0)}$ and $G^{(0)}$ in Reference 14.

Worst imperfection shape. - In this case, one obtains

$$(1/\pi)\Phi = \int_s \{[(\partial T_1^{(0)}/\partial\lambda+C\chi^{(0)}\partial\chi^{(0)}/\partial\lambda)\chi^{(1)}+T_1^{(1)}\partial\chi^{(0)}/\partial\lambda-pu^{(1)}]\hat{\chi}$$

$$+[(\partial T_2^{(0)}/\partial\lambda+G\chi^{(0)}\partial\chi^{(0)}/\partial\lambda)\psi^{(1)}+T_{12}^{(1)}\partial\chi^{(0)}/\partial\lambda-pv^{(1)}]\hat{\psi}$$

$$+\theta^{(1)}\hat{\theta}\partial[T_1^{(0)}+T_2^{(0)}]/\partial\lambda\}rds+\sum_k a[\omega_x^{(1)}\hat{\omega}_x+\omega_y^{(1)}\hat{\omega}_y]\partial T_\phi^{(0)}/\partial\lambda \qquad \text{(B-24)}$$

Imperfection shape proportional to buckling mode. - In this case, one obtains from the definition of $F^{(1)}(u_1,u_1)$

$$\Phi = k[F^{(1)}(u_1,u_1)-\{\sigma_1-H[L_{11}(u_0^*,u_1)]\}\cdot L_{11}(u_0^{(1)}*,u_1] \qquad \text{(B-25)}$$

The second functional in the brackets specializes to

$$\{\sigma_1 - H[L_{11}(u_0^*, u_1)]\} \cdot L_{11}(u_0^{(1)*}, u_1)$$

$$= \pi \int_s \{[T_1^{(1)} - C\chi^{(0)}\chi^{(1)}]\chi^{(1)} + [T_{12}^{(1)} - G\chi^{(0)}\psi^{(1)}]\psi^{(1)}\}\partial\chi^{(0)}/\partial\lambda r ds \qquad \text{(B-26)}$$

APPENDIX C

COMPUTER PROGRAM USER'S MANUAL

A postbuckling computer program has been written in CDC FORTRAN 2.0 language to run under the SCOPE 3.0 operating system. It requires a core space of approximately 62400_8 words and operates in the OVERLAY mode. The program is used to determine the initial postbuckling behavior and imperfection sensitivity of unique bifurcation buckling modes of discretely ring-stiffened orthotropic elastic shells of revolution subjected to axisymmetric torsionless loads.

General Description of Program Capability

At each meridional station the shell wall may consist of as many as five orthotropic layers, in each of which elastic properties may vary only in the meridional direction. At each material point the shell is assumed to possess orthotropic principal axes in meridional and circumferential directions. All geometric and mechanical properties of the structure are assumed to be axisymmetric, but may have arbitrary meridional variation. Live normal pressure fields, including meridional and normal pressure gradients, are treated. The shell may be stiffened by:

(1) up to 32 interior rings, for a maximum total of 34 rings including two edge rings,

(2) stringers, whose stiffness is circumferentially distributed, and

(3) an elastic foundation attached to the shell wall.

Input Data

The input data consists essentially of: (1) a case title card and a case option card, (2) input tables giving basic structural data as a function of meridional distance, (3) a prebuckling data deck (generated by a nonlinear prebuckling program), (4) a buckling mode data deck (generated by a buckling program), (5) discrete ring data, and (6) general boundary condition matrices. Each of these types of input are described further below.

Case title and option cards. - The first card of each case is a title card, on which any short description of the problem may be punched in standard alphanumeric symbols in the first 72 columns. The second card of each problem is a case option card (see Figure 2). Besides giving the relative error tolerance for the forward integration routine, and providing an indicator for the calculation of K* and β (which require an enlarged prebuckling data deck), this card allows, in a sequence of problems, groups of data to be taken from the preceding problem. Columns 6, 8, 10, 12, 14, 16, 20, 76, and 78 are input as either blank or 1. Columns 48-59 are read in E12.4 format. This data has the following meaning.

Col. 6	blank:	geometry (Table 1) taken from previous case
	1 :	new geometry to be input
Col. 8	blank:	wall properties (Table 2) taken from previous case
	1 :	new wall properties to be input
Col. 10	blank:	foundation moduli (Table 3) taken from previous case
	1 :	new foundation moduli to be input
Col. 12	blank:	stringer properties (Table 4) taken from previous case
	1 :	new stringer properties to be input
Col. 14	blank:	pressure gradient (Table 5) taken from previous case
	1 :	new pressure gradient to be input
Col. 16	blank:	prebuckling data taken from previous case
	1 :	new prebuckling data to be input
Col. 20	blank:	all boundary data taken from previous case (col. 5 of Table 1 does not apply)
	1 :	col. 5 of Table 1 controls input or generation of boundary conditions
Cols. 48-59	relative error tolerance for variable step Runge-Kutta forward integration subroutine	
Col. 76	blank:	K* and β not computed (if col. 16 = 1, input standard prebuckling data deck)
	1 :	K* and β computed (if col. 16 = 1, input enlarged prebuckling data deck)
Col. 78	blank:	abort run if subinterval length criterion is exceeded
	1 :	print diagnostic but continue execution if subinterval length criterion exceeded

If the indicator 1 is used for Tables 3, 4, or 5 and that table is absent from the corresponding case deck, it is assumed that that table does not apply (i.e., it will be set to zero). Tables 1 and 2 can be omitted only if the corresponding indicator is left blank. As an example, columns 6 through 20 are left blank if the previous problem in a sequence of problems corresponds simply to a different buckling mode of the same structure based on the same prebuckling data. A means for taking individual boundary data from the previous case is provided by column 5 of the geometry table cards (see below). A relative error tolerance of 0.01 is usually adequate, although if columns 48-59 are left blank, the value 0.001 will be used.

Input tables. - Five different basic tables may be input (See Figure 3). These tables are listed below with the input variables in parenthesis. All of these variables are input in E12.4 format. Each card of each of these tables prescribes data at one point of the shell meridian.

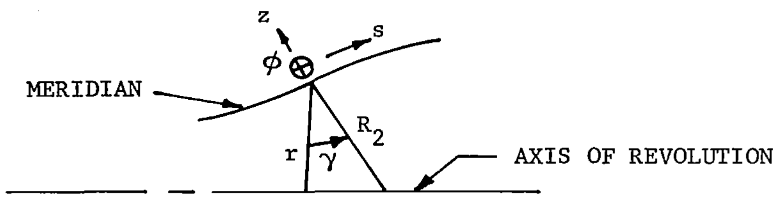
Table	
1	Geometry (s, r, r', r/R_2)
2	Wall properties (E_1, E_2, E_{12}, ν_1, h)
3	Foundation moduli (k_1, k_2, k_3)
4	Stringer properties (NEA, NEI, NGJ, $\bar{z}$)
5	Pressure gradient ($\partial p/\partial x$, $\partial p/\partial y$)

Table 5 is used only with a live pressure field.

Geometry: In order to define the geometry of a reference surface, a coordinate system must be established.* A right-handed (s,ϕ,z) coordinate system is used, where s measures meridional arc distance from an arbitrary reference point (e.g., a shell edge), ϕ measures circumferential angle from an arbitrary reference meridian, and z measures normal distance from the reference surface. The sense of coordinate directions is immaterial as long as they form a right-handed triad. In the following discussion the shell inner surface will mean the shell surface where the positive z-direction points into the interior of the shell wall.

*For the purpose of defining shell geometry, the reference surface is usually taken as the shell middle surface. However, it is within the accuracy of thin shell theory to use any convenient surface within the shell wall.

Each card of this table gives the values of s (columns 13-24), r (columns 25-36), r' (columns 37-48), and r/R_2 (columns 47-60) at one point of the shell meridian. As shown in the diagram, r is the (minimum) distance to the axis of revolution, and R_2 is numerically equal to the distance along a surface normal measured to the axis of revolution; furthermore, $r' = \sin\gamma$ and $r/R_2 = \cos\gamma$. By convention, r is always positive, but R_2 is positive only if the positive z-direction points away from the axis of revolution.



Two consecutive cards in Table 1 with the same values of s and r define a point of subdivision of the shell meridian. The first card prescribes data immediately before the subdivision point and the second card prescribes data immediately after the subdivision point. Thirty-two such points are allowed. A subdivision point is required at the location of:

(1) an interior ring or other elastic attachment,

(2) a circumferential line load,

(3) a meridional discontinuity in input data (e.g., the juncture of a cone and a cylinder or a change in the number of wall layers), and

(4) a fictitious boundary inserted to limit subinterval length.

Fictitious boundaries should be inserted according to the rule-of-thumb

$$\Delta\ell < 3(r_{av} t_{av})^{1/2}$$

where $\Delta\ell$ is the axial subinterval length, and r_{av} and t_{av} are the average radius and thickness over the subinterval considered.* This requirement

*It is often easier to use the alternate criterion $\Delta s < 3(R_{2_{av}} t_{av})^{1/2}$. For orthotropic layered shells these criteria may be applied with t replaced by $(12D_s/C_\phi)^{1/2}$, where D_s is the meridional bending stiffness and C_ϕ is the hoop stretching stiffness.

is necessary to control numerical round-off error. If a subinterval is too long, the problem will be aborted (if col. 78 of the case option card is blank) and an appropriate diagnostic printed.

In addition to the basic geometrical data, supplemental data is input on the geometry cards in columns 1, 3, 5, and 10-12. Columns 1 and 10-12 have a similar function for each of the tables. Column 1 is used primarily for table identification. The first card of Table 1 should have the identifier 1 in column 1. Each card of Table 1 (and of the other four tables) must have an entry number ($\leq$100) right adjusted in columns 10-12. The entry number starts at 1 at the initial shell edge and increases by whole number amounts on each succeeding card. If for two consecutive cards of Table 1, the entry number increases by more than unity, s, r, r', and r/R_2 are automatically generated for the intervening entry numbers by linear interpolation with respect to the entry number. This process of interpolation may be suppressed by repeating the table number in column 1 on the second card (see page 48). The entry number also serves to relate data between different tables to the same meridional point.

Each subinterval should have at least one interior point, i.e., the entry numbers of the initial and final point of each subinterval should differ by at least 2. Also, interior points within each subinterval should have equal s-spacing, although the spacing may be different for different subintervals. Note that in Table 1 only interior points of each subinterval can be interpolated points, since a point of subdivision is defined by inputting two cards for it. The actual number of cards input for Table 1 is therefore determined by the number of subdivision points and the degree of variation of the functions r, r', and r/R_2 in each subinterval. For example, for a cone only two geometry cards are required if no points of subdivision are necessary. However, in order to describe the response functions (and possibly input functions of other tables) accurately, many more than two points are required. This is easily accomplished by using an appropriate entry number for the second card.

Columns 3 and 5 of the geometry cards pertain to boundary conditions and are discussed under that heading.

Wall properties: This table is composed of separate subtables, one for each layer. Each card corresponds to one value of s for one layer and gives the value of

E_1	(columns 13-24)	meridional modulus of elasticity
E_2	(columns 25-36	circumferential modulus of elasticity
E_{12}	(columns 37-48)	shear modulus
ν_1	(columns 49-60)	Poisson's contraction ratio with T_1 acting
h	(columns 61-72)	layer <u>half</u>-thickness

In addition to the table number 2 in column 1 for the very first card of the wall layer tables, the first card of each subtable must have the layer number in column 7. Wall layers are numbered in the direction of increasing z starting with unity for the layer at the shell inner surface. It should be noted that layer numbering is done locally, so that a given continuous physical layer may have a different layer number at different locations on the meridian. However, since the number of layers can only change at a subinterval boundary, layer numbering is unique in each subinterval.

In the case of layer subtables of Table 2, and also Tables 3 - 5, if for two consecutive cards the entry number increases by more than unity, data for the intervening entry numbers are automatically generated by linear interpolation with respect to the s-values corresponding to the intervening entry numbers. For this purpose, it is necessary that Table 1, which contains the s-values, be input first. As with Table 1, the interpolation may be suppressed by repeating on the second card the table number in column 1 or, in the case of Table 2, the wall layer number in column 7. This would be done, for example, at the first entry of the second portion of a disjointed layer. Note that in contrast to Table 1, data cards for Tables 2 - 5 corresponding to interior points of subdivision may not be necessary.

Foundation moduli: It is assumed that an elastic foundation produces force components per unit area on the shell in s, ϕ, and z directions which are proportional and opposite to the local displacement components in s, ϕ, and z directions, respectively. The constants of proportionality (foundation moduli) for s, ϕ, and z directions, denoted by k_1(columns 13-24), k_2(columns 25-36), and k_3 (columns 37-48), respectively, are input on one card for each value of s. The tangential forces associated with k_1 and k_2 also produce small surface moments by virtue of the assumption that they act at the shell inner surface.

Stringer properties: Stringers are treated by circumferentially "smearing-out" their stiffness. In so doing it is assumed that at each meridional station the stringers are equally spaced around the shell circumference. For this approximation to be accurate it is necessary to have several (more than 2) stringers for each circumferential wave of the response. Since the harmonic $2n_c$ plays a role in the second-order postbuckling state, there should be, at the minimum, a number of stringers equal to 4 times the harmonic of the buckling mode being studied. Each card of this table contains the following stringer section properties at one point of the shell meridion:

NEA (columns 25-36)	total extensional stiffness of all stringers
NEI (columns 37-48)	total normal bending stiffness of all stringers (I taken about circumferential centroidal axis)

NGJ (columns 49-60) total torsional stiffness of all stringers

$\bar{z}$ (columns 61-72) normal eccentricity of the stringer centroid measured from the shell inner surface, positive in the direction of the positive z-axis.

Pressure gradient: This table is used only in connection with loading by a live normal pressure field. Each card corresponds to one value of s and contains the values of

$\partial p/\partial x$ (columns 13-24) pressure derivative in the axial direction

$\partial p/\partial y$ (columns 25-36) pressure derivative in the radial direction

The pressure distribution p is considered positive if acting in the positive z-direction. Note that the actual pressure is λp. The positive x and y directions are defined on page 47.

Prebuckling data. - Immediately following the input tables there should be a card with a 9 punched in column 1, but otherwise blank. This "nine" card separates the input tables from the prebuckling data, which immediately follows the "nine" card. The prebuckling deck consists of a standard part, which is always input if col. 16 of the case option card contains a 1, and an optional part input only if column 76 of the case option card contains a 1.

Standard prebuckling deck: The standard prebuckling deck is composed of three basic parts: (1) nonlinear state data at some load level λ_o, (2) linear perturbation state data about λ_o and (3) pressure field cards. The number and format of these cards are summarized below.

Nonlinear state: This state consists of the following cards:

(1) a single load card containing the load level λ_o (columns 1-12) in F12.0 format, and a live load indicator in column 14. If column 14 is blank dead loads are assumed, if in column 14 is a 1, live pressure loading is assumed.

(2) ring stress resultant cards: $[\frac{\text{no. of rings}}{6}]$ * cards required. Each card, except possibly the last card, contains six prebuckling hoop forces T_ϕ for six consecutive rings in the format 6(2X, E11.4). The rings are ordered in the direction of increasing s.

(3) shell stress resultant cards: $[\frac{\text{max. entry no.}}{3}]$ cards required. Each card, except possibly the last card, contains three pairs (T_1, T_2) of stress resultants at three consecutive entry points in the format 3(2X, 2E11.4).

*[x] denotes the smallest integer $\geq$ x

(4) meridional rotation cards: $[\frac{\text{max. entry no.}}{6}]$ cards required. Each card, except possibly the last card, contains six values of χ at six consecutive entry points in the format 6E12.4.

Linear perturbation state: This state is represented by cards of the types 2, 3, and 4 above in the same order and format but with the state variables at λ_o replaced by their derivatives with respect by λ at λ_o.

Pressure field cards: This set of cards is in the same format as the cards of type 4 above with the meridional rotation λ replaced by the normal pressure p corresponding to the values used to determine the prebuckling state. Although these cards are only used for live pressure loading, they must be in the prebuckling state deck in all cases.

Optional prebuckling deck: The optional prebuckling deck, if called for by a 1 in column 76 of the case option card, follows the standard prebuckling deck and is needed for three purposes:

(1) to compute the initial postbuckling stiffness K*

(2) to compute the second imperfection parameter β

(3) to correct the linear perturbation state at λ_o to the bifurcation load λ_c, thereby improving the value of the functional $F^{(1)}(u_1,u_1)$ used in the evaluation of b, α, and β.

This deck is composed of four parts, all of whose variables are evaluated at λ_o: (1) nonlinear and perturbation out-of-plane ring bending moments (M_y, $\partial M_y/\partial\lambda$), (2) nonlinear and perturbation shell bending moments (M_1, $\partial M_1/\partial\lambda$, M_2, $\partial M_2/\partial\lambda$), (3) the second-order perturbation state ($\partial^2 T_\phi/\partial\lambda^2, \partial^2 T_1/\partial\lambda^2, \partial^2 T_2/\partial\lambda^2, \partial^2\chi/\partial\lambda^2$), and (4) the prebuckling stiffness and its derivative ($K_0, \partial K_0/\partial\lambda$). The number and format of these cards are summarized below.

(1) Ring bending moments: $[\frac{\text{no. of rings}}{4}]$ cards required. Each card, except possibly the last card, contains 4 pairs (M_y, $M_y/\partial\lambda$) of ring moments for four consecutive rings in the format 4(2E10.0).

(2) Shell bending moments: $[\frac{\text{max. entry no.}}{2}]$ cards required. Each card, except possibly the last card, contains 2 quadruples ($M_1,\partial M_1/\partial\lambda, M_2, \partial M_2/\partial\lambda$) of shell bending moments at two consecutive entry points in the format 2(4E10.0).

(3) Second-order perturbation state: This set of cards is completely analogous to the linear perturbation state deck discussed above with second derivatives with respect to λ replacing the corresponding first derivatives.

(4) Structural stiffness card: This is a single card with K_0 and $\partial K_0/\partial\lambda$ in the format 2E12.4.

Buckling mode data. - This deck follows immediately after the prebuckling data deck. The first card of this deck gives the following three quantities:

(1) the harmonic number n_c of the buckling mode in the first six columns in the format F6.0.

(2) An indicator, applying only in the (unusual) case $n_c = 0$, in column 12; if 1, indicating a bending buckling mode; if 2, indicating a torsional buckling mode. This indicator has no effect on the program if $n_c \neq 0$.

(3) the difference between the bifurcation load level and the nonlinear prebuckling state load level, $\lambda_c-\lambda_o$, in columns 13-24 in the format E12.0.

The remaining cards of this deck give the values of the fundamental variables P, Q, S, M_1, ξ, η, v, χ (for sign convention, see page 47) of the buckling mode at each entry point. The number of these cards equals the maximum entry number, and each card gives all eight values for each point in the format 8E10.0.

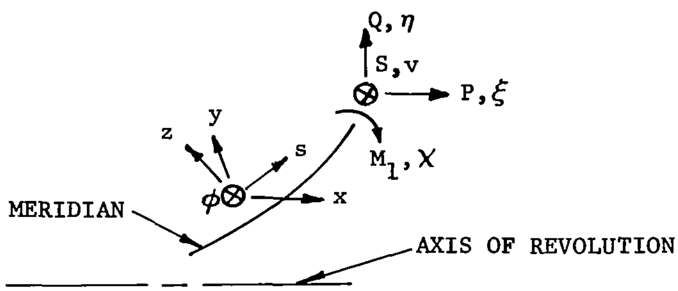
Boundary conditions. - The boundaries of the shell are defined as the two shell edges plus all interior subdivision points. As discussed previously, the interior boundaries are specified in the geometry table by repeating the same value of s on two consecutive cards. A set of boundary conditions must be determined for each boundary. In general, each set of boundary conditions is expressed by four equations relating four basic force variables to four corresponding displacement variables. In matrix notation, these four equations may be written as $[B]\Delta\{y\}+[D]\{z\} = \{L\}$, where $\{y\}$ is the column force vector (P, Q, S, M_1), and $\{z\}$ is the column displacement vector (ξ, η, v, χ). At an interior boundary $s = s_i$, $\Delta\{y\}$ represents the change in $\{y\}$ across the boundary,* i.e., $\Delta\{y\} = \{y\}|_{s_i+0}-\{y\}|_{s_i-0}$. At the initial edge, $\Delta\{y\}$ denotes simply $\{y\}$, whereas at the terminal shell edge $\Delta\{y\}$ denotes $-\{y\}$. Four types of boundaries are treated, and for three of these (force-free, rings, and dome closures), the

---

*The continuity of the displacement vector $\{z\}$ at an interior boundary is automatically enforced by the program.

4x4 matrices [B] and [D], and the vector {L} are automatically generated by the program. The fourth type of boundary is a more general type, for which the [B] and [D] matrices themselves may be input. In this case, however, it is assumed that {L} is a null vector.

For the purpose of defining the sign convention of the above forces and displacements, it is convenient to define positive axial (x) and radial (y) directions as follows (see diagram).



The positive x-direction is acute to the positive (negative) s-direction if the positive z-direction points away from (towards) the axis of revolution. The positive y-direction always points radially away from the axis of revolution. Then, ξ, η, v are positive if in the positive x, y, ϕ directions; and χ is positive if its vector points in the positive ϕ-direction. The same rule applies to the forces P, Q, S and moment M_1 acting on a normal section with outward normal pointing in the positive s-direction. The reverse is true for forces and moment acting on a normal section with outward normal pointing in the negative s-direction.

The boundary type is specified by an indicator in column 5 of the geometry table cards. This column applies only at the initial entry of each subinterval and the final point of the shell. The code for column 5 is given below.

Column 5	Type of boundary	Input data required
blank	force-free ($\Delta\{y\} = 0$)	none
1	ring	ring data
2	prescribed [B] and [D]	[B], [D]
3	boundary data taken from previous case	none
4	dome closure	none

Although the column 5 indicator is input on cards of Table 1, it should be thought of as a separate table within the computer. In a sequence of cases, in order to change the type of a boundary, it is necessary to re-input the complete geometry card corresponding to that boundary, repeating all the geometrical data. As an example, if three cases of three different buckling modes of the same ring-stiffened structure are to be run in succession, it would be desirable not to have to re-input the ring data for the second and third cases. This can be accomplished simply by leaving column 20 of the case option card blank. But if, instead, the properties of one ring varies from case to case, a 1 would be required in column 20. The data for the remaining rings would still not have to be re-input if for the second case the geometry cards corresponding to those ring boundaries are re-input, each with a 3 in column 5.* Each of these cards should also have a 1 in column 1 to suppress interpolation at the intervening entries (which would cause erroneous geometrical data to be generated). A 3 in column 5 simply changes the sign of corresponding value in the stored column 5 table, and the so-formed negative values cause the boundary data to be taken from the previous case. Therefore, in the third case of the sequence, no geometry cards should be input, since in this case a geometry card with a 3 in column 5 would make the stored value positive again, and the machine would expect the ring data to be input. The code 3 in column 5 should only be used if the previous case contains a 1 or 2 in column 5 for the corresponding boundary.

If the shell has a dome closure, the geometrical data is input only up to an artificial edge of small radius, which may be the initial or terminal edge of the model shell. A 4 is then inserted in column 5 of the geometry table card corresponding to this boundary. This causes boundary conditions to be generated which represent the effect of the small deleted cap (see Appendix A). Since these boundary conditions are correct only to first-order in the radius of the artificial edge, it is necessary that this edge be suitably small. It is found that good accuracy is obtained if at this edge $r/R_2 \leq 0.05$. For a plate, this condition may be replaced by $r/r_0 \leq 0.05$, where r_0 is the outer radius of the plate. It should be noted that the edge radius r cannot be decreased arbitrarily since execution time increases without bound as $r \to 0$.

Column 3 of geometry table cards applies only at the initial entry for the first and second subintervals. It has the following two functions:

(1) At the initial entry of the first or second subinterval, to specify artificial rigid body constraint necessary for the solution of the

---

*Since in this case the geometrical data is not being changed, column 6 of the case option card should be left blank.

axisymmetric portion of the second-order postbuckling state. The use of column 3 for this purpose depends on the following two conditions:

(A) The shell loading includes live normal pressure with $r'\partial p/\partial x$ not identically zero in the first subinterval.

(B) The quantity $(r')^2 T_1^{(0)} + T_2^{(0)} - (r^2/R_2)\lambda_c p$

is identically zero in the first subinterval, where the last term of the above expression is omitted for dead loading.

Note that in most cases neither condition is satisfied [condition (B), e.g., is satisfied for a membrane prebuckling state of a cylinder with live normal pressure loading].

The rules concerning this use of column 3 are the following:

(i) If condition (A) is not satisfied, then axial rigid body constraint is required at the first or second boundary. This may already be supplied by the real constraint $\xi = 0$, if it exists at the first or second boundary. However if not* (e.g., at the first boundary may be a ring and the second may be force-free) then one of these boundaries must be free of axial force and the geometry card at that boundary should contain a 4 in column 3. Furthermore, it is essential that at that boundary the first boundary condition (corresponding to the first row of [B] and [D]) should be $\Delta P = 0$, as is the case for an internally generated force-free boundary. Note that it is always possible to make the second boundary a force-free boundary by inserting it as a fictitious boundary.

(ii) If condition (B) is satisfied in the first subinterval, then rotational rigid body constraint is required at the first or second boundary. This may already be supplied by the real constraint $v = 0$ if it exists at the first or second boundary. However, if not, then one of these boundaries must be free of circumferential force and the geometry card at that boundary should contain a 5 in column 3. Furthermore, it is essential that at that boundary the third boundary condition (corresponding to the third row of [B] and [D]) should be $\Delta S = 0$, as is the case for an internally generated force-free boundary.

If both artificial translational and rotational constraint are required at the force-free boundary, column 5 of the geometry card for that boundary should contain a 6.

---

*None of the internally generated boundary conditions supply rigid body constraint.

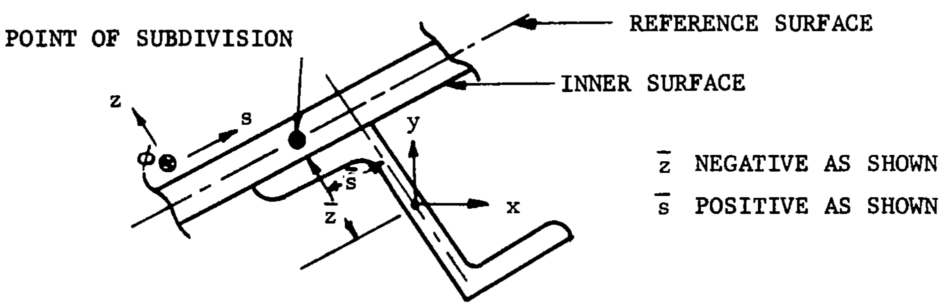
(2) A second use of column 3, applying only at the initial edge of the shell, pertains to shells which have a plane of symmetry about which the loading is also symmetrical. In such a case, the prebuckling normal deflection function is an even function about the plane of symmetry, the buckling mode normal deflection may be even or odd, and the second-order postbuckling normal deflection is even. Also, the computer time can be reduced (and possibly more accurate results obtained) by modeling only one-half of the shell. To avoid difficulties with the axisymmetric problem, the plane of symmetry should be set up as the initial edge of the model, since the rigid body constraint $\xi = 0$ is a symmetry condition. If, in addition, a ring (of symmetrical cross-section) is attached at the plane of symmetry, the problem can be run simply by inputting the real ring properties (see below) and inserting either an 8 or 9 in column 3 of the first card of the geometry table. It is important to note that in this case the prebuckling and buckling ring hoop forces for this ring transmitted to the program in the prebuckling and buckling data decks should be only one-half of their actual values.

Ring data: Ring data for ring boundaries specified by a 1 in column 5 of the appropriate boundary cards of the geometry table are input immediately after the buckling mode data deck. The ring reactions are assumed to enter the shell at the corresponding point of subdivision. For each ring, the ring data is input on two cards in the format 6E12.4 (see Figure 4). This data consists of the following section properties:

Card 1: EA (columns 1-12), EI_x (columns 13-24), EI_y (columns 25-36), EI_{xy} (columns 37-68), GJ (columns 49-60), $\bar{z}$ (columns 61-72)

Card 2: $\bar{s}$ (columns 1-12)

Here E and G are normal and shear elastic moduli of the ring (assumed homogeneous and isotropic), A is the ring cross-sectioned area, I_x, I_y, and I_{xy} are the moments and product of inertia about the axial and radial centroidal axes (see page 47), J is the torsion constant, and $\bar{s}$ and $\bar{z}$ are the coordinates of the ring centroid with respect to local s, z axes with origin at the intersection of a normal shell element through the point of subdivision and the shell inner surface (see diagram).



For each ring the pair of ring cards is input in the same order as the rings are encountered when the shell meridian is traversed starting at the initial shell edge.

Prescribed [B] and [D] matrices: If it is desired to input the boundary condition $[B]\Delta\{y\}+[D]\{z\} = \{0\}$, corresponding to a 2 in column 5 of the appropriate geometry card, this can be accomplished by inputting the [B] and [D] matrices. For example, a clamped shell edge corresponds to $[B] = [0]$ and $[D] = [I]$. Each set of this type of boundary condition consists of eight cards, each of the first four cards giving the elements of the corresponding row of the [B] matrix and each of the second four cards giving elements of the corresponding row of the [D] matrix (see Figure 5). Each of these cards should be in the format 4E12.4. For each such boundary, the set of eight cards is input in the order of occurrence starting at the initial shell edge. These cards follow immediately after the ring data cards and complete the input data deck.

Input Deck Set-Up

As a convenience to the user, seven types of input sheets are supplied (Figures 2 to 8), which may be used as an aid in setting up the input deck. These sheets are essentially self-explanatory and represent a condensation of the preceding discussion.

As mentioned previously, it is common to examine the imperfection sensitivity of several buckling modes in one pass through the computer. This is accomplished by stacking several cases in sequence. For each case of a stack, a minimum of three cards in addition to the buckling mode data deck is always required. These are the title card, the case option card, and the "nine" card signifying that no more input tables are to be read.

In order to illustrate the deck set-up, let us assume that three buckling modes have been obtained using the same prebuckling data,* and that we wish to evaluate them in one computer run. Figure 9 shows the deck set-up for this type of problem. The case option card of the first case should have a 1 in each of columns 6, 8, 10, 12, 14, 16, 20. If Tables 3, 4, or 5 are missing from the following table data deck, they will automatically be interpreted as not applying (i.e., set to zero). The set-up shown assumes that column 76 of the case option card contains

*Since the prebuckling data consists of a nonlinear state and a linear perturbation about it, it is not necessary that a buckling load coincide with load level of the nonlinear state.

a 1, since the optional prebuckling data deck is present. Corresponding to each 1 in column 5 of Table 1 there should be a pair of ring data cards, and corresponding to each 2 in column 5 of Table 1 there should be a set of eight boundary data cards. The case option card for the second and third cases should be left blank in columns 6, 8, 10, 12, 14, 16 and 20, as the corresponding data will automatically be taken from the previous case. However, in order that K* and β be computed, column 76 of each of these cards should contain a 1.

If, on the other hand, the buckling modes are based on different prebuckling decks, the case option card should contain a 1 in column 16 and the corresponding prebuckling decks should be input immediately after the "nine" card for each case.

Output Data

The output data of the program consists of a print-out of the input data and computed results. Since the print-out of the input data is self-explanatory, a discussion of it here is unnecessary.

The first computed result, printed immediately after the input boundary data, is the value of the buckling mode inner product. If the optional prebuckling data is input, this value is corrected for the difference $\lambda_c-\lambda_o$, and the corrected value is printed next (see page 32).

The next data printed are the computed values of the first and second imperfection parameters α and β for both the worst imperfection shape and a buckling mode imperfection shape.* These are used, along with the value of the postbuckling coefficient b (if negative), to compute the snapping load (see Figure 1). In order to show the effect of the terms in the β-formula which depend quadratically on prebuckling rotations [i.e., the terms in Equations (B-20) and (B-21) involving the elastic operator H], for each imperfection shape the value of β neglecting these terms is also given. These values are printed on the same line and to the right of the correct β-values. In the case of the buckling mode imperfection, the factor relating the root-mean-square angular amplitude to the normal displacement amplitude is also printed.

This data is followed by tables of the axisymmetric and unsymmetric components of the second-order postbuckling state. These components are presented in terms of the harmonic amplitudes of the basic force and

---

*As noted previously, the computation and printing of β is optional depending on column 76 of the case option card.

displacement variables of the [y] and [z] vectors as functions of meridional distance. For the user's convenience, immediately following these tables the displacement components referred to meridional, circumferential, and normal directions are tabulated as a function of meridional distance.

After the data for the unsymmetric component of the second-order postbuckling state, the associated value of the second postbuckling coefficient b is printed. Finally, if column 76 of the case option card contains a 1, the values of the prebuckling and postbuckling stiffness at the bifurcation load are printed.

Sample Problem

In order to illustrate the application of the program to a practical problem, a listing of the input deck and the output data are presented below for the N = 6 buckling mode of the 60° sandwich spherical dish of Reference 19. Each row of the input deck listing is the image of a punched card, ten columns of which correspond to one inch on the listing.* Note the 4 in column 3 at the second boundary (i.e., the first card of the second subinterval), which is required since no real rigid body constraint exists (cf. page 49). Input geometrical data is specified at intervals of one degree of meridional arc, with boundaries at two degree intervals. The spacing between the first and second data points is slightly less than one degree since the shell starts at a latitude angle of 10.083°; all other data points correspond to integral values of the latitude in degrees up to a maximum of 30°. Because the entry number jumps by four between successive entries, output points will be spaced at intervals of 0.25°. Note also that the order of the wall properties subtables for each layer is immaterial; in this case layer 3 properties were input before layer 2 properties. Only the cards preceding the standard prebuckling data, and the ring data cards following the buckling mode data were punched manually. Since the optional prebuckling data deck is included, column 76 of the case option card (the second card in the deck) contains a 1.

*In order to clarify the input data deck, explanatory comment cards, each separated from the actual data by a blank card on each side of it, have been inserted in the listing at the beginning of each group of cards.

In the output data listings, all data preceding the inner product value represents the input data.* The remaining data represents calculated results. Note that for each imperfection shape considered, two values of β are printed. The first value (reading from the left) is the correct one, the second value being obtained neglecting terms which depend quadratically on prebuckling rotations. Typically, the effect of these terms is greater for the maximum α imperfection than for the buckling mode imperfection.

*The N = 6 critical load of 2.091 shown in the output data is slightly below the reported minimum value of 2.10 for N = 7 given in Reference 19 because in the structural calculations of Reference 19, a crudely estimated heatshield weight was included, whereas in the present calculation the heatshield weight reported in Reference 19 was used.

INPUT DATA LISTING

60 DEGREE SPHERICAL DISH
1 1 1 1 1 1   1   1.-2   1

C   GEOMETRY TABLE FOLLOWS

1	1	140.106	39.9	.98457	.175
		543.929	44.428	.98083	.19486
		947.752	47.403	.97815	.20791
	4	1047.752	47.403	.97815	.20791
		1451.732	51.289	.97437	.22495
		1855.711	55.158	.97030	.24192
		1955.711	55.158	.97030	.24192
		2359.690	59.011	.96593	.25882
		2763.670	62.846	.96126	.27564
		2863.670	62.846	.96126	.27564
		3267.649	66.660	.95630	.29237
		3671.628	70.457	.95106	.30902
		3771.628	70.457	.95106	.30902
		4175.608	74.230	.94552	.32557
		4579.587	77.981	.93969	.34202
		4679.587	77.981	.93969	.34202
		5083.566	81.708	.93358	.35837
		5487.546	85.411	.92718	.37461
		5587.546	85.411	.92718	.37461
		5991.525	89.086	.92050	.39073
		6395.504	92.737	.91355	.40674
		6495.504	92.737	.91355	.40674
		6899.484	96.357	.90631	.42262
		72103.463	99.948	.89879	.43837
		73103.463	99.948	.89879	.43837
		77107.443	103.510	.89101	.45399
		81111.422	107.039	.88295	.46947
		82111.422	107.039	.88295	.46947
		86115.401	110.537	.87462	.48481
		90119.381	114.	.86603	.5

```
C     WALL PROPERTIES TABLES FOLLOW

2     1     1       9.35E6       9.35E6       3.54E6.32          .008
           90       9.35E6       9.35E6       3.54E6.32          .008
      3     1       9.35E6       9.35E6       3.54E6.32          .008
           90       9.35E6       9.35E6       3.54E6.32          .008
      2     1                                                    .43
           90                                                    .43
9

C     STANDARD PREBUCKLING DATA FOLLOWS

  2.1000E+00-0
 1 5.1119E+0411-3.6260E+03
 1 1.3771E+03 4.1243E+03 2 1.4047E+03 3.6480E+03 3 1.4182E+03 3.2098E+03
 4 1.4215E+03 2.8091E+03 5 1.4177E+03 2.4436E+03 6 1.4081E+03 2.1249E+03
 7 1.3946E+03 1.8300E+03 8 1.3781E+03 1.5551E+03 9 1.3591E+03 1.2958E+03
10 1.4115E+03 1.3126E+0311 1.3921E+03 1.0547E+0312 1.3704E+03 8.1208E+02
13 1.3467E+03 5.8581E+0214 1.3215E+03 3.7633E+0215 1.2948E+03 1.8343E+02
16 1.2669E+03 6.5852E+0017 1.2382E+03-1.5492E+0218 1.2087E+03-3.0195E+02
19 1.2087E+03-3.0195E+0220 1.1794E+03-4.3527E+0221 1.1495E+03-5.5608E+02
22 1.1191E+03-6.6534E+0223 1.0884E+03-7.6397E+0224 1.0578E+03-8.5281E+02
25 1.0276E+03-9.3256E+0226 9.9704E+02-1.0042E+0327 9.6645E+02-1.0683E+03
28 9.6645E+02-1.0683E+0329 9.3584E+02-1.1257E+0330 9.0538E+02-1.1768E+03
31 8.7514E+02-1.2221E+0332 8.4520E+02-1.2621E+0333 8.1556E+02-1.2972E+03
34 7.8633E+02-1.3278E+0335 7.5756E+02-1.3543E+0336 7.2927E+02-1.3769E+03
37 7.2927E+02-1.3769E+0338 7.0144E+02-1.3960E+0339 6.7416E+02-1.4119E+03
40 6.4744E+02-1.4247E+0341 6.2131E+02-1.4346E+0342 5.9572E+02-1.4421E+03
43 5.7074E+02-1.4470E+0344 5.4637E+02-1.4497E+0345 5.2261E+02-1.4501E+03
46 5.2261E+02-1.4501E+0347 4.9942E+02-1.4487E+0348 4.7685E+02-1.4454E+03
49 4.5490E+02-1.4403E+0350 4.3356E+02-1.4335E+0351 4.1279E+02-1.4252E+03
52 3.9262E+02-1.4154E+0353 3.7306E+02-1.4041E+0354 3.5409E+02-1.3913E+03
55 3.5409E+02-1.3913E+0356 3.3569E+02-1.3773E+0357 3.1788E+02-1.3619E+03
58 3.0064E+02-1.3452E+0359 2.8398E+02-1.3272E+0360 2.6786E+02-1.3081E+03
61 2.5231E+02-1.2877E+0362 2.3730E+02-1.2660E+0363 2.2285E+02-1.2431E+03
64 2.2285E+02-1.2431E+0365 2.0892E+02-1.2191E+0366 1.9552E+02-1.1938E+03
67 1.8266E+02-1.1673E+0368 1.7033E+02-1.1396E+0369 1.5850E+02-1.1107E+03
70 1.4720E+02-1.0806E+0371 1.3640E+02-1.0493E+0372 1.2611E+02-1.0168E+03
73 1.2611E+02-1.0168E+0374 1.1631E+02-9.8324E+0275 1.0700E+02-9.4854E+02
76 9.8182E+01-9.1277E+0277 8.9849E+01-8.7597E+0278 8.1988E+01-8.3831E+02
```

```
79 1.4597E-01-7.7778E-0280 6.7670E-01-7.6748E-0281 6.1197E-01-7.2056E-02
82 6.1197E-01-7.2056E-0283 5.5160E-01-6.8185E-0284 4.7572E-01-6.3948E-02
85 4.4402E-01-5.9654E-0286 3.9540E-01-5.5700E-0287 3.5265E-01-5.1744E-02
88 3.1304E-01-4.7750E-0289 2.7728E-01-4.3865E-0290 2.4446E-01-4.0092E-02
  2.1428E-01  1.9727E-01  1.8915E-01  1.8056E-01  1.7216E-01  1.6437E-01
  1.5763E-01  1.5227E-01  1.4863E-01  1.4863E-01  1.4515E-01  1.4058E-01
  1.3526E-01  1.2945E-01  1.2336E-01  1.1713E-01  1.1091E-01  1.0477E-01
  1.0477E-01  9.8783E-02  9.2991E-02  8.7423E-02  8.2096E-02  7.7021E-02
  7.2201E-02  6.7626E-02  6.3285E-02  6.3285E-02  5.9168E-02  5.5264E-02
  5.1562E-02  4.8051E-02  4.4720E-02  4.1560E-02  3.8562E-02  3.5715E-02
  3.5715E-02  3.3011E-02  3.0440E-02  2.7996E-02  2.5669E-02  2.3452E-02
  2.1336E-02  1.9315E-02  1.7380E-02  1.7380E-02  1.5524E-02  1.3741E-02
  1.2023E-02  1.0364E-02  8.7580E-03  7.1980E-03  5.6785E-03  4.1939E-03
  4.1939E-03  2.7393E-03  1.3092E-03 -1.0098E-04 -1.4954E-03 -2.8779E-03
 -4.2518E-03 -5.6196E-03 -6.9836E-03 -6.9836E-03 -8.3454E-03 -9.7054E-03
 -1.1063E-02 -1.2418E-02 -1.3767E-02 -1.5108E-02 -1.6436E-02 -1.7746E-02
 -1.7746E-02 -1.9032E-02 -2.0285E-02 -2.1495E-02 -2.2652E-02 -2.3744E-02
 -2.4756E-02 -2.5674E-02 -2.6481E-02 -2.6481E-02 -2.7158E-02 -2.7686E-02
 -2.8043E-02 -2.8207E-02 -2.8153E-02 -2.7857E-02 -2.7296E-02 -2.6447E-02
 1 2.0454E+0411-1.9101E+03
 1 5.5981E+02 1.5062E+03 2 5.6518E+02 1.3210E+03 3 5.6522E+02 1.1567E+03
 4 5.6175E+02 1.0117E+03 5 5.5606E+02 8.8367E+02 6 5.4867E+02 7.7534E+02
 7 5.4046E+02 6.7728E+02 8 5.3169E+02 5.8700E+02 9 5.2251E+02 5.0191E+02
10 5.4747E+02 5.0990E+0211 5.3894E+02 4.2446E+0212 5.2998E+02 3.4338E+02
13 5.2062E+02 2.6731E+0214 5.1107E+02 1.9659E+0215 5.0124E+02 1.3120E+02
16 4.9121E+02 7.0983E+0117 4.8104E+02 1.5672E+0118 4.7076E+02-3.5063E+01
19 4.7076E+02-3.5063E+0120 4.6074E+02-8.1473E+0121 4.5058E+02-1.2404E+02
22 4.4027E+02-1.6313E+0223 4.2983E+02-1.9905E+0224 4.1952E+02-2.3208E+02
25 4.0933E+02-2.6245E+0226 3.9899E+02-2.9051E+0227 3.8856E+02-3.1644E+02
28 3.8856E+02-3.1644E+0229 3.7806E+02-3.4048E+0230 3.6753E+02-3.6273E+02
31 3.5701E+02-3.8334E+0232 3.4651E+02-4.0242E+0233 3.3605E+02-4.2012E+02
34 3.2565E+02-4.3649E+0235 3.1533E+02-4.5161E+0236 3.0511E+02-4.6555E+02
37 3.0511E+02-4.6555E+0238 2.9496E+02-4.7843E+0239 2.8494E+02-4.9025E+02
40 2.7505E+02-5.0106E+0241 2.6529E+02-5.1090E+0242 2.5565E+02-5.1984E+02
43 2.4616E+02-5.2788E+0244 2.3683E+02-5.3505E+0245 2.2766E+02-5.4137E+02
46 2.2766E+02-5.4137E+0247 2.1863E+02-5.4691E+0248 2.0977E+02-5.5163E+02
49 2.0108E+02-5.5556E+0250 1.9256E+02-5.5871E+0251 1.8421E+02-5.6113E+02
52 1.7603E+02-5.6278E+0253 1.6804E+02-5.6366E+0254 1.6022E+02-5.6378E+02
55 1.6022E+02-5.6378E+0256 1.5259E+02-5.6320E+0257 1.4514E+02-5.6186E+02
58 1.3768E+02-5.5975E+0259 1.3081E+02-5.5688E+0260 1.2392E+02-5.5329E+02
```

61	1.1723E+02	-5.4893E+02	62	1.1073E+02	-5.4379E+02	63	1.0443E+02	-5.3787E+02
64	1.0443E+02	-5.3787E+02	65	9.8314E+01	-5.3121E+02	66	9.240[illegible]E+01	-5.2377E+02
67	8.6685E+01	-5.1553E+02	68	8.1173E+01	-5.0650E+02	69	7.5657E+01	-4.9672E+02
70	7.0745E+01	-4.8615E+02	71	6.5838E+01	-4.7480E+02	72	6.1135E+01	-4.6268E+02
73	6.1135E+01	-4.6268E+02	74	5.6631E+01	-4.4983E+02	75	5.2334E+01	-4.3624E+02
76	4.8242E+01	-4.2193E+02	77	4.4356E+01	-4.0694E+02	78	4.0672E+01	-3.9134E+02
79	3.7192E+01	-3.7513E+02	80	3.3915E+01	-3.5837E+02	81	3.0839E+01	-3.4112E+02
82	3.0839E+01	-3.4112E+02	83	2.7959E+01	-3.2347E+02	84	2.5275E+01	-3.0549E+02
85	2.2783E+01	-2.8727E+02	86	2.0480E+01	-2.6890E+02	87	1.8358E+01	-2.5053E+02
88	1.6414E+01	-2.3227E+02	89	1.4642E+01	-2.1427E+02	90	1.3035E+01	-1.9668E+02

6.0463E-02	5.6432E-02	5.2424E-02	4.8653E-02	4.5294E-02	4.2493E-02
4.0368E-02	3.9034E-02	3.8604E-02	3.8604E-02	3.8395E-02	3.7756E-02
3.6829E-02	3.5719E-02	3.4504E-02	3.3241E-02	3.1969E-02	3.0717E-02
3.0717E-02	2.9503E-02	2.8337E-02	2.7224E-02	2.6166E-02	2.5162E-02
2.4212E-02	2.3307E-02	2.2442E-02	2.2442E-02	2.1612E-02	2.0811E-02
2.0036E-02	1.9283E-02	1.8548E-02	1.7829E-02	1.7123E-02	1.6429E-02
1.6429E-02	1.5744E-02	1.5067E-02	1.4396E-02	1.3731E-02	1.3070E-02
1.2412E-02	1.1755E-02	1.1100E-02	1.1100E-02	1.0444E-02	9.7874E-03
9.1289E-03	8.4675E-03	7.8022E-03	7.1324E-03	6.4571E-03	5.7756E-03
5.7756E-03	5.0873E-03	4.3913E-03	3.6869E-03	2.9738E-03	2.2515E-03
1.5198E-03	7.7864E-04	2.8216E-05	2.8216E-05	-7.3120E-04	-1.4987E-03
-2.2731E-03	-3.0530E-03	-3.8362E-03	-4.6206E-03	-5.4033E-03	-6.1808E-03
-6.1808E-03	-6.9492E-03	-7.7039E-03	-8.4393E-03	-9.1496E-03	-9.8279E-03
-1.0467E-02	-1.1059E-02	-1.1595E-02	-1.1595E-02	-1.2067E-02	-1.2462E-02
-1.2772E-02	-1.2984E-02	-1.3086E-02	-1.3066E-02	-1.2913E-02	-1.2615E-02
-2.9252E+00	-2.9184E+00	-2.9117E+00	-2.9049E+00	-2.8982E+00	-2.8914E+00
-2.8847E+00	-2.8779E+00	-2.8712E+00	-2.8712E+00	-2.8642E+00	-2.8573E+00
-2.8508E+00	-2.8442E+00	-2.8377E+00	-2.8311E+00	-2.8245E+00	-2.8180E+00
-2.8180E+00	-2.8114E+00	-2.8048E+00	-2.7983E+00	-2.7917E+00	-2.7851E+00
-2.7786E+00	-2.7720E+00	-2.7654E+00	-2.7654E+00	-2.7589E+00	-2.7523E+00
-2.7457E+00	-2.7392E+00	-2.7326E+00	-2.7223E+00	-2.7104E+00	-2.6984E+00
-2.6984E+00	-2.6865E+00	-2.6745E+00	-2.6626E+00	-2.6506E+00	-2.6386E+00
-2.6267E+00	-2.6147E+00	-2.6028E+00	-2.6028E+00	-2.5908E+00	-2.5789E+00
-2.5669E+00	-2.5550E+00	-2.5430E+00	-2.5311E+00	-2.5191E+00	-2.5071E+00
-2.5071E+00	-2.4952E+00	-2.4822E+00	-2.4690E+00	-2.4559E+00	-2.4427E+00
-2.4296E+00	-2.4164E+00	-2.4033E+00	-2.4033E+00	-2.3901E+00	-2.3769E+00
-2.3638E+00	-2.3506E+00	-2.3375E+00	-2.3243E+00	-2.3112E+00	-2.2980E+00
-2.2980E+00	-2.2849E+00	-2.2717E+00	-2.2557E+00	-2.2383E+00	-2.2209E+00
-2.2035E+00	-2.1861E+00	-2.1687E+00	-2.1687E+00	-2.1513E+00	-2.1339E+00
-2.1165E+00	-2.0742E+00	-1.9889E+00	-1.9035E+00	-1.8182E+00	-1.7328E+00

```
C      OPTIONAL PREBUCKLING DATA FOLLOWS

-3.897E+04-1.153E+04 2.034E+04 9.700E+03
-3.110E+02-2.344E+02 1.099E+02 1.066E+01-4.176E+02-2.440E+02 1.378E+02-4.112E-01
-4.752E+02-2.374E+02 1.010E+02-5.834E+00-4.905E+02-2.177E+02 7.810E+01-6.343E+00
-4.093E+02-1.871E+02 6.801E+01-2.454E+00-4.176E+02-1.472E+02 7.113E+01 5.816E+00
-3.399E+02-9.935E+01 6.426E+01 1.764E+01-2.391E+02-4.358E+01 1.068E+02 3.306E+01
-1.171E+02 2.044E+01 1.386E+02 5.227E+01-1.171E+02 2.044E+01 1.386E+02 5.227E+01
-2.025E+02-1.313E+01 1.035E+02 4.032E+01-2.640E+02-3.634E+01 7.518E+01 3.125E+01
-3.066E+02-5.184E+01 5.238E+01 2.439E+01-3.343E+02-6.155E+01 3.420E+01 1.926E+01
-3.503E+02-6.702E+01 1.979E+01 1.545E+01-3.574E+02-6.941E+01 8.479E+00 1.265E+01
-3.576E+02-6.965E+01-3.230E-01 1.061E+01-3.527E+02-6.839E+01-7.070E+00 9.135E+00
-3.527E+02-6.839E+01-7.070E+00 9.135E+00-3.441E+02-6.615E+01-1.217E+01 8.082E+00
-3.331E+02-6.344E+01-1.606E+01 7.286E+00-3.206E+02-6.053E+01-1.898E+01 6.665E+00
-3.069E+02-5.750E+01-2.108E+01 6.188E+00-2.926E+02-5.444E+01-2.249E+01 5.817E+00
-2.785E+02-5.172E+01-2.357E+01 5.430E+00-2.649E+02-4.939E+01-2.440E+01 5.002E+00
-2.519E+02-4.740E+01-2.504E+01 4.536E+00-2.519E+02-4.740E+01-2.504E+01 4.536E+00
-2.395E+02-4.572E+01-2.553E+01 4.038E+00-2.276E+02-4.431E+01-2.587E+01 3.512E+00
-2.164E+02-4.313E+01-2.611E+01 2.961E+00-2.057E+02-4.215E+01-2.626E+01 2.391E+00
-1.956E+02-4.135E+01-2.633E+01 1.807E+00-1.860E+02-4.070E+01-2.634E+01 1.212E+00
-1.770E+02-4.018E+01-2.631E+01 6.095E-01-1.685E+02-3.978E+01-2.623E+01 2.204E-03
-1.685E+02-3.978E+01-2.623E+01 2.204E-03-1.604E+02-3.947E+01-2.614E+01-6.087E-01
-1.529E+02-3.925E+01-2.602E+01-1.222E+00-1.459E+02-3.911E+01-2.591E+01-1.837E+00
-1.393E+02-3.904E+01-2.580E+01-2.453E+00-1.332E+02-3.904E+01-2.571E+01-3.070E+00
-1.275E+02-3.910E+01-2.563E+01-3.688E+00-1.223E+02-3.922E+01-2.559E+01-4.308E+00
-1.175E+02-3.940E+01-2.558E+01-4.930E+00-1.175E+02-3.940E+01-2.558E+01-4.930E+00
-1.131E+02-3.963E+01-2.561E+01-5.555E+00-1.092E+02-3.992E+01-2.568E+01-6.183E+00
-1.056E+02-4.026E+01-2.581E+01-6.816E+00-1.025E+02-4.065E+01-2.599E+01-7.455E+00
-9.908E+01-4.110E+01-2.623E+01-8.100E+00-9.727E+01-4.160E+01-2.652E+01-8.752E+00
-9.521E+01-4.214E+01-2.688E+01-9.411E+00-9.349E+01-4.274E+01-2.730E+01-1.008E+01
-9.349E+01-4.274E+01-2.730E+01-1.008E+01-9.208E+01-4.338E+01-2.778E+01-1.075E+01
-9.097E+01-4.406E+01-2.832E+01-1.143E+01-9.014E+01-4.477E+01-2.890E+01-1.211E+01
-8.955E+01-4.551E+01-2.954E+01-1.280E+01-8.918E+01-4.627E+01-3.022E+01-1.349E+01
-8.899E+01-4.703E+01-3.094E+01-1.417E+01-8.895E+01-4.779E+01-3.168E+01-1.485E+01
-8.901E+01-4.853E+01-3.243E+01-1.551E+01-8.901E+01-4.853E+01-3.243E+01-1.551E+01
-8.913E+01-4.923E+01-3.319E+01-1.616E+01-8.927E+01-4.986E+01-3.393E+01-1.678E+01
-8.935E+01-5.041E+01-3.463E+01-1.737E+01-8.933E+01-5.085E+01-3.529E+01-1.792E+01
-8.913E+01-5.115E+01-3.587E+01-1.842E+01-8.869E+01-5.128E+01-3.636E+01-1.885E+01
-8.794E+01-5.120E+01-3.672E+01-1.920E+01-8.678E+01-5.088E+01-3.693E+01-1.947E+01
-8.578E+01-5.088E+01-3.693E+01-1.947E+01-8.514E+01-5.027E+01-3.696E+01-1.963E+01
```

```
-8.292E+01-4.933E+01-3.676E+01-1.968E+01-8.004E+01-4.803E+01-3.635E+01-1.959E+01
-7.641E+01-4.632E+01-3.564E+01-1.934E+01-7.192E+01-4.415E+01-3.462E+01-1.893E+01
-6.648E+01-4.148E+01-3.325E+01-1.834E+01-6.000E+01-3.826E+01-3.149E+01-1.754E+01
-5.238E+01-3.445E+01-2.930E+01-1.651E+01-5.238E+01-3.445E+01-2.930E+01-1.651E+01
-4.350E+01-2.999E+01-2.065E+01-1.525E+01-3.328E+01-2.485E+01-2.349E+01-1.373E+01
-2.100E+01-1.898E+01-1.978E+01-1.193E+01-8.363E+00-1.232E+01-1.549E+01-9.841E+00
 6.469E+00-4.870E+00-1.059E+01-7.442E+00 2.287E+01 3.364E+00-5.073E+00-4.738E+00
 4.080E+01 1.236E+01 1.033E+00-1.734E+00 6.022E+01 2.208E+01 7.738E+00 1.565E+00
 1-2.2138E+0311-1.2545E+02
 1-5.4629E+01-2.2383E+02 2-5.6210E+01-2.0143E+02 3-6.1090E+01-1.7772E+02
 4-6.3304E+01-1.5371E+02 5-6.4906E+01-1.3016E+02 6-6.5986E+01-1.0843E+02
 7-6.6593E+01-8.7777E+01 8-6.6776E+01-6.8454E+01 9-6.6586E+01-5.0645E+01
10-6.6586E+01-5.0645E+0111-6.6029E+01-3.3732E+0112-6.5177E+01-1.8484E+01
13-6.4079E+01-4.7052E+0014-6.2775E+01 7.7465E+0015-6.1298E+01 1.8986E+01
16-5.9682E+01 2.9106E+0117-5.7954E+01 3.8190E+0118-5.6139E+01 4.6310E+01
19-5.6139E+01 4.6310E+0120-5.4253E+01 5.3544E+0121-5.2319E+01 5.9948E+01
22-5.0352E+01 6.5586E+0123-4.8367E+01 7.0515E+0124-4.6371E+01 7.4799E+01
25-4.4379E+01 7.8480E+0126-4.2399E+01 8.1606E+0127-4.0441E+01 8.4220E+01
28-4.0441E+01 8.4220E+0129-3.8506E+01 8.6371E+0130-3.6604E+01 8.8088E+01
31-3.4740E+01 8.9406E+0132-3.2916E+01 9.0356E+0133-3.1135E+01 9.0972E+01
34-2.9400E+01 9.1273E+0135-2.7715E+01 9.1282E+0136-2.6081E+01 9.1022E+01
37-2.6081E+01 9.1022E+0138-2.4496E+01 9.0520E+0139-2.2965E+01 8.9785E+01
40-2.1488E+01 8.8835E+0141-2.0066E+01 8.7685E+0142-1.8697E+01 8.6356E+01
43-1.7383E+01 8.4855E+0144-1.6124E+01 8.3196E+0145-1.4919E+01 8.1390E+01
46-1.4919E+01 8.1390E+0147-1.3767E+01 7.9457E+0148-1.2[illegible]9E+01 7.7401E+01
49-1.1624E+01 7.5233E+0150-1.0631E+01 7.2964E+0151-9.6875E+00 7.0610E+01
52-8.7948E+00 6.8176E+0153-7.9514E+00 6.5672E+0154-7.1564E+00 6.3108E+01
55-7.1564E+00 6.3108E+0156-6.4081E+00 6.0500E+0157-5.7058E+00 5.7852E+01
58-5.0481E+00 5.5172E+0159-4.4339E+00 5.2472E+0160-3.8615E+00 4.9763E+01
61-3.3298E+00 4.7050E+0162-2.8374E+00 4.4343E+0163-2.3829E+00 4.1651E+01
64-2.3829E+00 4.1651E+0165-1.9645E+00 3.8983E+0166-1.5812E+00 3.6346E+01
67-1.2214E+00 3.3746E+0168-9.1357E-01 3.1192E+0169-6.2629E-01 2.8692E+01
70-3.6803E-01 2.6251E+0171-1.3728E-01 2.3875E+0172 6.7444E-02 2.1569E+01
73 6.7444E-02 2.1569E+0174 2.4766E-01 1.9341E+0175 4.0478E-01 1.7192E+01
76 5.4026E-01 1.5130E+0177 6.5553E-01 1.3157E+0178 7.5193E-01 1.1279E+01
79 8.3094E-01 9.4992E+0080 8.9391E-01 7.8208E+0081 9.4220E-01 6.2475E+00
82 9.4220E-01 6.2475E+0083 9.7704E-01 4.7833E+0084 9.9982E-01 3.4316E+00
85 1.0118E+00 2.1962E+0086 1.0143E+00 1.0809E+0087 1.0084E+00 8.9427E-02
88 9.9539E-01-7.7411E-0189 9.7655E-01-1.5059E+0090 9.5304E-01-2.1026E+00
 -1.5629E-02 -1.5700E-02 -1.5502E-02 -1.5115E-02 -1.4608E-02 -1.4038E-02
```

```
-1.3447E-02 -1.2862E-02 -1.2297E-02 -1.2297E-02 -1.1722E-02 -1.1145E-02
-1.0567E-02 -9.990[illegible]E-03 -9.4166E-03 -8.8508E-03 -8.2962E-03 -7.7559E-03
-7.7559E-03 -7.2325E-03 -6.7274E-03 -6.2418E-03 -5.7762E-03 -5.3306E-03
-4.9048E-03 -4.4982E-03 -4.1097E-03 -4.1097E-03 -3.7388E-03 -3.3843E-03
-3.0455E-03 -2.7216E-03 -2.4117E-03 -2.1153E-03 -1.8317E-03 -1.5605E-03
-1.5605E-03 -1.3016E-03 -1.0531E-03 -8.1638E-04 -5.9059E-04 -3.7558E-04
-1.7113E-04  2.2889E-05  2.0657E-04  2.0657E-04  3.7997E-04  5.4314E-04
 6.9609E-04  8.3884E-04  9.7141E-04  1.0938E-03  1.2058E-03  1.3077E-03
 1.3077E-03  1.3992E-03  1.4804E-03  1.5513E-03  1.6119E-03  1.6622E-03
 1.7023E-03  1.7322E-03  1.7519E-03  1.7519E-03  1.7617E-03  1.7617E-03
 1.7520E-03  1.7329E-03  1.7046E-03  1.6676E-03  1.6221E-03  1.5687E-03
 1.5687E-03  1.5077E-03  1.4398E-03  1.3656E-03  1.2856E-03  1.2007E-03
 1.1114E-03  1.0186E-03  9.2308E-04  9.2308E-04  8.2556E-04  7.2688E-04
 6.2782E-04  5.2917E-04  4.3166E-04  3.3602E-04  2.4294E-04  1.5305E-04
 1.2640E-05  2.7933E-06

C      BUCKLING MODE DATA FOLLOWS

     6      1 -9.2322E-03
-4.642E+01 2.191E+01-8.660E+01-7.983E+00-2.714E-02 1.203E-03-1.429E-04-2.033E-02
-4.318E+01 3.284E+01-8.394E+01-1.980E+01-4.568E-02 8.596E-03-2.169E-03-2.063E-02
-4.138E+01 4.307E+01-8.532E+01-2.865E+01-6.459E-02 1.616E-02-4.168E-03-2.121E-02
-4.042E+01 5.307E+01-8.987E+01-3.454E+01-8.410E-02 2.395E-02-6.149E-03-2.199E-02
-3.966E+01 6.317E+01-9.685E+01-3.758E+01-1.044E-01 3.202E-02-8.121E-03-2.294E-02
-3.942E+01 7.367E+01-1.057E+02-3.815E+01-1.256E-01 4.041E-02-1.009E-02-2.400E-02
-3.894E+01 8.479E+01-1.160E+02-3.655E+01-1.478E-01 4.913E-02-1.205E-02-2.516E-02
-3.821E+01 9.665E+01-1.273E+02-3.276E+01-1.710E-01 5.824E-02-1.403E-02-2.637E-02
-3.707E+01 1.093E+02-1.392E+02-2.677E+01-1.954E-01 6.778E-02-1.606E-02-2.760E-02
-3.707E+01 1.093E+02-1.392E+02-2.677E+01-1.954E-01 6.778E-02-1.606E-02-2.760E-02
-3.533E+01 1.233E+02-1.521E+02-1.951E+01-2.219E-01 7.821E-02-1.826E-02-2.887E-02
-3.285E+01 1.379E+02-1.654E+02-9.946E+00-2.495E-01 8.914E-02-2.055E-02-3.010E-02
-2.956E+01 1.533E+02-1.788E+02 1.566E+00-2.782E-01 1.005E-01-2.289E-02-3.126E-02
-2.544E+01 1.694E+02-1.921E+02 1.469E+01-3.080E-01 1.123E-01-2.526E-02-3.231E-02
-2.047E+01 1.860E+02-2.052E+02 2.910E+01-3.386E-01 1.245E-01-2.764E-02-3.323E-02
-1.468E+01 2.032E+02-2.177E+02 4.451E+01-3.701E-01 1.369E-01-3.000E-02-3.400E-02
-8.094E+00 2.209E+02-2.295E+02 6.065E+01-4.021E-01 1.495E-01-3.233E-02-3.460E-02
-7.494E-01 2.389E+02-2.401E+02 7.726E+01-4.346E-01 1.624E-01-3.461E-02-3.503E-02
-7.494E-01 2.389E+02-2.401E+02 7.726E+01-4.346E-01 1.624E-01-3.461E-02-3.503E-02
 7.292E+00 2.573E+02-2.496E+02 9.412E+01-4.675E-01 1.753E-01-3.682E-02-3.527E-02
 1.597E+01 2.758E+02-2.576E+02 1.110E+02-5.004E-01 1.883E-01-3.897E-02-3.531E-02
```

2.519E+01	2.944E+02	-2.640E+02	1.277E+02	-5.333E-01	2.012E-01	-4.104E-02	-3.516E-02
3.490E+01	3.129E+02	-2.687E+02	1.442E+02	-5.659E-01	2.141E-01	-4.302E-02	-3.481E-02
4.501E+01	3.312E+02	-2.717E+02	1.602E+02	-5.980E-01	2.269E-01	-4.490E-02	-3.426E-02
5.542E+01	3.492E+02	-2.728E+02	1.755E+02	-6.296E-01	2.394E-01	-4.669E-02	-3.352E-02
6.606E+01	3.668E+02	-2.720E+02	1.902E+02	-6.603E-01	2.517E-01	-4.836E-02	-3.259E-02
7.683E+01	3.837E+02	-2.693E+02	2.041E+02	-6.900E-01	2.637E-01	-4.993E-02	-3.148E-02
7.683E+01	3.837E+02	-2.693E+02	2.041E+02	-6.900E-01	2.637E-01	-4.993E-02	-3.148E-02
8.766E+01	4.000E+02	-2.648E+02	2.171E+02	-7.186E-01	2.754E-01	-5.139E-02	-3.020E-02
9.846E+01	4.154E+02	-2.585E+02	2.292E+02	-7.459E-01	2.866E-01	-5.273E-02	-2.875E-02
1.092E+02	4.300E+02	-2.504E+02	2.402E+02	-7.717E-01	2.973E-01	-5.395E-02	-2.714E-02
1.197E+02	4.435E+02	-2.406E+02	2.502E+02	-7.959E-01	3.076E-01	-5.505E-02	-2.539E-02
1.299E+02	4.560E+02	-2.293E+02	2.591E+02	-8.184E-01	3.172E-01	-5.603E-02	-2.350E-02
1.399E+02	4.673E+02	-2.165E+02	2.669E+02	-8.390E-01	3.263E-01	-5.689E-02	-2.150E-02
1.494E+02	4.775E+02	-2.023E+02	2.735E+02	-8.577E-01	3.347E-01	-5.762E-02	-1.938E-02
1.585E+02	4.863E+02	-1.869E+02	2.789E+02	-8.743E-01	3.424E-01	-5.822E-02	-1.717E-02
1.585E+02	4.863E+02	-1.869E+02	2.789E+02	-8.743E-01	3.424E-01	-5.822E-02	-1.717E-02
1.672E+02	4.939E+02	-1.703E+02	2.831E+02	-8.888E-01	3.493E-01	-5.870E-02	-1.488E-02
1.753E+02	5.001E+02	-1.528E+02	2.862E+02	-9.011E-01	3.555E-01	-5.906E-02	-1.251E-02
1.828E+02	5.050E+02	-1.344E+02	2.882E+02	-9.112E-01	3.609E-01	-5.930E-02	-1.009E-02
1.897E+02	5.086E+02	-1.153E+02	2.890E+02	-9.190E-01	3.655E-01	-5.941E-02	-7.632E-03
1.959E+02	5.107E+02	-9.557E+01	2.888E+02	-9.244E-01	3.692E-01	-5.941E-02	-5.141E-03
2.015E+02	5.116E+02	-7.543E+01	2.874E+02	-9.275E-01	3.721E-01	-5.929E-02	-2.633E-03
2.065E+02	5.111E+02	-5.498E+01	2.851E+02	-9.282E-01	3.740E-01	-5.905E-02	-1.212E-04
2.107E+02	5.093E+02	-3.436E+01	2.817E+02	-9.267E-01	3.751E-01	-5.870E-02	2.383E-03
2.107E+02	5.093E+02	-3.436E+01	2.817E+02	-9.267E-01	3.751E-01	-5.870E-02	2.383E-03
2.142E+02	5.062E+02	-1.370E+01	2.774E+02	-9.228E-01	3.752E-01	-5.825E-02	4.868E-03
2.169E+02	5.019E+02	6.884E+00	2.723E+02	-9.166E-01	3.745E-01	-5.769E-02	7.322E-03
2.190E+02	4.964E+02	2.726E+01	2.663E+02	-9.081E-01	3.728E-01	-5.703E-02	9.734E-03
2.204E+02	4.897E+02	4.731E+01	2.595E+02	-8.975E-01	3.702E-01	-5.627E-02	1.209E-02
2.211E+02	4.819E+02	6.693E+01	2.520E+02	-8.847E-01	3.667E-01	-5.541E-02	1.440E-02
2.211E+02	4.732E+02	8.601E+01	2.437E+02	-8.699E-01	3.623E-01	-5.447E-02	1.663E-02
2.204E+02	4.634E+02	1.044E+02	2.349E+02	-8.530E-01	3.570E-01	-5.344E-02	1.878E-02
2.191E+02	4.527E+02	1.222E+02	2.254E+02	-8.342E-01	3.508E-01	-5.234E-02	2.084E-02
2.191E+02	4.527E+02	1.222E+02	2.254E+02	-8.342E-01	3.508E-01	-5.234E-02	2.084E-02
2.172E+02	4.412E+02	1.391E+02	2.154E+02	-8.136E-01	3.438E-01	-5.115E-02	2.281E-02
2.147E+02	4.289E+02	1.551E+02	2.049E+02	-7.913E-01	3.360E-01	-4.990E-02	2.468E-02
2.116E+02	4.159E+02	1.701E+02	1.940E+02	-7.674E-01	3.274E-01	-4.857E-02	2.644E-02
2.080E+02	4.022E+02	1.842E+02	1.826E+02	-7.419E-01	3.180E-01	-4.719E-02	2.808E-02
2.039E+02	3.880E+02	1.972E+02	1.708E+02	-7.150E-01	3.079E-01	-4.575E-02	2.961E-02
1.993E+02	3.733E+02	2.090E+02	1.586E+02	-6.868E-01	2.971E-01	-4.425E-02	3.101E-02

```
1.943E+02 3.582E+02 2.197E+02 1.461E+02-6.574E-01 2.857E-01-4.271E-02 3.227E-02
1.890E+02 3.428E+02 2.293E+02 1.333E+02-6.270E-01 2.736E-01-4.113E-02 3.341E-02
1.890E+02 3.428E+02 2.293E+02 1.333E+02-6.270E-01 2.736E-01-4.113E-02 3.341E-02
1.833E+02 3.270E+02 2.376E+02 1.201E+02-5.957E-01 2.610E-01-3.951E-02 3.439E-02
1.773E+02 3.111E+02 2.447E+02 1.066E+02-5.636E-01 2.479E-01-3.787E-02 3.523E-02
1.710E+02 2.949E+02 2.506E+02 9.287E+01-5.308E-01 2.344E-01-3.620E-02 3.592E-02
1.645E+02 2.787E+02 2.553E+02 7.880E+01-4.976E-01 2.205E-01-3.451E-02 3.645E-02
1.578E+02 2.625E+02 2.588E+02 6.442E+01-4.640E-01 2.063E-01-3.281E-02 3.682E-02
1.510E+02 2.464E+02 2.610E+02 4.973E+01-4.302E-01 1.918E-01-3.110E-02 3.701E-02
1.441E+02 2.303E+02 2.621E+02 3.469E+01-3.964E-01 1.771E-01-2.939E-02 3.703E-02
1.371E+02 2.144E+02 2.620E+02 1.929E+01-3.627E-01 1.623E-01-2.769E-02 3.686E-02
1.371E+02 2.144E+02 2.620E+02 1.929E+01-3.627E-01 1.623E-01-2.769E-02 3.686E-02
1.301E+02 1.987E+02 2.609E+02 3.499E+00-3.293E-01 1.475E-01-2.600E-02 3.651E-02
1.231E+02 1.832E+02 2.586E+02-1.272E+01-2.963E-01 1.328E-01-2.433E-02 3.595E-02
1.162E+02 1.680E+02 2.553E+02-2.941E+01-2.640E-01 1.182E-01-2.268E-02 3.519E-02
1.093E+02 1.532E+02 2.511E+02-4.660E+01-2.326E-01 1.038E-01-2.106E-02 3.422E-02
1.026E+02 1.388E+02 2.460E+02-6.436E+01-2.022E-01 8.977E-02-1.947E-02 3.301E-02
9.601E+01 1.248E+02 2.401E+02-8.274E+01-1.730E-01 7.619E-02-1.792E-02 3.157E-02
8.960E+01 1.112E+02 2.334E+02-1.018E+02-1.453E-01 6.317E-02-1.641E-02 2.988E-02
8.338E+01 9.809E+01 2.261E+02-1.216E+02-1.193E-01 5.083E-02-1.495E-02 2.792E-02
8.338E+01 9.809E+01 2.261E+02-1.216E+02-1.193E-01 5.083E-02-1.495E-02 2.792E-02
7.739E+01 8.550E+01 2.183E+02-1.423E+02-9.520E-02 3.930E-02-1.354E-02 2.569E-02
7.163E+01 7.344E+01 2.101E+02-1.638E+02-7.328E-02 2.871E-02-1.218E-02 2.316E-02
6.612E+01 6.192E+01 2.016E+02-1.863E+02-5.380E-02 1.923E-02-1.088E-02 2.032E-02
6.087E+01 5.097E+01 1.930E+02-2.099E+02-3.702E-02 1.100E-02-9.621E-03 1.715E-02
5.588E+01 4.058E+01 1.844E+02-2.346E+02-2.325E-02 4.212E-03-8.418E-03 1.362E-02
5.116E+01 3.077E+01 1.760E+02-2.605E+02-1.279E-02-9.562E-04-7.266E-03 9.731E-03
4.670E+01 2.153E+01 1.681E+02-2.877E+02-5.967E-03-4.294E-03-6.162E-03 5.444E-03
4.248E+01 1.288E+01 1.606E+02-3.163E+02-3.117E-03-5.580E-03-5.102E-03 7.391E-04

C      RING DATA FOLLOWS

       6.70+6      1.29+6      7.58+6      -.15+6      6.78+3-.489
0.
      8.985+6      85.8+6      85.8+6                  65.0+6-4.3875
0.
       END OF FILE CARD
```

OUTPUT DATA LISTING

60 DEGREE SPHERICAL DISH

SURFACE LOADING, IF ANY, IS APPLIED AT SHELL REFERENCE SURFACE
AND, DURING BUCKLING, REMAINS FIXED IN MAGNITUDE AND DIRECTION

TABLE 1 (SURFACE GEOMETRY)

S	R	R PRIME	R/R2
4.0106E+01	3.9900E+01	9.8457E-01	1.7500E-01
4.1062E+01	4.1032E+01	9.8363E-01	1.7996E-01
4.2017E+01	4.2164E+01	9.8270E-01	1.8493E-01
4.2973E+01	4.3296E+01	9.8176E-01	1.8989E-01
4.3929E+01	4.4428E+01	9.8083E-01	1.9486E-01
4.4885E+01	4.5172E+01	9.8016E-01	1.9812E-01
4.5841E+01	4.5916E+01	9.7949E-01	2.0139E-01
4.6796E+01	4.6659E+01	9.7882E-01	2.0465E-01
4.7752E+01	4.7403E+01	9.7815E-01	2.0791E-01
4.7752E+01	4.7403E+01	9.7815E-01	2.0791E-01
4.8747E+01	4.8374E+01	9.7720E-01	2.1217E-01
4.9742E+01	4.9346E+01	9.7626E-01	2.1643E-01
5.0737E+01	5.0317E+01	9.7531E-01	2.2069E-01
5.1732E+01	5.1289E+01	9.7437E-01	2.2495E-01
5.2727E+01	5.2256E+01	9.7335E-01	2.2919E-01
5.3721E+01	5.3223E+01	9.7234E-01	2.3344E-01
5.4716E+01	5.4191E+01	9.7132E-01	2.3768E-01
5.5711E+01	5.5158E+01	9.7030E-01	2.4192E-01
5.5711E+01	5.5158E+01	9.7030E-01	2.4192E-01
5.6706E+01	5.6121E+01	9.6921E-01	2.4615E-01
5.7700E+01	5.7084E+01	9.6812E-01	2.5037E-01
5.8695E+01	5.8048E+01	9.6702E-01	2.5460E-01
5.9690E+01	5.9011E+01	9.6593E-01	2.5882E-01
6.0685E+01	5.9970E+01	9.6476E-01	2.6302E-01
6.1680E+01	6.0928E+01	9.6359E-01	2.6723E-01
6.2675E+01	6.1887E+01	9.6243E-01	2.7143E-01
6.3670E+01	6.2846E+01	9.6126E-01	2.7564E-01
6.3670E+01	6.2846E+01	9.6126E-01	2.7564E-01
6.4665E+01	6.3799E+01	9.6002E-01	2.7982E-01
6.5659E+01	6.4753E+01	9.5878E-01	2.8400E-01
6.6654E+01	6.5706E+01	9.5754E-01	2.8819E-01
6.7649E+01	6.6660E+01	9.5630E-01	2.9237E-01
6.8644E+01	6.7609E+01	9.5499E-01	2.9653E-01
6.9639E+01	6.8558E+01	9.5368E-01	3.0069E-01
7.0633E+01	6.9508E+01	9.5237E-01	3.0486E-01
7.1628E+01	7.0457E+01	9.5106E-01	3.0902E-01
7.1628E+01	7.0457E+01	9.5106E-01	3.0902E-01
7.2623E+01	7.1400E+01	9.4967E-01	3.1316E-01
7.3618E+01	7.2343E+01	9.4829E-01	3.1729E-01
7.4613E+01	7.3287E+01	9.4690E-01	3.2143E-01
7.5608E+01	7.4230E+01	9.4552E-01	3.2557E-01
7.6603E+01	7.5168E+01	9.4406E-01	3.2968E-01
7.7597E+01	7.6106E+01	9.4260E-01	3.3380E-01
7.8592E+01	7.7043E+01	9.4115E-01	3.3791E-01
7.9587E+01	7.7981E+01	9.3969E-01	3.4202E-01
7.9587E+01	7.7981E+01	9.3969E-01	3.4202E-01
8.0582E+01	7.8913E+01	9.3816E-01	3.4611E-01
8.1576E+01	7.9845E+01	9.3663E-01	3.5019E-01
8.2571E+01	8.0776E+01	9.3511E-01	3.5428E-01
8.3566E+01	8.1708E+01	9.3358E-01	3.5837E-01
8.4561E+01	8.2634E+01	9.3198E-01	3.6243E-01

8.5556E+01	8.3559E+01	9.3038E-01	3.[illegible]649E-01
8.6551E+01	8.4485E+01	9.2878E-01	3.7055E-01
8.7546E+01	8.5411E+01	9.2718E-01	3.7461E-01
8.7546E+01	8.5411E+01	9.2718E-01	3.7461E-01
8.8541E+01	8.6330E+01	9.2551E-01	3.7864E-01
8.9535E+01	8.7248E+01	9.2384E-01	3.8267E-01
9.0530E+01	8.8167E+01	9.2217E-01	3.8670E-01
9.1525E+01	8.9086E+01	9.2050E-01	3.9073E-01
9.2520E+01	8.9999E+01	9.1876E-01	3.9473E-01
9.3514E+01	9.0911E+01	9.1702E-01	3.9873E-01
9.4509E+01	9.1824E+01	9.1529E-01	4.0274E-01
9.5504E+01	9.2737E+01	9.1355E-01	4.0674E-01
9.5504E+01	9.2737E+01	9.1355E-01	4.0674E-01
9.6499E+01	9.3642E+01	9.1174E-01	4.1071E-01
9.7494E+01	9.4547E+01	9.0993E-01	4.1468E-01
9.8489E+01	9.5452E+01	9.0812E-01	4.1865E-01
9.9484E+01	9.6357E+01	9.0631E-01	4.2262E-01
1.0048E+02	9.7255E+01	9.0443E-01	4.2656E-01
1.0147E+02	9.8152E+01	9.0255E-01	4.3050E-01
1.0247E+02	9.9050E+01	9.0067E-01	4.3443E-01
1.0346E+02	9.9948E+01	8.9879E-01	4.3837E-01
1.0346E+02	9.9948E+01	8.9879E-01	4.3837E-01
1.0446E+02	1.0084E+02	8.9684E-01	4.4228E-01
1.0545E+02	1.0173E+02	8.9490E-01	4.4618E-01
1.0645E+02	1.0262E+02	8.9296E-01	4.5008E-01
1.0744E+02	1.0351E+02	8.9101E-01	4.5399E-01
1.0844E+02	1.0439E+02	8.8900E-01	4.5786E-01
1.0943E+02	1.0527E+02	8.8698E-01	4.6173E-01
1.1043E+02	1.0616E+02	8.8497E-01	4.6560E-01
1.1142E+02	1.0704E+02	8.8295E-01	4.6947E-01
1.1142E+02	1.0704E+02	8.8295E-01	4.6947E-01
1.1242E+02	1.0791E+02	8.8087E-01	4.7330E-01
1.1341E+02	1.0879E+02	8.7879E-01	4.7714E-01
1.1441E+02	1.0966E+02	8.7670E-01	4.8097E-01
1.1540E+02	1.1054E+02	8.7462E-01	4.8481E-01
1.1640E+02	1.1140E+02	8.7247E-01	4.8861E-01
1.1739E+02	1.1227E+02	8.7032E-01	4.9240E-01
1.1839E+02	1.1313E+02	8.6818E-01	4.9620E-01
1.1938E+02	1.1400E+02	8.6603E-01	5.0000E-01

TABLE 2 (WALL PROPERTIES)

S	E1	E2	E12	NU1	H
4.0106E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	-0.	-0.	-0.	-0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.1062E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.2017E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.2973E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.3929E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.4885E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.5841E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.6796E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.7752E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.7752E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.8747E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
4.9742E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.0737E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.1732E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.2727E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.3721E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.4716E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03

5.5711E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.5711E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.6706E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.7700E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.8695E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
5.9690E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.0685E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.1680E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.2675E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.3670E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.3670E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.4665E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.5659E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.6654E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.7649E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.8644E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
6.9639E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.0633E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.1628E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03

7.1628E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.2623E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.3618E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.4613E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.5608E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.6603E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.7597E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.8592E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.9587E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
7.9587E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.0582E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.1576E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.2571E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.3566E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.4561E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.5556E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.6551E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.7546E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.7546E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03

8.8541E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
8.9535E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	[illegible]000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.0530E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.1525E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.2520E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.3514E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.4509E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.5504E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.5504E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.6499E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.7494E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.8489E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
9.9484E+01	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0048E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0147E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0247E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0346E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0346E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0446E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03

1.0545E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0645E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0744E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0844E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.0943E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1043E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1142E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1142E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1242E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1341E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1441E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1540E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1640E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1739E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1839E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	0.	0.	0.	0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
1.1938E+02	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03
	-0.	-0.	-0.	-0.	4.3000E-01
	9.3500E+06	9.3500E+06	3.5400E+06	3.2000E-01	8.0000E-03

TABLE 3 (FOUNDATION MODULI) ALL ZEROES

TABLE 4 (STRINGER PROPERTIES) ALL ZEROES

TABLE 5 (PRESSURE GRADIENT) ALL ZEROES

INITIAL NONLINEAR STATE SHELL DATA, LAMBDA = 2.1000E+00

S	T10	T20	CHI0	X30	M10	M20
4.0106E+01	1.3771E+03	4.1243E+03	2.0428E-01	-2.9252E+00	-3.110E+02	1.899E+02
4.1062E+01	1.4047E+03	3.6480E+03	1.9727E-01	-2.9184E+00	-4.176E+02	1.378E+02
4.2017E+01	1.4182E+03	3.2098E+03	1.8915E-01	-2.9117E+00	-4.752E+02	1.010E+02
4.2973E+01	1.4215E+03	2.8091E+03	1.8058E-01	-2.9049E+00	-4.905E+02	7.810E+01
4.3929E+01	1.4177E+03	2.4436E+03	1.7216E-01	-2.8982E+00	-4.693E+02	6.801E+01
4.4885E+01	1.4081E+03	2.1249E+03	1.6437E-01	-2.8914E+00	-4.176E+02	7.113E+01
4.5841E+01	1.3946E+03	1.8300E+03	1.5763E-01	-2.8847E+00	-3.399E+02	8.426E+01
4.6796E+01	1.3781E+03	1.5551E+03	1.5227E-01	-2.8779E+00	-2.391E+02	1.068E+02
4.7752E+01	1.3591E+03	1.2958E+03	1.4863E-01	-2.8712E+00	-1.171E+02	1.386E+02
4.7752E+01	1.4115E+03	1.3126E+03	1.4863E-01	-2.8712E+00	-1.171E+02	1.386E+02
4.8747E+01	1.3921E+03	1.0547E+03	1.4515E-01	-2.8642E+00	-2.025E+02	1.035E+02
4.9742E+01	1.3704E+03	8.1208E+02	1.4058E-01	-2.8573E+00	-2.640E+02	7.518E+01
5.0737E+01	1.3467E+03	5.8581E+02	1.3526E-01	-2.8508E+00	-3.066E+02	5.238E+01
5.1732E+01	1.3215E+03	3.7633E+02	1.2945E-01	-2.8442E+00	-3.343E+02	3.420E+01
5.2727E+01	1.2948E+03	1.8343E+02	1.2336E-01	-2.8377E+00	-3.503E+02	1.979E+01
5.3721E+01	1.2669E+03	6.5852E+00	1.1713E-01	-2.8311E+00	-3.574E+02	8.479E+00
5.4716E+01	1.2382E+03	-1.5492E+02	1.1091E-01	-2.8245E+00	-3.576E+02	-3.230E-01
5.5711E+01	1.2087E+03	-3.0195E+02	1.0477E-01	-2.8180E+00	-3.527E+02	-7.070E+00
5.5711E+01	1.2087E+03	-3.0195E+02	1.0477E-01	-2.8180E+00	-3.527E+02	-7.070E+00
5.6706E+01	1.1794E+03	-4.3527E+02	9.8783E-02	-2.8114E+00	-3.441E+02	-1.217E+01
5.7700E+01	1.1495E+03	-5.5608E+02	9.2991E-02	-2.8048E+00	-3.331E+02	-1.606E+01
5.8695E+01	1.1191E+03	-6.6534E+02	8.7423E-02	-2.7983E+00	-3.206E+02	-1.898E+01
5.9690E+01	1.0884E+03	-7.6397E+02	8.2096E-02	-2.7917E+00	-3.069E+02	-2.108E+01
6.0685E+01	1.0578E+03	-8.5281E+02	7.7021E-02	-2.7851E+00	-2.926E+02	-2.249E+01
6.1680E+01	1.0276E+03	-9.3256E+02	7.2201E-02	-2.7786E+00	-2.785E+02	-2.357E+01
6.2675E+01	9.9704E+02	-1.0042E+03	6.7626E-02	-2.7720E+00	-2.649E+02	-2.440E+01
6.3670E+01	9.6645E+02	-1.0683E+03	6.3285E-02	-2.7654E+00	-2.519E+02	-2.504E+01
6.3670E+01	9.6645E+02	-1.0683E+03	6.3285E-02	-2.7654E+00	-2.519E+02	-2.504E+01
6.4665E+01	9.3584E+02	-1.1257E+03	5.9168E-02	-2.7589E+00	-2.395E+02	-2.553E+01
6.5659E+01	9.0538E+02	-1.1768E+03	5.5264E-02	-2.7523E+00	-2.276E+02	-2.587E+01
6.6654E+01	8.7514E+02	-1.2221E+03	5.1562E-02	-2.7457E+00	-2.164E+02	-2.611E+01
6.7649E+01	8.4520E+02	-1.2621E+03	4.8051E-02	-2.7392E+00	-2.057E+02	-2.626E+01
6.8644E+01	8.1556E+02	-1.2972E+03	4.4720E-02	-2.7326E+00	-1.956E+02	-2.633E+01
6.9639E+01	7.8633E+02	-1.3278E+03	4.1560E-02	-2.7223E+00	-1.860E+02	-2.634E+01
7.0633E+01	7.5756E+02	-1.3543E+03	3.8562E-02	-2.7104E+00	-1.770E+02	-2.631E+01
7.1628E+01	7.2927E+02	-1.3769E+03	3.5715E-02	-2.6984E+00	-1.685E+02	-2.623E+01
7.1628E+01	7.2927E+02	-1.3769E+03	3.5715E-02	-2.6984E+00	-1.685E+02	-2.623E+01
7.2623E+01	7.0144E+02	-1.3960E+03	3.3011E-02	-2.6865E+00	-1.604E+02	-2.614E+01
7.3618E+01	6.7416E+02	-1.4119E+03	3.0440E-02	-2.6745E+00	-1.529E+02	-2.602E+01
7.4613E+01	6.4744E+02	-1.4247E+03	2.7996E-02	-2.6626E+00	-1.459E+02	-2.591E+01
7.5608E+01	6.2131E+02	-1.4346E+03	2.5669E-02	-2.6506E+00	-1.393E+02	-2.580E+01
7.6603E+01	5.9572E+02	-1.4421E+03	2.3452E-02	-2.6386E+00	-1.332E+02	-2.571E+01
7.7597E+01	5.7074E+02	-1.4470E+03	2.1336E-02	-2.6267E+00	-1.275E+02	-2.563E+01
7.8592E+01	5.4637E+02	-1.4497E+03	1.9315E-02	-2.6147E+00	-1.223E+02	-2.559E+01
7.9587E+01	5.2261E+02	-1.4501E+03	1.7380E-02	-2.6028E+00	-1.175E+02	-2.558E+01
7.9587E+01	5.2261E+02	-1.4501E+03	1.7380E-02	-2.6028E+00	-1.175E+02	-2.558E+01
8.0582E+01	4.9942E+02	-1.4487E+03	1.5524E-02	-2.5908E+00	-1.131E+02	-2.561E+01
8.1576E+01	4.7685E+02	-1.4454E+03	1.3741E-02	-2.5789E+00	-1.092E+02	-2.568E+01
8.2571E+01	4.5490E+02	-1.4403E+03	1.2023E-02	-2.5669E+00	-1.056E+02	-2.581E+01
8.3566E+01	4.3356E+02	-1.4335E+03	1.0364E-02	-2.5550E+00	-1.025E+02	-2.599E+01

8.4561E+01	4.1279E+02	-1.4252E+03	8.7580E-03	-2.5430E+00	-9.968E+01	-2.623E+01
8.5556E+01	3.9262E+02	-1.4154E+03	7.1980E-03	-2.5311E+00	-9.727E+01	-2.652E+01
8.6551E+01	3.7306E+02	-1.4041E+03	5.6785E-03	-2.5191E+00	-9.521E+01	-2.688E+01
8.7546E+01	3.5409E+02	-1.3913E+03	4.1939E-03	-2.5071E+00	-9.349E+01	-2.730E+01
8.7546E+01	3.5409E+02	-1.3913E+03	4.1939E-03	-2.5071E+00	-9.349E+01	-2.730E+01
8.8541E+01	3.3569E+02	-1.3773E+03	2.7393E-03	-2.4952E+00	-9.208E+01	-2.778E+01
8.9535E+01	3.1788E+02	-1.3619E+03	1.3092E-03	-2.4822E+00	-9.097E+01	-2.832E+01
9.0530E+01	3.0064E+02	-1.3452E+03	-1.0098E-04	-2.4690E+00	-9.014E+01	-2.890E+01
9.1525E+01	2.8398E+02	-1.3272E+03	-1.4954E-03	-2.4559E+00	-8.955E+01	-2.954E+01
9.2520E+01	2.6786E+02	-1.3081E+03	-2.8779E-03	-2.4427E+00	-8.918E+01	-3.022E+01
9.3514E+01	2.5231E+02	-1.2877E+03	-4.2518E-03	-2.4296E+00	-8.899E+01	-3.094E+01
9.4509E+01	2.3730E+02	-1.2660E+03	-5.6196E-03	-2.4164E+00	-8.895E+01	-3.168E+01
9.5504E+01	2.2285E+02	-1.2431E+03	-6.9836E-03	-2.4033E+00	-8.901E+01	-3.243E+01
9.5504E+01	2.2285E+02	-1.2431E+03	-6.9836E-03	-2.4033E+00	-8.901E+01	-3.243E+01
9.6499E+01	2.0892E+02	-1.2191E+03	-8.3454E-03	-2.3901E+00	-8.913E+01	-3.319E+01
9.7494E+01	1.9552E+02	-1.1938E+03	-9.7054E-03	-2.3769E+00	-8.927E+01	-3.393E+01
9.8489E+01	1.8266E+02	-1.1673E+03	-1.1063E-02	-2.3638E+00	-8.935E+01	-3.463E+01
9.9484E+01	1.7033E+02	-1.1396E+03	-1.2418E-02	-2.3506E+00	-8.933E+01	-3.529E+01
1.0048E+02	1.5850E+02	-1.1107E+03	-1.3767E-02	-2.3375E+00	-8.913E+01	-3.587E+01
1.0147E+02	1.4720E+02	-1.0806E+03	-1.5108E-02	-2.3243E+00	-8.869E+01	-3.636E+01
1.0247E+02	1.3640E+02	-1.0493E+03	-1.6436E-02	-2.3112E+00	-8.794E+01	-3.672E+01
1.0346E+02	1.2611E+02	-1.0168E+03	-1.7746E-02	-2.2980E+00	-8.678E+01	-3.693E+01
1.0346E+02	1.2611E+02	-1.0168E+03	-1.7746E-02	-2.2980E+00	-8.678E+01	-3.693E+01
1.0446E+02	1.1631E+02	-9.8324E+02	-1.9032E-02	-2.2849E+00	-8.514E+01	-3.696E+01
1.0545E+02	1.0700E+02	-9.4854E+02	-2.0285E-02	-2.2717E+00	-8.292E+01	-3.678E+01
1.0645E+02	9.8182E+01	-9.1277E+02	-2.1495E-02	-2.2557E+00	-8.004E+01	-3.635E+01
1.0744E+02	8.9849E+01	-8.7597E+02	-2.2652E-02	-2.2383E+00	-7.641E+01	-3.564E+01
1.0844E+02	8.1988E+01	-8.3831E+02	-2.3744E-02	-2.2209E+00	-7.192E+01	-3.462E+01
1.0943E+02	7.4597E+01	-7.9978E+02	-2.4756E-02	-2.2035E+00	-6.648E+01	-3.325E+01
1.1043E+02	6.7670E+01	-7.6048E+02	-2.5674E-02	-2.1861E+00	-6.000E+01	-3.149E+01
1.1142E+02	6.1197E+01	-7.2056E+02	-2.6481E-02	-2.1687E+00	-5.238E+01	-2.930E+01
1.1142E+02	6.1197E+01	-7.2056E+02	-2.6481E-02	-2.1687E+00	-5.238E+01	-2.930E+01
1.1242E+02	5.5166E+01	-6.8018E+02	-2.7158E-02	-2.1513E+00	-4.350E+01	-2.665E+01
1.1341E+02	4.9572E+01	-6.3948E+02	-2.7686E-02	-2.1339E+00	-3.328E+01	-2.349E+01
1.1441E+02	4.4402E+01	-5.9864E+02	-2.8043E-02	-2.1165E+00	-2.160E+01	-1.978E+01
1.1540E+02	3.9646E+01	-5.5786E+02	-2.8207E-02	-2.0742E+00	-8.363E+00	-1.549E+01
1.1640E+02	3.5285E+01	-5.1744E+02	-2.8153E-02	-1.9889E+00	6.469E+00	-1.059E+01
1.1739E+02	3.1309E+01	-4.7760E+02	-2.7857E-02	-1.9035E+00	2.287E+01	-5.078E+00
1.1839E+02	2.7702E+01	-4.3865E+02	-2.7296E-02	-1.8182E+00	4.080E+01	1.033E+00
1.1938E+02	2.4446E+01	-4.0092E+02	-2.6447E-02	-1.7328E+00	6.022E+01	7.738E+00

INITIAL PERTURBATION STATE SHELL DATA

S	T11	T21	CHI1		M11	M21
4.0106E+01	5.5981E+02	1.5062E+03	6.0463E-02		-2.344E+02	1.066E+01
4.1062E+01	5.6518E+02	1.3210E+03	5.6432E-02		-2.440E+02	-4.112E-01
4.2017E+01	5.6522E+02	1.1567E+03	5.2424E-02		-2.374E+02	-5.834E+00
4.2973E+01	5.6175E+02	1.0117E+03	4.8653E-02		-2.177E+02	-6.343E+00
4.3929E+01	5.5606E+02	8.8367E+02	4.5294E-02		-1.871E+02	-2.454E+00
4.4885E+01	5.4867E+02	7.7534E+02	4.2493E-02		-1.472E+02	5.816E+00
4.5841E+01	5.4046E+02	6.7728E+02	4.0368E-02		-9.935E+01	1.764E+01

4.6796E+01	5.3169E+02	5.8700E+02	3.9034E-02	-4.358E+01	3.306E+01
4.7752E+01	5.2251E+02	5.0191E+02	3.8604E-02	2.044E+01	5.227E+01
4.7752E+01	5.4747E+02	5.0990E+02	3.8604E-02	2.044E+01	5.227E+01
4.8747E+01	5.3894E+02	4.2446E+02	3.8395E-02	-1.313E+01	4.032E+01
4.9742E+01	5.2998E+02	3.4338E+02	3.7756E-02	-3.634E+01	3.125E+01
5.0737E+01	5.2062E+02	2.6731E+02	3.6829E-02	-5.184E+01	2.439E+01
5.1732E+01	5.1107E+02	1.9659E+02	3.5719E-02	-6.155E+01	1.926E+01
5.2727E+01	5.0124E+02	1.3120E+02	3.4504E-02	-6.702E+01	1.545E+01
5.3721E+01	4.9121E+02	7.0983E+01	3.3241E-02	-6.941E+01	1.265E+01
5.4716E+01	4.8104E+02	1.5672E+01	3.1969E-02	-6.965E+01	1.061E+01
5.5711E+01	4.7076E+02	-3.5063E+01	3.0717E-02	-6.839E+01	9.135E+00
5.5711E+01	4.7076E+02	-3.5063E+01	3.0717E-02	-6.839E+01	9.135E+00
5.6706E+01	4.6074E+02	-8.1473E+01	2.9503E-02	-6.615E+01	8.082E+00
5.7700E+01	4.5058E+02	-1.2404E+02	2.8337E-02	-6.344E+01	7.286E+00
5.8695E+01	4.4027E+02	-1.6313E+02	2.7224E-02	-6.053E+01	6.665E+00
5.9690E+01	4.2983E+02	-1.9905E+02	2.6166E-02	-5.750E+01	6.188E+00
6.0685E+01	4.1952E+02	-2.3208E+02	2.5162E-02	-5.444E+01	5.817E+00
6.1680E+01	4.0933E+02	-2.6245E+02	2.4212E-02	-5.172E+01	5.430E+00
6.2675E+01	3.9899E+02	-2.9051E+02	2.3307E-02	-4.939E+01	5.002E+00
6.3670E+01	3.8856E+02	-3.1644E+02	2.2442E-02	-4.740E+01	4.536E+00
6.3670E+01	3.8856E+02	-3.1644E+02	2.2442E-02	-4.740E+01	4.536E+00
6.4665E+01	3.7806E+02	-3.4048E+02	2.1612E-02	-4.572E+01	4.038E+00
6.5659E+01	3.6753E+02	-3.6273E+02	2.0811E-02	-4.431E+01	3.512E+00
6.6654E+01	3.5701E+02	-3.8334E+02	2.0036E-02	-4.313E+01	2.961E+00
6.7649E+01	3.4651E+02	-4.0242E+02	1.9283E-02	-4.215E+01	2.391E+00
6.8644E+01	3.3605E+02	-4.2012E+02	1.8548E-02	-4.135E+01	1.807E+00
6.9639E+01	3.2565E+02	-4.3649E+02	1.7829E-02	-4.070E+01	1.212E+00
7.0633E+01	3.1533E+02	-4.5161E+02	1.7123E-02	-4.018E+01	6.095E-01
7.1628E+01	3.0511E+02	-4.6555E+02	1.6429E-02	-3.978E+01	2.204E-03
7.1628E+01	3.0511E+02	-4.6555E+02	1.6429E-02	-3.978E+01	2.204E-03
7.2623E+01	2.9496E+02	-4.7843E+02	1.5744E-02	-3.947E+01	-6.087E-01
7.3618E+01	2.8494E+02	-4.9025E+02	1.5067E-02	-3.925E+01	-1.222E+00
7.4613E+01	2.7505E+02	-5.0106E+02	1.4396E-02	-3.911E+01	-1.837E+00
7.5608E+01	2.6529E+02	-5.1090E+02	1.3731E-02	-3.904E+01	-2.453E+00
7.6603E+01	2.5565E+02	-5.1984E+02	1.3070E-02	-3.904E+01	-3.070E+00
7.7597E+01	2.4616E+02	-5.2788E+02	1.2412E-02	-3.910E+01	-3.688E+00
7.8592E+01	2.3683E+02	-5.3505E+02	1.1755E-02	-3.922E+01	-4.308E+00
7.9587E+01	2.2766E+02	-5.4137E+02	1.1100E-02	-3.940E+01	-4.930E+00
7.9587E+01	2.2766E+02	-5.4137E+02	1.1100E-02	-3.940E+01	-4.930E+00
8.0582E+01	2.1863E+02	-5.4691E+02	1.0444E-02	-3.963E+01	-5.555E+00
8.1576E+01	2.0977E+02	-5.5163E+02	9.7874E-03	-3.992E+01	-6.183E+00
8.2571E+01	2.0108E+02	-5.5556E+02	9.1289E-03	-4.026E+01	-6.816E+00
8.3566E+01	1.9256E+02	-5.5871E+02	8.4675E-03	-4.065E+01	-7.455E+00
8.4561E+01	1.8421E+02	-5.6113E+02	7.8022E-03	-4.110E+01	-8.100E+00
8.5556E+01	1.7603E+02	-5.6278E+02	7.1324E-03	-4.160E+01	-8.752E+00
8.6551E+01	1.6804E+02	-5.6366E+02	6.4571E-03	-4.214E+01	-9.411E+00
8.7546E+01	1.6022E+02	-5.6378E+02	5.7756E-03	-4.274E+01	-1.008E+01
8.7546E+01	1.6022E+02	-5.6378E+02	5.7756E-03	-4.274E+01	-1.008E+01
8.8541E+01	1.5259E+02	-5.6320E+02	5.0873E-03	-4.338E+01	-1.075E+01
8.9535E+01	1.4514E+02	-5.6186E+02	4.3913E-03	-4.406E+01	-1.143E+01
9.0530E+01	1.3788E+02	-5.5975E+02	3.6869E-03	-4.477E+01	-1.211E+01
9.1525E+01	1.3081E+02	-5.5688E+02	2.9738E-03	-4.551E+01	-1.280E+01
9.2520E+01	1.2392E+02	-5.5329E+02	2.2515E-03	-4.627E+01	-1.349E+01
9.3514E+01	1.1723E+02	-5.4893E+02	1.5198E-03	-4.703E+01	-1.417E+01
9.4509E+01	1.1073E+02	-5.4379E+02	7.7864E-04	-4.779E+01	-1.485E+01
9.5504E+01	1.0443E+02	-5.3787E+02	2.8216E-05	-4.853E+01	-1.551E+01
9.5504E+01	1.0443E+02	-5.3787E+02	2.8216E-05	-4.853E+01	-1.551E+01

9.6499E+01	9.8314E+01	-5.3121E+02	-7.3120E-04	-4.923E+01	-1.616E+01
9.7494E+01	9.2400E+01	-5.2377E+02	-1.4987E-03	-4.986E+01	-1.678E+01
9.8489E+01	8.6685E+01	-5.1553E+02	-2.2731E-03	-5.041E+01	-1.737E+01
9.9484E+01	8.1173E+01	-5.0650E+02	-3.0530E-03	-5.085E+01	-1.792E+01
1.0048E+02	7.5857E+01	-4.9672E+02	-3.8362E-03	-5.115E+01	-1.842E+01
1.0147E+02	7.0745E+01	-4.8615E+02	-4.6206E-03	-5.128E+01	-1.885E+01
1.0247E+02	6.5838E+01	-4.7480E+02	-5.4033E-03	-5.120E+01	-1.920E+01
1.0346E+02	6.1135E+01	-4.6268E+02	-6.1808E-03	-5.088E+01	-1.947E+01
1.0346E+02	6.1135E+01	-4.6268E+02	-6.1808E-03	-5.088E+01	-1.947E+01
1.0446E+02	5.6631E+01	-4.4983E+02	-6.9492E-03	-5.027E+01	-1.963E+01
1.0545E+02	5.2334E+01	-4.3624E+02	-7.7039E-03	-4.933E+01	-1.968E+01
1.0645E+02	4.8242E+01	-4.2193E+02	-8.4393E-03	-4.803E+01	-1.959E+01
1.0744E+02	4.4356E+01	-4.0694E+02	-9.1496E-03	-4.632E+01	-1.934E+01
1.0844E+02	4.0672E+01	-3.9134E+02	-9.8279E-03	-4.415E+01	-1.893E+01
1.0943E+02	3.7192E+01	-3.7513E+02	-1.0467E-02	-4.148E+01	-1.834E+01
1.1043E+02	3.3915E+01	-3.5837E+02	-1.1059E-02	-3.826E+01	-1.754E+01
1.1142E+02	3.0839E+01	-3.4112E+02	-1.1595E-02	-3.445E+01	-1.651E+01
1.1142E+02	3.0839E+01	-3.4112E+02	-1.1595E-02	-3.445E+01	-1.651E+01
1.1242E+02	2.7959E+01	-3.2347E+02	-1.2067E-02	-2.999E+01	-1.525E+01
1.1341E+02	2.5275E+01	-3.0549E+02	-1.2462E-02	-2.485E+01	-1.373E+01
1.1441E+02	2.2783E+01	-2.8727E+02	-1.2772E-02	-1.898E+01	-1.193E+01
1.1540E+02	2.0480E+01	-2.6890E+02	-1.2984E-02	-1.232E+01	-9.841E+00
1.1640E+02	1.8358E+01	-2.5053E+02	-1.3086E-02	-4.870E+00	-7.442E+00
1.1739E+02	1.6414E+01	-2.3227E+02	-1.3066E-02	3.364E+00	-4.738E+00
1.1839E+02	1.4642E+01	-2.1427E+02	-1.2913E-02	1.236E+01	-1.734E+00
1.1938E+02	1.3035E+01	-1.9668E+02	-1.2615E-02	2.208E+01	1.565E+00

INITIAL 2ND-ORDER PERTURBATION STATE SHELL DATA

S	T12	T22	CHI2
4.0106E+01	-5.4629E+01	-2.2383E+02	-1.5629E-02
4.1062E+01	-5.8210E+01	-2.0143E+02	-1.5700E-02
4.2017E+01	-6.1090E+01	-1.7772E+02	-1.5502E-02
4.2973E+01	-6.3304E+01	-1.5371E+02	-1.5115E-02
4.3929E+01	-6.4906E+01	-1.3016E+02	-1.4608E-02
4.4885E+01	-6.5986E+01	-1.0843E+02	-1.4038E-02
4.5841E+01	-6.6593E+01	-8.7777E+01	-1.3447E-02
4.6796E+01	-6.6776E+01	-6.8454E+01	-1.2862E-02
4.7752E+01	-6.6586E+01	-5.0645E+01	-1.2297E-02
4.7752E+01	-6.6586E+01	-5.0645E+01	-1.2297E-02
4.8747E+01	-6.6029E+01	-3.3732E+01	-1.1722E-02
4.9742E+01	-6.5177E+01	-1.8464E+01	-1.1145E-02
5.0737E+01	-6.4079E+01	-4.7052E+00	-1.0567E-02
5.1732E+01	-6.2775E+01	7.7465E+00	-9.9900E-03
5.2727E+01	-6.1298E+01	1.8986E+01	-9.4166E-03
5.3721E+01	-5.9682E+01	2.9106E+01	-8.8508E-03
5.4716E+01	-5.7954E+01	3.8190E+01	-8.2962E-03
5.5711E+01	-5.6139E+01	4.6310E+01	-7.7559E-03
5.5711E+01	-5.6139E+01	4.6310E+01	-7.7559E-03
5.6706E+01	-5.4253E+01	5.3544E+01	-7.2325E-03
5.7700E+01	-5.2319E+01	5.9948E+01	-6.7274E-03
5.8695E+01	-5.0352E+01	6.5586E+01	-6.2418E-03

5.9690E+01	-4.8367E+01	7.0515E+01	-5.7762E-03
6.0685E+01	-4.6371E+01	7.4799E+01	-5.3306E-03
6.1680E+01	-4.4379E+01	7.8480E+01	-4.9048E-03
6.2675E+01	-4.2399E+01	8.1606E+01	-4.4982E-03
6.3670E+01	-4.0441E+01	8.4220E+01	-4.1097E-03
6.3670E+01	-4.0441E+01	8.4220E+01	-4.1097E-03
6.4665E+01	-3.8506E+01	8.6371E+01	-3.7388E-03
6.5659E+01	-3.6604E+01	8.8088E+01	-3.3843E-03
6.6654E+01	-3.4740E+01	8.9406E+01	-3.0455E-03
6.7649E+01	-3.2916E+01	9.0356E+01	-2.7216E-03
6.8644E+01	-3.1135E+01	9.0972E+01	-2.4117E-03
6.9639E+01	-2.9400E+01	9.1273E+01	-2.1153E-03
7.0633E+01	-2.7715E+01	9.1282E+01	-1.8317E-03
7.1628E+01	-2.6081E+01	9.1022E+01	-1.5605E-03
7.1628E+01	-2.6081E+01	9.1022E+01	-1.5605E-03
7.2623E+01	-2.4496E+01	9.0520E+01	-1.3010E-03
7.3618E+01	-2.2965E+01	8.9785E+01	-1.0531E-03
7.4613E+01	-2.1488E+01	8.8835E+01	-8.1638E-04
7.5608E+01	-2.0066E+01	8.7685E+01	-5.9059E-04
7.6603E+01	-1.8697E+01	8.6356E+01	-3.7558E-04
7.7597E+01	-1.7383E+01	8.4855E+01	-1.7113F-04
7.8592E+01	-1.6124E+01	8.3196E+01	2.2889E-05
7.9587E+01	-1.4919E+01	8.1390E+01	2.0657E-04
7.9587E+01	-1.4919E+01	8.1390E+01	2.0657E-04
8.0582E+01	-1.3767E+01	7.9457E+01	3.7997E-04
8.1576E+01	-1.2669E+01	7.7401E+01	5.4314E-04
8.2571E+01	-1.1624E+01	7.5233E+01	6.9609E-04
8.3566E+01	-1.0631E+01	7.2964E+01	8.3884E-04
8.4561E+01	-9.6875E+00	7.0610E+01	9.7141E-04
8.5556E+01	-8.7948E+00	6.8176E+01	1.0938E-03
8.6551E+01	-7.9514E+00	6.5672E+01	1.2058E-03
8.7546E+01	-7.1564E+00	6.3108E+01	1.3077E-03
8.7546E+01	-7.1564E+00	6.3108E+01	1.3077E-03
8.8541E+01	-6.4081E+00	6.0500E+01	1.3992F-03
8.9535E+01	-5.7058E+00	5.7852E+01	1.4804F-03
9.0530E+01	-5.0481E+00	5.5172E+01	1.5513E-03
9.1525E+01	-4.4339E+00	5.2472E+01	1.6119E-03
9.2520E+01	-3.8615E+00	4.9763E+01	1.6622E-03
9.3514E+01	-3.3298E+00	4.7050E+01	1.7023E-03
9.4509E+01	-2.8374E+00	4.4343E+01	1.7322E-03
9.5504E+01	-2.3829E+00	4.1651E+01	1.7519E-03
9.5504E+01	-2.3829E+00	4.1651E+01	1.7519E-03
9.6499E+01	-1.9645E+00	3.8983E+01	1.7617E-03
9.7494E+01	-1.5812E+00	3.6346E+01	1.7617E-03
9.8489E+01	-1.2314E+00	3.3746E+01	1.7520E-03
9.9484E+01	-9.1357E-01	3.1192E+01	1.7329E-03
1.0048E+02	-6.2629E-01	2.8692E+01	1.7046E-03
1.0147E+02	-3.6803E-01	2.6251E+01	1.6676E-03
1.0247E+02	-1.3728E-01	2.3875E+01	1.6221E-03
1.0346E+02	6.7444E-02	2.1569E+01	1.5687E-03
1.0346E+02	6.7444E-02	2.1569E+01	1.5687E-03
1.0446E+02	2.4766E-01	1.9341E+01	1.5077E-03
1.0545E+02	4.0478E-01	1.7192E+01	1.4398E-03
1.0645E+02	5.4026E-01	1.5130E+01	1.3656E-03
1.0744E+02	6.5553E-01	1.3157E+01	1.2856E-03
1.0844E+02	7.5193E-01	1.1279E+01	1.2007E-03
1.0943E+02	8.3094E-01	9.4992E+00	1.1114E-03

1.1043E+02	8.9391E-01	7.8208E+00	1.0186E-03
1.1142E+02	9.4220E-01	6.2475E+00	9.2308E-04
1.1142E+02	9.4220E-01	6.2475E+00	9.2308E-04
1.1242E+02	9.7704E-01	4.7833E+00	8.2556E-04
1.1341E+02	9.9982E-01	3.4316E+00	7.2688E-04
1.1441E+02	1.0118E+00	2.1962E+00	6.2782E-04
1.1540E+02	1.0143E+00	1.0809E+00	5.2917E-04
1.1640E+02	1.0084E+00	8.9427E-02	4.3166E-04
1.1739E+02	9.9539E-01	-7.7411E-01	3.3602E-04
1.1839E+02	9.7655E-01	-1.5059E+00	2.4294E-04
1.1938E+02	9.5304E-01	-2.1026E+00	1.5305E-04

PREBUCKLING STIFFNESS = 1.2640E-05

RATE OF CHANGE OF STIFFNESS WITH LAMBDA = 2.7933E-06

BUCKLING MODE

CRITICAL HARMONIC = 6
CRITICAL LOAD = 2.091E+00

S	P	Q	CAP S	M 1	XI	ETA	V	CHI
4.0106E+01	-4.642E+01	2.191E+01	-8.660E+01	-7.983E+00	-2.714E-02	1.203E-03	-1.429E-04	-2.033E-02
4.1062E+01	-4.318E+01	3.284E+01	-8.394E+01	-1.980E+01	-4.568E-02	8.596E-03	-2.169E-03	-2.063E-02
4.2017E+01	-4.138E+01	4.307E+01	-8.532E+01	-2.865E+01	-6.459E-02	1.616E-02	-4.168E-03	-2.121E-02
4.2973E+01	-4.042E+01	5.307E+01	-8.987E+01	-3.454E+01	-8.410E-02	2.395E-02	-6.149E-03	-2.199E-02
4.3929E+01	-3.986E+01	6.317E+01	-9.685E+01	-3.758E+01	-1.044E-01	3.202E-02	-8.121E-03	-2.294E-02
4.4885E+01	-3.942E+01	7.367E+01	-1.057E+02	-3.815E+01	-1.256E-01	4.041E-02	-1.009E-02	-2.400E-02
4.5841E+01	-3.894E+01	8.479E+01	-1.160E+02	-3.655E+01	-1.478E-01	4.913E-02	-1.205E-02	-2.516E-02
4.6796E+01	-3.821E+01	9.665E+01	-1.273E+02	-3.276E+01	-1.710E-01	5.824E-02	-1.403E-02	-2.637E-02
4.7752E+01	-3.707E+01	1.093E+02	-1.392E+02	-2.677E+01	-1.954E-01	6.778E-02	-1.606E-02	-2.760E-02
4.7752E+01	-3.707E+01	1.093E+02	-1.392E+02	-2.677E+01	-1.954E-01	6.778E-02	-1.606E-02	-2.760E-02
4.8747E+01	-3.533E+01	1.233E+02	-1.521E+02	-1.951E+01	-2.219E-01	7.821E-02	-1.826E-02	-2.887E-02
4.9742E+01	-3.285E+01	1.379E+02	-1.654E+02	-9.948E+00	-2.495E-01	8.914E-02	-2.055E-02	-3.010E-02
5.0737E+01	-2.956E+01	1.533E+02	-1.788E+02	1.566E+00	-2.782E-01	1.005E-01	-2.289E-02	-3.126E-02
5.1732E+01	-2.544E+01	1.694E+02	-1.921E+02	1.469E+01	-3.080E-01	1.123E-01	-2.526E-02	-3.231E-02
5.2727E+01	-2.047E+01	1.860E+02	-2.052E+02	2.910E+01	-3.386E-01	1.245E-01	-2.764E-02	-3.323E-02
5.3721E+01	-1.468E+01	2.032E+02	-2.177E+02	4.451E+01	-3.701E-01	1.369E-01	-3.000E-02	-3.400E-02
5.4716E+01	-8.094E+00	2.209E+02	-2.295E+02	6.065E+01	-4.021E-01	1.495E-01	-3.233E-02	-3.460E-02
5.5711E+01	-7.494E-01	2.389E+02	-2.401E+02	7.726E+01	-4.346E-01	1.624E-01	-3.461E-02	-3.503E-02
5.5711E+01	-7.494E-01	2.389E+02	-2.401E+02	7.726E+01	-4.346E-01	1.624E-01	-3.461E-02	-3.503E-02
5.6706E+01	7.292E+00	2.573E+02	-2.496E+02	9.412E+01	-4.675E-01	1.753E-01	-3.682E-02	-3.527E-02
5.7700E+01	1.597E+01	2.758E+02	-2.576E+02	1.110E+02	-5.004E-01	1.883E-01	-3.897E-02	-3.531E-02
5.8695E+01	2.519E+01	2.944E+02	-2.640E+02	1.277E+02	-5.333E-01	2.012E-01	-4.104E-02	-3.516E-02
5.9690E+01	3.490E+01	3.129E+02	-2.687E+02	1.442E+02	-5.659E-01	2.141E-01	-4.302E-02	-3.481E-02
6.0685E+01	4.501E+01	3.312E+02	-2.717E+02	1.602E+02	-5.980E-01	2.269E-01	-4.490E-02	-3.426E-02
6.1680E+01	5.542E+01	3.492E+02	-2.728E+02	1.755E+02	-6.296E-01	2.394E-01	-4.669E-02	-3.352E-02
6.2675E+01	6.606E+01	3.668E+02	-2.720E+02	1.902E+02	-6.603E-01	2.517E-01	-4.836E-02	-3.259E-02

6.3670E+01	7.683E+01	3.837E+02	-2.693E+02	2.041E+02	-6.900E-01	2.637E-01	-4.993E-02	-3.148E-02
6.3670E+01	7.683E+01	3.837E+02	-2.693E+02	2.041E+02	-6.900E-01	2.637E-01	-4.993E-02	-3.148E-02
6.4665E+01	8.766E+01	4.000E+02	-2.648E+02	2.171E+02	-7.186E-01	2.754E-01	-5.139E-02	-3.020E-02
6.5659E+01	9.846E+01	4.154E+02	-2.585E+02	2.292E+02	-7.459E-01	2.866E-01	-5.273E-02	-2.875E-02
6.6654E+01	1.092E+02	4.300E+02	-2.504E+02	2.402E+02	-7.717E-01	2.973E-01	-5.395E-02	-2.714E-02
6.7649E+01	1.197E+02	4.435E+02	-2.406E+02	2.502E+02	-7.959E-01	3.076E-01	-5.505E-02	-2.539E-02
6.8644E+01	1.299E+02	4.560E+02	-2.293E+02	2.591E+02	-8.184E-01	3.172E-01	-5.603E-02	-2.350E-02
6.9639E+01	1.399E+02	4.673E+02	-2.165E+02	2.669E+02	-8.390E-01	3.263E-01	-5.689E-02	-2.150E-02
7.0633E+01	1.494E+02	4.775E+02	-2.023E+02	2.735E+02	-8.577E-01	3.347E-01	-5.762E-02	-1.938E-02
7.1628E+01	1.585E+02	4.863E+02	-1.869E+02	2.789E+02	-8.743E-01	3.424E-01	-5.822E-02	-1.717E-02
7.1628E+01	1.585E+02	4.863E+02	-1.869E+02	2.789E+02	-8.743E-01	3.424E-01	-5.822E-02	-1.717E-02
7.2623E+01	1.672E+02	4.939E+02	-1.703E+02	2.831E+02	-8.888E-01	3.493E-01	-5.870E-02	-1.488E-02
7.3618E+01	1.753E+02	5.001E+02	-1.528E+02	2.862[illegible]02	-9.011E-01	3.555E-01	-5.906E-02	-1.251E-02
7.4613E+01	1.828E+02	5.050E+02	-1.344E+02	2.8[illegible]+02	-9.112E-01	3.609E-01	-5.930E-02	-1.009E-02
7.5608E+01	1.897E+02	5.086E+02	-1.153E+02	2.890[illegible]02	-9.190E-01	3.655E-01	-5.941E-02	-7.632E-03
7.6603E+01	1.959E+02	5.107E+02	-9.557E+01	2.888E+02	-9.244E-01	3.692E-01	-5.941E-02	-5.141E-03
7.7597E+01	2.015E+02	5.116E+02	-7.543E+01	2.874E+02	-9.275E-01	3.721E-01	-5.929E-02	-2.633E-03
7.8592E+01	2.065E+02	5.111E+02	-5.498E+01	2.851E+02	-9.282E-01	3.740E-01	-5.905E-02	-1.212E-04
7.9587E+01	2.107E+02	5.093E+02	-3.436E+01	2.817E+02	-9.267E-01	3.751E-01	-5.870E-02	2.383E-03
7.9587E+01	2.107E+02	5.093E+02	-3.436E+01	2.817E+02	-9.267E-01	3.751E-01	-5.870E-02	2.383E-03
8.0582E+01	2.142E+02	5.062E+02	-1.370E+01	2.774E+02	-9.228E-01	3.752E-01	-5.825E-02	4.868E-03
8.1576E+01	2.169E+02	5.019E+02	6.884E+00	2.723E+02	-9.166E-01	3.745E-01	-5.769E-02	7.322E-03
8.2571E+01	2.198E+02	4.964E+02	2.726E+01	[illegible].663E+02	-9.081E-01	3.728E-01	-5.703E-02	9.734E-03
8.3566E+01	2.204E+02	4.897E+02	4.731E+01	2.595E+02	-8.975E-01	3.702E-01	-5.627E-02	1.209E-02
8.4561E+01	2.211E+02	4.819E+02	6.693E+01	2.[illegible]20E+02	-8.847E-01	3.667E-01	-5.541E-02	1.440E-02
8.5556E+01	2.211E+02	4.732E+02	8.601E+01	2.437E+02	-8.699E-01	3.623E-01	-5.447E-02	1.663E-02
8.6551E+01	2.204E+02	4.634E+02	1.044E+02	2.349E+02	-8.530E-01	3.570E-01	-5.344E-02	1.878E-02
8.7546E+01	2.191E+02	4.527E+02	1.222E+02	2.254E+02	-8.342E-01	3.508E-01	-5.234E-02	2.084E-02
8.7546E+01	2.191E+02	4.527E+02	1.222E+02	2.2[illegible]02	-8.342E-01	3.508E-01	-[illegible].234E-02	2.084E-02
8.8541E+01	2.172E+02	4.412E+02	1.391E+02	2.154E+02	-8.136E-01	3.438E-01	-5.115E-02	2.281E-02
8.9535E+01	2.147E+02	4.289E+02	1.551E+02	2.049E+02	-7.913E-01	3.360E-01	-4.990E-02	2.468E-02
9.0530E+01	2.116E+02	4.159E+02	1.701E+02	1.940E+02	-7.674E-01	3.274E-01	-4.857E-02	2.644E-02
9.1525E+01	2.080E+02	4.022E+02	1.842E+02	1.826E+02	-7.419E-01	3.180E-01	-4.719E-02	2.808E-02
9.2520E+01	2.039E+02	3.880E+02	1.972E+02	1.708E+02	-7.150E-01	3.079E-01	-4.575E-02	2.961E-02
9.3514E+01	1.993E+02	3.733E+02	2.090E+02	1.586E+02	-6.868E-01	2.971E-01	-4.425E-02	3.101E-02
9.4509E+01	1.943E+02	3.582E+02	2.197E+02	1.461E+02	-6.574E-01	2.857E-01	-4.271E-02	3.227E-02
9.5504E+01	1.890E+02	3.428E+02	2.293E+02	1.333E+02	-6.270E-01	2.736E-01	-4.113E-02	3.341E-02
9.5504E+01	1.890E+02	3.428E+02	2.293E+02	1.333E+02	-6.270E-01	2.736E-01	-4.113E-02	3.341E-02
9.6499E+01	1.833E+02	3.270E+02	2.376E+02	1.201E+02	-5.957E-01	2.610E-01	-3.951E-02	3.439E-02
9.7494E+01	1.773E+02	3.111E+02	2.447E+02	1.066E+02	-5.636E-01	2.479E-01	-3.787E-02	3.523E-02
9.8489E+01	1.710E+02	2.949E+02	2.506E+02	9.287E+01	-5.308E-01	2.344E-01	-3.620E-02	3.592E-02
9.9484E+01	1.645E+02	2.787E+02	2.553E+02	7.880E+01	-4.976E-01	2.205E-01	-3.451E-02	3.645E-02
1.0048E+02	1.578E+02	2.625E+02	2.588E+02	6.442E+01	-4.640E-01	2.063E-01	-[illegible].281E-02	3.682E-02
1.0147E+02	1.510E+02	2.464E+02	2.610E+02	4.973E+01	-4.302E-01	1.918E-01	-3.110E-02	3.701E-02
1.0247E+02	1.441E+02	2.303E+02	2.621E+02	3.469E+01	-3.964E-01	1.771E-01	-2.939E-02	3.703E-02
1.0346E+02	1.371E+02	2.144E+02	2.620E+02	1.929E+01	-3.627E-01	1.623E-01	-2.769E-02	3.686E-02
1.0346E+02	1.371E+02	2.144E+02	2.620E+02	1.929E+01	-3.627E-01	1.623E-01	-2.769E-02	3.686E-02
1.0446E+02	1.301E+02	1.987E+02	2.609E+02	3.499E+00	-3.293E-01	1.475E-01	-2.600E-02	3.651E-02
1.0545E+02	1.231E+02	1.832E+02	2.586E+02	-1.272E+01	-2.963E-01	1.328E-01	-2.433E-02	3.595E-02
1.0645E+02	1.162E+02	1.680E+02	2.553E+02	-2.941E+01	-2.640E-01	1.182E-01	-2.268E-02	3.519E-02
1.0744E+02	1.093E+02	1.532E+02	2.511E+02	-4.660E+01	-2.326E-01	1.038E-01	-2.106E-02	3.[illegible]22E-02
1.0844E+02	1.026E+02	1.388E+02	2.460E+02	-6.436E+01	-2.022E-01	8.977E-02	-1.947E-02	3.[illegible]01E-02
1.0943E+02	9.601E+01	1.248E+02	2.401E+02	-8.274E+01	-1.730E-01	7.619E-02	-1.792E-02	3.157E-02
1.1043E+02	8.960E+01	1.112E+02	2.334E+02	-1.018E+02	-1.453E-01	6.317E-02	-1.641E-02	2.988E-02
1.1142E+02	8.338E+01	9.809E+01	2.261E+02	-1.216E+02	-1.193E-01	5.083E-02	-1.495E-02	2.792E-02
1.1142E+02	8.338E+01	9.809E+01	2.261E+02	-1.216E+02	-1.193E-01	5.083E-02	-1.495E-02	2.792E-02

1.1242E+02	7.739E+01	8.550E+01	2.183E+02	-1.423E+02	-9.520E-02	3.930E-02	-1.354E-02	2.569E-02
1.1341E+02	7.163E+01	7.344E+01	2.101E+02	-1.638E+02	-7.328E-02	2.871E-02	-1.218E-02	2.316E-02
1.1441E+02	6.612E+01	6.192E+01	2.016E+02	-1.863E+02	-5.380E-02	1.923E-02	-1.088E-02	2.032E-02
1.1540E+02	6.087E+01	5.097E+01	1.930E+02	-2.099E+02	-3.702E-02	1.100E-02	-9.621E-03	1.715E-02
1.1640E+02	5.588E+01	4.058E+01	1.844E+02	-2.346E+02	-2.325E-02	4.212E-03	-8.418E-03	1.362E-02
1.1739E+02	5.116E+01	3.077E+01	1.760E+02	-2.605E+02	-1.279E-02	-9.562E-04	-7.266E-03	9.731E-03
1.1839E+02	4.670E+01	2.153E+01	1.681E+02	-2.877E+02	-5.967E-03	-4.294E-03	-6.162E-03	5.444E-03
1.1938E+02	4.248E+01	1.288E+01	1.608E+02	-3.163E+02	-3.117E-03	-5.580E-03	-5.102E-03	7.391E-04

BOUNDARY NUMBER 1   S = 4.0106E+01

RING DATA

EA = 6.7000E+06   EIX = 1.2900E+06   EIY = 7.5800E+06   EIXY = -1.5000E+05   GJ = 6.7800E+03   ZBAR = -4.8900E-01

SBAR = -0.   TPHI0 = 5.1119E+04   TPHI1 = 2.0454E+04   TPHI2 = -2.2138E+03   MY0 = -3.8970E+04   MY1 = -1.1530E+04

BOUNDARY NUMBER 2   S = 4.7752E+01

B = I, D = 0, L VECTOR = 0 (P,Q,S,M1 CONTINUOUS)

BOUNDARY NUMBER 3   S = 5.5711E+01

B = I, D = 0, L VECTOR = 0 (P,Q,S,M1 CONTINUOUS)

BOUNDARY NUMBER 4   S = 6.3670E+01

B = I, D = 0, L VECTOR = 0 (P,Q,S,M1 CONTINUOUS)

BOUNDARY NUMBER 5   S = 7.1628E+01

B = I, D = 0, L VECTOR = 0 (P,Q,S,M1 CONTINUOUS)

BOUNDARY NUMBER 6　　S = 7.9587E+01

B = I, D = 0, L VECTOR = 0 (P,Q,S,M1 CONTINUOUS)

BOUNDARY NUMBER 7　　S = 8.7546E+01

B = I, D = 0, L VECTOR = 0 (P,Q,S,M1 CONTINUOUS)

BOUNDARY NUMBER 8　　S = 9.5504E+01

B = I, D = 0, L VECTOR = 0 (P,Q,S,M1 CONTINUOUS)

BOUNDARY NUMBER 9　　S = 1.0346E+02

B = I, D = 0, L VECTOR = 0 (P,Q,S,M1 CONTINUOUS)

BOUNDARY NUMBER 10　　S = 1.1142E+02

B = I, D = 0, L VECTOR = 0 (P,G,S,M1 CONTINUOUS)

BOUNDARY NUMBER 11　　S = 1.1938E+02

RING DATA

EA = 8.9850E+06	EIX = 8.5800E+07	EIY = 8.5800E+07	EIXY = -0.	GJ = 6.5000E+07	ZBAR = -4.3875E+00
SBAR = -0.	TPHI0 = -3.6260E+03	TPHI1 = -1.9101E+03	TPHI2 = -1.2545E+02	MY0 = 2.0340E+04	MY1 = 9.7000E+03

INNER PRODUCT = 7.924E+03

CORRECTED INNER PRODUCT = 7.938E+03

MAX ALPHA = 3.615E+01 BETA = 4.437E+01 BETA = 3.519E+01

FOR BUCKLING MODE IMPERFECTION, ALPHA = 2.938E+01 BETA = 2.581E+01 BETA = 2.751E+01
MAX NORMAL IMPERFECTION = 2.473E+01 TIMES RMS VALUE OF ANGULAR IMPERFECTION

AXISYMMETRIC COMPONENT OF SECOND-ORDER CONTRIBUTION TO BUCKLED STATE

S	P	Q	CAP S	M 1	XI	ETA	V	CHI
4.0106E+01	0.	-7.0445E+00	0.	2.0765E+01	-3.1228E-02	8.7025E-04	0.	2.9870E-03
4.1062E+01	0.	-6.8360E+00	0.	2.1797E+01	-2.8409E-02	-3.7331E-04	0.	3.2813E-03
4.2017E+01	0.	-6.7874E+00	0.	2.3131E+01	-2.5319E-02	-1.7135E-03	0.	3.5918E-03
4.2973E+01	0.	-6.8699E+00	0.	2.4690E+01	-2.1941E-02	-3.1562E-03	0.	3.9225E-03
4.3929E+01	0.	-7.0585E+00	0.	2.6401E+01	-1.8255E-02	-4.7098E-03	0.	4.2761E-03
4.4885E+01	0.	-7.3316E+00	0.	2.8188E+01	-1.4240E-02	-6.3813E-03	0.	4.6541E-03
4.5841E+01	0.	-7.6691E+00	0.	2.9972E+01	-9.8721E-03	-8.1791E-03	0.	5.0568E-03
4.6796E+01	0.	-8.0519E+00	0.	3.1674E+01	-5.1319E-03	-1.0117E-02	0.	5.4835E-03
4.7752E+01	0.	-8.4608E+00	0.	3.3209E+01	5.5511E-16	-1.2211E-02	0.	5.9322E-03
4.7752E+01	-7.0486E-12	-8.4608E+00	0.	3.3209E+01	0.	-1.2211E-02	0.	5.9322E-03
4.8747E+01	-6.9068E-12	-8.8953E+00	0.	3.4871E+01	5.7763E-03	-1.4576E-02	0.	6.4220E-03
4.9742E+01	-6.7708E-12	-9.3227E+00	0.	3.6239E+01	1.2015E-02	-1.7137E-02	0.	6.9331E-03
5.0737E+01	-6.6402E-12	-9.7270E+00	0.	3.7249E+01	1.8734E-02	-1.9894E-02	0.	7.4604E-03
5.1732E+01	-6.5146E-12	-1.0092E+01	0.	3.7837E+01	2.5947E-02	-2.2849E-02	0.	7.9979E-03
5.2727E+01	-6.3938E-12	-1.0403E+01	0.	3.7944E+01	3.3658E-02	-2.5996E-02	0.	8.5384E-03
5.3721E+01	-6.2776E-12	-1.0649E+01	0.	3.7515E+01	4.1869E-02	-2.9333E-02	0.	9.0742E-03
5.4716E+01	-6.1656E-12	-1.0817E+01	0.	3.6502E+01	5.0573E-02	-3.2851E-02	0.	9.5969E-03
5.5711E+01	-6.0576E-12	-1.0900E+01	0.	3.4868E+01	5.9754E-02	-3.6541E-02	0.	1.0097E-02
5.5711E+01	-5.6843E-12	-1.0900E+01	0.	3.4868E+01	5.9754E-02	-3.6541E-02	0.	1.0097E-02
5.6706E+01	-5.5866E-12	-1.0892E+01	0.	3.2590E+01	6.9386E-02	-4.0389E-02	0.	1.0565E-02
5.7700E+01	-5.4923E-12	-1.0788E+01	0.	2.9660E+01	7.9435E-02	-4.4381E-02	0.	1.0991E-02
5.8695E+01	-5.4013E-12	-1.0588E+01	0.	2.6080E+01	8.9857E-02	-4.8498E-02	0.	1.1366E-02
5.9690E+01	-5.3133E-12	-1.0294E+01	0.	2.1863E+01	1.0060E-01	-5.2720E-02	0.	1.1679E-02
6.0685E+01	-5.2282E-12	-9.9089E+00	0.	1.7042E+01	1.1161E-01	-5.7023E-02	0.	1.1921E-02
6.1680E+01	-5.1458E-12	-9.4397E+00	0.	1.1666E+01	1.2280E-01	-6.1381E-02	0.	1.2084E-02
6.2675E+01	-5.0662E-12	-8.8936E+00	0.	5.7953E+00	1.3411E-01	-6.5764E-02	0.	1.2160E-02
6.3670E+01	-4.9890E-12	-8.2814E+00	0.	-4.9890E-01	1.4544E-01	-7.0142E-02	0.	1.2142E-02

6.3670E+01	-5.0591E-12	-8.2814E+00	0.	-4.9890E-01	[illegible].4544E-01	-7.0142E-02	0.	1.2142E-02
6.4665E+01	-4.9833E-12	-7.6135E+00	0.	-7.1354E+00	1.5671E-01	-7.4482E-02	0.	1.2025E-02
6.5659E+01	-4.9098E-12	-6.9018E+00	0.	-1.4026E+01	1.6781E-01	-7.8750E-02	0.	1.1804E-02
6.6654E+01	-4.8386E-12	-6.1597E+00	0.	-2.1070E+01	1.7866E-01	-8.2911E-02	0.	1.1477E-02
6.7649E+01	-4.7695E-12	-5.4005E+00	0.	-2.8163E+01	[illegible].8916E-01	-8.6930E-02	0.	1.1042E-02
6.8644E+01	-4.7025E-12	-4.6374E+00	0.	-3.5196E+01	1.9920E-01	-9.0771E-02	0.	1.0500E-02
6.9639E+01	-4.6373E-12	-3.8840E+00	0.	-4.2065E+01	2.0868E-01	-9.4398E-02	0.	9.8535E-03
7.0633E+01	-4.5741E-12	-3.1526E+00	0.	-4.8662E+01	2.1751E-01	-9.7777E-02	0.	9.1058E-03
7.1628E+01	-4.5126E-12	-2.4552E+00	0.	-5.4882E+01	2.2559E-01	-1.0087E-01	0.	8.2624E-03
7.1628E+01	-4.1362E-12	-2.4552E+00	0.	-5.4882E+01	2.2559E-01	-1.0087E-01	0.	8.2624E-03
7.2623E+01	-4.0815E-12	-1.8031E+00	0.	-6.0630E+01	2.3285E-01	-1.0366E-01	0.	7.3299E-03
7.3618E+01	-4.0282E-12	-1.2060E+00	0.	-6.5814E+01	2.3920E-01	-1.0610E-01	0.	6.3168E-03
7.4613E+01	-3.9764E-12	-6.7189E-01	0.	-7.0354E+01	2.4457E-01	-1.0817E-01	0.	5.2327E-03
7.5608E+01	-3.9259E-12	-2.0713E-01	0.	-7.4180E+01	2.4890E-01	-1.0984E-01	0.	4.0886E-03
7.6603E+01	-3.8769E-12	1.8185E-01	0.	-7.7232E+01	2.5215E-01	-1.1110E-01	0.	2.8957E-03
7.7597E+01	-3.8291E-12	4.9107E-01	0.	-7.9466E+01	2.5426E-01	-1.1193E-01	0.	1.6669E-03
7.8592E+01	-3.7825E-12	7.1806E-01	0.	-8.0850E+01	2.5523E-01	-1.1232E-01	0.	4.1494E-04
7.9587E+01	-3.7371E-12	8.6242E-01	0.	-8.1367E+01	2.5502E-01	-1.1225E-01	0.	-8.4691E-04
7.9587E+01	-1.7888E-12	8.6242E-01	0.	-8.1367E+01	2.5502E-01	-1.1225E-01	0.	-8.4691E-04
8.0582E+01	-1.7676E-12	9.2516E-01	0.	-8.1011E+01	2.5365E-01	-1.1173E-01	0.	-2.1052E-03
8.1576E+01	-1.7470E-12	9.0779E-01	0.	-7.9792E+01	2.5112E-01	-1.1075E-01	0.	-3.3466E-03
8.2571E+01	-1.7268E-12	8.1338E-01	0.	-7.7733E+01	2.4745E-01	-1.0933E-01	0.	-4.5581E-03
8.3566E+01	-1.7072E-12	6.4649E-01	0.	-7.4870E+01	2.4268E-01	-1.0746E-01	0.	-5.7271E-03
8.4561E+01	-1.6880E-12	4.1269E-01	0.	-7.[illegible]47E+01	2.368[illegible]E-01	-1.0517E-01	0.	-6.8419E-03
8.5556E+01	-1.6693E-12	1.1819E-01	0.	-6.6920E+01	2.3004E-01	[illegible]E-01	0.	-7.8913E-03
8.6551E+01	-1.6510E-12	-2.3011E-01	0.	-6.1959E+01	2.2228E-01	-9.9397E-02	0.	-8.8651E-03
8.7546E+01	-1.6332E-12	-6.2513E-01	0.	-5.6439E+01	2.1367E-01	-9.5959E-02	0.	-9.7543E-03
8.7546E+01	-7.9581E-13	-6.2513E-01	0.	-5.6439E+01	2.1367E-01	-9.5959E-02	0.	-9.7543E-03
8.8541E+01	-7.8731E-13	-1.0589E+00	0.	-5.0439E+01	2.0429E-01	-9.2195E-02	0.	-1.0551E-02
8.9535E+01	-7.7901E-13	-1.5233E+00	0.	-4.4045E+01	1.9423E-01	-8.8137E-02	0.	-1.1249E-02
9.0530E+01	-7.7090E-13	-2.0100E+00	0.	-3.7347E+01	1.8358E-01	-8.3820E-02	0.	-1.1844E-02
9.1525E+01	-7.6297E-13	-2.5111E+00	0.	-3.0438E+01	1.7243E-01	-7.9283E-02	0.	-1.2331E-02
9.2520E+01	-7.5521E-13	-3.0194E+00	0.	-2.3407E+01	1.6089E-01	-7.4564E-02	0.	-1.2709E-02
9.3514E+01	-7.4763E-13	-3.5273E+00	0.	-1.6348E+01	1.4907E-01	-6.9705E-02	0.	-1.2977E-02
9.4509E+01	-7.4021E-13	-4.0279E+00	0.	-9.3494E+00	1.3705E-01	-6.4746E-02	0.	-1.3135E-02
9.5504E+01	-7.3295E-13	-4.5146E+00	0.	-2.4950E+00	1.2494E-01	-5.9729E-02	0.	-1.3185E-02
9.5504E+01	-1.5632E-13	-4.5146E+00	0.	-2.4950E+00	1.2494E-01	-5.9729E-02	0.	-1.3185E-02
9.6499E+01	-1.5480E-13	-4.9814E+00	0.	4.1362E+00	1.1284E-01	-5.4694E-02	0.	-1.3131E-02
9.7494E+01	-1.5332E-13	-5.4230E+00	0.	1.0466E+01	1.0085E-01	-4.9681E-02	0.	-1.2977E-02
9.8489E+01	-1.5187E-13	-5.8346E+00	0.	1.6427E+01	8.9042E-02	-4.4730E-02	0.	-1.2728E-02
9.9484E+01	-1.5044E-13	-6.2123E+00	0.	2.1957E+01	7.7511E-02	-3.9875E-02	0.	-1.2391E-02
1.0048E+02	-1.4905E-13	-6.5524E+00	0.	2.7006E+01	6.6334E-02	-3.5153E-02	0.	-1.1973E-02
1.0147E+02	-1.4769E-13	-6.8527E+00	0.	3.1530E+01	[illegible].5579E-02	-3.0594E-02	0.	-1.1483E-02
1.0247E+02	-1.4635E-13	-7.1112E+00	0.	3.5494E+01	[illegible].5306E-02	-2.6226E-02	0.	-1.0928E-02
1.0346E+02	-1.4504E-13	-7.3264E+00	0.	3.8872E+01	3.5571E-02	-2.2073E-02	0.	-1.0318E-02
1.0346E+02	-3.2685E-13	-7.3264E+00	0.	3.8872E+01	3.5571E-02	-2.2073E-02	0.	-1.0318E-02
1.0446E+02	-3.2395E-13	-7.4980E+00	0.	4.1651E+01	2.6417E-02	-1.8156E-02	0.	-9.6628E-03
1.0545E+02	-3.2112E-13	-7.6257E+00	0.	4.3823E+01	1.7883E-02	-1.4494E-02	0.	-8.9708E-03
1.0645E+02	-3.1833E-13	-7.7102E+00	0.	4.5389E+01	9.9975E-03	-1.1101E-02	0.	-8.2521E-03
1.0744E+02	-3.1560E-13	-7.7525E+00	0.	4.6363E+01	2.7806E-03	-7.9860E-03	0.	-7.5159E-03
1.0844E+02	-3.1293E-13	-7.7543E+00	0.	4.6766E+01	-3.7545E-03	-5.1567E-03	0.	-6.7714E-03
1.0943E+02	-3.1030E-13	-7.7179E+00	0.	4.6626E+01	-9.6062E-03	-2.6149E-03	0.	-6.0272E-03
1.1043E+02	-3.0772E-13	-7.6457E+00	0.	4.5976E+01	-1.4779E-02	-3.6002E-04	0.	-5.2913E-03
1.1142E+02	-3.0520E-13	-7.5408E+00	0.	4.4858E+01	-1.9283E-02	1.6118E-03	0.	-4.5713E-03
1.1142E+02	0.	-7.5408E+00	0.	4.4858E+01	-1.9283E-02	1.6118E-03	0.	-4.5713E-03
1.1242E+02	0.	-7.4066E+00	0.	4.3318E+01	-2.3137E-02	3.3068E-03	0.	-3.8740E-03
1.1341E+02	0.	-7.2468E+00	0.	4.1407E+01	-2.6365E-02	4.7340E-03	0.	-3.2055E-03

1.1441E+02	0.	-7.0654E+00	0.	3.9180E+01	-2.8996E-02	5.9041E-03	0.	-2.5710E-03
1.1540E+02	0.	-6.8666E+00	0.	3.6692E+01	-3.1064E-02	6.8292E-03	0.	-1.9749E-03
1.1640E+02	0.	-6.6548E+00	0.	3.3998E+01	-3.2607E-02	7.5[illegible]6E-03	0.	-1.4206E-03
1.1739E+02	0.	-6.4346E+00	0.	3.1159E+01	-3.3667E-02	7.9971E-03	0.	-9.1067E-04
1.1839E+02	0.	-6.2104E+00	0.	2.8229E+01	-3.4287E-02	8.2656E-03	0.	-4.4696E-04
1.1938E+02	0.	-5.9868E+00	0.	2.5265E+01	-3.4513E-02	8.3399E-03	0.	-3.0262E-05

S	U	V	W
4.0106E+01	-4.6080E-03	0.	3.0898E-02
4.1062E+01	-5.4799E-03	0.	2.7877E-02
4.2017E+01	-6.3661E-03	0.	2.4564E-02
4.2973E+01	-7.2651E-03	0.	2.0941E-02
4.3929E+01	-8.1766E-03	0.	1.6987E-02
4.4885E+01	-9.0758E-03	0.	1.2693E-02
4.5841E+01	-9.9994E-03	0.	8.0225E-03
4.6796E+01	-1.0953E-02	0.	2.9528E-03
4.7752E+01	-1.1944E-02	0.	-2.5388E-03
4.7752E+01	-1.1944E-02	0.	-2.5388E-03
4.8747E+01	-1.3018E-02	0.	-8.7372E-03
4.9742E+01	-1.4129E-02	0.	-[illegible].5439E-02
5.0737E+01	-1.5269E-02	0.	-2.2662E-02
5.1732E+01	-1.6427E-02	0.	-3.0422E-02
5.2727E+01	-1.7590E-02	0.	-3.8719E-02
5.3721E+01	-1.8748E-02	0.	-4.7558E-02
5.4716E+01	-1.9889E-02	0.	-5.6931E-02
5.5711E+01	-2.1000E-02	0.	-6.6819E-02
5.5711E+01	-2.1000E-02	0.	-6.6819E-02
5.6706E+01	-2.2067E-02	0.	-7.7191E-02
5.7700E+01	-2.3078E-02	0.	-8.8014E-02
5.8695E+01	-2.4022E-02	0.	-9.9241E-02
5.9690E+01	-2.4886E-02	0.	-1.1082E-01
6.0685E+01	-2.5659E-02	0.	-1.2267E-01
6.1680E+01	-2.6330E-02	0.	-1.3473E-01
6.2675E+01	-2.6892E-02	0.	-1.4692E-01
6.3670E+01	-2.7336E-02	0.	-1.5914E-01
6.3670E+01	-2.7336E-02	0.	-1.5914E-01
6.4665E+01	-2.7654E-02	0.	-1.7128E-01
6.5659E+01	-2.7844E-02	0.	-1.8326E-01
6.6654E+01	-2.7902E-02	0.	-1.9497E-01
6.7649E+01	-2.7827E-02	0.	-2.0631E-01
6.8644E+01	-2.7618E-02	0.	-2.1715E-01
6.9639E+01	-2.7278E-02	0.	-2.2740E-01
7.0633E+01	-2.6811E-02	0.	-2.3695E-01
7.1628E+01	-2.6224E-02	0.	-2.4572E-01
7.1628E+01	-2.6224E-02	0.	-2.4572E-01
7.2623E+01	-2.5521E-02	0.	-2.5359E-01
7.3618E+01	-2.4713E-02	0.	-2.6050E-01
7.4613E+01	-2.3809E-02	0.	-2.6635E-01
7.5608E+01	-2.2821E-02	0.	-2.7111E-01
7.6603E+01	-2.1757E-02	0.	-2.7467E-01
7.7597E+01	-2.0634E-02	0.	-2.7703E-01
7.8592E+01	-1.9463E-02	0.	-2.7816E-01

7.9587E+01	-1.8258E-02	0.	-2.7803E-01
7.9587E+01	-1.8258E-02	0.	-2.7803E-01
8.0582E+01	-1.7030E-02	0.	-2.7664E-01
8.1576E+01	-1.5796E-02	0.	-2.7399E-01
8.2571E+01	-1.4567E-02	0.	-2.7013E-01
8.3566E+01	-1.3357E-02	0.	-2.6507E-01
8.4561E+01	-1.2176E-02	0.	-2.5886E-01
8.5556E+01	-1.1037E-02	0.	-2.5158E-01
8.6551E+01	-9.9510E-03	0.	-2.4328E-01
8.7546E+01	-8.9271E-03	0.	-2.3406E-01
8.7546E+01	-8.9271E-03	0.	-2.3406E-01
8.8541E+01	-7.9736E-03	0.	-2.2398E-01
8.9535E+01	-7.0984E-03	0.	-2.1316E-01
9.0530E+01	-6.3075E-03	0.	-2.0170E-01
9.1525E+01	-5.6061E-03	0.	-1.8970E-01
9.2520E+01	-4.9970E-03	0.	-1.7725E-01
9.3514E+01	-4.4835E-03	0.	-1.6449E-01
9.4509E+01	-4.0665E-03	0.	-1.5152E-01
9.5504E+01	-3.7460E-03	0.	-1.3844E-01
9.5504E+01	-3.7460E-03	0.	-1.3844E-01
9.6499E+01	-3.5203E-03	0.	-1.2535E-01
9.7494E+01	-3.3869E-03	0.	-1.1237E-01
9.8489E+01	-3.3422E-03	0.	-9.9587E-02
9.9484E+01	-3.3814E-03	0.	-8.7101E-02
1.0048E+02	-3.4983E-03	0.	-7.4989E-02
1.0147E+02	-3.6864E-03	0.	-6.3333E-02
1.0247E+02	-3.9382E-03	0.	-5.2199E-02
1.0346E+02	-4.2456E-03	0.	-4.1647E-02
1.0346E+02	-4.2456E-03	0.	-4.1647E-02
1.0446E+02	-4.5999E-03	0.	-3.1722E-02
1.0545E+02	-4.9921E-03	0.	-2.2470E-02
1.0645E+02	-5.4129E-03	0.	-1.3924E-02
1.0744E+02	-5.8532E-03	0.	-6.1031E-03
1.0844E+02	-6.3033E-03	0.	9.7670E-04
1.0943E+02	-6.7548E-03	0.	7.3131E-03
1.1043E+02	-7.1995E-03	0.	1.2911E-02
1.1142E+02	-7.6297E-03	0.	1.7783E-02
1.1142E+02	-7.6297E-03	0.	1.7783E-02
1.1242E+02	-8.0381E-03	0.	2.1946E-02
1.1341E+02	-8.4197E-03	0.	2.5428E-02
1.1441E+02	-8.7703E-03	0.	2.8261E-02
1.1540E+02	-9.0873E-03	0.	3.0480E-02
1.1640E+02	-9.3690E-03	0.	3.2125E-02
1.1739E+02	-9.6177E-03	0.	3.3239E-02
1.1839E+02	-9.8371E-03	0.	3.3868E-02
1.1938E+02	-1.0034E-02	0.	3.4059E-02

NON-AXISYMMETRIC COMPONENT OF SECOND-ORDER CONTRIBUTION TO BUCKLED STATE

S	P	Q	CAP S	M 1	XI	ETA	V	CHI
4.0106E+01	1.8591E+00	-2.0174E-01	-1.1388E+01	-1.0360E+00	2.0001E-04	3.1941E-04	-4.3912E-05	3.0833E-04
4.1062E+01	2.9470E+00	2.9188E+00	-1.1372E+01	-1.1531E-01	4.6015E-04	1.1925E-04	4.7867E-06	3.0527E-04
4.2017E+01	4.1088E+00	5.7653E+00	-1.1043E+01	7.0132E-01	7.2693E-04	-7.8201E-05	5.7606E-05	3.2219E-04
4.2973E+01	5.2943E+00	8.3081E+00	-1.0607E+01	1.4239E+00	1.0171E-03	-2.8194E-04	1.1982E-04	3.5716E-04
4.3929E+01	6.4847E+00	1.0560E+01	-1.0172E+01	2.0579E+00	1.3460E-03	-5.0038E-04	1.9554E-04	4.0875E-04
4.4885E+01	7.6887E+00	1.2557E+01	-9.8117E+00	2.6166E+00	1.7278E-03	-7.4096E-04	2.8883E-04	4.7633E-04
4.5841E+01	8.9266E+00	1.4346E+01	-9.5697E+00	3.1064E+00	2.1769E-03	-1.0108E-03	4.0326E-04	5.5983E-04
4.6796E+01	1.0210E+01	1.5967E+01	-9.4420E+00	3.5262E+00	2.7064E-03	-1.3173E-03	5.4191E-04	6.5919E-04
4.7752E+01	1.1553E+01	1.7457E+01	-9.4186E+00	3.8807E+00	3.3319E-03	-1.6677E-03	7.0818E-04	7.7459E-04
4.7752E+01	1.1553E+01	1.7457E+01	-9.4186E+00	3.8807E+00	3.3319E-03	-1.6677E-03	7.0818E-04	7.7459E-04
4.8747E+01	1.3017E+01	1.8895E+01	-9.4423E+00	4.2189E+00	4.0985E-03	-2.0876E-03	9.1426E-04	9.1219E-04
4.9742E+01	1.4534E+01	2.0237E+01	-9.4233E+00	4.4538E+00	4.9994E-03	-2.5708E-03	1.1558E-03	1.0678E-03
5.0737E+01	1.6093E+01	2.1484E+01	-9.3159E+00	4.5525E+00	6.0513E-03	-3.1229E-03	1.4342E-03	1.2411E-03
5.1732E+01	1.7680E+01	2.2625E+01	-9.0954E+00	4.4840E+00	7.2708E-03	-3.7487E-03	1.7506E-03	1.4316E-03
5.2727E+01	1.9275E+01	2.3649E+01	-8.7375E+00	4.2241E+00	8.6733E-03	-4.4518E-03	2.1049E-03	1.6381E-03
5.3721E+01	2.0858E+01	2.4542E+01	-8.2286E+00	3.7517E+00	1.0274E-02	-5.2355E-03	2.4971E-03	1.8594E-03
5.4716E+01	2.2408E+01	2.5289E+01	-7.5576E+00	3.0455E+00	1.2086E-02	-6.1018E-03	2.9257E-03	2.0939E-03
5.5711E+01	2.3900E+01	2.5873E+01	-6.7167E+00	2.0869E+00	1.4122E-02	-7.0521E-03	3.3892E-03	2.3395E-03
5.5711E+01	2.3900E+01	2.5873E+01	-6.7167E+00	2.0869E+00	1.4122E-02	-7.0521E-03	3.3892E-03	2.3395E-03
5.6706E+01	2.5307E+01	2.6279E+01	-5.7262E+00	8.6519E-01	1.6391E-02	-8.0869E-03	3.8853E-03	2.5940E-03
5.7700E+01	2.6610E+01	2.6497E+01	-4.5816E+00	-6.2605E-01	1.8901E-02	-9.2059E-03	4.4106E-03	2.8550E-03
5.8695E+01	2.7787E+01	2.6515E+01	-3.2927E+00	-2.3950E+00	2.1659E-02	-1.0408E-02	4.9612E-03	3.1199E-03
5.9690E+01	2.8817E+01	2.6324E+01	-1.8778E+00	-4.4478E+00	2.4665E-02	-1.1692E-02	5.5329E-03	3.3855E-03
6.0685E+01	2.9679E+01	2.5919E+01	-3.4544E-01	-6.7806E+00	2.7923E-02	-1.3055E-02	6.1209E-03	3.6490E-03
6.1680E+01	3.0358E+01	2.5295E+01	1.2819E+00	-9.3831E+00	3.1426E-02	-1.4494E-02	6.7201E-03	3.9071E-03
6.2675E+01	3.0840E+01	2.4451E+01	2.9808E+00	-1.2251E+01	3.5170E-02	-1.6005E-02	7.3248E-03	4.1566E-03
6.3670E+01	3.1112E+01	2.3392E+01	4.7388E+00	-1.5374E+01	3.9144E-02	-1.7584E-02	7.9294E-03	4.3941E-03
6.3670E+01	3.1112E+01	2.3392E+01	4.7388E+00	-1.5374E+01	3.9144E-02	-1.7584E-02	7.9294E-03	4.3941E-03
6.4665E+01	3.1164E+01	2.2119E+01	6.5259E+00	-1.8733E+01	4.3336E-02	-1.9226E-02	8.5281E-03	4.6162E-03
6.5659E+01	3.0991E+01	2.0642E+01	8.3192E+00	-2.2308E+01	4.7730E-02	-2.0925E-02	9.1150E-03	4.8197E-03
6.6654E+01	3.0591E+01	1.8969E+01	1.0101E+01	-2.6078E+01	5.2307E-02	-2.2676E-02	9.6843E-03	5.0015E-03
6.7649E+01	2.9961E+01	1.7112E+01	1.1845E+01	-3.0020E+01	5.7045E-02	-2.4471E-02	1.0230E-02	5.1584E-03
6.8644E+01	2.9105E+01	1.5086E+01	1.3527E+01	-3.4101E+01	6.1920E-02	-2.6303E-02	1.0748E-02	5.2876E-03
6.9639E+01	2.8028E+01	1.2908E+01	1.5127E+01	-3.8291E+01	6.6903E-02	-2.8164E-02	1.1232E-02	5.3863E-03
7.0633E+01	2.6737E+01	1.0596E+01	1.6621E+01	-4.2559E+01	7.1964E-02	-3.0046E-02	1.1678E-02	5.4521E-03
7.1628E+01	2.5242E+01	8.1704E+00	1.7986E+01	-4.6867E+01	7.7071E-02	-3.1941E-02	1.2082E-02	5.4829E-03
7.1628E+01	2.5242E+01	8.1704E+00	1.7986E+01	-4.6867E+01	7.7071E-02	-3.1941E-02	1.2082E-02	5.4829E-03
7.2623E+01	2.3556E+01	5.6528E+00	1.9212E+01	-5.1181E+01	8.2190E-02	-3.3838E-02	1.2440E-02	5.4767E-03
7.3618E+01	2.1694E+01	3.0655E+00	2.0279E+01	-5.5459E+01	8.7284E-02	-3.5728E-02	1.2749E-02	5.4323E-03
7.4613E+01	1.9674E+01	4.3215E-01	2.1163E+01	-5.9665E+01	9.2316E-02	-3.7599E-02	1.3008E-02	5.3484E-03
7.5608E+01	1.7512E+01	-2.2214E+00	2.1848E+01	-6.3762E+01	9.7249E-02	-3.9442E-02	1.3214E-02	5.2244E-03
7.6603E+01	1.5231E+01	-4.8679E+00	2.2332E+01	-6.7712E+01	1.0204E-01	-4.1245E-02	1.3366E-02	5.0601E-03
7.7597E+01	1.2851E+01	-7.4837E+00	2.2613E+01	-7.1479E+01	1.0666E-01	-4.2997E-02	1.3464E-02	4.8554E-03
7.8592E+01	1.0393E+01	-1.0045E+01	2.2687E+01	-7.5029E+01	1.1106E-01	-4.4685E-02	1.3507E-02	4.6109E-03
7.9587E+01	7.8796E+00	-1.2528E+01	2.2547E+01	-7.8328E+01	1.1520E-01	-4.6299E-02	1.3497E-02	4.3276E-03
7.9587E+01	7.8796E+00	-1.2528E+01	2.2547E+01	-7.8328E+01	1.1520E-01	-4.6299E-02	1.3497E-02	4.3276E-03
8.0582E+01	5.3343E+00	-1.4912E+01	2.2192E+01	-8.1344E+01	1.1906E-01	-4.7826E-02	1.3435E-02	4.0066E-03
8.1576E+01	2.7792E+00	-1.7173E+01	2.1631E+01	-8.4051E+01	1.2260E-01	-4.9255E-02	1.3322E-02	3.6498E-03
8.2571E+01	2.3598E-01	-1.9293E+01	2.0875E+01	-8.6422E+01	1.2577E-01	-5.0573E-02	1.3161E-02	3.2592E-03
8.3566E+01	-2.2735E+00	-2.1254E+01	1.9930E+01	-8.8435E+01	1.2857E-01	-5.1770E-02	1.2954E-02	2.8371E-03
8.4561E+01	-4.7299E+00	-2.3041E+01	1.8808E+01	-9.0071E+01	1.3094E-01	-5.2834E-02	1.2703E-02	2.3860E-03
8.5556E+01	-7.1132E+00	-2.4640E+01	1.7520E+01	-9.1311E+01	1.3288E-01	-5.3754E-02	1.2413E-02	1.9092E-03

8.6551E+01	-9.4048E+00	-2.6040E+01	1.6083E+01	-9.2142E+01	1.3435E-01	-5.4520E-02	1.2086E-02	1.4098E-03
8.7546E+01	-1.1587E+01	-2.7232E+01	1.4518E+01	-9.2557E+01	1.3535E-01	-5.5122E-02	1.1726E-02	8.9134E-04
8.7546E+01	-1.1587E+01	-2.7232E+01	1.4518E+01	-9.2557E+01	1.3535E-01	-5.5122E-02	1.1726E-02	8.9134E-04
8.8541E+01	-1.3646E+01	-2.8209E+01	1.2845E+01	-9.2552E+01	1.3584E-01	-5.5552E-02	1.1336E-02	3.5750E-04
8.9535E+01	-1.5569E+01	-2.8969E+01	1.1078E+01	-9.2122E+01	1.3583E-01	-5.5801E-02	1.0921E-02	-1.8804E-04
9.0530E+01	-1.7344E+01	-2.9509E+01	9.2336E+00	-9.1267E+01	1.3531E-01	-5.5863E-02	1.0484E-02	-7.4138E-04
9.1525E+01	-1.8962E+01	-2.9829E+01	7.3336E+00	-8.9991E+01	1.3426E-01	-5.5733E-02	1.0029E-02	-1.2985E-03
9.2520E+01	-2.0416E+01	-2.9932E+01	5.4026E+00	-8.8303E+01	1.3270E-01	-5.5404E-02	9.5595E-03	-1.8555E-03
9.3514E+01	-2.1700E+01	-2.9822E+01	3.4594E+00	-8.6208E+01	1.3061E-01	-5.4875E-02	9.0789E-03	-2.4082E-03
9.4509E+01	-2.2811E+01	-2.9505E+01	1.5233E+00	-8.3717E+01	1.2802E-01	-5.4142E-02	8.5910E-03	-2.9525E-03
9.5504E+01	-2.3749E+01	-2.8992E+01	-3.8679E-01	-8.0842E+01	1.2494E-01	-5.3204E-02	8.0990E-03	-3.4843E-03
9.5504E+01	-2.3749E+01	-2.8992E+01	-3.8679E-01	-8.0842E+01	1.2494E-01	-5.3204E-02	8.0990E-03	-3.4843E-03
9.6499E+01	-2.4512E+01	-2.8290E+01	-2.2538E+00	-7.7597E+01	1.2137E-01	-5.2064E-02	7.6059E-03	-3.9998E-03
9.7494E+01	-2.5104E+01	-2.7412E+01	-4.0610E+00	-7.3999E+01	1.1733E-01	-5.0721E-02	7.1148E-03	-4.4946E-03
9.8489E+01	-2.5529E+01	-2.6369E+01	-5.7910E+00	-7.0062E+01	1.1286E-01	-4.9182E-02	6.6285E-03	-4.9650E-03
9.9484E+01	-2.5793E+01	-2.5176E+01	-7.4296E+00	-6.5801E+01	1.0797E-01	-4.7450E-02	6.1494E-03	-5.4068E-03
1.0048E+02	-2.5904E+01	-2.3845E+01	-8.9635E+00	-6.1230E+01	1.0270E-01	-4.5533E-02	5.6800E-03	-5.8162E-03
1.0147E+02	-2.5870E+01	-2.2393E+01	-1.0379E+01	-5.6362E+01	9.7083E-02	-4.3440E-02	5.2224E-03	-6.1892E-03
1.0247E+02	-2.5701E+01	-2.0834E+01	-1.1663E+01	-5.1203E+01	9.1151E-02	-4.1181E-02	4.7784E-03	-6.5219E-03
1.0346E+02	-2.5410E+01	-1.9184E+01	-1.2806E+01	-4.5762E+01	8.4947E-02	-3.8769E-02	4.3497E-03	-6.8102E-03
1.0346E+02	-2.5410E+01	-1.9184E+01	-1.2806E+01	-4.5762E+01	8.4947E-02	-3.8769E-02	4.3497E-03	-6.8102E-03
1.0446E+02	-2.5008E+01	-1.7459E+01	-1.3799E+01	-4.0040E+01	7.8514E-02	-3.6217E-02	3.9376E-03	-7.0499E-03
1.0545E+02	-2.4510E+01	-1.5675E+01	-1.4633E+01	-3.4035E+01	7.1901E-02	-3.3543E-02	3.5432E-03	-7.2365E-03
1.0645E+02	-2.3930E+01	-1.3849E+01	-1.5302E+01	-2.7738E+01	6.5162E-02	-3.0766E-02	3.1676E-03	-7.3651E-03
1.0744E+02	-2.3284E+01	-1.1996E+01	-1.5802E+01	-2.1130E+01	5.8353E-02	-2.7907E-02	2.8112E-03	-7.4307E-03
1.0844E+02	-2.2586E+01	-1.0133E+01	-1.6132E+01	-1.4191E+01	5.1536E-02	-2.4993E-02	2.4744E-03	-7.4274E-03
1.0943E+02	-2.1852E+01	-8.2740E+00	-1.6294E+01	-6.8840E+00	4.4777E-02	-2.2050E-02	2.1573E-03	-7.3487E-03
1.1043E+02	-2.1098E+01	-6.4340E+00	-1.6296E+01	8.3560E-01	3.8148E-02	-1.9109E-02	1.8593E-03	-7.1874E-03
1.1142E+02	-2.0338E+01	-4.6261E+00	-1.6148E+01	9.0241E+00	3.1727E-02	-1.6209E-02	1.5800E-03	-6.9352E-03
1.1142E+02	-2.0338E+01	-4.6261E+00	-1.6148E+01	9.0241E+00	3.1727E-02	-1.6209E-02	1.5800E-03	-6.9352E-03
1.1242E+02	-1.9586E+01	-2.8621E+00	-1.5872E+01	1.7750E+01	2.5601E-02	-1.3389E-02	1.3181E-03	-6.5823E-03
1.1341E+02	-1.8855E+01	-1.1518E+00	-1.5496E+01	2.7095E+01	1.9864E-02	-1.0699E-02	1.0721E-03	-6.1178E-03
1.1441E+02	-1.8154E+01	4.9747E-01	-1.5061E+01	3.7157E+01	1.4621E-02	-8.1915E-03	8.4034E-04	-5.5290E-03
1.1540E+02	-1.7491E+01	2.0819E+00	-1.4620E+01	4.8046E+01	9.9857E-03	-5.9314E-03	6.2031E-04	-4.8011E-03
1.1640E+02	-1.6870E+01	3.6022E+00	-1.4244E+01	5.9894E+01	6.0863E-03	-3.9908E-03	4.0922E-04	-3.9170E-03
1.1739E+02	-1.6288E+01	5.0637E+00	-1.4026E+01	7.2838E+01	3.0656E-03	-2.4551E-03	2.0393E-04	-2.8575E-03
1.1839E+02	-1.5739E+01	6.4788E+00	-1.4082E+01	8.7039E+01	1.0814E-03	-1.4228E-03	8.5480E-07	-1.6005E-03
1.1938E+02	-1.5209E+01	7.8683E+00	-1.4556E+01	1.0267E+02	3.0959E-04	-1.0080E-03	-2.0391E-04	-1.2073E-04

S	U	V	W
4.0106E+01	3.4949E-04	-4.3912E-05	-1.4103E-04
4.1062E+01	2.0010E-04	4.7867E-06	-4.3116E-04
4.2017E+01	5.7583E-05	5.7606E-05	-7.2882E-04
4.2973E+01	-8.3652E-05	1.1982E-04	-1.0521E-03
4.3929E+01	-2.2851E-04	1.9554E-04	-1.4177E-03
4.4885E+01	-3.8394E-04	2.8883E-04	-1.8403E-03
4.5841E+01	-5.5167E-04	4.0326E-04	-2.3358E-03
4.6796E+01	-7.3539E-04	5.4191E-04	-2.9192E-03
4.7752E+01	-9.3853E-04	7.0818E-04	-3.6059E-03
4.7752E+01	-9.3853E-04	7.0818E-04	-3.6059E-03
4.8747E+01	-1.1705E-03	9.1426E-04	-4.4480E-03
4.9742E+01	-1.4278E-03	1.1558E-03	-5.4371E-03
5.0737E+01	-1.7103E-03	1.4342E-03	-6.5911E-03
5.1732E+01	-2.0170E-03	1.7506E-03	-7.9277E-03
5.2727E+01	-2.3453E-03	2.1049E-03	-9.4625E-03
5.3721E+01	-2.6924E-03	2.4971E-03	-1.1212E-02
5.4716E+01	-3.0542E-03	2.9257E-03	-1.3189E-02
5.5711E+01	-3.4264E-03	3.3892E-03	-1.5408E-02
5.5711E+01	-3.4264E-03	3.3892E-03	-1.5408E-02
5.6706E+01	-3.8034E-03	3.8853E-03	-1.7877E-02
5.7700E+01	-4.1801E-03	4.4106E-03	-2.0603E-02
5.8695E+01	-4.5507E-03	4.9612E-03	-2.3594E-02
5.9690E+01	-4.9095E-03	5.5329E-03	-2.6851E-02
6.0685E+01	-5.2504E-03	6.1209E-03	-3.0372E-02
6.1680E+01	-5.5681E-03	6.7201E-03	-3.4155E-02
6.2675E+01	-5.8572E-03	7.3248E-03	-3.8193E-02
6.3670E+01	-6.1131E-03	7.9294E-03	-4.2475E-02
6.3670E+01	-6.1131E-03	7.9294E-03	-4.2475E-02
6.4665E+01	-6.3308E-03	8.5281E-03	-4.6983E-02
6.5659E+01	-6.5070E-03	9.1150E-03	-5.1705E-02
6.6654E+01	-6.6385E-03	9.6843E-03	-5.6621E-02
6.7649E+01	-6.7228E-03	1.0230E-02	-6.1707E-02
6.8644E+01	-6.7575E-03	1.0748E-02	-6.6932E-02
6.9639E+01	-6.7422E-03	1.1232E-02	-7.2273E-02
7.0633E+01	-6.6766E-03	1.1678E-02	-7.7696E-02
7.1628E+01	-6.5611E-03	1.2082E-02	-8.3169E-02
7.1628E+01	-6.5611E-03	1.2082E-02	-8.3169E-02
7.2623E+01	-6.3967E-03	1.2440E-02	-8.8650E-02
7.3618E+01	-6.1853E-03	1.2749E-02	-9.4107E-02
7.4613E+01	-5.9296E-03	1.3008E-02	-9.9501E-02
7.5608E+01	-5.6324E-03	1.3214E-02	-1.0479E-01
7.6603E+01	-5.2969E-03	1.3366E-02	-1.0993E-01
7.7597E+01	-4.9276E-03	1.3464E-02	-1.1489E-01
7.8592E+01	-4.5288E-03	1.3507E-02	-1.1962E-01
7.9587E+01	-4.1051E-03	1.3497E-02	-1.2409E-01

7.9587E+01	-4.1051E-03	1.3497E-02	-1.2409E-01
8.0582E+01	-3.6608E-03	1.3435E-02	-1.2825E-01
8.1576E+01	-3.2014E-03	1.3322E-02	-1.3208E-01
8.2571E+01	-2.7319E-03	1.3161E-02	-1.3553E-01
8.3566E+01	-2.2573E-03	1.2954E-02	-1.3858E-01
8.4561E+01	-1.7824E-03	1.2703E-02	-1.4118E-01
8.5556E+01	-1.3123E-03	1.2413E-02	-1.4333E-01
8.6551E+01	-8.5181E-04	1.2086E-02	-1.4499E-01
8.7546E+01	-4.0535E-04	1.1726E-02	-1.4614E-01
8.7546E+01	-4.0535E-04	1.1726E-02	-1.4614E-01
8.8541E+01	2.2612E-05	1.1336E-02	-1.4676E-01
8.9535E+01	4.2826E-04	1.0921E-02	-1.4684E-01
9.0530E+01	8.0789E-04	1.0484E-02	-1.4638E-01
9.1525E+01	1.1582E-03	1.0029E-02	-1.4536E-01
9.2520E+01	1.4762E-03	9.5595E-03	-1.4379E-01
9.3514E+01	1.7591E-03	9.0789E-03	-1.4166E-01
9.4509E+01	2.0049E-03	8.5910E-03	-1.3898E-01
9.5504E+01	2.2117E-03	8.0990E-03	-1.3578E-01
9.5504E+01	2.2117E-03	8.0990E-03	-1.3578E-01
9.6499E+01	2.3778E-03	7.6059E-03	-1.3204E-01
9.7494E+01	2.5027E-03	7.1148E-03	-1.2780E-01
9.8489E+01	2.5858E-03	6.6285E-03	-1.2308E-01
9.9484E+01	2.6271E-03	6.1494E-03	-1.1791E-01
1.0048E+02	2.6271E-03	5.6800E-03	-1.1231E-01
1.0147E+02	2.5870E-03	5.2224E-03	-1.0632E-01
1.0247E+02	2.5083E-03	4.7784E-03	-9.9987E-02
1.0346E+02	2.3930E-03	4.3497E-03	-9.3344E-02
1.0346E+02	2.3930E-03	4.3497E-03	-9.3344E-02
1.0446E+02	2.2434E-03	3.9376E-03	-8.6432E-02
1.0545E+02	2.0631E-03	3.5432E-03	-7.9311E-02
1.0645E+02	1.8558E-03	3.1676E-03	-7.2034E-02
1.0744E+02	1.6257E-03	2.8112E-03	-6.4663E-02
1.0844E+02	1.3777E-03	2.4744E-03	-5.7258E-02
1.0943E+02	1.1174E-03	2.1573E-03	-4.9897E-02
1.1043E+02	8.5042E-04	1.8593E-03	-4.2657E-02
1.1142E+02	5.8331E-04	1.5800E-03	-3.5623E-02
1.1142E+02	5.8331E-04	1.5800E-03	-3.5623E-02
1.1242E+02	3.2281E-04	1.3181E-03	-2.8888E-02
1.1341E+02	7.6128E-05	1.0721E-03	-2.2561E-02
1.1441E+02	-1.4941E-04	8.4034E-04	-1.6758E-02
1.1540E+02	-3.4650E-04	6.2031E-04	-1.1609E-02
1.1640E+02	-5.0799E-04	4.0922E-04	-7.2601E-03
1.1739E+02	-6.2723E-04	2.0393E-04	-3.8770E-03
1.1839E+02	-6.9865E-04	8.5480E-07	-1.6448E-03
1.1938E+02	-7.1812E-04	-2.0391E-04	-7.7209E-04

UNSYMMETRICAL BUCKLING MODE WITH 6 CIRCUMFERENTIAL WAVES, B = -1.6709E-01

PREBUCKLING STIFFNESS = 1.2614E-05 POSTBUCKLING STIFFNESS = 2.2939E-05

APPENDIX D

COMPUTER PROGRAM DOCUMENTATION

This appendix consists of program details necessary to modify the program but unnecessary to use the program. This information is divided into four main parts: (1) an overall logical flow chart of the program; (2) brief descriptions of contractor-supplied subprograms; (3) a glossary of the major FORTRAN variables; and (4) a listing of the source program.

Overall Logical Flow of Postbuckling Program

MAIN

Read and write case title card
IDONE = 0
ITER = 0
Call OVERLAY 1

OVERLAY 1

Read case option card: NSG, NWP, NFM, NST, NPG, NML, NIC, RTABL,
ISS4, ISSW6
FN = 0.
If NSG = 1, LSTAB = 1 (Max entry no. to be determined from input geometry cards)
If NWP = 1, LTAB(I) = 1 (No. of layers for each subinterval to be determined from input wall properties cards)
Read basic input tables
- Geometry: NOUT2, NOUT1, TS, TR, TRP, TRR2
- Wall properties: TE1, TE2, TE12, TNU1, TH
- Foundation moduli: TK1, TK2, TK3
- Stringer properties: TEAST, TEIST, TGJST, TZBST
- Pressure gradient: TX3X, TX3Y

Read standard prebuckling data (if NML $\neq$ 0)
- FLAM, LTYPE
- TTPHIN, TTIN, TT2N, TCHIN
- TTPHIO, TT1O, TT2O, TCHIO
- TX3O

Read additional prebuckling data (if NML and ISS4 $\neq$ 0)
- TMYN, TMYO
- TM1N, TM1O, TM2N, TM2O
- TPHI1, TT11, TT21, TCHI1
- STIFN, STIFO

Write statement telling if live or dead loading
Write geometry table (if NSG input as 1)
Write wall properties table if input
Write foundation moduli table if input;
    if not input and NFM = 1, set to zero
Write stringer properties table if input;
    if not input and NST = 1, set to zero
Write pressure gradient table if input;
    if not input and NPG = 1, set to zero
Write prebuckling data (if NML $\neq$ 0)
Read buckling mode data
    FNC, NTLC, GUESS
Write harmonic number (FNC) and critical load (FLAM + GUESS)

Read and write buckling mode response variables for each point, (CP, CQ, CS,
    CM1, XI, ETA, SV, CHI)
Compute buckling mode shell stress resultants: TT1C, TT2C, TT12C
Compute buckling mode rotations: TCHIC, TPSIC, TTHETC
Compute buckling mode normal strains: TEPS1C, TEPS2C, TCAP1C, TCAP2C
Compute prebuckling shell stress resultants and rotations at buckling load:
    TT1NO, TT2NO, TCHINO
If NIC = 0, make NOUT1-table negative at all boundaries except dome closures
    and write "ALL BOUNDARY DATA TAKEN FROM PREVIOUS CASE"
Read or generate boundary conditions for each boundary:
    a) If NOUT1 = 0, set boundary condition matrices for force free
       boundary: BBP = I, BD = 0, SL = 0 and write same
    b) If NOUT1 = 1, read & write ring data: TEA, TEIX, TEIY, TEIXY,
       TGJT, TZBAR, TSBAR
       Write ring prebuckling data: TTPHIN, TTPHIO and
           TPHI1, TMYN, TMYO (if ISS4 $\neq$ 0)
       (If NOUT1 = -1, use ring data already in memory and write
           "BOUNDARY DATA TAKEN FROM PREVIOUS CASE")
       Compute boundary condition matrices (BBP, BD, SL) and buckling
           mode stress resultant and rotations (TPHIC, TWXC, TWYC)
    c) If NOUT1 = 2, read and write BBP, BD matrices and set SL vector
           to zero
       (If NOUT1 = -2, use BBP, BD, SL already in memory and write
           "BOUNDARY DATA TAKEN FROM PREVIOUS CASE")
Compute prebuckling stiffness at buckling load: STIFNO (if ISS4 $\neq$ 0)
Compute and write inner product (PRODC)
Correct and write corrected inner product (if ISS4 $\neq$ 0)
Compute and write α(AMAX) for worst imperfection shape
Compute and write β(BMAX) for worst imperfection shape (if ISS4 $\neq$ 0)
Compute and write α(AMODE) and ratio (FI1) of max normal
    amplitude to angular amplitude for buckling mode imperfection
Compute and write β(BMODE) for buckling mode imperfection (if ISS4 $\neq$ 0)
Compute $\sigma_1 . \varepsilon_1$(S1E1)
Buffer out labeled common (TAPE 1)
Compute BBP, BD, SL for dome closure(s) (if NOUT1 = 4)
If FNC = 0., compute and write 1st postbuckling coefficient (SA) and stiffness
    K* (if ISS4 $\neq$ 0); set IDONE = 1 and return to MAIN for next case

Set up artificial rigid body constraint(s), if necessary, for boundary value problem for axisymmetric component of second-order post-buckling state
Return

MAIN

Check to make sure all buffered data is out of core
Call OVERLAY 2

OVERLAY 2

ITER = 3
Compute complementary solutions (PRU, PRV, PRW, PRZ) for axisymmetric component of second-order state
ITER = 1
Compute particular solution (PRG, PRJ)
Combine complementary and particular solutions to form axisymmetric solution (Y, Z)
Return

MAIN

Call OVERLAY 1

OVERLAY 1

Buffer in labeled common
Write axisymmetric solution
Check to make sure all buffered data is in core
Compute associated shell stress resultants: TT1SO, TT2SO
Compute associated shell rotations: TCHISO
Compute associated shell strains: EPS1SO, EPS2SO, CAP1SO, CAP2SO
Compute associated ring stress resultants: TPHISO
Compute associated ring strains: TEPSSO
If ISS4 $\neq$ 0, compute $\sigma_0 {*} \cdot \varepsilon_2$ (SOE2)
FN = 2.*FNC
Save NOUT1-table
Make NOUT1 negative at all boundaries except dome closures
Recompute BBP, BD, SL matrices for rings (NOUT1 = -1)
Restore NOUT1-table for next case
Buffer out labeled common
Recompute BBP, BD, SL matrices for dome closure(s) (NOUT1 = 4)
Eliminate artificial rigid body constraint(s) if necessary
Return

MAIN

Check to make sure all buffered data is out of core
Call OVERLAY 2

OVERLAY 2

ITER = 4
Compute complementary solutions (PRU, PRV, PRW, PRZ) for nonsymmetric component of second-order state
ITER = 2
Compute particular solution (PRG, PRJ) for nonsymmetric component
Combine complementary and particular solutions to form nonsymmetric solution (Y, Z)
Return

MAIN

Call OVERLAY 1

OVERLAY 1

Buffer in labeled common
Write nonsymmetric solution
Check to make sure all buffered data is in core
Compute associated shell stress resultants: TT1SN, TT2SN, TT12S
Compute associated shell rotations: TCHISN, TPSIS, TTHETS
Compute associated ring stress resultants: TPHISN
Compute associated ring rotations: TWXS, TWYS
Compute and write 2nd postbuckling coefficient (SB)
IDONE = 1
If ISS4 ≠ 0, compute K* (STIF) and write STIFNO and STIF
Return to MAIN for next case

Subprogram Descriptions

MAIN

This program always resides in core and calls the two primary overlays. It reads and prints the title card and terminates the job when completed. A flow chart of MAIN is shown in Figure 10.

PRIMARY OVERLAY 1

This overlay consists of three contractor-supplied programs: INPUT, INT1, and I1I2. INT1 and I1I2 are quadrature subprograms called by INPUT. This overlay essentially performs all functions other than the actual solution of the differential equations for the second-order postbuckling state.

INPUT

This program reads, writes, and processes all of the input data. It prepares the boundary conditions for the axisymmetric and nonsymmetric problems and processes their solutions. It writes all output results.

INT1 (called by INPUT)

This subprogram computes nine different functionals. Integrations over the shell meridian are performed by Simpson's rule. The functional to be computed is determined by the value of the parameter INTGRD, which is transmitted to INT1 through blank COMMON, according to the following table.

INTGRD	FUNCTIONAL	USE
[illegible]	[illegible]	$a(n_c = 0)$
[illegible]	$F^{(1)}(u_1,u_1)$	$a(n_c = 0)$, b, α, β
3	$\sigma_0{}^* \cdot \varepsilon_1$	$K^*(n_c = 0)$
4	$\sigma_1 \cdot \varepsilon_1$	K^*, $\sigma_1 \cdot L_1(u_1)$
5	$\sigma_0{}^* \cdot \varepsilon_2$	K^*
6	$F^{(2)}(u_1,u_1)$	$\hat{\beta}, \beta_{mode}$, correct $F^{(1)}(u_1,u_1)$
7	$H[L_{11}(u_0^{(1)}*,u_1)] \cdot L_{11}(u_0^{(1)}*,u_1)$	$\hat{\beta}, \beta_{mode}$
8	$\sigma_0^{(1)}* \cdot L_{11}(\hat{u},u_1) + \sigma_1 \cdot L_{11}(\hat{u},u_0^{(1)}*) - q_1(\hat{u}) \cdot u_1 + H[L_{11}(u_0^{(1)}*,u_1)] \cdot L_{11}(\hat{u},u_0*)$	$\hat{\beta}$
9	$\{\sigma_1 - H[L_{11}(u_1,u_0*)]\} \cdot L_{11}(u_0^{(1)}*,u_1)$	β_{mode}

The functionals shown above for INTGRD = 3, 5, 6, 7, 8, 9 depend on data in the optional prebuckling data deck, and consequently are not computed unless ISS4 (column 76 of the case option card) $\neq$ 0.

I1I2 (called by INPUT)

This subprogram is similar to INT1 except that it computes two functionals simultaneously each time it is entered. As with INT1, the parameter INTGRD determines the functionals to be computed according to the following table

INTGRD	FUNCTIONALS	USE
0	$\sigma_2 \cdot L_2(u_1)$	b
	$\sigma_1 \cdot L_{11}(u_1, u_2)$	b
+1	A	$\hat{\alpha}, \alpha_{mode}, \hat{\beta}$
	μ	$\hat{\alpha}$
-1	$\bar{\delta}/\bar{\xi}$	α_{mode}
	$\sigma_1 \cdot L_{11}(u_0{}^*, u_1)$	$\sigma_1 \cdot L_1(u_1)$

PRIMARY OVERLAY 2

This overlay consists of thirteen contractor-supplied programs: SRA202, RKS3, DER, CNT, MATS, MMM, MVM, MMA, VVA, MAE, SLOPE, SLOPE1, and SLOPE3. The only function of this overlay to compute the axisymmetric and nonsymmetric components of the second-order postbuckling state for processing by PRIMARY OVERLAY 1. It accomplishes this task by solution of the linear boundary-value problem for each of these components.

SRA202

This program sets up the initial conditions for the forward integration to obtain complementary and particular solutions of the differential equations for the axisymmetric problem (in the first pass through OVERLAY 2) and the nonsymmetric problem (in the second pass through OVERLAY 2). It also combines the complementary and particular solutions to form the solution for each of these problems.

RKS3 (called by SRA202)

This is a general purpose subroutine which integrates a system of first-order ordinary differential equations of the form $dy_i/ds = f_i(s,y_i)$ by the fourth-order Runge-Kutta method. Each integration step is actually performed in two half-steps, each using conventional Runge-Kutta, to obtain midpoint values of the derivatives f_i. These are used along with the derivatives at the initial and end points to form a Simpson's rule evaluation for the full step. The magnitude of the difference between the Runge-Kutta integration over the two half-steps and the Simpson's rule integration over the full step is taken as an indication of the truncation error and is used as a basis for modification of the step size. Automatic step modification is controlled by values of the absolute (ATABL) and relative (RTABL) error tolerances provided to the routine. Since RKS3 has no COMMON block, all communication with it is through its calling sequence.

DER (called by RKS3)

Upon each call from RKS3, this subprogram computes the derivatives $f_i(s,y_i)$ for RKS3 using the values of s and y_i provided by RKS3. This subprogram is entered eight times for each full integration step.

CNT (called by RKS3)

This subprogram is entered at the end of each full integration step. Upon each entry to CNT during the integration for complementary solutions, it performs the following functions:

(1) checks the growth of χ to determine if the subinterval is too long,

(2) forces the integration to land on the specified input stations, and stores the values of the complementary solutions at these points in the arrays PRU, PRV, PRW, and PRZ,

(3) restarts the integration at each point of subdivision with new initial conditions, and

(4) terminates the integration process at the end of the shell.

Functions (3) and (4) above are also performed upon each entry during integration for the particular solution. Also, during particular solution integration, CNT performs the following additional functions:

(1) forces the integration to land on the specified input stations, and stores the values of the particular solution in the arrays PRG and PRJ,

(2) performs at points of subdivision the matrix calculations required in the forward pass of the Gaussian elimination technique (Reference 14) used in the solution of the superposition constants for the complementary solutions, and

(3) performs at the terminal edge of the shell the matrix calculations required in the backward pass of the Gaussian elimination technique and stores the superposition constants for each subinterval in the CV and DV arrays.

MATS (called by CNT)

This is a general purpose subroutine which solves simultaneously systems of linear algebraic equations (with a common coefficient matrix) by the Crout method (Reference 20). It is used in this program solely to invert 4x4 matrices by solving four systems of equations whose right-hand sides form the identity matrix.

MMM (called by CNT)

This subprogram forms the product of two 4x4 matrices.

MVM (called by CNT)

This subprogram forms the product of a 4x4 matrix with a 4x1 matrix.

MMA (called by CNT)

This subprogram forms the sum of two 4x4 matrices.

VVA (called by CNT)

This subprogram forms the sum of two 4x1 matrices.

MAE (called by CNT)

This subprogram augments each 4x4 matrix to be inverted with the identity matrix. It is entered immediately before each call to MATS.

SLOPE (called by DER)

This subprogram performs linear interpolation (with respect to s) on the one-dimensional arrays representing the input geometry, foundation moduli, stringer properties, and pressure gradient.

SLOPE1 (called by DER)

This subprogram performs linear interpolation (with respect to s) on the two-dimensional arrays representing the input wall properties.

SLOPE3 (called by DER)

This subprogram performs quadratic interpolation (with respect to s) on the one-dimensional arrays representing the stress resultants and rotations of the prebuckling state at the critical load and the buckling mode.

Glossary of Major Fortran Variables

Variable	Definition	Subprogram(s) where generated
A(4,4)	[e]	INPUT
AMAX	$\hat{\alpha}$	INPUT
AMODE	α_{mode}	INPUT
ATABL	absolute error tolerance for variable step Runge-Kutta integration	INPUT
B(4,4)	[B] matrix for a ring ($[B]^{-1} = [e]^T/r$)	INPUT
BBP(34,4,4)	stored [B] matrices	INPUT
BBZ(4,4)	[B] matrix at initial boundary	INPUT
BB1(4,4)	[B] matrix at final boundary	INPUT
BD(34,4,4)	stored [D] matrices	INPUT
BDM(4,4)	[D] matrix at final boundary	INPUT
BDZ(4,4)	[D] matrix at initial boundary	INPUT
BMAX	$\hat{\beta}$	INPUT
BMODE	β_{mode}	INPUT
C(4,4)	[k]	INPUT
CAP1SO(100)	${}_0\kappa_1^{(2)}$	INPUT
CAP2SO(100)	${}_0\kappa_2^{(2)}$	INPUT

Variable	Definition	Subprogram(s) where generated
CARD1(5)	input table data on next to last card read	INPUT
CARD2(5)	input table data on last card read	INPUT
CHI	temporary value of χ	INPUT
CM1	temporary value of M_1	INPUT
COMENT(5)	interpolated table data	INPUT
CP	temporary value of axial component of stress resultant (P)	INPUT
CQ	temporary value of Q	INPUT
CS	temporary value of S	INPUT
CV(4,34)	superposition constants for first four complementary solutions (denoted by c_i in Reference 14)	CNT
D(4,4)	[D] matrix for a ring ([D] = -[k][e])	INPUT
DS	step size for next Runge-Kutta integration step	SRA202, CNT
DSS	step size for previous Runge-Kutta integration step	CNT
DV(4,34)	superposition constants for last four complementary solutions (denoted by d_i in Reference 14)	CNT
DY1(8,9)	current derivative values for complementary and particular solutions	DER
DY9(8)	current derivative values for particular solution	DER
EPS1SO(100)	${}_0\varepsilon_1^{(2)}$	INPUT

Variable	Definition	Subprogram(s) where generated
EPS2SO(100)	${}_0\varepsilon_2^{(2)}$	INPUT
ETA	temporary value of η	INPUT
E1(5)	current values of E_1 for each layer	DER
E12(5)	current values of E_{12} for each layer	DER
E2(5)	current values of E_2 for each layer	DER
FI1, FI2	functional values computed by I1I2	I1I2
FLAM	λ_o	INPUT
FN	harmonic number (n) of second-order postbuckling component being calculated	INPUT
FNC	n_c	INPUT
FNU1(5)	current values of ν_1 for each layer	DER
GLAM	λ_c	INPUT
GUESS	$\lambda_c - \lambda_o$	INPUT
IDONE	flag to indicate when solution is complete	MAIN, INPUT
INTGRD	flag to determine function of I1I2 and INT1	INPUT
IOP	logical output unit number	MAIN, MATS
IP	logical input unit number	MAIN
ISSW6	flag to override abort if a subinterval exceeds length criterion	INPUT

Variable	Definition	Subprogram(s) where generated
ISS4	flag to indicate if additional prebuckling deck is present (for β and K* calculations)	INPUT
ITER	flag to indicate which pass is being made through OVERLAY 1	MAIN, SRA202
JENT(34)	table of entry numbers at boundaries	INPUT
KASE	parameter to indicate whether integration is for complementary or particular solutions	SRA202
LSTAB	maximum entry number	INPUT
LTAB(100)	number of wall layers at each entry point	INPUT
LTYPE	flag to indicate whether live or dead loading	INPUT
NDIS	maximum boundary number	INPUT
NFM	flag for foundation moduli table	INPUT
NIC	flag for boundary conditions	INPUT
NML	flag for prebuckling data deck	INPUT
NOUT1(100)	table to indicate type of boundary condition	INPUT
NOUT2(100)	table to indicate need for artificial rigid body constraint; also indicates a symmetrical edge ring	INPUT
NPG	flag for pressure gradient table	INPUT
NSG	flag for geometry table	INPUT
NST	flag for stringer properties table	INPUT
NTLC	flag for axisymmetric torsional buckling mode	INPUT

Variable	Definition	Subprogram(s) where generated
NTERP	parameter used in quadratic interpolation	DER
NTRY	parameter to control termination, restart, or continuation of Runge-Kutta integration	SRA202, CNT
NWP	flag for wall properties table	INPUT
P(4,4,34)	4x4 matrices used in solution for superposition constants (denoted by p_i in Reference 14)	CNT
PP(4,4,34)	4x4 matrices used in solution for superposition constants (denoted by p_i' (in Reference 14)	CNT
PPSTOR(4,4)	temporary storage for PP-matrices	CNT
PRG(4,100)	particular solution force vector (denoted by G_i in Reference 14)	CNT
PRJ(4,100)	particular solution displacement vector (denoted by J_i in Reference 14)	CNT
PRODC	inner product of buckling mode	INPUT
PRS(100)	table of stored s-values [same as TS(100)]	INPUT
PSTOR(4,4)	temporary storage for P-matrices	CNT
PRU(4,4,100)	first submatrix of complementary solution force vectors (denoted by U_i in Reference 14)	CNT
PRV(4,4,100)	second submatrix of complementary solution force vectors (denoted by V_i in Reference 14)	CNT

Variable	Definition	Subprogram(s) where generated
PRW(4,4,100)	first submatrix of complementary solution displacement vectors (denoted by W_i in Reference 14)	CNT
PRZ(4,4,100)	second submatrix of complementary solution displacement vectors (denoted by Z_i in Reference 14)	CNT
Q(4,34)	4x1 matrices used in solution for superposition constants (denoted by q_i in Reference 14)	CNT
QP(4,34)	4x1 matrices used in solution for superposition constants (denoted by q_i' in Reference 14)	CNT
QPSTOR(4)	temporary storage for QP-matrices	CNT
QSTOR(4)	temporary storage for Q-matrices	CNT
RTABL	relative error tolerance for variable step Runge-Kutta integration	INPUT
S	current value of s	SRA202, CNT, RKS3
SA	first postbuckling coefficient (a)	INPUT
SB	b	INPUT
SH(5)	current values of h for each layer	DER
SL(34,4)	stored {L} matrices	INPUT
SLM(4)	{L} matrix at final boundary	INPUT
SLZ(4)	{L} matrix at initial boundary	INPUT
STIF	K*	INPUT
STIFN	K_0 at $\lambda = \lambda_o$	INPUT
STIFNO	K_0*	INPUT

Variable	Definition	Subprogram(s) where generated
STIFO	$dK_0/d\lambda$ at $\lambda = \lambda_o$	INPUT
SUM1	functional value computed by INT1	INT1
SV	temporary value of circumferential displacement (v)	INPUT
SOE2	$\sigma_0{}^{*}\cdot\varepsilon_2$	INPUT
S1E1	$\sigma_1\cdot\varepsilon_1$	INPUT
TCAP1C(100)	$\kappa_1^{(1)}$	INPUT
TCAP2C(100)	$\kappa_2^{(1)}$	INPUT
TCHIC(100)	$\chi^{(1)}$	INPUT
TCHIN(100)	$\chi^{(0)}$ at $\lambda = \lambda_o$	INPUT
TCHINO(100)	$\chi^{(0)}$ at $\lambda = \lambda_c$	INPUT
TCHISN(100)	${}_2\chi^{(2)}$	INPUT
TCHISO(100)	${}_0\chi^{(2)}$	INPUT
TCHIO(100)	$\partial\chi^{(0)}/\partial\lambda$ at $\lambda = \lambda_o$	INPUT
TCHI1(100)	$\partial^2\chi^{(0)}/\partial\lambda^2$ at $\lambda = \lambda_o$	INPUT
TC1(100)	C	INPUT
TDIS(34)	table of s-values at boundaries	INPUT
TEA(34)	ring stretching stiffnesses (EA)	INPUT
TEAST(100)	total stringer stretching stiffness (NEA)	INPUT
TECCX(34)	ring axial eccentricities	INPUT
TECCY(34)	ring radial eccentricities	INPUT
TEIST(100)	total stringer bending stiffness (NEI)	INPUT

Variable	Definition	Subprogram(s) where generated
TEIX(34)	in-plane ring bending stiffnesses (EI_x)	INPUT
TEIXY(34)	coupling ring stiffnesses (EI_{xy})	INPUT
TEIY(34)	out-of-plane ring bending stiffnesses (EI_y)	INPUT
TEPSS0(34)	${}_0\varepsilon_\phi^{(2)}$	INPUT
TEPS1C(100)	$\varepsilon_1^{(1)}$	INPUT
TEPS2C(100)	$\varepsilon_2^{(1)}$	INPUT
TE1(100,5)	E_1	INPUT
TE12(100,5)	E_{12}	INPUT
TE2(100,5)	E_2	INPUT
TG(100)	shell wall shear stiffness (G)	INPUT
TGJST(100)	total stringer torsional stiffness (NGJ)	INPUT
TGJT(34)	ring torsional stiffnesses (GJ)	INPUT
TH(100,5)	h	INPUT
TK1(100)	k_1	INPUT
TK2(100)	k_2	INPUT
TK3(100)	k_3	INPUT
TLAMIJ(100) (I,J = 1,4)	λ_{ij}	INPUT
TMUIJ(100) (I,J = 1,2)	μ_{ij}	INPUT
TMYN(34)	$M_y^{(0)}$ at $\lambda = \lambda_o$	INPUT
TMY0(34)	$\partial M_y^{(0)}/\partial\lambda$ at $\lambda = \lambda_o$	INPUT

Variable	Definition	Subprogram(s) where generated
TM1N(100)	$M_1^{(0)}$ at $\lambda = \lambda_o$	INPUT
TM1O(100)	$\partial M_1^{(0)}/\partial\lambda$ at $\lambda = \lambda_o$	INPUT
TM2N(100)	$M_2^{(0)}$ at $\lambda = \lambda_o$	INPUT
TM2O(100)	$\partial M_2^{(0)}/\partial\lambda$ at $\lambda = \lambda_o$	INPUT
TNU1(100,5)	ν_1	INPUT
TPHIC(34)	$T_\phi^{(1)}$	INPUT
TPHISN(34)	${}_2T_\phi^{(2)}$	INPUT
TPHISO(34)	${}_0T_\phi^{(2)}$	INPUT
TPHI1(34)	$\partial T_\phi^{(0)}/\partial\lambda$ at $\lambda = \lambda_o$	INPUT
TPSIC(100)	$\psi^{(1)}$	INPUT
TPSIS(100)	$\psi^{(2)}$	INPUT
TR(100)	r	INPUT
TRP(100)	dr/ds	INPUT
TRR2(100)	r/R_2	INPUT
TS(100)	table of s-values	INPUT
TSA(34)	ring radii (a)	INPUT
TSBAR(34)	$\bar{s}$	INPUT
TTHETC(100)	$\theta^{(1)}$	INPUT
TTHETS(100)	$\theta^{(2)}$	INPUT
TTPHIN(34)	$T_\phi^{(0)}$ at $\lambda = \lambda_o$	INPUT
TTPHIO(34)	$\partial T_\phi^{(0)}/\partial\lambda$ at $\lambda = \lambda_o$	INPUT

Variable	Definition	Subprogram(s) where generated
TT1C(100)	$T_1^{(1)}$	INPUT
TTIN(100)	$T_1^{(0)}$ at $\lambda = \lambda_o$	INPUT
TT1NO(100)	$T_1^{(0)}$ at $\lambda = \lambda_c$	INPUT
TT1SN(100)	${}_2T_1^{(2)}$	INPUT
TT1SO(100)	${}_0T_1^{(2)}$	INPUT
TT10(100)	$\partial T_1^{(0)}/\partial\lambda$ at $\lambda = \lambda_o$	INPUT
TT11(100)	$\partial^2 T_1^{(0)}/\partial\lambda^2$ at $\lambda = \lambda_o$	INPUT
TT12C(100)	$T_{12}^{(1)}$	INPUT
TT12S(100)	$T_{12}^{(2)}$	INPUT
TT2C(100)	$T_2^{(1)}$	INPUT
TT2N(100)	$T_2^{(0)}$ at $\lambda = \lambda_o$	INPUT
TT2NO(100)	$T_2^{(0)}$ at $\lambda = \lambda_c$	INPUT
TT2SN(100)	${}_2T_2^{(2)}$	INPUT
TT2SO(100)	${}_0T_2^{(2)}$	INPUT
TT20(100)	$\partial T_2^{(0)}/\partial\lambda$ at $\lambda = \lambda_o$	INPUT
TT21(100)	$\partial^2 T_2^{(0)}/\partial\lambda^2$ at $\lambda = \lambda_o$	INPUT
TWXC(34)	$\omega_x^{(1)}$	INPUT
TWXS(34)	$\omega_x^{(2)}$	INPUT
TWYC(34)	$\omega_y^{(1)}$	INPUT
TWYS(34)	$\omega_y^{(2)}$	INPUT
TX3X(100)	$\partial p/\partial x$	INPUT
TX3Y(100)	$\partial p/\partial y$	INPUT

Variable	Definition	Subprogram(s) where generated
TX30(100)	p	INPUT
TZBAR(34)	normal ring eccentricities ($\bar{z}$)	INPUT
TZBST(100)	normal stringer eccentricity ($\bar{z}$)	INPUT
WORK(486)	working storage used by Runge-Kutta integration subroutine	RKS3
XI	temporary value of axial displacement (ξ)	INPUT
Y(4,100)	solution for $\{y\}$	SRA202
Z(4,100)	solutions for $\{z\}$; also used to store $\xi^{(1)}$, $\eta^{(1)}$, $v^{(1)}$, $\chi^{(1)}$	INPUT

```
      OVERLAY(OVLY,0,0)
      PROGRAM MAIN(INPUT=1024,OUTPUT,TAPE5=OUTPUT,TAPE8=INPUT
     1 ,TAPE1=1024)
C      POSTBUCKLING STATE OF SHELLS OF REVOLUTION
      COMMON RAT,IUONE,IOP,IP,ITER,          ISSW6
      COMMON          ATABL
      COMMON          BB1(4,4),BBP(34,4,4),BBZ(4,4)
      COMMON BD(34,4,4),BDM(4,4),BDZ(4,4),BL1,BL2,BLC1,BLC2,BM2,BR2
      COMMON          C12,CAP1,CAP12E,CAP2
      COMMON CH1,CHIC,CHIC2,CHINO,CM1,                        CP,CQ
      COMMON CS,CSE
      COMMON          DEL1,DEN,             DS,DSS
      COMMON                         LA,EAST,EIST,EIX,EIXY,EIY
      COMMON EPS1,EPS12,EPS2,EPS2S,ETA
      COMMON F11,F12,FK1,FK2,FK3
      COMMON FLAM,FLAM11,FLAM12,FLAM13,FLAM14
      COMMON        FLAM21,FLAM22,FLAM23,FLAM24
      COMMON        FLAM31,FLAM32,FLAM33,FLAM34
      COMMON        FLAM41,FLAM42,FLAM43,FLAM44
      COMMON FMU11,FMU12,FMU21,FMU22,FN,FNC
      COMMON GJST,GJT,GLAM,GUESS
      COMMON HH,HHH,HK,HKM1
      COMMON I,IBKP,IDER,IDERF,IERR,IFVD,I1,III,INTER,INTGRD
      COMMON J,JE,JENT(34),JJ
      COMMON K,KASE,KENT,KENT1,KENT2,KIC2,KJ,KM1,KPATH,KS,KSS
      COMMON LL,LSM1,LSTAB,LSTAB1,LTAB(100),LTYPE
      COMMON NDIS,NDIS1,NEQ,NFM,NIC,NJE,NLFLAG,NML
      COMMON NTRY,NWP,NWPC,NTERP
      COMMON PSIC,PSIT
      COMMON R,          RP,RR2,RTABL
      COMMON S,SA,SAVE,SB,SFL,          SL(34,4),SLM(4),SLZ(4),SN,SU,SUM1
      COMMON SUMM,SV,SW
      COMMON T1,T1C,T1NO,T1S0,T2,T2C,T2NO,T12C
      COMMON            TCHIC(100),            TCHINO(100)
      COMMON TDIS(34),TE1(100,5),TE1IJ,TE2(100,5),TE2IJ,TE2JK
      COMMON TE12(100,5),          TEAST(100)
      COMMON TEIST(100),                          TGJST(100)
      COMMON TH(100,5),THETA,THETC,THETC2,THIJ,THJK
      COMMON TK1(100),TK2(100),TK3(100)
      COMMON            TNU1(100,5),TNU1IJ,TNU1JK
```

```
      COMMON TPSIC(100),            TR(100),TRI,TRP(100),TRPI,TRR2(100)
      COMMON TRR2I,TS(100)
      COMMON                        TT1C(100),           TT1NO(100)
      COMMON                        TT2C(100),           TT2NO(100)
      COMMON                        TT12C(100)
      COMMON TTAB1(4),TTAB2(4),TTAB3(4),TTAB4(4),TTHETC(100)
      COMMON TX3U(100),TX3X(100),TX3Y(100),              TZBST(100)
      COMMON WORK(4R6),WXC,WYC
      COMMON X1,X1S,X2,X3,X3U,X3X,X3Y,XB,XC1,XC2,XC3,XI
      COMMON Y(4,100)
      COMMON Z(4,100),ZBAR,ZBST,ZZERO
      DIMENSION COM(12)
      EQUIVALENCE (RBZ,COM)
1002  FORMAT(12A6)
1003  FORMAT(1H1,12A6)
      IP=6
      IOP=5
205   READ(IP,1002)(COM(I),I=1,12)
      IF(EOF,IP)1,2
2     WRITE(IOP,1003)(COM(I),I=1,12)
      IDONE=0
      ITER=0
210   CALL OVERLAY(4LOVLY,1,0,6HRECALL)
      IF(IDONE.EQ.1)GO TO 205
10    IF(UNIT,1)10,11
11    CALL OVERLAY(4LOVLY,2,0,6HRECALL)
      GO TO 210
1     STOP
      END
```

```
      OVERLAY(OVLY,1,0)
      PROGRAM INPUT
      COMMON RAT,IDONE,IOP,IP,ITER,          ISSW6
      COMMON        ATABL
      COMMON        BB1(4,4),BBP(34,4,4),BBZ(4,4)
      COMMON BD(34,4,4),BDM(4,4),BDZ(4,4),BL1,BL2,BLC1,BLC2,BM2,BR2
      COMMON        C12,CAP1,CAP12E,CAP2
      COMMON CHI,CHIC,CHIC2,CHINO,CM1,                      CP,CQ
      COMMON CS,CSE
      COMMON        DEL1,DEN,           DS,DSS
      COMMON                     EA,EAST,EIST,EIX,EIXY,EIY
      COMMON EPS1,EPS12,EPS2,EPS2S,ETA
      COMMON FI1,FI2,FK1,FK2,FK3
      COMMON FLAM,FLAM11,FLAM12,FLAM13,FLAM14
      COMMON      FLAM21,FLAM22,FLAM23,FLAM24
      COMMON      FLAM31,FLAM32,FLAM33,FLAM34
      COMMON      FLAM41,FLAM42,FLAM43,FLAM44
      COMMON FMU11,FMU12,FMU21,FMU22,FN,FNC
      COMMON GJST,GJT,GLAM,GUESS
      COMMON HH,HHH,HK,HKM1
      COMMON I,IBKP,IDER,IDERF,IERR,IFVD,II,III,INTER,INTGRD
      COMMON J,JE,JENT(34),JJ
      COMMON K,KASE,KENT,KENT1,KENT2,KIC2,KJ,KM1,KPATH,KS,KSS
      COMMON LL,LSM1,LSTAB,LSTAB1,LTAB(100),LTYPE
      COMMON NDIS,NDIS1,NEQ,NFM,NIC,NJE,NLFLAG,NML
      COMMON NTRY,NWP,NWPC,NTERP
      COMMON PSIC,PSIT
      COMMON R,         RP,RR2,RTABL
      COMMON S,SA,SAVE,SB,SFL,        SL(34,4),SLM(4),SLZ(4),SN,SU,SUM1
      COMMON SUMM,SV,SW
      COMMON T1,T1C,T1NO,T1SO,T2,T2C,T2NO,T12C
      COMMON           TCHIC(100),            TCHINO(100)
      COMMON TDIS(34),TE1(100,5),TE1IJ,TE2(100,5),TE2IJ,TE2JK
      COMMON TE12(100,5),         TEAST(100)
      COMMON TEIST(100),                            TGJST(100)
      COMMON TH(100,5),THETA,THETC,THETC2,THIJ,THJK
      COMMON TK1(100),TK2(100),TK3(100)
      COMMON           TNU1(100,5),TNU1IJ,TNU1JK
      COMMON TPSIC(100),          TR(100),TRI,TRP(100),TRPI,TRR2(100)
```

```
      COMMON TRR2I,TS(100)
      COMMON                         TT1C(100),           TT1N0(100)
      COMMON                         TT2C(100),           TT2N0(100)
      COMMON                          TT12C(100)
      COMMON TTAB1(4),TTAB2(4),TTAB3(4),TTAB4(4),TTHETC(100)
      COMMON TX30(100),TX3X(100),TX3Y(100),          TZBST(100)
      COMMON WORK(486),WXC,WYC
      COMMON X1,X1S,X2,X3,X30,X3X,X3Y,XB,XC1,XC2,XC3,XI
      COMMON Y(4,100)
      COMMON Z(4,100),ZBAR,ZBST,ZZERO
      COMMON /OV1/A(4,4),B(4,4),C(4,4),CARD1(5),CARD2(5),COMENT(5),
     1 D(4,4),RATIO(5),TCHIN(100),TCHI0(100),TEIX(34),TEIXY(34),TEIY(34)
     2 ,TGJT(34),TM1N(100),TM10(100),TM2N(100),TM20(100),TMYN(34),
     3TMY0(34),TSBAR(34),TT1N(100),TT10(100),TT2N(100),TT20(100),
     4 TCHI1(100),TPHI1(34),TT11(100),TT21(100)
     1,       TLAM11(100),TLAM12(100),TLAM13(100),TLAM14(100),
     1        TLAM23(100),TLAM33(100),TLAM34(100),TMU11(100),TMU12(100),
     1        TLAM24(100),TLAM44(100),
     1           TT1SN(100),TT2SN(100),TT12S(100),TCHISN(100),TPSIS(100),
     1  TTHETS(100),TPHISN(34),TWXS(34),TWYS(34)
     1 ,NOUT1(100),NOUT2(100),
     1 TCHIS0(100),TT1S0(100),TT2S0(100),TPHIS0(34),
     1 TEA(34),TSA(34),TECCX(34),TECCY(34),
     1 TPHIC(34),TWXC(34),TWYC(34)
     1 ,FNXE,FNYE,FPHIE,FYE,ISS4,PRODC,STIF,STIFN,STIF0,STIFN0,S1E1,S0E2
     1 ,UPHI,UX,UY,KTAB,KTAB1,KTAB2,KWL,KWL2,NPG,NRB,NSG,NST,NTJE,NTLC
     5 ,TTPHIN(34),TTPHI0(34),TZBAR(34)
      DIMENSION NOUT(100),PRS(100)
      DIMENSION TEPS1C(100),TEPS2C(100),TCAP1C(100),TCAP2C(100)
      DIMENSION EPS1S0(100),EPS2S0(100),CAP1S0(100),CAP2S0(100),
     1 TEPSS0(34)
      DIMENSION COM(12)
      DIMENSION TC1(100),TG(100)
      EQUIVALENCE (TS,PRS),(WORK,NOUT,TEPS1C),(WORK(101),TEPS2C),
     1(WORK(201),TCAP1C),(WORK(301),TCAP2C)
      EQUIVALENCE            (WORK,      EPS1S0),(WORK(101),EPS2S0),(WORK
     1 (201),CAP1S0),(WORK(301),CAP2S0),(WORK(401),TEPSS0)
      EQUIVALENCE (BBZ,COM)
      EQUIVALENCE (TT1S0,TC1),(TT2S0,TG)
```

```
935  FORMAT(/// 63H SURFACE LOADING, IF ANY, IS APPLIED AT SHELL REFERE
    1NCE SURFACE/63H AND, DURING BUCKLING, REMAINS FIXED IN MAGNITUDE A
    2ND DIRECTION)
945  FORMAT(///50H SURFACE LOADING IS APPLIED AT SHELL OUTER SURFACE/
    1 63H AND, DURING BUCKLING, REMAINS FIXED IN MAGNITUDE AND DIRECTIO
    2N)
1002 FORMAT(12A6)
1003 FORMAT(1H1,12A6)
1010 FORMAT(4X,6I2,3X,I1,27X,E12.4,14X,I1,1X,I1,1X,I1)
1088 FORMAT (/// 77H DURING BUCKLING, SHELL PRESSURE LOAD REMAINS LOCAL
    1LY NORMAL TO SHELL ELEMENT, // 57H WITH MAGNITUDE DETERMINED BY TA
    2BLE 5 (PRESSURE GRADIENT))
1165 FORMAT(I1,1X,I1,1X,I1,1X,I1,2X,I3,5E12.4)
2108 FORMAT(5H+NON-)
2109 FORMAT(73H      AXISYMMETRIC COMPONENT OF SECOND-ORDER CONTRIBUTION
    1 TO BUCKLED STATE)
2110 FORMAT(1H0,6X,1HS,12X,1HP,12X,1HQ,10X,5HCAP S,9X,3HM 1,11X,2HXI,
    1 10X,3HETA,11X,1HV,11X,3HCHI//(1X,  9E13.4))
2130 FORMAT(////15X,1HS,17X,1HU,17X,1HV,17X,1HW//)
2140 FORMAT(4E18.4)
2169 FORMAT(33H0UNSYMMETRICAL BUCKLING MODE WITH, I3, 27H CIRCUMFERENTI
    1AL WAVES, B =,  E12.4)
2170 FORMAT(F6.0,I6, E12.0)
2171 FORMAT(8E10.0)
2172 FORMAT(14H1BUCKLING MODE//10X,19HCRITICAL HARMONIC =,I3/10X,19HCRI
    1TICAL LOAD      =,  E11.3                                //7X,1HS,
    212X,1HP,12X,1HQ,10X,5HCAP S,9X,3HM 1,11X,2HXI,10X,3HETA,11X,1HV,11
    3X,3HCHI//)
2173 FORMAT(1X,  E13.4,8E13.3)
2174 FORMAT(40H0AXISYMMETRIC BENDING BUCKLING MODE, A =,  E12.5)
2175 FORMAT(   26H CORRECTED INNER PRODUCT =,  E11.3,///)
2176 FORMAT(24H0PREBUCKLING STIFFNESS =,  E12.4,6X,24HPOSTBUCKLING STIF
    1FNESS =,  12.4)
2177 FORMAT(12H MAX ALPHA =,  E11.3,///)
2178 FORMAT(40H FOR BUCKLING MODE IMPERFECTION, ALPHA =,  E11.3/27X,
    16X,25HMAX NORMAL IMPERFECTION =,  E11.3,40H TIMES RMS VALUE OF ANG
    2ULAR IMPERFECTION//)
2180 FORMAT(1H+,35X,6HBETA =,  E11.3)
2181 FORMAT(1H+,63X,6HBETA =,  E11.3)
```

```
2182 FORMAT(1H+,91X,6HBETA =,  E11,3)
2758 FORMAT(////43H ALL BOUNDARY DATA TAKEN FROM PREVIOUS CASE)
2780 FORMAT(////16H BOUNDARY NUMBER,I3,10X,3HS =,  E12,4)
2816 FORMAT(//43H B = I, D = 0, L VECTOR = 0  (P,Q,S,M1 = 0))
2819 FORMAT(//50H B = I, D = 0, L VECTOR = 0  (P,Q,S,M1 CONTINUOUS))
2844 FORMAT(//43H SYMMETRICAL RESPONSE ABOUT BOUNDARY NUMBER,I3)
2846 FORMAT(//47H ANTISYMMETRICAL RESPONSE ABOUT BOUNDARY NUMBER,I3)
2850 FORMAT(//10H RING DATA,//
    15H EA =,  E12,4,6X,5HEIX =,  E12,4,6X,5HEIY =,  E12,4,
    26X,6HEIXY =,  E12,4,6X,4HGJ =,  E12,4,6X,6HZBAR =,  E12,4,//)
2851 FORMAT(1H+,68X,7HTPHI2 =,  E12,4,5X,5HMY0 =,  E12,4,5X,5HMY1 =,
    1 E12,4)
2852 FORMAT(7H SBAR =,  E12,4,3X,8H TPHI0 =,  E12,4,3X,8H TPHI1 =,
    1E12,4)
2895 FORMAT(//39H BOUNDARY DATA TAKEN FROM PREVIOUS CASE//)
2897 FORMAT(8H TPHI0 =,  E12.4,5X,7HTPHI1 =,  E12,4)
2910 FORMAT(4E12,4)
2920 FORMAT(////16H BOUNDARY NUMBER,I3,10X,3HS =,  E12,4,//
    1 21X, 8HB MATRIX,40X,8HD MATRIX,//(  8E12,4))
2951 FORMAT(47H ARTIFICIAL CONSTRAINT NEEDED BUT NOT SPECIFIED)
2980 FORMAT(////16H BOUNDARY NUMBER,I3,10X,3HS = ,  E12.4 //
    1       12X,28HTHIS EDGE HAS A DOME CLOSURE    )
3175 FORMAT(F12,0,I2)
3200 FORMAT (6(2X,E11.4))
3205 FORMAT (3(2X,2E11,4))
3206 FORMAT (6E12,4)
3230  FORMAT(///61H THIS CASE USES TABLE 1 (SURFACE GEOMETRY) FROM PREV
    1IOUS CASE)
3280 FORMAT(27H1TABLE 1 (SURFACE GEOMETRY)///
    1   68H             S                     R                  R PRIME
    2    R/R2,//(  4E18,4))
3310 FORMAT(///60H THIS CASE USES TABLE 2 (WALL PROPERTIES) FROM PREVIO
    1US CASE)
3360 FORMAT(26H1TABLE 2 (WALL PROPERTIES),///
    1  103H            S                  E1                  E2
    2    E12               NU1                H//)
3370 FORMAT(1H ,  6E18,4)
3390 FORMAT(19H                   ,  5E18,4)
```

113

```
 3430 FORMAT(///62H THIS CASE USES TABLE 3 (FOUNDATION MODULI) FROM PREV
     1IOUS CASE)
 3460 FORMAT(///39H TABLE 3 (FOUNDATION MODULI) ALL ZEROES)
 3480 FORMAT(28H1TABLE 3 (FOUNDATION MODULI),///
     1   67H              S                       K1                  K2
     2      K3,//(   4E18.4))
 3494 FORMAT (///62H THIS CASE USES TABLE 5 (PRESSURE GRADIENT) FROM PRE
     1VIOUS CASE)
 3496 FORMAT (///39H TABLE 5 (PRESSURE GRADIENT) ALL ZEROES)
 3497 FORMAT (28H1TABLE 5 (PRESSURE GRADIENT),///9X,1HS,17X,3HX3X,
     1 15X, 3HX3Y,//(   3E18.4))
 3501 FORMAT(///49H INITIAL PERTURBATION STATE SHELL DATA ALL ZEROES)
 3525 FORMAT (///44H INITIAL STATE DATA TAKEN FROM PREVIOUS CASE)
 3550 FORMAT(45H1INITIAL NONLINEAR STATE SHELL DATA, LAMBDA =,E12.4,//)
 3551 FORMAT(1H ,9X,1HS,17X,3HT10,15X,3HT20,15X,4HCHI0,14X,3HX30,//)
 3552 FORMAT(1H+,99X,3HM10,15X,3HM20)
 3553 FORMAT(1H+,90X,  2E17.3)
 3554 FORMAT(1H ,5E18.4)
 3555 FORMAT( 38H1INITIAL PERTURBATION STATE SHELL DATA,//)
 3556 FORMAT(1H+,99X,3HM11,15X,3HM21)
 3557 FORMAT(1H ,9X,1HS,17X,3HT11,15X,3HT21,15X,4HCHI1,//)
 3558 FORMAT(48H1INITIAL 2ND-ORDER PERTURBATION STATE SHELL DATA,///9X
     1,1HS,17X,3HT12,15X,3HT22,15X,4HCHI2,//(4E18.4))
 3559 FORMAT(////24H PREBUCKLING STIFFNESS =,  E12.4,//42H RATE OF CHANG
     1E OF STIFFNESS WITH LAMBDA =,  E12.4)
 3684 FORMAT(///64H THIS CASE USES TABLE 4 (STRINGER PROPERTIES) FROM PR
     1EVIOUS CASE)
 3687 FORMAT(///41H TABLE 4 (STRINGER PROPERTIES) ALL ZEROES)
 3689 FORMAT(30H1TABLE 4 (STRINGER PROPERTIES),///
     1 11X,1HS,18X,        3HNEA,15X,3HNEI,15X,3HNGJ,14X,
     2 4HZBAR//)
 4000 FORMAT(1H1)
12172 FORMAT(35H0TORSIONAL BUCKLING MODE (N=0), B =,  E12.4)
12173 FORMAT(39H0ANTISYMMETRIC BUCKLING MODE (N=0), B =,  E12.4)
12175 FORMAT(///16H0INNER PRODUCT =,  E11.3,///)
12176 FORMAT(24H0PREBUCKLING STIFFNESS =,  E12.4,6X,24HPOSTBUCKLING STIF
     1FNESS =,  E12.4)
      IF(ITER .EQ. 0)GO TO 1000
      REWIND 1
```

```
      BUFFER IN (1,1)(A(1),TZBAR(34))
      WRITE(IOP,4000)
      IF(FN.NE.0.)WRITE(IOP,2108)
      WRITE(IOP,2109)
      WRITE (IOP,2110) (PRS(KS),(Y(I,KS),I=1,4),(Z(I,KS),I=1,4),
     1KS = 1,LSTAB)
      WRITE(IOP,2130)
      DO 1970 I=1,LSTAB
      SU=TRR2(I)*Z(1,I)+TRP(I)*Z(2,I)
      SW=-TRP(I)*Z(1,I)+TRR2(I)*Z(2,I)
 1970 WRITE(IOP,2140)TS(I),SU,Z(3,I),SW
 803  IF(UNIT,1)803,804
 804  IF(FN)824,805,824
 805  DO 813 I=1,LSTAB
      R=TR(I)
      RP=TRP(I)
      RR2=TRR2(I)
      PSIC=TPSIC(I)
      THETC=TTHETC(I)
      T1S0=RR2*Y(1,I)+RP*Y(2,I)
      EPS2=Z(2,I)/R+.25*(PSIC*PSIC+THETC*THETC)
      CHI=Z(4,I)
      CAP2=RP*CHI/R
      TT1S0(I)=T1S0
      TT2S0(I)=TLAM11(I)*EPS2+TLAM12(I)*CAP2+TLAM13(I)*T1S0
     1  +TLAM14(I)*Y(4,I)
      TCHIS0(I)=CHI
      EPS2S0(I)=EPS2
      CAP2S0(I)=CAP2
      EPS1S0(I)=-TLAM13(I)*EPS2-TLAM23(I)*CAP2+TLAM33(I)*T1S0+TLAM34
     1 (I)*Y(4,I)
      CAP1S0(I)=-TLAM14(I)*EPS2-TLAM24(I)*CAP2+TLAM34(I)*T1S0+TLAM44
     1 (I)*Y(4,I)
 813  CONTINUE
      DO 818 I=1,NDIS
      JE=JENT(I)
      NTJE=NOUT1(JE)
      IF(NTJE*NTJE-1)818,820,818
```

```
820  UY=Z(2,JE)-TECCX(I)*Z(4,JE)
     WXC=TWXC(I)
     WYC=TWYC(I)
     TEPSS0(I)=UY/TSA(I)+,25*(WXC*WXC+WYC*WYC)
     TPHIS0(I)=TEA(I)*TEPSS0(I)
818  CONTINUE
     IF(ISS4,EQ,0)GO TO 840
     INTGRD=5
     CALL INT1
     S0E2=SUM1*6,283185307
840  IF(FNC ,NE, 0,)GO TO 1008
     S0E2=2,*S0E2
     DO 850 I=1,LSTAB
     TT1SN(I)=0,
     TT2SN(I)=0,
     TT12S(I)=0,
     TCHISN(I)=0,
     TPSIS(I)=0,
850  TTHETS(I)=0,
     GO TO 865
824  DO 830 I=1,LSTAB
     R=TR(I)
     RP=TRP(I)
     RR2=TRR2(I)
     BR2=  RR2/R
     DEN=FN/R
     PSIC=TPSIC(I)
     THETC=TTHETC(I)
     HH=FN*BR2
     HHH=Z(3,I)+FN*Z(2,I)
     TT1SN(I)=RR2*Y(1,I)+RP*Y(2,I)
     EPS2=(Z(2,I)+FN*Z(3,I))/R -,25*(PSIC*PSIC+THETC*THETC)
     CAP2=(RP*(Z(4,I)-FN*DEN*Z(1,I))+HH*HHH)/R
     TT2SN(I)=TLAM11(I)*EPS2+TLAM12(I)*CAP2+TLAM13(I)*TT1SN(I)
    1 +TLAM14(I)*Y(4,I)
     TPSIS(I)=HHH*BR2-DEN*RP*Z(1,I)
     TTHETS(I)=RP*HHH/R+HH*Z(1,I)
     T1N0=TT1N0(I)
     T2N0=TT2N0(I)
```

```
      CHINO=TCHINO(I)
      TT12S(I)=(1,-TMU12(I)*BR2)*(Y(3,I)-,5*(T1NO+T2NO)*TTHETS(I)
     1 -,25*(TT1C(I)+TT2C(I))*TTHETC(I))-TMU11(I)*(DEN*(Z(1,I)/R-Z(4,I))
     2 -(CHINO*TPSIS(I)+,5*TPSIC(I)*TCHIC(I))*BR2)*BR2
      TCHISN(I)=Z(4,I)
830   CONTINUE
      DO 836 I=1,NDIS
      JE=JENT(I)
      NTJE=NOUT1(JE)
      IF(NTJE*NTJE-1)836,839,836
839   UY=Z(2,JE)-TECCX(I)*Z(4,JE)
      UX=Z(1,JE)+TECCY(I)*Z(4,JE)
      UPHI=(TSA(I)*Z(3,JE)+FN*(TECCX(I)*Z(1,JE)+TECCY(I)*Z(2,JE)))/
     1 TR(JE)
      TPHISN(I)=TEA(I)*((FN*UPHI+UY)/TSA(I)-,25*(TWXC(I)*TWXC(I)
     1 +TWYC(I)*TWYC(I)))
      TWXS(I)=-(FN*UY+UPHI)/TSA(I)
      TWYS(I)=  FN*UX/TSA(I)
836   CONTINUE
865   INTGRD=0
      CALL I1I2
      SB=(FI1+2,*FI2)/PRODC
      IDONE=1
      IF(FNC)872,874,872
874   SB=2,*SB
      IF(NTLC,EQ,1)GO TO 875
      WRITE(IOP,12172)SB
      GO TO 880
 875  WRITE(IOP,12173)SB
      GO TO 880
872   I=FNC
      WRITE(IOP,2169)I,SB
 880  IF(ISS4,EQ,0)RETURN
      HH=S1E1+2.*S0E2
      HK=STIFNO/(2,*SB*GLAM*GLAM)
      STIF=STIFNO/(1,+HH*HK)
      WRITE(IOP,12175)STIFNO,STIF
      RETURN
```

```
1008 FN=2.*FNC
     FN2=FN*FN
1007 DO 1009 I=1,NDIS
     JE=JENT(I)
     NJE=NOUT1(JE)
     NOUT(JE)=NJE
     IF(NJE-4)1015,1009,1015
1015 NOUT1(JE)=-IABS (NJE)
1009 CONTINUE
     GO TO 2759
1000 READ (IP,1010)NSG,NWP,NFM,NST,NPG,NM[illegible],NIC,RTABL      ,ISS2,ISS4,
    1 ISSW6
     IF(RTABL .NE. 0.)GO TO 1006
     RTABL=1.E-3
1006 ATABL=1.E-9
     FN=0.
     FN2=0.
     IF(NSG)1095,1100,1095
1095 LSTAB = 1
1100 IF(NWP) 1105,1150,1105
1105 DO 1110 I = 1,100
1110 LTAB(I) = 1
1150 KTAB=6
1160 READ (IP,1165)          KTAB2,NRB,KIC[illegible],KW[illegible]E [illegible]ENT2,(CARD2(I),I=1,5)
     IF(KTAB2) 1210,1210,1170
1170 IF(KTAB2-6) 1175,1207,1207
1175 GO TO (1180,1185,1190,1204,1195),KTA[illegible]
1180 IF(NSG) 1182,1205,1182
1182 NSG = 2
     GO TO 1205
1185 NWP = 2
     GO TO 1205
1190 NFM = 2
     GO TO 1205
1204 NST=2
     GO TO 1205
1195 NPG=2
1205 KTAB = KTAB2
     GO TO 1225
```

```
1207 IF(KENT2) 1210,2730,1210
1210 IF (KTAB-2) 1230,1220,1230
1220 IF(KWL2) 1225,1230,1225
1225 KWL = KWL2
     GO TO 1340
1230 IF(KENT2 - KENT1 - 1) 1340,1340,1335
1335 KENT = KENT2 - KENT1
     INTER = 2
     GO TO 1345
1340 INTER = 1
1345 GO TO (1350,1355,1360,1355,1361),KTAB
1350 NWPC = 4
     GO TO 1365
1355 NWPC = 5
     GO TO 1365
1360 NWPC = 3
     GO TO 1365
1361 NWPC=2
1365 IF(INTER - 2) 3060,1370,3060
1370 DO 1375  I = 1,NWPC
     IF (KTAB-1) 1374,1372,1374
1372 RATIO(I) =(CARD2(I) - CARD1(I))/FLOAT(KENT)
     GO TO 1375
1374 RATIO(I) = (CARD2(I) - CARD1(I))/(TS(KENT2) - TS(KENT1))
1375 CONTINUE
     KM1 = KENT - 1
     DO 3050 J = 1,KM1
     KJ = KENT1 + J
     DO 1380 I = 1,NWPC
     IF (KTAB-1) 1379,1377,1379
1377 COMENT(I) = CARD1(I) + FLOAT (J)*RATIO(I)
     GO TO 1380
1379 COMENT(I) = CARD1(I) + (TS(KJ) - TS(KENT1))*RATIO(I)
1380 CONTINUE
     GO TO (3000,3010,3020,3047,3030),KTAB
3000 TS(KJ) = COMENT(1)
     TR(KJ) = COMENT(2)
     TRP(KJ) = COMENT(3)
     TRR2(KJ) = COMENT(4)
     GO TO 3050
```

```
3010 TE1(KJ,KWL) = COMENT(1)
     TE2(KJ,KWL) = COMENT(2)
     TE12(KJ,KWL) = COMENT(3)
     TNU1(KJ,KWL) = COMENT(4)
     TH(KJ,KWL)  = COMENT(5)
3012 LTAB( KJ) = MAX0 (LTAB(KJ),KWL)
     GO TO 3050
3020 TK1(KJ) = COMENT(1)
     TK2(KJ) = COMENT(2)
     TK3(KJ) = COMENT(3)
     GO TO 3050
3030 TX3X(KJ)=COMENT(1)
     TX3Y(KJ)=COMENT(2)
     GO TO 3050
3047 TEAST(KJ)=COMENT(2)
     TEIST(KJ)=COMENT(3)
     TGJST(KJ)=COMENT(4)
     TZBST(KJ)=COMENT(5)
3050 CONTINUE
3060 DO 3065  I = 1,NWPC
3065 COMENT(I) = CARD2(I)
     GO TO (3070,3080,3100,3127,3110),KTAB
3070 TS(KENT2) = COMENT(1)
     TR(KENT2) = COMENT(2)
     TRP(KENT2) = COMENT(3)
     TRR2(KENT2) = COMENT(4)
     IF(KIC2-3) 3076,3075,3076
3075 NOUT1(KENT2)=-NOUT1(KENT2)
     GO TO 3077
3076 NOUT1(KENT2) = KIC2
3077 NOUT2(KENT2)=NRB
     LSTAR = MAX0 (LSTAB,KENT2)
     GO TO 3130
3080 TE1(KENT2,KWL) = COMENT(1)
     TE2(KENT2,KWL) = COMENT(2)
     TE12(KENT2,KWL) = COMENT(3)
     TNU1(KENT2,KWL) = COMENT(4)
     TH(KENT2,KWL) = COMENT(5)
```

```
3090 LTAB(KENT2) = MAX0 (LTAB(KENT2),KW_)
     GO TO  3130
3100 TK1(KENT2) = COMENT(1)
     TK2(KENT2) = COMENT(2)
     TK3(KENT2) = COMENT(3)
     GO TO 3130
3110 TX3X(KENT2)=COMENT(1)
     TX3Y(KENT2)=COMENT(2)
     GO TO 3130
3127 TEAST(KENT2)=COMENT(2)
     TEIST(KENT2)=COMENT(3)
     TGJST(KENT2)=COMENT(4)
     TZBST(KENT2)=COMENT(5)
3130 IF (KTAB2-6) 3140,2730,2730
3140 KTAB1 = KTAB2
     KENT1 = KENT2
     DO 3150 I = 1,5
3150 CARD1(I) = CARD2(I)
     GO TO 1160
2730 TDIS(1) = TS(1)
     JENT(1) = 1
     K = 1
     LSTAB1 = LSTAB-1
     DO 2750 I = 1,LSTAB1
     IF (TS(I) - TS(I+1))2738,2746,2738
2738 LTAB(I+1) =  LTAB(I)
     GO TO 2750
2746 K=K+1
     TDIS(K)=TS(I)
     JENT(K) = I + 1
2750 CONTINUE
     NDIS=K+1
     TDIS(NDIS) = TS(_STAB)
     JENT(NDIS) =LSTAB
3210 IF(NML)3192,1092,3192
3192 READ (IP,3175) F_AM,LTYPE
     NLFLAG=0
3191 J=0
     DO 3190 I=1,NDIS
```

```
      JE=JENT(I)
      K=NOUT1(JE)
      IF (K*K        -1)3190,3160,3190
 3160 IF (J) 3180,3170,3180
 3170 READ (IP,3200) (COM(K),K=1,6)
 3180 J=J+1
      IF(NLFLAG)3184,3182,3181
 3182 TTPHIN(I)=COM(J)
      GO TO 3183
 3181 TTPHIO(I)=COM(J)
      GO TO 3183
 3184 TPHI1(I)=COM(J)
 3183 IF(J-6)3190,3185,3190
 3185 J=0
 3190 CONTINUE
      IF(NLFLAG)2630,3198,3197
 3198 READ (IP,3205) (TT1N(I),TT2N(I),I=1,LSTAB)
      READ (IP,3206) (TCHIN(I),I=1,LSTAB)
      NLFLAG=1
      GO TO 3191
 3197 IF(NML-1)3194,3193,3194
 3193 NML=2
      READ (IP,3205) (TT10(I),TT20(I), I=1,LSTAB)
      READ (IP,3206) (TCHIO(I),I=1,LSTAB)
      READ (IP,3206) (TX30(I),I=1,LSTAB)
      IF(ISS4.EQ.0)GO TO 3195
      J=0
      DO 2620 I=1,NDIS
      JE=JENT(I)
      K=NOUT1(JE)
      IF(K*K.NE.1)GO TO 2620
      IF(J.NE.0)GO TO 2610
      READ(IP,2171)(TTAB1(K),TTAB2(K),K=1,4)
 2610 J=J+1
      TMYN(I)=TTAB1(J)
      TMYO(I)=TTAB2(J)
      IF(J.EQ.4)J=0
 2620 CONTINUE
      READ(IP,2171)(TM1N(I),TM1O(I),TM2N(I),TM2O(I),I=1,LSTAB)
```

```
      NLFLAG=-1
      GO TO 3191
2630  READ(IP,3205)(TT11(I),TT21(I),I=1,LSTAB)
      READ(IP,3206)(TCHI1(I),I=1,LSTAB)
      READ(IP,3206)STIFN,STIFO
      GO TO 3195
3194  NML=1
      DO 3196 I=1,LSTAB
      TT10(I)=0.
      TT20(I)=0.
      TCHI0(I)=0.
3196  TX30(I)=0.
3195  SFL=0.
      IF(LTYPE-1)930,950,940
 930  WRITE (IOP,935)
      GO TO 1092
940   SFL=1.
      LTYPE=0
      WRITE (IOP,945)
      GO TO 1092
950   WRITE (IOP,1088)
1092  IF(NSG-1)3220,3290,3270
3220  WRITE (IOP,3230)
      GO TO 3290
3270  WRITE (IOP,3280) (TS(I),TR(I),TRP(I),TRR2(I),I=1,LSTAB)
3290  IF (NWP-1) 3300,3410,3350
3300  WRITE (IOP,3310)
      GO TO  3410
3350  WRITE (IOP,3360)
      DO 3400  J = 1,LSTAB
      WRITE (IOP,3370) TS(J),TE1(J,1),TE2(J,1),TE12(J,1),
     1TNU1(J,1),TH(J,1)
      IF(LTAB(J) - 1) 3400,3400,3380
3380  LL = LTAB(J)
      WRITE (IOP,3390) (TE1(J,K),TE2(J,K),TE12(J,K),TNU1(J,K),
     1TH(J,K),K=2,LL)
3400  CONTINUE
3410  IF(NFM - 1) 3420,3440,3470
```

```
3420 WRITE (IOP,3430)
     GO TO 3490
3440 DO 3450 I = 1,LSTAB
     TK1(I) = 0.
     TK2(I) = 0.
3450 TK3(I) = 0.
     WRITE (IOP,3460)
     GO TO 3490
3470 WRITE (IOP,3480) (TS(J),TK1(J),TK2(J),TK3(J),J=1,LSTAB)
3490 IF(NST-1)3683,3685,3688
3683 WRITE (IOP,3684)
     GO TO 3690
3685 DO 3686 I=1,LSTAB
     TZBST(I)=0.
     TEAST(I)=0.
     TEIST(I)=0.
3686 TGJST(I)=0.
     WRITE (IOP,3687)
     GO TO 3690
3688 WRITE (IOP,3689)
     DO 3691 I=1,LSTAB
3691 WRITE (IOP,3370) TS(I),          TEAST(I),TEIST(I),
    1 TGJST(I),TZBST(I)
3690 IF (NPG-1) 3491,3492,3493
3491 WRITE (IOP,3494)
     GO TO 3498
3492 DO 3495 I=1,LSTAB
     TX3X(I)=0.
3495 TX3Y(I)=0.
     WRITE (IOP,3496)
     GO TO 3498
3493 WRITE (IOP,3497) (TS(I),TX3X(I),TX3Y(I),I=1,LSTAB)
3498 IF(NML-1)3499,3500,3540
3499 WRITE (IOP,3525)
     GO TO 3560
3500 WRITE (IOP,3501)
     GO TO 3560
3540 WRITE(IOP,3550)F_AM
     IF(ISS4.EQ.0)GO TO 3541
```

```
      WRITE(IOP,3552)
 3541 WRITE(IOP,3551)
      DO 3543 I=1,LSTAB
      IF(ISS4.EQ.0)GO TO 3542
      WRITE(IOP,3553)TM1N(I),TM2N(I)
 3542 WRITE(IOP,3554)TS(I),TT1N(I),TT2N(I),TCHIN(I),TX30(I)
 3543 CONTINUE
      WRITE(IOP,3555)
      IF(ISS4.EQ.0)GO TO 3544
      WRITE(IOP,3556)
 3544 WRITE(IOP,3557)
      DO 3546 I=1,LSTAB
      IF(ISS4.EQ.0)GO TO 3545
      WRITE(IOP,3553)TM10(I),TM20(I)
 3545 WRITE(IOP,3554)TS(I),TT10(I),TT20(I),TCHI0(I)
 3546 CONTINUE
      IF(ISS4.EQ.0)GO TO 3560
      WRITE(IOP,3558)(TS(I),TT11(I),TT21(I),TCHI1(I),I=1,LSTAB)
      WRITE(IOP,3559)STIFN,STIF0
 3560 READ (IP,2170) FNC,NTLC,GUESS
 3561 I=FNC
      GLAM=GUESS+FLAM
      WRITE (IOP,2172) I,GLAM
      DO 1093 I=1,LSTAB
      READ (IP,2171) CP,CQ,CS,CM1,XI,ETA,SV,CHI
      R=TR(I)
      RP=TRP(I)
      RR2=TRR2(I)
      BR2=  RR2/R
      DO 1094 J=1,4
      TTAB1(J)=0.
      TTAB2(J)=0.
      TTAB3(J)=0.
 1094 CONTINUE
      HK=0.
      LL=LTAB(I)
      DO 1096 J=1,LL
      TNU1IJ=TNU1(I,J)
      TE1IJ=TE1(I,J)
```

```
      TE2IJ=TE2(I,J)
      THIJ=TH(I,J)
      DEN=THIJ
      IF(TE1IJ.NE.0.)
     1DEN=THIJ/(1.-TNU1IJ*TNU1IJ*TE2IJ/TE1IJ)
      TTAB4(1)=TE1IJ*DEN
      TTAB4(2)=TE2IJ*DEN
      TTAB4(3)=TNU1IJ*TTAB4(2)
      TTAB4(4)=TE12(I,J)*THIJ
      HKM1=HK
      HK=HK+THIJ
      HH=HK+HKM1
      HHH=HK*HH+HKM1*HKM1
      DO 1096 K=1,4
      TTAB1(K)=TTAB1(K)+TTAB4(K)
      TTAB2(K)=TTAB2(K)+TTAB4(K)*HH
      TTAB3(K)=TTAB3(K)+TTAB4(K)*HHH
 1096 CONTINUE
      XB=0.
      IF(TTAB1(3). NE. 0.)
     1XB=TTAB2(3)/TTAB1(3)
      DO 1097 J=1,4
      TTAB1(J)=2.*TTAB1(J)
      TTAB2(J)=2.*TTAB2(J)-XB*TTAB1(J)
      TTAB3(J)=2.666666667*TTAB3(J)-XB*(2.*TTAB2(J)+XB*TTAB1(J))
 1097 CONTINUE
      DEN=      1./(TR(I)*6.283185307)
      ZZERO=TZBST(I)-XB
      HH=DEN*TEAST(I)
      HHH=HH*ZZERO
      TTAB1(1)=TTAB1(1)+HH
      TTAB2(1)=TTAB2(1)+HHH
      TTAB3(1)=TTAB3(1)+DEN*TEIST(I)+HHH*ZZERO
      TTAB3(4)=TTAB3(4)+.25*DEN*TGJST(I)
      DEL1=TTAB1(1)*TTAB3(1)-TTAB2(1)*TTAB2(1)
      TC1(I)=TTAB1(1)
      TG(I)=TTAB1(4)
      FLAM44=TTAB1(1)/DEL1
      TLAM34(I)=-TTAB2(1)/DEL1
```

```
      TLAM33(I)= TTAB3(1)/DEL1
      FLAM24=TTAB3(3)*FLAM44
      TLAM23(I)= TTAB3(3)*TLAM34(I)
      TLAM13(I)= TTAB1(3)*TLAM33(I)
      FLAM14=TTAB1(3)*TLAM34(I)
      FLAM12=TTAB2(2)-TTAB3(3)*FLAM14
      FLAM11=TTAB1(2)-TTAB1(3)*TLAM13(I)
      TLAM14(I)=FLAM14
      TLAM11(I)=FLAM11
      TLAM12(I)=FLAM12
      TLAM24(I)=FLAM24
      TLAM44(I)=FLAM44
      FMU22=TTAB1(4)+4.*(TTAB2(4)+TTAB3(4)*BR2)*BR2
      FMU22=1./FMU22
      IF(I.EQ.1)CARD2(1)=FMU22
      IF(I.EQ.LSTAB)CARD2(2)=FMU22
      TMU12(I)=2.*(TTAB2(4)+2.*TTAB3(4)*BR2)*FMU22
      TMU11(I)=4.*(TTAB1(4)*TTAB3(4)-TTAB2(4)*TTAB2(4))*FMU22
      TT1C(I)=RR2*CP+RP*CQ
      EPS2=(ETA+FNC*SV)/R
      TEPS2C(I)=EPS2
      DEN=FNC*ETA+SV
      HH=FNC/R
      HHH=FNC*BR2
      CAP2=(RP*(CHI-FNC*HH*XI)+HHH*DEN)/R
      TCAP2C(I)=CAP2
      TEPS1C(I)=-TLAM13(I)*EPS2-TLAM23(I)*CAP2+TLAM33(I)*TT1C(I)+
     1 TLAM34(I)*CM1
      TCAP1C(I)=-FLAM14*EPS2-FLAM24*CAP2+TLAM34(I)*TT1C(I)+FLAM44*CM1
      TT2C(I)=FLAM11*EPS2+FLAM12*CAP2+TLAM13(I)*TT1C(I)+FLAM14*CM1
      TCHIC(I)=CHI
      TPSIC(I)=DEN*BR2-HH*RP*XI
      TTHETC(I)=RP*DEN/R+HHH*XI
      TCHIN0(I)=TCHIN(I)+GUESS*TCHI0(I)
      TT1N0(I)=TT1N(I)+GUESS*TT10(I)
      TT2N0(I)=TT2N(I)+GUESS*TT20(I)
      TT12C(I)=(1.-TMU12(I)*BR2)*(CS-.5*(TT1N0(I)+TT2N0(I))*TTHETC(I))
     1  -(TMU11(I)*BR2)*(HH*(XI/R-CHI)-TCHIN0(I)*TPSIC(I)*BR2)
      Z(1,I)=XI
```

```
      Z(2,I)=ETA
      Z(3,I)=SV
      Z(4,I)=CHI
      WRITE (IOP,2173) TS(I),CP,CQ,CS,CM1,XI,ETA,SV,CHI
 1093 CONTINUE
      IF(NIC.NE.0)GO TO 2759
      WRITE(IOP,2758)
      GO TO 1007
2759  IF(ITER .EQ. 0)WRITE(IOP,4000)
 2756 DO 2965 II=1,2
      DO 2965 I = 1,NDIS
      JE = JENT(I)
      NJE=NOUT1(JE)
      IF (II-1)2900,2760,2900
 2760 IF(NJE        - 4) 2765,2965,2965
 2765 IF(NJE        - 2) 2770,2965,2770
 2770 IF(ITER)2772,2771,2772
 2772 IF(NJE+1)2965,2894,2965
 2771 WRITE (IOP,2780) I,TDIS(I)
      IF(NJE        ) 2890,2790,2830
 2790 DO 2800 J = 1,4
      DO 2800 K = 1,4
      D(J,K) = 0.
 2800 B(J,K) = 0.
      DO 2810 J = 1,4
 2810 B(J,J) = 1.
      IF(I-1)  2812,2814,2812
 2812 IF(I-NDIS) 2818,2814,2818
 2814 WRITE (IOP,2816)
      GO TO 2945
 2818 WRITE (IOP,2819)
      GO TO 2945
 2830 READ (IP,3206) EA,EIX,EIY,EIXY,GJT,ZBAR,SA
      TEIY(I)=EIY
      TGJT(I)=GJT
      TZBAR(I)=ZBAR
      TSBAR(I)=SA
 2893 TPHI0=TTPHI0(I)
      TPHIN=TTPHIN(I)
```

```
      TMP=TPHI1(I)
      IF(NOUT2(JE)-8)2833,2832,2832
 2832 TPHI0=2.*TPHI0
      TPHIN=2.*TPHIN
      TMP=2.*TMP
 2833 IF(NJE)2899,2898,2898
 2898 WRITE(IOP,2850)EA,EIX,EIY,EIXY,GJT,ZBAR
      IF(ISS4.EQ.0)GO TO 2901
      WRITE(IOP,2851)TMP,TMYN(I),TMYU(I)
 2901 WRITE(IOP,2852)SA,TPHIN,TPHI0
 2831 KS=0
      IF(NOUT2(JE)-8)2849,2843,2843
 2843 IF(ITER.NE.0)GO TO 2845
      WRITE (IOP,2844) I
 2845 KS=1
      LSM1=4
      IF(NJE .LT. 0)GO TO 2849
      EA=.5*EA
      EIX=.5*EIX
      EIXY=0.
 2849 R=TR(JE)
      TEA(I)=EA
      TEIX(I)=EIX
      TEIXY(I)=EIXY
      RP = TRP(JE)
      RR2 = TRR2(JE)
      LL = LTAB(JE)
      HK=0.
      ZZERO=0.
      C12 =0.
      DO 2856     K = 1,LL
      TNU1JK=TNU1(JE,K)
      TE2JK=TE2(JE,K)
      THJK=TH(JE,K)
      DEN=1.
      TE1IJ=TE1(JE,K)
      IF(TE1IJ.NE.0.)
     1 DEN=1.-TNU1JK*TNU1JK*TE2JK/TE1IJ
      SAVE=TNU1JK*TE2JK*THJK/DEN
```

```
      HKM1=HK
      HK=HK+THJK
      HH=HK+HKM1
      C12=C12+SAVE
      ZZERO=ZZERO+SAVE*HH
 2856 CONTINUE
      XB=0.
      IF(C12. NE. 0.)
     1 XB=ZZERO/C12
      ZZERO = ZBAR - XB
      TECCX(I)=SA*RR2-ZZERO*RP
      TECCY(I)=SA*RP +ZZERO*RR2
      HH=-TECCX(I)
      HK= TECCY(I)
      HHH = HK / R
      SA=R+HK
      TSA(I) = SA
      IF(ITER)2858,2857,2858
 2857 XI=Z(1,JE)
      ETA=Z(2,JE)
      SV=Z(3,JE)
      CHI=TCHIC(JE)
      UX=XI+HK*CHI
      UY=ETA+HH*CHI
      UPHI=(SA*SV+FNC*(HK*ETA-HH*XI))/R
      TPHIC(I)=EA*(UY+FNC*UPHI)/SA
      TWXC(I)=-(FNC*UY+UPHI)/SA
      TWYC(I)=FNC*UX/SA
C A-MATRIX
 2858 A(1,1) = 1.
      A(1,2) = 0.
      A(1,3) = 0.
      A(1,4) = HK
C
      A(2,1) = 0.
      A(2,2) = 1.
      A(2,3) = 0.
      A(2,4) = HH
```

```
C
      B(1,3) = FN * HH
C
      A(3,1) = -B(1,3) / R
      A(3,2) = FN * HHH
      A(3,3) = 1. + HHH
      A(3,4) = 0.
C
      A(4,1) = 0.
      A(4,2) = 0.
      A(4,3) = 0.
      A(4,4) = 1.
C
C B-MATRIX
      B(1,1) = R
      B(1,2) = 0.
      B(1,3) = B(1,3)/A(3,3)
      B(1,4) = 0.
C
      B(2,1) = 0.
      B(2,2) = R
      B(2,3) = -FN * HK /A(3,3)
      B(2,4) = 0.
C
      B(3,1) = 0.
      B(3,2) = 0.
      B(3,3) = R/A(3,3)
      B(3,4) = 0.
C
      B(4,1) =-HK * R
      B(4,2) =-HH * R
      B(4,3) = 0.
      B(4,4) = R
C
      DEN = SA * SA
      SAVE= FN2 / DEN
      HH = FN / SA
      HK = SAVE * EIX
      HHH=(GUESS*TTPHIO(I)+TTPHIN(I))/SA
```

```
C C-MATRIX
      C(1,4) = -SAVE * (EIY + GJT)
      C(2,4) = -SAVE * EIXY
      C(3,4)=-FN*EIXY/DEN
      C(4,4) = (EIY + FN2 * GJT) / SA
C
      C(1,3) = -C(2,4) * HH
      C(2,3)=(EA+HK)*HH+HHH*FN
      C(3,3)=(EA+EIX/DEN)*HH*FN+HHH
C
      C(1,2) = C(1,3) * FN
      HHH=HHH*FN2
      C(2,2)=(EA+HK*FN2)/SA+HHH
C
      C(1,1)=(FN2*EIY+GJT)*SAVE/SA+HHH
C SYMMETRY FOLLOWS (C MATRIX)
      C(2,1)=C(1,2)
      C(3,1)=C(1,3)
      C(3,2)=C(2,3)
      C(4,1)=C(1,4)
      C(4,2)=C(2,4)
      C(4,3)=C(3,4)
      DO 2880  J = 1,4
      DO 2880  K = 1,4
      D(J,K)  = 0.
      DO 2880  JJ = 1,4
 2880 D(J,K) = D(J,K) - C(J,JJ)*A(JJ,K)
      HH=TWXC(I)
      HHH=TWYC(I)
      DEN= EA   *.25/ SA
      FYE=-DEN*(HH*HH+HHH*HHH)
      IF(FN)426,425,426
 425  FPHIE=0.
      FNXE=0.
      FNYE=0.
      GO TO 427
 426  FYE=-FYE
      FPHIE=2.*FNC*FYE
      FNXE=-.5*TPHIC(I)
```

```
      FNYE=FNXE*HHH
      FNXE=FNXE*HH
427   SL(I,1)=-FN*FNYE
      SL(I,2)= FN*FNXE- SA   *FYE
      SL(I,3)= FNXE- SA   *FPHIE
      SL(I,4)=0.
      IF(KS)2930,2945,2930
2930  DO 2938 J=1,4
      B(KS,J)=0.
      B(LSM1,J)=0.
      D(KS,J)=0.
2938  D(LSM1,J)=0.
      D(KS,KS)=1.
      D(LSM1,LSM1)=1.
      GO TO 2945
2890  WRITE (IOP,2895)
      IF(NJE+1)2965,2892,2965
2892  IF(NML)2893,2894,2893
2899  IF(ISS4.NE.0)WRITE(IOP,2851)TMP,TMYN(I),TMYO(I)
      WRITE(IOP,2897)TPHIN,TPHIO
2894  EA=TEA(I)
      EIX=TEIX(I)
      EIY=TEIY(I)
      EIXY=TEIXY(I)
      GJT=TGJT(I)
      ZBAR=TZBAR(I)
      SA=TSBAR(I)
      GO TO 2831
2900  IF(NJE       - 2) 2965,2905,2965
2905  READ (IP,2910) ((B(J,K),K=1,4),J=1,4)
      READ (IP,2910) ((D(J,K),K=1,4),J=1,4)
      WRITE (IOP,2920) I,TDIS(I),((B(J,K),K=1,4),(D(J,K),K=1,4),
     1 J=1,4)
2945  DO 2950 J = 1,4
      IF(NJE*NJE .NE. 1)
     1SL(I,J) =  0.
      DO 2950 K = 1,4
      BBP(I,J,K) = B(J,K)
2950  BD(I,J,K) =  D(J,K)
```

```
2965 CONTINUE
     IF(ITER.NE.0)GO TO 2969
     IF(ISS4.NE.0)
    1STIFNO=STIFN+GUESS*STIFO
     INTGRD=2
     CALL INT1
     PRODC=      SUM1
     WRITE(IOP,12175)PRODC
     IF(ISS4 ,EQ, 0)GO TO 2995
     INTGRD=6
     CALL INT1
     PRODC=PRODC+GUESS*SUM1
     SAVE=-SUM1*,5
     WRITE(IOP,2175)PRODC
2995 PRODC=PRODC*GLAM
     INTGRD=1
     CALL I1I2
     FI2=SQRT(FI2)
     AMAX=FI2/PRODC
     IF(FNC .NE, 0,)AMAX=AMAX*1,414213562
     IF(ISS4 ,EQ, 0)GO TO 2996
     INTGRD=7
     CALL INT1
     SV=SUM1
     JJ=0
2999 INTGRD=8
     CALL INT1
     IF(FNC .NE, 0,)SUM1=SUM1*1,414213562
     BMAX=(SUM1+AMAX*GLAM*SAVE)*GLAM/PRODC
     IF(JJ ,NE, 0)GO TO 2998
     WRITE(IOP,2181)BMAX
     JJ=1
     SAVE=SAVE+SV
     GO TO 2999
2998 WRITE(IOP,2180)BMAX
2996 WRITE(IOP,2177)AMAX
     INTGRD=4
     CALL INT1
     INTGRD=-1
```

```
      CALL I1I2
      S1E1=SUM1-FI2
      FI1=1./SQRT(FI1)
      IF(FNC .NE. 0.)FI1=FI1*1.414213562
      AMODE=FI1*S1E1/PRODC
      IF(NOUT2(1) .GE. 8)SUM1=2.*SUM1
      IF(NOUT2(LSTAB) .GE. 8)SUM1=2.*SUM1
      S1E1=SUM1*3.141592654
      IF(ISS4 .EQ. 0)GO TO 2997
      SAVE=SAVE-SV
      JJ=0
12999 INTGRD=9
      CALL INT1
      BMODE=FI1+(FI1*SUM1+AMODE*GLAM*SAVE)*GLAM/PRODC
      IF(JJ .NE. 0)GO TO 12998
      WRITE(IOP,2182)BMODE
      JJ=1
      SAVE=SAVE+SV
      GO TO 12999
12998 WRITE(IOP,2181)BMODE
 2997 WRITE(IOP,2178)AMODE,FI1
      GO TO 2971
 2969 DO 2968 I=1,NDIS
      JE=JENT(I)
 2968 NOUT1(JE)=NOUT(JE)
 2971 REWIND 1
      BUFFER OUT (1,1)(A(1),TZBAR(34))
C
C     SET UP B AND D MATRICES FOR DOME LOGIC
C
      IF(NOUT1(1) .NE. 4)GO TO 2974
 2972 II = 1
      I = 1
      SN = 1.
      GO TO 2978
 2974 IF(NOUT1(LSTAB) - 4) 2966,2976,2965
 2976 I = LSTAB
      II = NDIS
      SN = -1.
```

```
2978 IF(ITER.EQ.0)WRITE(IOP,2980)II,TS(I)
     DO 2982 J=1,4
     SL(II,J) = 0.
     DO 2982 K=1,4
     BBP(II,J,K) = 0.
     BD(II,J,K) = 0.
2982 CONTINUE
     FLAM44=TLAM44(I)
     FLAM34=TLAM34(I)
     FLAM33=TLAM33(I)
     FLAM24=TLAM24(I)
     FLAM23=TLAM23(I)
     FLAM14=TLAM14(I)
     FLAM13=TLAM13(I)
     FMU12=TMU12(I)
     IF(I.EQ.LSTAB)GO TO 2986
     FMU22=CARD2(1)
     GO TO 2988
2986 FMU22=CARD2(2)
2988 TRI = TR(I)
     TRR2I = TRR2(I)
     TRPI = TRP(I)
     BR2=TRR2I/TRI
     BBP(II,2,2) = SN*TRI*TRPI*FLAM33
     BBP(II,2,4) = SN*TRI*FLAM34
     BBP(II,3,3) = SN*TRI*FMU22
     BBP(II,4,2) = SN*TRI*TRPI*FLAM34
     BBP(II,4,4) = SN*TRI*FLAM44
     BD(II,1,1) = 1.
     BD(II,2,2) = -FLAM13- FN2 *FLAM23*BR2/2.-1.
     BD(II,2,3) = -FN*(FLAM13 + FLAM23* BR2 )
     BD(II,2,4) = -SN*FLAM23*(1.- FN2 /2.)
     BD(II,3,2) = SN*FN*(1.-FMU12*BR2/2.)
     BD(II,3,4) = FN*FMU12/2.
     BD(II,4,2) = -FLAM14- FN2 *FLAM24*BR2/2.
     BD(II,4,3) = - FN*(FLAM14 + FLAM24 * BR2 )
     BD(II,4,4) = -SN*(1.+(1.- FN2 /2.)*FLAM24)
     HHH=TT1NO(I)+TT2NO(I)
     IF(FN - 1.) 2990,2992,2992
```

```
2990 BBP(II,1,1) = SN
     BBP(II,3,3) = SN
     BD(II,1,1) = -SN*TRI*TK3(I) / 2.
     BD(II,3,3)=-SN*HHH/TRI/3.
     IF (LTYPE)2991,2992,2991
2991 BD(II,1,1)=BD(II,1,1)-TRI*GLAM*TX3X(I)/2.
     BD(II,1,2)=-GLAM*TX30(I)
2992 IF(FNC-1.)131,132,133
131  CHIC=TTHETC(I)
     GO TO 128
132  CHIC=TCHIC(I)
128  HH=.25*TRI*CHIC*CHIC
     IF(FN)130,160,130
130  SL(II,2)=HH*(1.-FLAM13    )
     SL(II,3)=-2.*SN*HH*(1.-FMU12*BR2)
     SL(II,4)=-HH*FLAM14
     GO TO 133
160  SL(II,2)=HH*(1.+FLAM13    )
     SL(II,4)=HH*FLAM14
133  IF(SN .GT. 0.)GO TO 2974
2966 IF(ITER.NE.0)GO TO 3001
     IF(FNC.EQ.0.)S1E1=2.*S1E1
     IF(FNC .NE. 0. .OR. NTLC .NE. 1)GO TO 3695
     IF(NOUT2(1) .EQ. 9 .OR. NOUT2(LSTA3) .EQ. 9)GO TO 3695
     INTGRD=1
     CALL INT1
     SA=1.5*SUM1/PRODC
     WRITE (IOP,2174) SA
     IF(ISS4.EQ.0)GO TO 3696
     INTGRD=3
     CALL INT1
     SUM1=SUM1*6.283185307
     STIF=STIFNO/(1.+STIFNO*SUM1/(SA*GLAM*GLAM))
     WRITE(IOP,2176)STIFNO,STIF
3696 IDONE=1
     RETURN
3695 III=0
     IF(NOUT2(1).EQ.0)GO TO 2956
     IF(NOUT2(1).GT.7)GO TO 2956
```

```
2955 III=1
     JE=1
     GO TO 2958
2956 JE=JENT(2)
     IF(NOUT2(JE))2957,2960,2957
2957 III=2
2958 IF(NOUT2(JE)-5)2959,2953,2959
2959 BBP(III,1,1)=0.
     BD (III,1,1)=1.
     IF(NOUT2(JE)-4)2953,2964,2953
2953 BBP(III,3,3)=0.
     BD (III,3,3)=1.
     IF(NOUT2(JE)-5)2964,2960,2964
3001 IF(III)3002,2964,3002
3002 JE=JENT(III)
     IF(NOUT2(JE)-5)3005,3006,3005
3005 BD (III,1,1)=0.
     BBP(III,1,1)=1.
     IF(NOUT2(JE)-4)3006,2964,3006
3006 BD (III,3,3)=0.
     BBP(III,3,3)=1.
2964 DO 2967 J=1,4
     SLZ(J) = SL(1,J)
     SLM(J) = SL(NDIS,J)
     DO 2967 K = 1,4
     BBZ(J,K) = BBP(1,J,K)
     BB1(J,K) = -BBP(NDIS,J,K)
     BDZ(J,K) = BD(1,J,K)
2967 BDM(J,K) = BD(NDIS,J,K)
2970 RETURN
2960 IF(LTYPE)2961,2963,2961
2961 J=JENT(2)-1
     DO 2962 I=1,J
     IF(TRP(I)*TX3X(I))2964,2962,2964
2962 CONTINUE
2963 IF(NOUT2(1).GT.7)GO TO 2964
     IF(IABS(NOUT1(1))-2)3003,2964,3003
3003 J=JENT(2)
     IF(IABS(NOUT1(J))-2)3004,2964,3004
```

```
3004 WRITE (IOP,2951)
     CALL EXIT
     GO TO 2970
     END




      SUBROUTINE INT1
      COMMON RAT,IDONE,IOP,IP,ITER,          ISS46
      COMMON         ATABL
      COMMON         BB1(4,4),BBP(34,4,4),BBZ(4,4)
      COMMON BD(34,4,4),BDM(4,4),BDZ(4,4),BL1,BL2,BLC1,BLC2,BM2,BR2
      COMMON         C12,CAP1,CAP12E,CAP2
      COMMON CHI,CHIC,CHIC2,CHINO,CM1,                    CP,CQ
      COMMON CS,CSE
      COMMON         DEL1,DEN,             DS,DSS
      COMMON                     EA,EAST,EIST,EIX,EIXY,EIY
      COMMON EPS1,EPS12,EPS2,EPS2S,ETA
      COMMON FI1,FI2,FK1,FK2,FK3
      COMMON FLAM,FLAM11,FLAM12,FLAM13,FLAM14
      COMMON      FLAM21,FLAM22,FLAM23,FLAM24
      COMMON      FLAM31,FLAM32,FLAM33,FLAM34
      COMMON      FLAM41,FLAM42,FLAM43,FLAM44
      COMMON FMU11,FMU12,FMU21,FMU22,FN,FNC
      COMMON GJST,GJT,GLAM,GUESS
      COMMON HH,HHH,HK,HKM1
      COMMON I,IBKP,IDER,IDERF,IERR,IFVD,II,III,INTER,INTGRD
      COMMON J,JE,JENT(34),JJ
      COMMON K,KASE,KENT,KENT1,KENT2,KIC2,KJ,KM1,KPATH,KS,KSS
      COMMON LL,LSM1,LSTAB,LSTAB1,LTAB(100),LTYPE
      COMMON NDIS,NDIS1,NEQ,NFM,NIC,NJE,NLFLAG,NML
      COMMON NTRY,NWP,NWPC,NTERP
      COMMON PSIC,PSIT
      COMMON R,          RP,RR2,RTABL
      COMMON S,SA,SAVE,SB,SFL,       SL(34,4),SLM(4),SLZ(4),SN,SU,SUM1
      COMMON SUMM,SV,SW
      COMMON T1,T1C,T1NO,T1SO,T2,T2C,T2NO,T12C
```

```
      COMMON            TCHIC(100),            TCHINO(100)
      COMMON TDIS(34),TE1(100,5),TE1IJ,TE2(100,5),TE2IJ,TE2JK
      COMMON TE12(100,5),        TEAST(100)
      COMMON TEIST(100),                             TGJST(100)
      COMMON TH(100,5),THETA,THETC,THETC2,THIJ,THJK
      COMMON TK1(100),TK2(100),TK3(100)
      COMMON            TNU1(100,5),TNU1IJ,TNU1JK
      COMMON TPSIC(100),           TR(100),TRI,TRP(100),TRPI,TRR2(100)
      COMMON TRR2I,TS(100)
      COMMON                         TT1C(100),          TT1NO(100)
      COMMON                         TT2C(100),          TT2NO(100)
      COMMON                          TT12C(100)
      COMMON TTAB1(4),TTAB2(4),TTAB3(4),TTAB4(4),TTHETC(100)
      COMMON TX30(100),TX3X(100),TX3Y(100),             TZBST(100)
      COMMON WORK(486),WXC,WYC
      COMMON X1,X1S,X2,X3,X30,X3X,X3Y,XB,XC1,XC2,XC3,XI
      COMMON Y(4,100)
      COMMON Z(4,100),ZBAR,ZBST,ZZERO
      COMMON /OV1/A(4,4),B(4,4),C(4,4),CARD1(5),CARD2(5),COMENT(5),
     1 D(4,4),RATIO(5),TCHIN(100),TCHIO(100),TEIX(34),TEIXY(34),TEIY(34)
     2 ,TGJT(34),TM1N(100),TM10(100),TM2N(100),TM20(100),TMYN(34),
     3TMY0(34),TSBAR(34),TT1N(100),TT10(100),TT2N(100),TT20(100),
     4 TCHI1(100),TPHI1(34),TT11(100),TT21(100)
     1,      TLAM11(100),TLAM12(100),TLAM13(100),TLAM14(100),
     1       TLAM23(100),TLAM33(100),TLAM34(100),TMU11(100),TMU12(100),
     1       TLAM24(100),TLAM44(100),
     1          TT1SN(100),TT2SN(100),TT12S(100),TCHISN(100),TPSIS(100),
     1  TTHETS(100),TPHISN(34),TWXS(34),TWYS(34)
     1 ,NOUT1(100),NOUT2(100),
     1 TCHIS0(100),TT1S0(100),TT2S0(100),TPHIS0(34),
     1 TEA(34),TSA(34),TECCX(34),TECCY(34),
     1 TPHIC(34),TWXC(34),TWYC(34)
     1 ,FNXE,FNYE,FPHIE,FYE,ISS4,PRODC,STIF,STIFN,STIFO,STIFNO,S1E1,S0E2
     1 ,UPHI,UX,UY,KTAB,KTAB1,KTAB2,KWL,KWL2,NPG,NRB,NSG,NST,NTJE,NTLC
     5 ,TTPHIN(34),TTPHI0(34),TZBAR(34)
      DIMENSION NOUT(100),PRS(100)
      DIMENSION TEPS1C(100),TEPS2C(100),TCAP1C(100),TCAP2C(100),TEPSS0(
     1 34)
      DIMENSION TC1(100),TG(100)
```

```
      EQUIVALENCE (TS,PRS),(WORK,NOUT,TEPS1C),(WORK(101),TEPS2C),
     1(WORK(201),TCAP1C),(WORK(301),TCAP2C)
      EQUIVALENCE (WORK(401),TEPSS0)
      EQUIVALENCE (TT1S0,TC1),(TT2S0,TG)
      NSUBI=NDIS-1
      SUM1=0.
      DO 230 N=1,NSUBI
      ILO=JENT(N)
      IUP=JENT(N+1)
      IF(N-NSUBI)10,20,10
10    IUP=IUP-1
20    DS=TS(ILO+1)-TS(ILO)
      NNNN=IUP-ILO
      IF(NNNN-NNNN/2*2)40,30,40
30    NFLAG=0
      GO TO 50
40    NFLAG=1
50    ODD1=0.
      EVE1=0.
      K=ILO
      IFLAG=1
60    R=TR(K)
      CHIC=TCHIC(K)
      PSIC=TPSIC(K)
      THETC=TTHETC(K)
      THETC2=THETC*THETC
      GO TO (61,62,63,64,63,65,66,66,66),INTGRD
   61 DPDS1=R*TT1C(K)*CHIC*CHIC
      GO TO 69
62    DPDS1=      -R*       (2.*TCHI0(K)*(PSIC*TT12C(K)+CHIC*TT1C(K))+
     1 TT10(K)*(CHIC*CHIC+THETC2)+TT20(K)*(PSIC*PSIC+THETC2))
      GO TO 68
65    DPDS1=      -R*       (2.*TCHI1(K)*(PSIC*TT12C(K)+CHIC*TT1C(K))+
     1 TT11(K)*(CHIC*CHIC+THETC2)+TT21(K)*(PSIC*PSIC+THETC2))
      GO TO 69
63    HH=TM1N(K)+GUESS*TM10(K)
      HK=TM2N(K)+GUESS*TM20(K)
      DPDS1=R*(TT1N0(K)*TEPS1C(K)+TT2N0(K)*TEPS2C(K)+HH*TCAP1C(K)+HK*
     1 TCAP2C(K))
      GO TO 69
```

```
64 DPDS1=-(TT1N0(K)*(CHIC*CHIC+THETC2)+TT2N0(K)*(PSIC*PSIC+THETC2))*R
68 IF(LTYPE.EQ.0)GO TO 69
   XI=Z(1,K)
   ETA=Z(2,K)
   X30=TX30(K)
   X1=X30*CHIC
   X2=X30*PSIC
   EPS1=TEPS1C(K)-TCHIN0(K)*CHIC
   X3=X30*(EPS1+TEPS2C(K))+XI*TX3X(K)+ETA*TX3Y(K)
   RR2=TRR2(K)
   RP=TRP(K)
   FK1=RR2*X1-RP*X3
   FK2=RP*X1+RR2*X3
   FK3=          R*      (FK1*XI+FK2*ETA+X2*Z(3,K))
   IF(INTGRD.EQ.4)FK3=FK3*GLAM
   DPDS1=DPDS1+FK3
   GO TO 69
66 CHI=TCHI0(K)+GUESS*TCHI1(K)
   IF(INTGRD .GE. 8)GO TO 67
   DPDS1=(TC1(K)*CHIC*CHIC+TG(K)*PSIC*PSIC)*CHI*CHI*R
   GO TO 69
67 CHIN0=TCHIN0(K)
   T1C=TT1C(K)
   T12C=TT12C(K)
   IF(INTGRD .GT. 8)GO TO 72
   T1=TT10(K)+GUESS*TT11(K)
   T2=TT20(K)+GUESS*TT21(K)
   T1N0=TT1N0(K)
   T2N0=TT2N0(K)
   CHI2=CHIN0*CHI
   IF(JJ .EQ. 0)CHI2=0.
   HH=0.
   HK=0.
   IF(LTYPE .EQ. 0)GO TO 71
   HH=TX30(K)*(TRR2(K)*Z(1,K)+TRP(K)*Z(2,K))
   HK=TX30(K)*Z(3,K)
71 DPDS1=(((T1+TC1(K)*CHI2)*CHIC+T1C*CHI-HH)*(T1N0*CHIC+T1C*CHIN0-
  1 GLAM*HH)+((T2+T3(K)*CHI2)*PSIC+T12C*CHI-HK)*(T2N0*PSIC+T12C*CHIN0
  2 -GLAM*HK)+(T1+T2)*(T1N0+T2N0)*THETC2)*R
```

```
      GO TO 69
72    IF(JJ .EQ. 0)CHINO=0.
      DPDS1=((T1C-TC1(K)*CHINO*CHIC)*CHIC+(T12C-TG(K)*CHINO*PSIC)*PSIC)
     1 *CHI*R
69    GO TO(70,120,190,210),IFLAG
70    PSUM1=DPDS1
      IFLAG=2
      IF(NFLAG)80,90,80
80    IEND=NNNN-2
      GO TO 100
90    IEND=NNNN-1
100   I=1
110   K=ILO+I
      GO TO 60
120   IF(I-I/2*2)140,130,140
130   EVE1=EVE1+DPDS1
      GO TO 150
140   ODD1=ODD1+DPDS1
150   I=I+1
      IF(I-IEND)110,110,160
160   PSUM1=PSUM1+4.*ODD1+2.*EVE1
      IFLAG=3
      IF(NFLAG)180,170,180
170   K=IUP
      GO TO 60
180   K=IUP-1
      GO TO 60
190   PSUM1=DS/3.*(PSUM1+DPDS1)
      IF(NFLAG)200,220,200
200   TERM1=DPDS1
      K=IUP
      IFLAG=4
      GO TO 60
210   PSUM1=PSUM1+DS*.5*(TERM1+DPDS1)
220   SUM1=SUM1+PSUM1
230   CONTINUE
      IF(INTGRD .EQ. 1 .OR. INTGRD .EQ. 7 .OR. INTGRD .EQ. 9)RETURN
      PSUM1=0.
      DO 400 I=1,NDIS
```

```
      JE=JENT(I)
      K=NOUT1(JE)
      IF(K*K,NE,1)GO TO 400
      IF(INTGRD,NE,6 ,AND, INTGRD,NE,2)GO TO 317
      IF(INTGRD,EQ,6)HH=TPHI1(I)
      IF(INTGRD,EQ,2)HH=TTPHI0(I)
      GO TO 318
317   HH=TTPHIN(I)+GJESS*TTPHI0(I)
      IF(INTGRD ,EQ, 8)HH=-HH*(TTPHI0(I)+GJESS*TPHI1(I))
      IF(INTGRD ,EQ, 8 ,AND, NOUT2(JE) ,GE, 8)HH=2,*HH
      IF(INTGRD ,EQ, 3 ,OR, INTGRD ,EQ, 5)GO TO 320
318   PSUM1=PSUM1-TSA(I)*HH*(TWXC(I)**2+TWYC(I)**2)
      GO TO 400
320   HK=TMYN(I)+GUESS*TMY0(I)
      IF(INTGRD,NE,3)GO TO 321
      CHIC=TCHIC(JE)
      HHH=Z(2,JE)-TECCX(I)*CHIC
      SUM1=SUM1+HH*HHH-HK*CHIC
      GO TO 400
321   SUM1=SUM1+TSA(I)*HH*TEPSS0(I)-HK*TCHIS0(JE)
400   CONTINUE
      IF(INTGRD ,EQ, 4 ,OR, INTGRD ,EQ, 5 ,OR, INTGRD,EQ,2)
     1SUM1=SUM1+PSUM1
      IF(NOUT1(1),NE,4)GO TO 340
      K=1
      SN=1,
      GO TO 350
 340  IF(NOUT1(LSTAB),NE,4)GO TO 360
      K=LSTAB
      SN=-1,
 350  R=TR(K)
      IF(INTGRD ,NE, 6 ,AND, INTGRD,NE,2)GO TO 352
      IF(INTGRD,EQ,6)HH=TT11(K)
      IF(INTGRD,EQ,2)HH=TT10(K)
      GO TO 353
 352  HH=TT1N0(K)
      IF(INTGRD ,EQ, 8)HH=-HH*(TT10(K)+GJESS*TT11(K))
      IF(INTGRD ,EQ, 3 ,OR, INTGRD ,EQ, 5)GO TO 355
```

```
 353 CHIC=TCHIC(K)
     THETC=TTHETC(K)
     HK=THETC*THETC
     IF(INTGRD ,EQ, 8)H<=2,*HK
     IF(FNC ,EQ, 1,)H<=HK+CHIC*CHIC
     SUM1=SUM1-R*R*HH*H<
     IF(LTYPE,EQ,0)GO TO 354
     IF(INTGRD,NE,2 ,AND, INTGRD,NE,4 ,AND, INTGRD,NE,8)GO TO 354
     IF(FNC-1,)356,357,354
 356 IF(INTGRD,EQ,8)GO TO 354
     FK3=-SN*R*Z(1,<)*(TX30(K)*Z(2,K)+,5*R*TX3X(K)*Z(1,K))
     IF(INTGRD,EQ,4)F<3=FK3*GLAM
     GO TO 358
 357 IF(INTGRD,EQ,8)GO TO 359
     FK3=SN*R*R*TX30(<)*Z(2,K)*Z(4,K)
     IF(INTGRD,EQ,4)F<3=FK3*GLAM
 358 SUM1=SUM1+FK3
     GO TO 354
 359 FK3=TX30(K)*Z(2,<)
     HK=TT1N0(K)
     HH=-HH/HK
     SUM1=SUM1+R*R*FK3*(GLAM*FK3-SN*Z(4,K)*(H<+GLAM*HH))
     GO TO 354
 355 SUM1=SUM1+R*(       HH*Z(2,K)+SN*(TM1N(<)+GUESS*TM10(K))*Z(4,K))
     IF(INTGRD ,EQ, 3)GO TO 354
     HH=-,25*HH
     GO TO 353
 354 IF(SN,GT,0,)GO TO 340
 360 IF(INTGRD ,EQ, 6 ,OR, INTGRD ,EQ, 4 ,OR, INTGRD,EQ,2)RETURN
     IF(INTGRD ,NE, 8)GO TO 365
     SUM1=(FI1*SUM1+UPHI*PSUM1)/FI2
     RETURN
 365 IF(NOUT2(1) ,GE, 8)SUM1=2.*SUM1
     IF(NOUT2(LSTAB),GE,8)SUM1=2,*SUM1
     RETURN
     END

     SUBROUTINE I1I2
```

```
      COMMON RAT,IDONE,IOP,IP,ITER,        ISS,5
      COMMON        ATABL
      COMMON        BB1(4,4),BBP(34,4,4),BBZ(4,4)
      COMMON BD(34,4,4),BDM(4,4),BDZ(4,4),BL1,BL2,BLC1,BLC2,BM2,BR2
      COMMON        C12,CAP1,CAP12E,CAP2
      COMMON CHI,CHIC,CHIC2,CHINO,CM1,                       CP,CQ
      COMMON CS,CSE
      COMMON        DEL1,DEN,           DS,DSS
      COMMON                       EA,EAST,EIST,EIX,EIXY,EIY
      COMMON EPS1,EPS12,EPS2,EPS2S,ETA
      COMMON FI1,FI2,FK1,FK2,FK3
      COMMON FLAM,FLAM11,FLAM12,FLAM13,FLAM14
      COMMON       FLAM21,FLAM22,FLAM23,FLAM24
      COMMON       FLAM31,FLAM32,FLAM33,FLAM34
      COMMON       FLAM41,FLAM42,FLAM43,FLAM44
      COMMON FMU11,FMU12,FMU21,FMU22,FN,FNC
      COMMON GJST,GJT,GLAM,GUESS
      COMMON HH,HHH,HK,HKM1
      COMMON I,IBKP,IDER,IDERF,IERR,IFVD,II,III,INTER,INTGRD
      COMMON J,JE,JENT(34),JJ
      COMMON K,KASE,KENT,KENT1,KENT2,KIC2,KJ,KM1,KPATH,KS,KSS
      COMMON LL,LSM1,LSTAB,LSTAB1,LTAB(100),LTYPE
      COMMON NDIS,NDIS1,NEQ,NFM,NIC,NJE,NLFLAG,NML
      COMMON NTRY,NWP,NWPC,NTERP
      COMMON PSIC,PSIT
      COMMON R,           RP,RR2,RTABL
      COMMON S,SA,SAVE,SB,SFL,       SL(34,4),SLM(4),SLZ(4),SN,SU,SUM1
      COMMON SUMM,SV,SW
      COMMON T1,T1C,T1NO,T1SO,T2,T2C,T2NO,T12C
      COMMON           TCHIC(100),        TCHINO(100)
      COMMON TDIS(34),TE1(100,5),TE1IJ,TE2(100,5),TE2IJ,TE2JK
      COMMON TE12(100,5),        TEAST(100)
      COMMON TEIST(100),                            TGJST(100)
      COMMON TH(100,5),THETA,THETC,THETC2,THIJ,THJK
      COMMON TK1(100),TK2(100),TK3(100)
      COMMON           TNU1(100,5),TNU1IJ,TNU1JK
      COMMON TPSIC(100),              TR(100),TRI,TRP(100),TRPI,TRR2(100)
      COMMON TRR2I,TS(100)
      COMMON                      TT1C(100),          TT1NO(100)
      COMMON                      TT2C(100),          TT2NO(100)
```

```
      COMMON                          TT12C(100)
      COMMON TTAB1(4),TTAB2(4),TTAB3(4),TTAB4(4),TTHETC(100)
      COMMON TX30(100),TX3X(100),TX3Y(100),            TZBST(100)
      COMMON WORK(486),WXC,WYC
      COMMON X1,X1S,X2,X3,X30,X3X,X3Y,XB,XC1,XC2,XC3,XI
      COMMON Y(4,100)
      COMMON Z(4,100),ZBAR,ZBST,ZZERO
      COMMON /OV1/A(4,4),B(4,4),C(4,4),CARD1(5),CARD2(5),COMENT(5),
     1 D(4,4),RATIO(5),TCHIN(100),TCHIO(100),TEIX(34),TEIXY(34),TEIY(34)
     2 ,TGJT(34),TM1N(100),TM10(100),TM2N(100),TM20(100),TMYN(34),
     3TMY0(34),TSBAR(34),TT1N(100),TT10(100),TT2N(100),TT20(100),
     4 TCHI1(100),TPHI1(34),TT11(100),TT21(100)
     1,      TLAM11(100),TLAM12(100),TLAM13(100),TLAM14(100),
     1       TLAM23(100),TLAM33(100),TLAM34(100),TMU11(100),TMU12(100),
     1       TLAM24(100),TLAM44(100),
     1          TT1SN(100),TT2SN(100),TT12S(100),TCHISN(100),TPSIS(100),
     1  TTHETS(100),TPHISN(34),TWXS(34),TWYS(34)
     1 ,NOUT1(100),NOUT2(100),
     1 TCHIS0(100),TT1S0(100),TT2S0(100),TPHIS0(34),
     1 TEA(34),TSA(34),TECCX(34),TECCY(34),
     1 TPHIC(34),TWXC(34),TWYC(34)
     1 ,FNXE,FNYE,FPHIE,FYE,ISS4,PRODC,STIF,STIFN,STIF0,STIFN0,S1E1,S0E2
     1 ,UPHI,UX,UY,KTAB,KTAB1,KTAB2,KWL,KWL2,NPG,NRB,NSG,NST,NTJE,NTLC
     5 ,TTPHIN(34),TTPHI0(34),TZBAR(34)
      DIMENSION NOUT(100),PRS(100)
      EQUIVALENCE (WORK,NOUT),(TS,PRS)
      SW   =FLOAT(LTYPE)*GLAM
      NSUBI=NDIS-1
      FI1=0.
      FI2=0.
      DO 230 N=1,NSUBI
      ILO=JENT(N)
      IUP=JENT(N+1)
      IF(N-NSUBI)10,20,10
   10 IUP=IUP-1
   20 DS=TS(ILO+1)-TS(ILO)
      NNNN=IUP-ILO
      IF(NNNN-NNNN/2*2)40,30,40
   30 NFLAG=0
      GO TO 50
```

```
 40    NFLAG=1
 50    ODD1=0.
       ODD2=0.
       EVE1=0.
       EVE2=0.
       K=ILO
       IFLAG=1
C BEGINNING OF DERIVATIVE EVALUATION
 60    HK=TCHIC(K)
       THETC=TTHETC(K)
       PSIC=TPSIC(K)
       R=TR(K)
       HH=HK*HK
       HHH=THETC*THETC
       T12C=TT12C(K)
       CHINO=TCHINO(K)
       T1C=TT1C(K)
       IF(INTGRD)66,61,65
 61    DPDS1=(TT1SO(K)*(HH+HHH)+.5*TT1SN(K)*(HH-HHH)+(TT2SO(K)-.5*TT2SN(K
      1 ))*(PSIC*PSIC+HHH)+TT12S(K)*HK*PSIC)*R
       HH=T1C
       HHH=TT2C(K)
       DEN=TCHISO(K)
       DEL1=TCHISN(K)
       PSIS=TPSIS(K)
       DPDS2=(HH*HK*(DEN+.5*DEL1)+.5*((HH+HHH)*THETC*TTHETS(K)+
      1 HHH*PSIC*PSIS)+TT12C(K)*(.5*(HK*PSIS-PSIC*DEL1)+PSIC*DEN))*R
       GO TO 69
 65    DPDS1=R
       T1NO=TT1NO(K)
       T2NO=TT2NO(K)
       SU=TRR2(K)*Z(1,K)+TRP(K)*Z(2,K)
       X30=      TX30(K)*SW
       DPDS2=((T1NO*HK+T1C*CHINO-X30*SU       )**2+(T2NO*PSIC+T12C*CHINO-
      1 X30*Z(3,K))**2+((T1NO+T2NO)*THETC)**2)*R
       GO TO 69
 66    DPDS1=(HH+HHH+PSIC*PSIC)*R
       DPDS2=(T1C*HK+T12C*PSIC)*CHINO*R
C END OF DERIVATIVE EVALUATION
 69    GO TO (70,120,190,210),IFLAG
```

```
70    PSUM1=DPDS1
      PSUM2=DPDS2
      IFLAG=2
      IF(NFLAG)80,90,80
80    IEND=NNNN-2
      GO TO 100
90    IEND=NNNN-1
100   I=1
110   K=ILO+I
      GO TO 60
120   IF (I-I/2*2)140,130,140
130   EVE1=EVE1+DPDS1
      EVE2=EVE2+DPDS2
      GO TO 150
140   ODD1=ODD1+DPDS1
      ODD2=ODD2+DPDS2
150   I=I+1
      IF(I-IEND)110,110,160
160   PSUM1=PSUM1+4.*ODD1+2.*EVE1
      PSUM2=PSUM2+4.*ODD2+2.*EVE2
      IFLAG=3
      IF(NFLAG)180,170,180
170   K=IUP
      GO TO 60
180   K=IUP-1
      GO TO 60
190   HH=DS/3.
      PSUM1=HH*(PSUM1+DPDS1)
      PSUM2=HH*(PSUM2+DPDS2)
      IF(NFLAG)200,220,200
200   TERM1=DPDS1
      TERM2=DPDS2
      K=IUP
      IFLAG=4
      GO TO 60
210   HH=DS/2.
      PSUM1=PSUM1+HH*(TERM1+DPDS1)
      PSUM2=PSUM2+HH*(TERM2+DPDS2)
220   FI1=FI1+PSUM1
      FI2=FI2+PSUM2
```

```
 230   CONTINUE
C
C CORRECTION FOR RINGS
       PSUM1=0.
       PSUM2=0.
       DO 250 I=1,NDIS
       JE=JENT(I)
       IT=NOUT1(JE)
       IF(IT*IT-1)250,240,250
 240   WXC=TWXC(I)
       WYC=TWYC(I)
       SA=TSA(I)
       IF(TEA(I) .EQ. 0.)SA=0.
       HH=WXC*WXC+WYC*WYC
       IF(INTGRD)248,245,247
 245   FI1=FI1+SA*(TPHISO(I)-.5*TPHISN(I))*HH
       PSUM2=PSUM2+SA*TPHIC(I)*(WXC*TWXS(I)+WYC*TWYS(I))
       GO TO 250
 247   HK=TTPHIN(I)+GUESS*TTPHIO(I)
       IF(NOUT2(JE) .LT. 8)GO TO 246
       HK=2.*HK
       SA=.5*SA
  246  HK=SA*HK*HK
       PSUM1=PSUM1+SA
       PSUM2=PSUM2+HK*HH
       GO TO 250
 248   IF(NOUT2(JE) .GE. 8)SA=.5*SA
       PSUM1=PSUM1+SA
       PSUM2=PSUM2+SA*HH
 250   CONTINUE
       IF(INTGRD .NE. 0)GO TO 260
       FI2=FI2+.5*PSUM2
C
C CORRECTION FOR DOME CLOSURE
       IF(FNC-1.)260,260,310
 260   IF(NOUT1(1)-4)270,280,270
 270   IF(NOUT1(LSTAB)-4)310,290,310
 280   K=1
       GO TO 300
```

```
290   K=LSTAB
300   R=TR(K)
      THETC=TTHETC(K)
      CHIC=TCHIC(K)
      IF(INTGRD .NE, 0)GO TO 304
      HH=TT1S0(K)
      IF(FNC)302,301,302
301   HK=TPSIC(K)*R/TRR2(K)
      FI1=FI1+HH*HK*HK
      GO TO 303
302   HK=CHIC*R
      FI1=FI1+HK*HK*(HH+TT1SN(K)-Y(4,K)*,5*TRR2(K)/R)
      GO TO 303
304   HH=THETC*THETC
      CHIC2=CHIC*CHIC
      HK=R*R
      IF(INTGRD .LT, 0)GO TO 305
      HH=2,*HH
      IF(FNC ,EQ, 1,)HH=HH+CHIC2
      T1N0=TT1N0(K)
      HH=T1N0*T1N0*HH
      IF(FNC,NE,1,)GO TO 306
      FK3=SW*TX30(K)*Z(2,K)
      HH=HH+FK3*(FK3*SW*2,*T1N0*Z(4,K))
306   FI1=FI1+,5*HK
      FI2=FI2+HH*HK
      GO TO 303
305   IF(FNC ,EQ, 1,)HH=HH+2,*CHIC2
      FI1=HH*HK*,5+FI1
303   IF(K-LSTAB)270,310,270
310   IF(INTGRD)316,320,315
315   FI2=FI1*FI2+PSUM1*PSUM2
      AREA=FI1
      UPHI=PSUM1
      RETURN
316   FI1=FI1/AREA
      IF(PSUM1 ,NE, 0.)FI1=FI1*PSUM2/PSUM1
320   RETURN
      END
```

```
OVERLAY(OVLY,2,0)
PROGRAM SRA202
COMMON RAT,IDONE,IOP,IP,ITER,          ISSW6
COMMON          ATABL
COMMON          BBI(4,4),BBP(34,4,4),BBZ(4,4)
COMMON BD(34,4,4),BDM(4,4),BDZ(4,4),BL1,BL2,BLC1,BLC2,BM2,BR2
COMMON          C12,CAP1,CAP12E,CAP2
COMMON CHI,CHIC,CHIC2,CHINO,CM1,                       CP,CQ
COMMON CS,CSE
COMMON          DEL1,DEN,             DS,DSS
COMMON                         EA,EAST,EIST,EIX,EIXY,EIY
COMMON EPS1,EPS12,EPS2,EPS2S,ETA
COMMON FI1,FI2,FK1,FK2,FK3
COMMON FLAM,FLAM11,FLAM12,FLAM13,FLAM14
COMMON        FLAM21,FLAM22,FLAM23,FLAM24
COMMON        FLAM31,FLAM32,FLAM33,FLAM34
COMMON        FLAM41,FLAM42,FLAM43,FLAM44
COMMON FMU11,FMU12,FMU21,FMU22,   ,FNC
COMMON GJST,GJT,GLAM,GUESS
COMMON HH,HHH,HK,HKM1
COMMON I,IBKP,IDER,IDERF,IERR,IFVD,I1,III,INTER,INTGRD
COMMON J,JE,JENT(34),JJ
COMMON K,KASE,KENT,KENT1,KENT2,KIC2,KJ,KM1,KPATH,KS,KSS
COMMON LL,LSM1,LSTAB,LSTAB1,LTAB(100),LTYPE
COMMON NDIS,NDIS1,NEQ,NFM,NIC,NJE,NLFLAG,NML
COMMON NTRY,NWP,NWPC,NTERP
COMMON PSIC,PSIT
COMMON R,          RP,RR2,RTABL
COMMON S,SA,SAVE,SB,SFL,          SL(34,4),SLM(4),SLZ(4),SN,SU,SUM1
COMMON SUMM,SV,SW
COMMON T1,T1C,T1NO,T1SO,T2,T2C,T2NO,T12C
COMMON              TCHIC(100),                TCHINO(100)
COMMON TDIS(34),TE1(100,5),TE1IJ,TE2(100,5),TE2IJ,TE2JK
COMMON TE12(100,5),            TEAST(100)
COMMON TEIST(100),                              TGJST(100)
COMMON  TH(100,5),THETA,THETC,THETC2,THIJ,THJK
COMMON TK1(100),TK2(100),TK3(100)
COMMON              TNU(100,5),TNUIJ,TNUJK
COMMON TPSIC(100),              TR(100),TR1,TRP(100),TRP1,TRR2(100)
COMMON TRR21,TS(100)
```

```
      COMMON                          TT1C(100),           TT1NO(100)
      COMMON                          TT2C(100),           TT2NO(100)
      COMMON                           TT12C(100)
      COMMON TTAB1(4),TTAB2(4),TTAB3(4),TTAB4(4),TIMETC(100)
      COMMON TX3J(100),TX3X(100),TX3Y(100),               TZBST(100)
      COMMON WORK(486),WXC,WYC
      COMMON X1,X1S,X2,X3,X30,X3X,X3Y,XB,XC1,XC2,XC3,XI
      COMMON Y(4,100)
      COMMON Z(4,100),ZBAR,ZBST,ZZERO
      COMMON /DV2/            DV(4,34),DY9(8),E1(5),E2(5),E12(5),FNU1(5),
     1 P(4,4,34),PP(4,4,34),PPSTOR(4,4),PRV(4,4,100),PRW(4,4,100),
     2 PRZ(4,4,100),QPSTOR(4),SH(5),CV(4,34),Y9(8),PRU(4,4,100)
      DIMENSION NOUT(100),PRS(100)
      DIMENSION DY1(8,9),Y1(8,9)
      EQUIVALENCE (TS,PRS),(WORK,NOUT)
      EQUIVALENCE (CV(73),Y1),(DV(73),DY1)
200   FORMAT(13H DS TOO SMALL)
      EXTERNAL DER,CNT
      IF(ITER .NE. 0)GO TO 1002
      ITER =3
      GO TO 1003
1002  ITER=4
1003  S = TS(1)
      NDIST=1
      LSTABT=1
      LL=LTAB(1)
      KPATH=1
      KS=1
      IFVD = 0
      IBKP = 1
      KASE=3
      NTRY=1
      DS = (TDIS(2) - TDIS(1))/20.
      NEQ=64
      IDER=1
      IDERP=0
      X1=0.
      X2=0.
      X3=0.
      EL1=0.
```

```
      BL2=0.
      DO 1005 I=1,8
      DO 1005 J=1,8
 1005 Y1(I,J)=0.
      DO 1010 I=1,8
 1010 Y1(I,I)=1.
      CALL RKS3(DER,CNT,Y1,DY1,ATABL,RTABL,WORK,S,DS,NEQ,IFVD,IBKP,
     1NTRY,IERR)
      IF(IERR)1922,1020,1922
 1020 KASE=2
      ITER=ITER-2
      S = TS(1)
      NDIS1 = 1
      LSTAB1 = 1
      LL=LTAB(1)
      KPATH = 1
      KS = 1
      IFVD = 0
      IBKP = 1
      DS = (TDIS(2) - TDIS(1))/20.
      NTRY = 1
      IDER=9
      IDERF=9
      NEQ =  8
      DO 1052 II = 1,8
 1052 Y9(II) = 0.
      CALL RKS3(DER,CNT,Y9,DY9,ATABL,RTABL,WORK,S,DS,NEQ,IFVD,IBKP,
     1NTRY,IERR)
 1920 IF(IERR)1922,1926,1922
 1922 WRITE (IOP,200)
      CALL EXIT
 1926 NDIS1 = 2
      DO 1960 KS=1,LSTAB
      IF(NDIS1 - NDIS) 1930,1950,1930
 1930 IF(KS-JENT(NDIS1))1950,1940,1950
 1940 NDIS1 = NDIS1 + 1
 1950 DO 1960 I = 1,4
      DO 1960 J =  1,4
      Y(I,KS) =  Y(I,KS) + PRU(I,J,KS)*CV(J,NDIS1)
     1  + PRV(I,J,KS)*DV(J,NDIS1)
 1960 Z(I,KS) =  Z(I,KS) + PRW(I,J,KS)*CV(J,NDIS1)
     1 +  PRZ(I,J,KS)*DV(J,NDIS1)
      RETURN
      END
```

```
      SUBROUTINE CNT
      COMMON RAT,IDONE,IOP,IP,ITER,          ISS*6
      COMMON        ATABL
      COMMON        BB1(4,4),BBP(34,4,4),BB2(4,4)
      COMMON BD(34,4,4),BDM(4,4),BD2(4,4),BL1,BL2,BLC1,BLC2,BM2,BR2
      COMMON        C12,CAP1,CAP12E,CAP2
      COMMON CH1,CH1C,CH1C2,CHINO,CM1,                    CP,CQ
      COMMON CS,CSE
      COMMON        DELT,DEN,              DS,DSS
      COMMON                      EA,EAST,EIST,EIX,EIXY,EIY
      COMMON EPS1,EPS12,EPS2,EPS2S,ETA
      COMMON F11,F12,FK1,FK2,FK3
      COMMON FLAM,FLAM11,FLAM12,FLAM13,FLAM14
      COMMON       FLAM21,FLAM22,FLAM23,FLAM24
      COMMON       FLAM31,FLAM32,FLAM33,FLAM34
      COMMON       FLAM41,FLAM42,FLAM43,FLAM44
      COMMON FMU11,FMU12,FMU21,FMU22,FN,FNC
      COMMON GJST,GJT,GLAM,GUESS
      COMMON HH,HHH,HK,HKM1
      COMMON I,IBKP,IDER,IDERF,IERR,IFVO,I1,III,INTER,INTGRD
      COMMON J,JE,JENT(34),JJ
      COMMON K,KASE,KENT,KENT1,KENT2,KIC2,KJ,KM1,KPATH,KS,KSS
      COMMON LL,LSM1,LSTAB,LSTAB1,LTAB(100),LTYPE
      COMMON NDIS,NDIS1,NEQ,NFM,NIC,NJE,NLFLAG,NML
      COMMON NTRY,NWP,NWPC,NTERP
      COMMON PSIC,PSIT
      COMMON R,          RP,RR2,RTABL
      COMMON S,SA,SAVE,SB,SFL,          SL(34,4),SLM(4),SL2(4),SN,SU,SUM1
      COMMON SUMM,SV,SW
      COMMON T1,T1C,T1NO,T1SO,T2,T2C,T2NO,T12C
      COMMON             TCHIC(100),              TCHINO(100)
      COMMON TDIS(34),TE1(100,5),TE11J,TE2(100,5),TE21J,TE2JK
      COMMON TE12(100,5),          TEAST(100)
      COMMON TEIST(100),                            TGJST(100)
      COMMON TH(100,5),THETA,THETC,THETC2,THIJ,THJK
      COMMON TK1(100),TK2(100),TK3(100)
      COMMON             TNU1(100,5),TNU1IJ,TNU1JK
      COMMON TPSIC(100),           TR(100),TR1,TRP(100),TRP1,TRR2(100)
      COMMON TRR21,TS(100)
      COMMON                       TT1C(100),         TT1NO(100)
      COMMON                       TT2C(100),         TT2NO(100)
      COMMON                       TT12C(100)
```

```
      COMMON TTAB1(4),TTAB2(4),TTAB3(4),TTAB4(4),THETC(100)
      COMMON TX30(100),TX3X(100),TX3Y(100),            TZBST(100)
      COMMON WORK(486),WXC,WYC
      COMMON X1,X15,X2,X3,X30,X3X,X3Y,XB,XC1,XC2,XC3,XI
      COMMON Y(4,100)
      COMMON Z(4,100),ZBAR,ZBST,ZZERO
      COMMON /DV2/        DV(4,34),DY9(8),E1(5),E2(5),E12(5),FNU1(5),
     1 P(4,4,34),PP(4,4,34),PPSTOR(4,4),PRV(4,4,100),PRW(4,4,100),
     2 PRZ(4,4,100),QPSTOR(4),SH(5),CV(4,34),Y9(8),PRU(4,4,100)
C
C DIMENSION
      DIMENSION NOUT(100),PRS(100)
      DIMENSION DY1(8,9),Y1(8,9)
C ADDITIONAL DIMENSION FOR CNT
      DIMENSION ALPHA(4,4),AUG(4,8)
      DIMENSION BBMT(4,4),BBPT(4,4),BG(4),BJJ(4),BDLTA(4,4)
      DIMENSION BU(4,4),BV(4,4),BW(4,4),BZ(4,4)
      DIMENSION DELTA(4,4)
      DIMENSION GAMMA(4,4)
      DIMENSION OMEGA(4)
      DIMENSION PRG(4,100),PRJ(4,100),PS1(4),PSTOR(4,4
      DIMENSION Q(4,34),QP(4,34),QSTOR(4)
      DIMENSION SDELTA(4,4)
      DIMENSION TEMM1(4,4)
      DIMENSION WMAT1(4,4),WMAT2(4,4),WMAT3(4,4),WMAT4(4,4),WMAT5(4,4)
      DIMENSION WMAT6(4,4),WMAT7(4,4),WMAT8(4,4),WMAT9(4,4),WMAT10(4,4)
      DIMENSION WMAT11(4,4),WMAT12(4,4),WMAT13(4,4),WMAT14(4,4)
      DIMENSION WMAT15(4,4),WMAT16(4,4),WMAT17(4,4),WMAT18(4,4)
      DIMENSION WMAT19(4,4),WMAT20(4,4),WMAT21(4,4),WMAT22(4,4)
      DIMENSION WMAT23(4,4),WMAT24(4,4),WMAT25(4,4),WMAT26(4,4)
      DIMENSION WMAT27(4,4)
      DIMENSION WVEC1(4),WVEC2(4),WVEC3(4),WVEC4(4),WVEC5(4),WVEC6(4)
      DIMENSION WVEC7(4),WVEC8(4),WVEC9(4),WVEC10(4),WVEC11(4),WVEC12(4)
      DIMENSION WVEC13(4),WVEC14(4),WVEC15(4),WVEC16(4),WVEC17(4)
      DIMENSION WVEC18(4),WVEC19(4),WVEC20(4),WVEC21(4),WVEC22(4)
C
C EQUIVALENCE
      EQUIVALENCE (WORK,NOUT),(TS,PRS)
      EQUIVALENCE (CV(73),Y1),(DV(73),DY1)
```

```
C ADDITIONAL EQUIVALENCE FOR CNT
      EQUIVALENCE(Y,PRG),(Z,PRJ),(CV,Q),(DV,QP)
      EQUIVALENCE (WORK(291),WMAT2,WMAT4,WMAT5,WMAT12,WMAT13,WMAT14,
     1 ALPHA,WMAT23,WMAT24,WMAT25)
      EQUIVALENCE (WORK(307),WMAT1,GAMMA,WMAT15,WMAT16,BETA)
      EQUIVALENCE (WORK(323),WMAT9,WMAT10,WMAT11,WMAT17,WMAT18,WMAT19,
     1 WMAT20,WMAT21,BBMT)
      EQUIVALENCE (WORK(339),WMAT3,DELTA,WMAT6,WMAT7,WMAT8,WMAT22,BU)
      EQUIVALENCE (WORK(355),TEMM1,BBPI,BV)
      EQUIVALENCE (WORK(371),WVEC1,WVEC3,OMEGA,WVEC10,WVEC12,PSI)
      EQUIVALENCE (WORK(375),WVEC2,WVEC4,WVEC5,WVEC11,WVEC13,WVEC14,
     1 WVEC15,WVEC16,WVEC17,WVEC18,WVEC19,WVEC20,WVEC21)
      EQUIVALENCE (WORK(379),WVEC6,WVEC7,WVEC8,WVEC9,BG)
      EQUIVALENCE (WORK(383),AUG),(WORK(415),BW),(WORK(431),BZ),
     1 (WORK(447),BJJ),(WORK(451),SDELTA),(WORK(467),PSTOR),
     2 (WORK(483),QSTOR)
C
 1283 FORMAT (//12H SUBINTERVAL,I3,19H IS TOO LONG AT S =,  E12.4)
C
      IF (KASE-3)1290,1280,1290
 1280 IF(Y1(8,8)-1.E4)1290,1282,1282
 1282 WRITE (IOP,1283)           NDIS1,S
      IF(ISSW6. NE. 0)GO TO 1290
      CALL EXIT
 1290 NTRY = 1
      IF(     (PRS(KS) - S) - 1.E-6) 1315,1315,1350
 1315 S=PRS(KS)
      IF(KASE-2)1331,1320,1324
 1320 DO 1322 I=1,4
      PRG(I,KS)=Y9(I)
 1322 PRJ(I,KS)=Y9(I+4)
      GO TO 1331
 1324 DO 1326 I=1,4
      DO 1326 J=1,4
      PRU(I,J,KS)=Y1(I,J)
      PRV(I,J,KS)=Y1(I,J+4)
      PRW(I,J,KS)=Y1(I+4,J)
      PRZ(I,J,KS)=Y1(I+4,J+4)
```

```
1320 CONTINUE
1331 KSS=KS
     IF(KS-1)1332,1333,1332
1332 DS = DSS
1333 KS = KS + 1
1340 IF(ABS (S - TDIS(NDIS1 + 1)) - 1.E-6) 1390,1390,1350
1350 IF(PRS(KS)-S-DS)1360,1365,1365
1360 DSS = DS
     DS = PRS(KS) - S
     GO TO 2070
1365 DSS=DS
     GO TO 2070
1390 NDIS1 = NDIS1 + 1
     IF(NDIS1 - NDIS) 1410,1400,1410
1400 NTRY = 2
     IF (KASE-3)1420,2080,1420
1410 S = TDIS(NDIS1)
     LSTAB1 = JENT(NDIS1)
     LL=LTAB(LSTAB1)
     NTRY = 4
     IF(KASE-2)1420,1430,1440
1420 DO 1425 I = 1,4
     EG(I) = PRG(I,KSS)
     EJJ(I) = PRJ(I,KSS)
     DO 1425 J = 1,4
     EU(I,J) = PRU(I,J,KSS)
     EV(I,J) = PRV(I,J,KSS)
     EW(I,J) = PRW(I,J,KSS)
1425 EZ(I,J) = PRZ(I,J,KSS)
     IF(NTRY-2)1510,1820,1510
1430 DO 1435 I=1,8
1435 Y9(I) = 0.
     GO TO 1420
1440 DO 1445 I = 1,8
     DO 1445 J= 1,8
1445 Y1(I,J) = 0.
     DO 1450 I = 1,8
1450 Y1(I,I) = 1.
     GO TO 2080
```

```
1510 DO 1530 I =  1,4
     DO 1530 J =  1,4
1530 BBMT(I,J)=-BBP(NDIS1,I,J)
     CALL MMM(BBMT,BU,WMAT1)
     CALL MAE(BZ,AUG)
     CALL MATS(AUG,WMAT2,4,4)
     IF(KPATH - 1) 1536,1536,1539
1536 DO 1538 I = 1,4
     WVEC22(I) = BJJ(I)
     DO 1538 J = 1,4
     WMAT26(I,J) = WMAT2(I,J)
1538 WMAT27(I,J) = BW(I,J)
1539 CALL MMM(BV,WMAT2,WMAT3)
     CALL MMM(BBMT,WMAT3,TEMM1)
     DO 1540  I = 1,4
     DO 1540  J = 1,4
1540 DELTA(I,J) = - TEMM1(I,J)
     CALL MMM(DELTA,BW,WMAT4)
     CALL MMA(WMAT1,WMAT4,GAMMA)
     DO  1560  I = 1,4
     DO 1560 J = 1,4
1560 SDELTA(I,J) =            BD(NDIS1,I,J)-DELTA(I,J)
     CALL MVM(DELTA,BJJ,WVEC1)
     CALL MVM(BBMT,BG,WVEC2)
     CALL VVA(WVEC1,WVEC2,WVEC3)
     DO  1570  I = 1,4
1570 OMEGA(I) = SL(NDIS1,I)-WVEC3(I)
     GO TO (1600,1700),KPATH
1600 CALL MMM(BBZ,WMAT26,WMAT5)
     CALL MMM(WMAT5,WMAT27,WMAT6)
     DO  1620  I = 1,4
     DO  1620  J = 1,4
1620 TEMM1(I,J) = - BBZ(I,J)
     CALL MMA(WMAT6,TEMM1,WMAT7)
     CALL MAE(WMAT7,AUG)
     CALL MATS(AUG,WMAT8,4,4)
     CALL MMM(WMAT8,WMAT5,PSTOR)
     CALL MVM(WMAT5,BJJ,WVEC4)
     CALL VVA(SLZ,WVEC4,WVEC5)
     CALL MVM(WMAT8,WVEC5,GSTOR)
```

```
1640 CALL MMM(GAMMA,PSTOR,WMAT9)
     CALL MMA(WMAT9,DELTA,WMAT10)
     CALL MAE(WMAT10,AUG)
     CALL MATS(AUG,WMAT11,4,4)
     DO 1650 I=1,4
     DO 1650 J=1,4
1650 BBPT(I,J)=BBP(NDIS1,I,J)
     CALL MMM(WMAT11,BBPT,PPSTOR)
     CALL MVM(GAMMA,QSTOR,WVEC6)
     CALL VVA(WVEC6,OMEGA,WVEC7)
     CALL MVM(WMAT11,WVEC7,QPSTOR)
     KPATH = 2
     GO TO  1800
1700 CALL MMM(BZ,PPSTOR,WMAT12)
     DO  1710 I = 1,4
     DO  1710 J = 1,4
1710 WMAT13(I,J) = BW(I,J) - WMAT12(I,J)
     CALL MAE(WMAT13,AUG)
     CALL MATS(AUG,PSTOR,4,4)
     CALL MVM(BZ,QPSTOR,WVEC8)
     CALL VVA(BJJ,WVEC8,WVEC9)
     CALL MVM(PSTOR,WVEC9,QSTOR)
     GO TO 1640
1800 DO  1810 I = 1,4
     Q(I,NDIS1) = QSTOR(I)
     QP(I,NDIS1+1) = QPSTOR(I)
     DO  1810 J = 1,4
     P(I,J,NDIS1) = PSTOR(I,J)
1810 PP(I,J,NDIS1+1) = PPSTOR(I,J)
     GO TO 2070
1820 II = NDIS
     CALL MMM(BB1,BU,WMAT14)
1830 CALL MMM(BUM,BW,WMAT15)
     CALL MMA(WMAT14,WMAT15,ALPHA)
     CALL MMM(BB1,BV,WMAT16)
1834 CALL MMM(BUM,BZ,WMAT17)
     CALL MMA(WMAT16,WMAT17,BETA)
     CALL [illegible]VEC10)
1838 CALL [illegible]BJJ,WVEC11)
     CALL VVA(WVEC10,WVEC11,WVEC12)
     DO 1840 I = 1,4
```

```
1840 PSI(I) = SUM(I) - WVEC12(I)
     IF(II - 2) 2000,2000,1850
1850 DO 1860  I = 1,4
     DO 1860  K = 1,4
     WMAT18(I,K) = 0.
     DO 1860 J = 1,4
1860 WMAT18(I,K)  = WMAT18(I,K)  + BETA(I,J)*PPSTOR(J,K)
     DO 1880 I = 1,4
     DO 1880 J = 1,4
1880 WMAT19(I,J) = ALPHA(I,J) - WMAT18(I,J)
     CALL MAE(WMAT19,AUG)
     CALL MATS(AUG,WMAT20,4,4)
     DO 1890 I = 1,4
     WVEC13(I) = 0.
     DO 1890  J = 1,4
1890 WVEC13(I) = WVEC13(I)  + BETA(I,J)*QPSTOR(J)
     DO  1900 I = 1,4
1900 WVEC14(I) = PSI(I) - WVEC13(I)
     DO 1910 I = 1,4
     CV(I,II) = 0.
     DO 1910 J = 1,4
1910 CV(I,II) = CV(I,II) + WMAT20(I,J)*WVEC14(J)
1915 DO  1920 I = 1,4
     DO  1920 J = 1,4
1920 DV(I,II) = DV(I,II) - PP(I,J,II)*CV(J,II)
     II = II - 1
     DO  1930 I = 1,4
     CV(I,II)  = - Q(I,II)
     DO 1930 J = 1,4
1930 CV(I,II) = CV(I,II) + P(I,J,II)*DV(J,II+1)
     IF(II - 2) 1940,1940,1915
1940 DO 1950 I = 1,4
     WVEC15(I) =  0.
     DO 1950 J = 1,4
1950 WVEC15(I) = WVEC15(I) + WMAT27(I,J)*CV(J,II)
     DO 1960   I = 1,4
1960 WVEC16(I) = WVEC15(I) + WVEC22(I)
1965 DO 1970 I = 1,4
1970 WVEC17(I) = DV(I,3) - WVEC16(I)
     DO 1980 I = 1,4
     CV(I,2) = 0.
     DO 1980 J = 1,4
```

```
1980 DV(I,2) = DV(I,2) + WMAT26(I,J)*WVEC17(J)
     GO TO 2070
2000 CALL MAE(ALPHA,AUG)
     CALL MATS(AUG,WMAT21,4,4)
     CALL MMM(BBZ,WMAT21,WMAT22)
     CALL MMM(WMAT22,BETA,WMAT23)
     DO  2020  I = 1,4
     DO 2020 J = 1,4
2020 WMAT24(I,J) = WMAT24(I,J) - [illegible](I,J)
     CALL MAE(WMAT24,AUG)
     CALL MATS(AUG,WMAT25,4,4)
     CALL MVM(WMAT22,PSI,WVEC18)
     DO  2030 I = 1,4
2030 WVEC19(I) = WVEC18(I) - SLZ(I)
     DO  2040 I = 1,4
     DV(I,2) = 0.
     DO  2040 J = 1,4
2040 DV(I,2) = DV(I,2) + WMAT25(I,J)*WVEC19(J)
     DO  2050 I = 1,4
     WVEC20(I) = 0.
     DO  2050 J = 1,4
2050 WVEC20(I) = WVEC20(I) - BETA(I,J)*DV(J,2)
     CALL VVA(PSI,WVEC20,WVEC21)
     DO  2060 I = 1,4
     CV(I,2) = 0.
     DO 2060 J = 1,4
2060 CV(I,2) = CV(I,2) + WMAT21(I,J)*WVEC21(J)
2070 CONTINUE
2080 RETURN
     END
```

```
      SUBROUTINE  DER
      COMMON RAT,IDONE,IOP,IP,ITER,          ISSW6
      COMMON         ATABL
      COMMON         BB1(4,4),BBP(34,4,4),BB2(4,4)
      COMMON BD(34,4,4),BDM(4,4),BD2(4,4),BL1,BL2,BLC1,BLC2,BM2,BR2
      COMMON         C12,CAP1,CAP12E,CAP2
      COMMON CH1,CH1C,CH1C2,CHINO,CM1,                    CP,CQ
      COMMON CS,CSE
      COMMON         DEL1,DEN,           DS,DSS
      COMMON                       EA,EAST,EIST,EIX,EIXY,EIY
      COMMON EPS1,EPS12,EPS2,EPS2S,ETA
      COMMON F11,F12,FK1,FK2,FK3
      COMMON FLAM,FLAM11,FLAM12,FLAM13,FLAM14
      COMMON       FLAM21,FLAM22,FLAM23,FLAM24
      COMMON       FLAM31,FLAM32,FLAM33,FLAM34
      COMMON       FLAM41,FLAM42,FLAM43,FLAM44
      COMMON FMU11,FMU12,FMU21,FMU22,FN,FNC
      COMMON GJST,GJT,GLAM,GUESS
      COMMON HH,HHH,HK,HKM1
      COMMON I,IBKP,IDER,IDERF,IERR,IFVD,II,III,INTER,INTGRD
      COMMON J,JE,JENT(34),JJ
      COMMON K,KASE,KENT,KENT1,KENT2,KIC2,KJ,KM1,KPATH,KS,KSS
      COMMON LL,LSM1,LSTAB,LSTAB1,LTAB(100),LTYPE
      COMMON NDIS,NDIS1,NEQ,NFM,NIC,NJE,NLFLAG,NML
      COMMON NTRY,NWP,NWPC,NTERP
      COMMON PSIC,PSIT
      COMMON R,          RP,RR2,RTABL
      COMMON S,SA,SAVE,SB,SFL,        SL(34,4),SLM(4),SL2(4),SN,SU,SUM1
      COMMON SUMM,SV,SW
      COMMON T1,T1C,T1NO,T1SO,T2,T2C,T2NO,T12C
      COMMON           TCHIC(100),           TCHINO(100)
      COMMON TDIS(34),TE1(100,5),TE1IJ,TE2(100,5),TE2IJ,TE2JK
      COMMON TE12(100,5),          TEAST(100)
      COMMON TEIST(100),                              TGJST(100)
      COMMON TH(100,5),THETA,THETC,THETC2,THIJ,THJK
      COMMON TK1(100),TK2(100),TK3(100)
      COMMON           TNU1(100,5),TNU1IJ,TNU1JK
      COMMON TPSIC(100),          TR(100),TRI,TRP(100),TRPI,TRR2(100)
      COMMON TRR21,TS(100)
```

```
      COMMON                         TT1C(100),          TT1NO(100)
      COMMON                         TT2C(100),          TT2NO(100)
      COMMON                         TT12C(100)
      COMMON TTAB1(4),TTAB2(4),TTAB3(4),TTAB4(4),TTHETC(100)
      COMMON TX30(100),TX3X(100),TX3Y(100),              TZBST(100)
      COMMON WORK(480),WXC,WYC
      COMMON X1,X1S,X2,X3,X30,X3X,X3Y,XB,XC1,XC2,XC3,XI
      COMMON Y(4,100)
      COMMON Z(4,100),ZBAR,ZBST,ZZERO
      COMMON /DV2/            DV(4,34),DY9(8),E1(5),E2(5),E12(5),FNU1(5),
     1 P(4,4,34),PP(4,4,34),PPSTOR(4,4),PRV(4,4,100),PRW(4,4,100),
     2 PRZ(4,4,100),QPSTOR(4),SH(5),CV(4,34),YS(8),PRU(4,4,100)
      DIMENSION NOUT(100),PRS(100)
      DIMENSION DY1(8,9),Y1(8,9)
      EQUIVALENCE (WORK,NOUT),(TS,PRS)
      EQUIVALENCE (CV(73),Y1),(DV(73),DY1)
 1390 IF(S - TS(LSTAB1)) 1395,1410,1392
 1392 LSTAB1=LSTAB1+1
      GO TO 1390
 1395 IF(S - TS(LSTAB1 - 1)) 1400,1440,1420
 1400 LSTAB1 = LSTAB1 - 1
      GO TO 1395
 1410 LSM1=LSTAB1
      GO TO 1441
 1420 RAT = (S - TS(LSTAB1 - 1))/(TS(LSTAB1) - TS(LSTAB1 - 1))
      R = SLOPE(TR,LSTAB1)
      RP = SLOPE(TRP,LSTAB1)
      RR2 = SLOPE(TRR2,LSTAB1)
      FK1 = SLOPE(TK1,LSTAB1)
      FK2 = SLOPE(TK2,LSTAB1)
      FK3 = SLOPE(TK3,LSTAB1)
      EAST = SLOPE(TEAST,LSTAB1)
      EIST = SLOPE(TEIST,LSTAB1)
      GJST = SLOPE(TGJST,LSTAB1)
      ZBST = SLOPE(TZBST,LSTAB1)
      X30=SLOPE(TX30,LSTAB1)
      X3X=SLOPE(TX3X,LSTAB1)
      X3Y=SLOPE(TX3Y,LSTAB1)
```

```
1422 IF(LSTAB1 - 1 - JENT(NDIS1)) 1426,1426,1424
1424 IF(LSTAB1+1-LSTAB)1423,1425,1428
1423 IF(LSTAB1 - JENT(NDIS1+1) + 1) 1425,1428,1428
1425 IF((TS(LSTAB1 + 1) - S - S + TS(LSTAB1 -2)) 1426,1426,1428
1426 NTERP = 0
     GO TO 1429
1428 NTERP = 1
1429 T1C  =SLOPE3(TT1C  ,LSTAB1,NTERP)
     T2C  =SLOPE3(TT2C  ,LSTAB1,NTERP)
     T12C =SLOPE3(TT12C ,LSTAB1,NTERP)
     PSIC =SLOPE3(TPSIC ,LSTAB1,NTERP)
     CHIC =SLOPE3(TCHIC ,LSTAB1,NTERP)
     THETC=SLOPE3(TTHETC,LSTAB1,NTERP)
     T1N0=SLOPE3(TT1N0,LSTAB1,NTERP)
     T2N0=SLOPE3(TT2N0,LSTAB1,NTERP)
     CHIN0=SLOPE3(TCHIN0,LSTAB1,NTERP)
     DO 1430 K = 1,LL
     FNU1(K) = SLOPE1(TNU1,LSTAB1,K)
     E1(K)  =  SLOPE1(TE1,LSTAB1,K)
     E2(K)  =  SLOPE1(TE2,LSTAB1,K)
     E12(K) =  SLOPE1(TE12,LSTAB1,K)
     SH(K) = SLOPE1(TH,LSTAB1,K)
1430 CONTINUE
     GO TO 1460
1440 LSM1 = LSTAB1 - 1
1441 R = TR(LSM1)
     RP = TRP(LSM1)
     RR2 = TRR2(LSM1)
     FK1 = TK1(LSM1)
     FK2 = TK2(LSM1)
     FK3 = TK3(LSM1)
     EAST = TEAST(LSM1)
     EIST = TEIST(LSM1)
     GJST = TGJST(LSM1)
     ZBST = TZBST(LSM1)
     X30=TX30(LSM1)
     X3X=TX3X(LSM1)
     X3Y=TX3Y(LSM1)
     T1C  =TT1C  (LSM1)
     T2C  =TT2C  (LSM1)
```

```
      T12C =TT12C (LSM1)
      PSIC =TPSIC (LSM1)
      CHIC =TCHIC (LSM1)
      THETC=TTHETC(LSM1)
      T1N0=TT1N0(LSM1)
      T2N0=TT2N0(LSM1)
      CHIN0=TCHIN0(LSM1)
      DO 1450  K = 1,LL
      FNU1(K) = TNU1(LSM1,K)
      E1(K)   = TE1(LSM1,K)
      E2(K)   = TE2(LSM1,K)
      E12(K)  = TE12(LSM1,K)
      SH(K)   = TH(LSM1,K)
 1450 CONTINUE
 1460 ER2 =   RR2/R
      DO 220 J=1,4
      TTAB1(J)=0.
      TTAB2(J)=0.
      TTAB3(J)=0.
  220 CONTINUE
      HK=0.
      DO 240 K=1,LL
      DEN=SH(K)
      IF(E1(K).NE.0.)
     1DEN=SH(K)/(1.-FNU1(K)*FNU1(K)*E2(K)/E1(K))
      TTAB4(1)=E1(K)*DEN
      TTAB4(2)=E2(K)*DEN
      TTAB4(3)=FNU1(K)*TTAB4(2)
      TTAB4(4)=E12(K)*SH(K)
      HKM1=HK
      HK=HK+SH(K)
      HH=HK+HKM1
      HHH=HK*HH+HKM1*HKM1
      DO 230 J=1,4
      TTAB1(J)=TTAB1(J)+TTAB4(J)
      TTAB2(J)=TTAB2(J)+TTAB4(J)*HH
  230 TTAB3(J)=TTAB3(J)+TTAB4(J)*HHH
```

```
240  CONTINUE
     XB=0.
     IF(TTAB1(3). NE. 0.)
    1XB=TTAB2(3)/TTAB1(3)
     DO 260 J=1,4
     TTAB1(J)=2.*TTAB1(J)
     TTAB2(J)=2.*TTAB2(J)-XB*TTAB1(J)
     TTAB3(J)=2.666666667*TTAB3(J)-XB*(2.*TTAB2(J)+XB*TTAB1(J))
260  CONTINUE
     SW=             1./(R*6.283185307)
     ZZERO=ZBST-XB
     HH=SW*EAST
     HHH=HH*ZZERO
     TTAB1(1)=TTAB1(1)+HH
     TTAB2(1)=TTAB2(1)+HHH
     TTAB3(1)=TTAB3(1)+SW*EIST+HHH*ZZERO
     TTAB3(4)=TTAB3(4)+.25*SW*GJST
     DEL1=TTAB1(1)*TTAB3(1)-TTAB2(1)*TTAB2(1)
     FLAM44=TTAB1(1)/DEL1
     FLAM34=-TTAB2(1)/DEL1
     FLAM33=TTAB3(1)/DEL1
     FLAM24=TTAB3(3)*FLAM44
     FLAM23=TTAB3(3)*FLAM34
     FLAM22=TTAB3(2)-TTAB3(3)*FLAM24
     FLAM14=TTAB1(3)*FLAM34
     FLAM13=TTAB1(3)*FLAM33
     FLAM12=TTAB2(2)-TTAB3(3)*FLAM14
     FLAM11=TTAB1(2)-TTAB1(3)*FLAM13
     FMU22=1./(TTAB1(4)+4.*(TTAB2(4)+TTAB3(4)*BR2)*BR2)
     FMU12=2.*(TTAB2(4)+2.*TTAB3(4)*BR2)*FMU22
     FMU11=4.*(TTAB1(4)*TTAB3(4)-TTAB2(4)*TTAB2(4))*FMU22
     FMU21 = - FMU12
     FLAM21 = FLAM12
     FLAM31 = - FLAM13
     FLAM41 = - FLAM14
     FLAM32 = - FLAM23
     FLAM42 = - FLAM24
     FLAM43 = FLAM34
     DEN=FN/R
     HHN = HP/R
```

```
      FKM1=FN*BR2
      TTAB4(4)= GLAM*X30
      FK=X30*(2.*HK-XB)*SFL
      IF(IDERF-8)265,286,265
  265 X3=0.
      BL1=T1C*CHIC
      BL2=T12C*PSIC
      IF(FN)275,270,275
  270 BL2=-.5*(BL1+BL2)
      X1=0.
      X2=0.
      BL1=0.
      GO TO 286
  275 BL2=-.5*(BL1-BL2)
      BL1= .5*(T2C*PSIC+T12C*CHIC)
      X1S=(T1C+T2C)*THETC
      X2=-.5*HHH*X1S
      X1=-FNC*X1S/R
  286 SAVE=HK*GLAM
  290 DO 1500 J=IDER,IDERF
 1474 SU = RR2*Y1(5,J) + RP*Y1(6,J)
      SW = -RP*Y1(5,J) + RR2*Y1(6,J)
      PSIT=-Y1(7,J)*BR2-DEN*SW
      FH = FN*Y1(6,J) + Y1(7,J)
      XC1=-FK1*(SU-XB*Y1(8,J))
      XC2=-FK2*(Y1(7,J)+XB*PSIT)
      XC3  = -FK3 *SW
      BLC1=BL1+XB*XC2
      BLC2=BL2-XB*XC1
      THETA=(FKM1*Y1(5,J)+HHH*HR)*(T1N0+T2N0)
      XC1=XC1+X1-DEN*THETA
      XC2=XC2+X2-HHH*THETA
      XC3=XC3+X3
 1490 T1 = RR2*Y1(1,J) + RP*Y1(2,J)
      EPS2S= (Y1(6,J) + FN*Y1(7,J))/R
      CAP2 =  HHH*Y1(8,J)+DEN*(-DEN*Y1(5,J)*RP +  HH*BR2)
      CAP12E =DEN*(Y1(5,J)/R - Y1(8,J))+CHIN0*PSIT*BR2
      CSE=Y1(3,J)-.5*THETA
      IF(J-9)1491,1493,1491
```

```
1491 EPS2=EPS2S
     TTAB1(3)=0.
     GO TO 1494
1493 THETC2=THETC*THETC
     SV=.25*(PSIC*PSIC+THETC2)
     CHIC2=CHIC*CHIC
     IF(FN)1498,1497,1498
1497 EPS2=EPS2S+SV
     TTAB1(3)=.25*(CHIC2+THETC2)
     GO TO 1494
1498 EPS2=EPS2S-SV
     TTAB1(2)=.5*PSIC*CHIC
     CAP12E=CAP12E-TTAB1(2)*BR2
     TTAB1(3)=.25*(CHIC2-THETC2)
     CSE=CSE-.25*X1S
1494 T2 = FLAM11*EPS2+FLAM12*CAP2+FLAM13*T1 +FLAM14*Y1(4,J)
     BM2 = FLAM21*EPS2+FLAM22*CAP2+FLAM23*T1 +FLAM24*Y1(4,J)
     EPS1= FLAM31*EPS2+FLAM32*CAP2+FLAM33*T1 +FLAM34*Y1(4,J)
     CAP1= FLAM41*EPS2+FLAM42*CAP2+FLAM43*T1 +FLAM44*Y1(4,J)
     SUMM =FMU11*CAP12E+FMU12*CSE
     EPS12=FMU21*CAP12E+FMU22*CSE
     TTAB4(3)=CHINO*Y1(8,J)
     BLC1=BLC1-(T2NO*PSIT-CHINO*(CSE-SUMM*BR2))
     BLC2=BLC2-(T1NO*Y1(8,J)+CHINO*T1)
     IF (LTYPE)1496,1492,1496
1492 BLC1=BLC1-PSIT*SAVE
     BLC2=BLC2-Y1(8,J)*SAVE
     GO TO 1495
1496 XC1=XC1+TTAB4(4)*Y1(8,J)
     XC2=XC2-TTAB4(4)*PSIT
     XC3=XC3+TTAB4(4)*(EPS1+EPS2S-TTAB4(3)-TTAB1(3))
    1   +GLAM*(Y1(5,J)*X3X+Y1(6,J)*X3Y)
```

```
1495 HK =DEN*BM2    + BLC1
     DY1(1,J) = -HHH*(Y1(1,J)+FN*HK)        - HKM1*Y1(3,J)+DEN*SUMM/R
    1-RR2*XC1 + RP*XC3
     DY1(2,J) = -HHH*(Y1(2,J)+FN*Y1(3,J))+T2/R+HKM1*HK  -RP*XC1-RR2*XC3
     DY1(3,J) = -2.*HHH*Y1(3,J) +DEN*T2  + HK*BR2 - XC2
     DY1(4,J) = -RP*Y1(1,J)+RR2*Y1(2,J)+HHH*(BM2-Y1(4,J))-DEN*SUMM-BLC2
     DY1(5,J) = RP*Y1(8,J) + RR2*EPS1-RR2*TTAB4(3)
     DY1(6,J) = -RR2*Y1(8,J) + RP*EPS1-RP*TTAB4(3)
     DY1(7,J)=HKM1*Y1(5,J)+HHH*HH+EPS12+PSIT*CHINO
     DY1(8,J)=CAP1
1500 CONTINUE
     IF(IDER - 9) 1530,1510,1530
1510 IF(FN)1512,1514,1512
1512 DY1(7,9)=DY1(7,9)-TTAB1(2)
1514 DY1(5,9)=DY1(5,9)-RR2*TTAB1(3)
     DY1(6,9)=DY1(6,9)-RP *TTAB1(3)
1530 RETURN
     END
```

```
      SUBROUTINE RKS3 (DERIV,CNTRL,Y,DY,ATABL,RTABL,WORK,X,DX,N,           RKS3
     1                 IFVD,IBKP,NTRY,IERR)                                 RKS3
      DIMENSION Y(1),DY(1),WORK(1)
      EXTERNAL CNTRL, DERIV                                                 RKS3
      IJ = 2 +     N                                                        RKS3
      IH = 2 + 2 * N                                                        RKS3
      IK = 2 + 3 * N                                                        RKS3
      IL = 2 + 4 * N                                                        RKS3
      IA = 2 + 5 * N                                                        RKS3
      LIMIT = 2 + 6 * N                                                     RKS3
      ISWTCH = 1                                                            RKS3
   10 I = 1                                                                 RKS3
   13 WORK(I) = 0.0                                                         RKS3
      IF (I - LIMIT) 15,16,16                                               RKS3
   15 I = I + 1                                                             RKS3
      GO TO13                                                               RKS3
   16 CALL DERIV                                                            RKS3
   20 NTRY = 1                                                              RKS3
      CALL CNTRL
      GO TO (30,25,40,10), NTRY                                             RKS3
   25 IERR = J                                                              RKS3
      GO TO 220                                                             RKS3
   30 WORK(2) = X                                                           RKS3
      I = 1                                                                 RKS3
   32 IXJ = IJ + I                                                          RKS3
      WORK(IXJ)= Y(I)                                                       RKS3
      IXK= IK + I                                                           RKS3
      WORK(IXK)= DY(I)                                                      RKS3
      IXA= IA + I                                                           RKS3
      WORK(IXA)= 0.0                                                        RKS3
      IF (I - N) 33,50,50                                                   RKS3
   33 I = I + 1                                                             RKS3
      GO TO 32                                                              RKS3
   40 X = WORK(2)                                                           RKS3
      I = 1                                                                 RKS3
   41 IXJ = IJ + I                                                          RKS3
      Y(I) = WORK(IXJ)                                                      RKS3
      IXK= IK + I                                                           RKS3
      DY(I) = WORK(IXK)                                                     RKS3
      IXA = IA + I                                                          RKS3
```

```
      WORK(IXA) = 0.0                                    RKS3
      IF (I - N) 42,50,50                                RKS3
   42 I = I + 1                                          RKS3
      GO TO 41                                           RKS3
   50 IF (DX) 70,60,70                                   RKS3
   60 IERR = -1                                          RKS3
      GO TO 220                                          RKS3
   70 WORK(1) = DX                                       RKS3
      HDX = .50 * DX                                     RKS3
      QDX = .25 * DX                                     RKS3
   80 XHALF = X                                          RKS3
      X = X + QDX                                        RKS3
      I = 1                                              RKS3
   82 IXL = IL + I                                       RKS3
      WORK(IXL)= DY(I) * QDX                             RKS3
      WORK(I+2) = Y(I)                                   RKS3
      Y(I) = WORK(I+2) + WORK(IXL)                       RKS3
      IF (I - N) 83,84,84                                RKS3
   83 I = I + 1                                          RKS3
      GO TO 82                                           RKS3
   84 CALL DERIV                                         RKS3
      I = 1                                              RKS3
   85 RKAS = DY(I) * QDX                                 RKS3
      Y(I) = WORK(I+2) + RKAS                            RKS3
      IXL= IL + I                                        RKS3
      WORK(IXL)= WORK(IXL)+ 2.0 * RKAS                   RKS3
      IF (I - N) 86,87,87                                RKS3
   86 I = I + 1                                          RKS3
      GO TO 85                                           RKS3
   87 CALL DERIV                                         RKS3
      X = XHALF + HDX                                    RKS3
      I = 1                                              RKS3
   88 RKAS = DY(I) * HDX                                 RKS3
      Y(I) = WORK(I+2) + RKAS                            RKS3
      IXL= IL + I                                        RKS3
      WORK(IXL)= WORK(IXL)+ RKAS                         RKS3
      IF (I - N) 89,90,90                                RKS3
   89 I = I + 1                                          RKS3
      GO TO 88                                           RKS3
```

```
   90 CALL DERIV                                                    RKS3
      I = 1                                                         RKS3
   91 IXL = IL + I                                                  RKS3
      WORK(IXL) = (WORK(IXL) + DY(I) * QDX)* .33333333333           RKS3
      Y(I) = WORK(IXL)+ WORK(I+2)                                   RKS3
      IXA= IA + I                                                   RKS3
      WORK(IXA)= WORK(IXA) + WORK(IXL)                              RKS3
      IF (I - N) 92,93,93                                           RKS3
   92 I = I + 1                                                     RKS3
      GO TO 91                                                      RKS3
   93 CALL DERIV                                                    RKS3
      IF (ISWTCH) 94,100,94                                         RKS3
   94 ISWTCH = 0                                                    RKS3
      I = 1                                                         RKS3
   95 IXH = IH + I                                                  RKS3
      WORK(IXH) = DY(I)                                             RKS3
      IF (I - N) 96,80,80                                           RKS3
   96 I = I + 1                                                     RKS3
      GO TO 95                                                      RKS3
  100 ISWTCH = 1                                                    RKS3
      IF (IFVD) 20,105,20                                           RKS3
  105 XM = 0.0                                                      RKS3
      I = 1                                                         RKS3
 106  YX = ATABL    + RTABL    * ABS (Y(I))
  110 IF (YX) 120,210,120                                           RKS3
  120 IXH = IH + I                                                  RKS3
      IXK = IK + I                                                  RKS3
      SI = (WORK(IXK) + 4.0 * WORK(IXH) + DY(I)) * HDX * .33333333333   RKS3
      IXA = IA + I                                                  RKS3
      DI = SI - WORK(IXA)                                           RKS3
      ERROR = ABS (DI/YX)                                           RKS3
      IF (ERROR - XM) 140,140,130                                   RKS3
```

```
130 XM = ERROR                                                  RKS3
140 IF (I - N) 141,142,142                                      RKS3
141 I = I + 1                                                   RKS3
    GO TO 106                                                   RKS3
142 IF (XM - 1.0) 150,180,190                                   RKS3
150 IF (XM - .75) 160,20,180                                    RKS3
160 IF (XM - .075) 170,20,20                                    RKS3
170 DX = DX * 1.584893193                                       RKS3
    GO TO 20                                                    RKS3
180 DX = DX * .630957344                                        RKS3
    GO TO 20                                                    RKS3
190 DX = DX * .630957344                                        RKS3
    IF (IBKP) 200,40,200                                        RKS3
200 XM = XM * .1                                                RKS3
    IF (XM - 1.0) 40,190,190                                    RKS3
210 IERR =1                                                     RKS3
220 RETURN                                                      RKS3
    END                                                         RKS3
```

```
      SUBROUTINE MATS    (A,X,N,M)                                      MATS0001
      DIMENSION A(4,8),X(4,4)
      IOP=5
      DO 2 I=1,4
      DO 2 J=1,4
2     X(I,J)=A(I,J)
      MM=N+M                                                            MATS0003
      IF(ABS(1.-A(1,2)*A(2,1)/(A(1,1)*A(2,2))) .GT..0001)GO TO 6
      DO 5 K=1,MM
      R=A(2,K)
      A(2,K)=A(4,K)
    5 A(4,K)=R
6     DO 15 I=2,N                                                       MATS0004
70    II=I-1                                                            MATS0005
7     DO 15 J=1,II                                                      MATS0006
      B=A(I,J)
      IF(B .EQ. 0.)GO TO 15
      R=A(J,J)
      IF(ABS(R) .LT. 1.E-10)GO TO 16
      R=B/R
130   JJ=J+1                                                            MATS0016
13    DO 14 K=JJ,MM                                                     MATS0017
14    A(I,K)=A(I,K)-R*A(J,K)                                            MATS0018
15    CONTINUE                                                          MATS0019
      R=A(N,N)
      IF(ABS(R) .GT. 1.E-10)GO TO 17
16    WRITE(IOP,162)R
162   FORMAT(////82H SINGULAR MATRIX - CHECK BOUNDARY CONDITIONS, DIAGON
     1AL ELEMENT OF REDUCED MATRIX =,E12.4)
      WRITE(IOP,163)((X(I,J),J=1,4),I=1,4)
163   FORMAT(4E20.7)
      IF(EOF,0)17,17
17    DO28J=1,M                                                         MATS0022
      KK=N+J                                                            MATS0023
      X(N,J)=A(N,KK)/A(N,N)                                             MATS0024
      DO28I=2,N                                                         MATS0025
      JJ=N-I+1                                                          MATS0026
      B=0.                                                              MATS0027
      II=N-I+2                                                          MATS0028
      DO 25 K=II,N                                                      MATS0029
25    B=B+A(JJ,K)*X(K,J)                                                MATS0030
28    X(JJ,J)=(A(JJ,KK)-B)/A(JJ,JJ)                                     MATS0032
      RETURN                                                            MATS0033
      END
```

```
      SUBROUTINE  MMM(A,B,C)
      DIMENSION   A(4,4),B(4,4),C(4,4)
      DO 100 I = 1,4
      DO 100 K = 1,4
      C(I,K) = 0.
      DO 100 J = 1,4
100   C(I,K) = C(I,K) +  A(I,J)*B(J,K)
      RETURN
      END


      SUBROUTINE  MVM(A,B,C)
      DIMENSION A(4,4),B(4),C(4)
      DO 100 I = 1,4
      C(I)  = 0.
      DO 100 J = 1,4
100   C (I) = C(I) + A(I,J)*B(J)
      RETURN
      END


      SUBROUTINE MMA(A,B,C)
      DIMENSION A(4,4),B(4,4),C(4,4)
      DO 100 I = 1,4
      DO 100 J = 1,4
100   C(I,J) = A(I,J) + B(I,J)
      RETURN
      END


      SUBROUTINE  VVA(A,B,C)
      DIMENSION A(4),B(4),C(4)
      DO  100 I = 1,4
100   C(I) = A(I) + B(I)
      RETURN
      END
```

```
      SUBROUTINE  MAE(A,B)
      DIMENSION A(4,4), B(4,8)
      DO 100 I = 1,4
      DO 100 J = 1,4
100   B(I,J) = A(I,J)
      DO 120 I = 1,4
      DO 120 J = 5,8
120   B(I,J) = 0.
      DO 140 I = 1,4
140   B(I,I+4) = 1.
      RETURN
      END


      FUNCTION SLOPE(X,LSTAB1)
      COMMON RAT
      DIMENSION X(100)
      SLOPE = X(LSTAB1 - 1) + RAT*(X(LSTAB1) - X(LSTAB1 - 1))
      RETURN
      END


      FUNCTION SLOPE1(X,LSTAB1,K)
      COMMON RAT
      DIMENSION X(100,5)
      LSM1 = LSTAB1 - 1
100   SLOPE1 =  X(LSM1,K) + RAT*(X(LSTAB1,K) - X(LSM1,K))
      RETURN
      END
```

```
      FUNCTION SLOPE3(X,LSTAB1,NTERP)
      COMMON RAT
      DIMENSION X(100)
      IF (NTERP)140,120,140
120   JJ=LSTAB1-1
      RAT1=RAT
      RAT2=(RAT-1.)/2.
      GO TO 160
140   JJ=LSTAB1-2
      RAT1=RAT+1.
      RAT2=RAT/2.
160   DF = X(JJ+1)-X(JJ)
      DF1= X(JJ+2)-X(JJ+1)
      D2F= DF1-DF
180   SLOPE3 = X(JJ) + RAT1 * (DF + RAT2*D2F)
      RETURN
      END
```

REFERENCES

1. Koiter, W. T.: On the Stability of Elastic Equilibrium (in Dutch with English summary). Thesis, Polytechnic Institute at Delft, H. J. Paris (Amsterdam), 1945; English translation, NASA TT F-10,833, 1967.

2. Koiter, W. T.: Elastic Stability and Post-Buckling Behavior. Nonlinear Problems, R. E. Langer, ed., University of Wisconsin Press (Madison), 1963, pp. 257-275.

3. Budiansky, B.; and Hutchinson, J.W.: Dynamic Buckling of Imperfection - Sensitive Structures. Proceedings of the XI International Congress of Applied Mechanics. H. Gortler, ed., Springer-Verlag (Berlin), 1964, pp. 636-651.

4. Budiansky, B.: Dynamic Buckling of Elastic Structures: Criteria and Estimates. Proceedings, International Conference on Dynamic Stability of Structures, Pergamon (New York), 1966, pp. 83-106.

5. Hutchinson, J. W.: Initial Post-Buckling Behavior of Toroidal Shell Segments. Int. J. Solids Structures, vol. 3, 1967, pp. 97-115.

6. Hutchinson, J. W.; and Amazigo, J. C.: Imperfection-Sensitivity of Eccentrically Stiffened Cylindrical Shells. AIAA J., vol. 5, no. 3, March 1967, pp. 392-401.

7. Danielson, D. A.: Buckling and Initial Post-Buckling Behavior of Spheroidal Shells under Pressure. AIAA J., vol. 7, no. 5, May 1969, pp. 936-944.

8. Fitch, J. R.: The Buckling and Post-Buckling Behavior of Spherical Caps under Concentrated Load. Int. J. Solids Structures, vol. 4, 1968, pp. 421-446.

9. Fitch, J. R.: and Budiansky, B.: The Buckling and Post-Buckling Behavior of Spherical Caps under Axisymmetric Load. Proceedings, 10th ASME/AIAA Structures, Structural Dynamics and Materials Conference, New Orleans, April 1969.

10. Hutchinson, J. W.: and Fraventhal, J. C.: Elastic Post-Buckling Behavior of Stiffened and Barreled Cylindrical Shells. J. Appl. Mech., Paper No. 69-APM-U.

11. Cohen, G. A.: Effect of a Nonlinear Prebuckling State on the Postbuckling Behavior and Imperfection Sensitivity of Elastic Structures. AIAA J., vol. 6, no. 8, August 1968, pp. 1616-1619.

12. Cohen, G. A.: Reply by Author to J. R. Fitch and J. W. Hutchinson. AIAA J., vol. 7, no. 7, July 1969, pp. 1407-1408.

13. Cohen, G. A.: Computer Analysis of Asymmetric Buckling of Ring-Stiffened Orthotropic Shells of Revolution. AIAA J., vol. 6, no. 1, January 1968, pp. 141-149.

14. Cohen, G. A.: Computer Analysis of Asymmetrical Deformation of Orthotropic Shells of Revolution. AIAA J., vol. 2, no. 5, May 1964, pp. 932-934.

15. Cohen, G. A.: Computer Analysis of Asymmetric Vibrations of Ring-Stiffened Orthotropic Shells of Revolution. AIAA J., vol. 3, no. 12, December 1965, pp. 2305-2312.

16. Hutchinson, J. W.: Private Communication, October 1969.

17. Cohen, G. A.: Buckling of Axially Compressed Cylindrical Shells with Ring-Stiffened Edges. AIAA J., vol. 4, no. 10, October 1966, pp. 1859-1862.

18. Greenbaum, G. A.: Comments on "Numerical Analysis of Unsymmetrical Bending of Shells of Revolution." AIAA J., vol. 2, no. 3, March 1964, pp. 590-591.

19. Cohen, G. A.: Evaluation of Configuration Changes on Optimum Structural Designs for a Mars Entry Capsule. NASA CR-1414, 1969.

20. Hildebrand, F. B.: Methods of Applied Mathematics. Prentice-Hall, Inc., 1952.

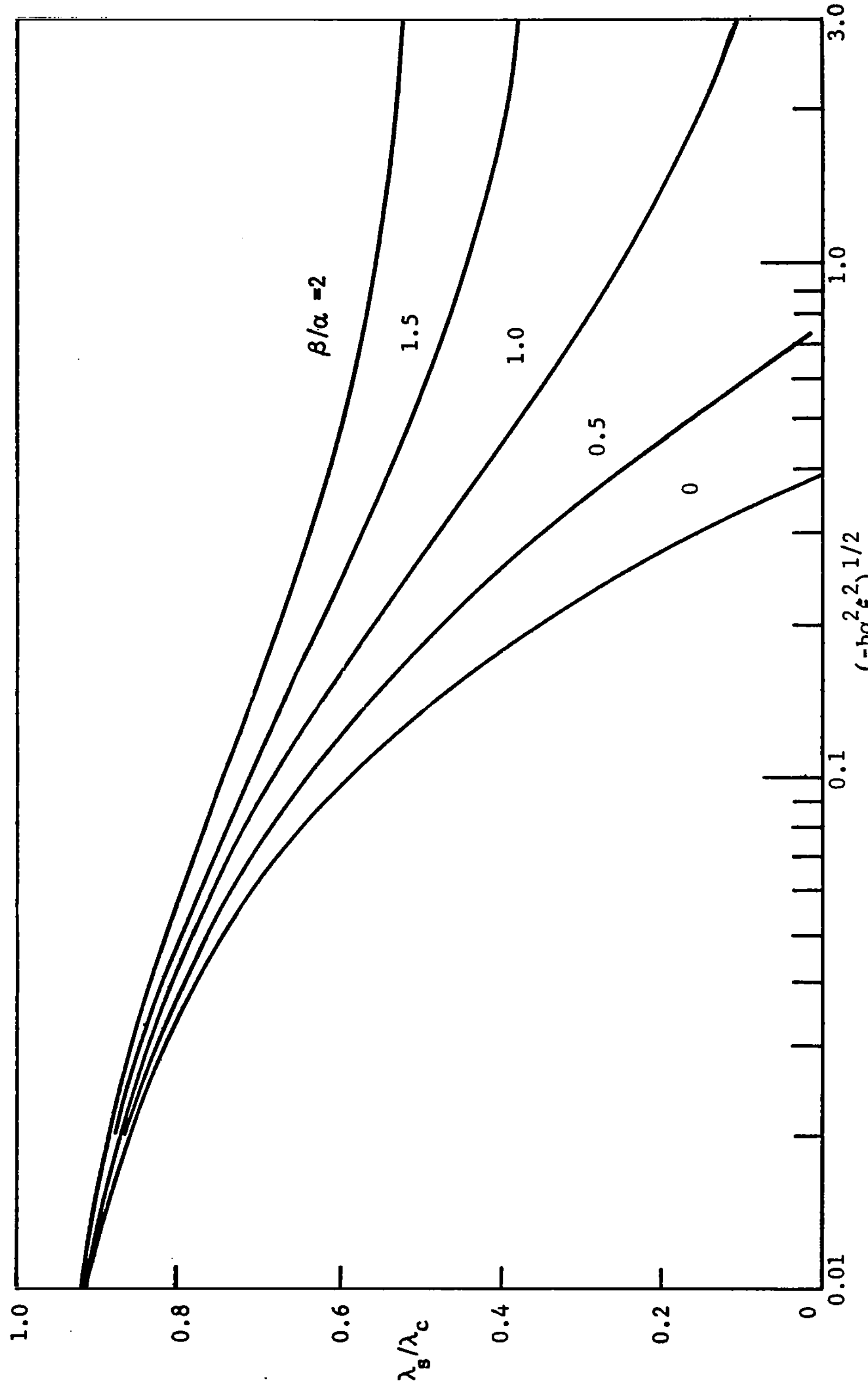


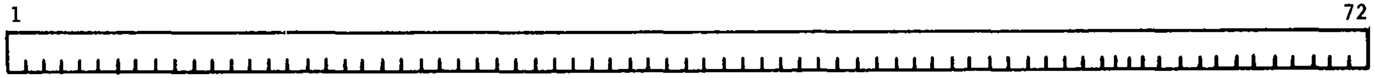
FIGURE 1. CRITICAL LOADS OF IMPERFECTION SENSITIVE STRUCTURES

SHEET A

INITIAL POSTBUCKLING OF SHELLS OF REVOLUTION

'ALWAYS REQUIRED -
ONE PAIR FOR EACH CASE)

CASE TITLE CARD (FORMAT 12A6)



CASE OPTION CARD

COLUMN 6 = BLANK, USE GEOMETRY FROM PREVIOUS CASE; = 1, INPUT NEW GEOMETRY

COLUMN 8 = BLANK, USE WALL PROPERTIES FROM PREVIOUS CASE; = 1, INPUT NEW WALL PROPERTIES

COLUMN 10 = BLANK, USE FOUNDATION MODULE FROM PREVIOUS CASE; = 1, INPUT NEW FOUNDATION MODULE

COLUMN 12 = BLANK, USE STRINGER PROPERTIES FROM PREVIOUS CASE; = 1, INPUT NEW STRINGER PROPERTIES

COLUMN 14 = BLANK, USE PRESSURE GRADIENT FROM PREVIOUS CASE; = 1, INPUT NEW PRESSURE GRADIENT

COLUMN 16 = BLANK, USE PREBUCKLING DATA FROM PREVIOUS CASE; = 1, INPUT NEW PREBUCKLING DATA

COLUMN 20 = BLANK, ALL BOUNDARY DATA FROM PREVIOUS CASE; = 1, INPUT OR GENERATE BOUNDARY CONDITIONS ACCORDING TO COLUMN 5 OF TABLE 1

COLUMNS 48-59 = RELATIVE ERROR TOLERANCE (E12.4)

COLUMN 76 = BLANK, K* AND β NOT COMPUTED (STANDARD PREBUCKLING DECK INPUT IF COLUMN 16 = 1); = 1, K* AND β COMPUTED (REQUIRES ENLARGED PREBUCKLING DECK INPUT IF COLUMN 16 = 1)

COLUMN 78 = BLANK, ABORT RUN IF SUBINTERVAL LENGTH CRITERION EXCEEDED
= 1, PRINT DIAGNOSTIC BUT CONTINUE EXECUTION IF SUBINTERVAL LENGTH CRITERION EXCEEDED

FIGURE 2. CASE TITLE AND OPTION CARDS

SHEET B

INITIAL POSTBUCKLING OF SHELLS OF REVOLUTION

TABLE NO. = 1-5, INDICATES FIRST ENTRY OF TABLE

= 9, INDICATES END OF TABLES (ALWAYS REQUIRED FOR EACH CASE)

1 - GEOMETRY
2 - WALL PROP.
3 - FOUND. MOD.
4 - STRING. PROP.
5 - PRESS. GRAD.

= 4, ARTIFICAL TRANS. CONSTRAINT; = 5, ARTIF. ROT. CONSTR; = 6, ARTIF. TRANS. & ROT. CONSTR. (TABLE 1, APPLIES ONLY AT 1ST ENTRY OF 1ST OR 2ND SUBINTERVAL)

= 8,9, SYMMETRICAL RESPONSE (TABLE 1, APPLIES ONLY AT 1ST ENTRY)

= BLANK, FORCE FREE BDY.; = 1, INPUT RING DATA; = 2, INPUT [B] & [D] MATRICES,

= 3, TAKE BOUND. DATA FROM PREV. CASE (TABLE 1, APPLIES ONLY AT 1ST ENTRY OF EACH SUBINTERVAL & TERMINAL POINT OF SHELL);

= 4, DOME CLOSURE (TABLE 1, APPLIES ONLY AT SHELL EDGES)

WALL LAYER NO. (≤ 5); INDICATES FIRST ENTRY OF NEW LAYER OR NEW PORTION OF A DISJOINTED LAYER (TABLE 2)

ENTRY NO. (≤ 100) MUST BE RIGHT ADJUSTED

NOTE: ALL NUMBERS IN COLUMNS 13-72 HAVE FORMAT E12.4

$s, E_1, k_1, -, \partial p/\partial x$ $\quad r, E_2, k_2, NEA, \partial p/\partial y$ $\quad r', E_{12}, k_3, NEI, -$ $\quad r/R_2, \nu_1, -, NGJ, -$ $\quad -, h, -, \bar{z}, -$

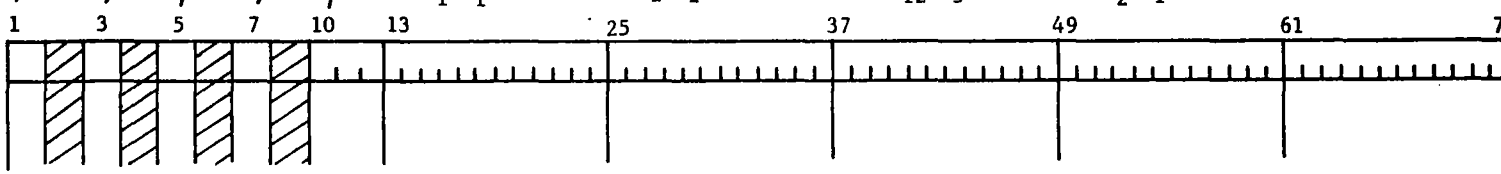


FIGURE 3. INPUT TABLES

SHEET C

INITIAL POSTBUCKLING OF SHELLS OF REVOLUTION

(TO BE USED ONLY IF COLUMN 16, SHEET A, CONTAINS A 1)

NONLINEAR LOAD CARD

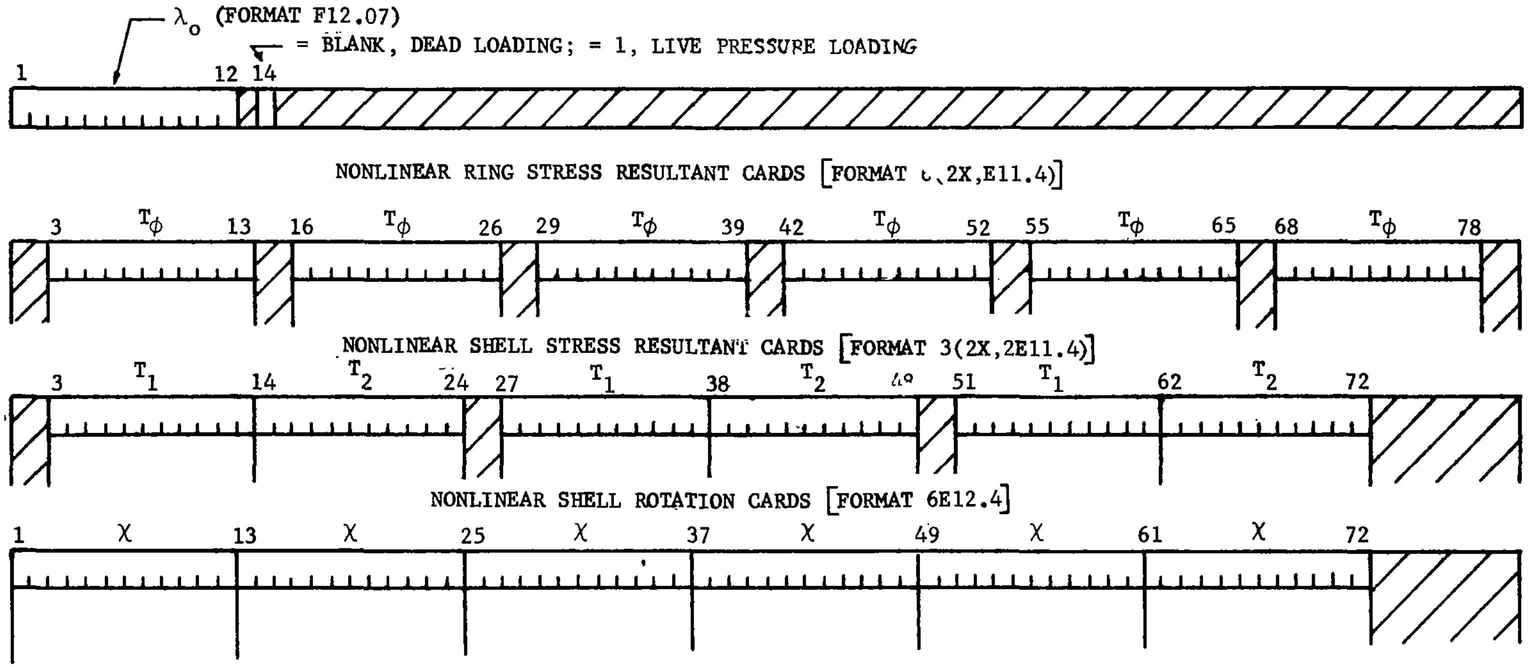
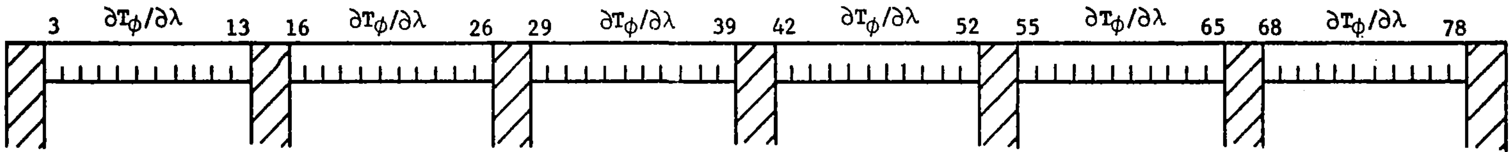
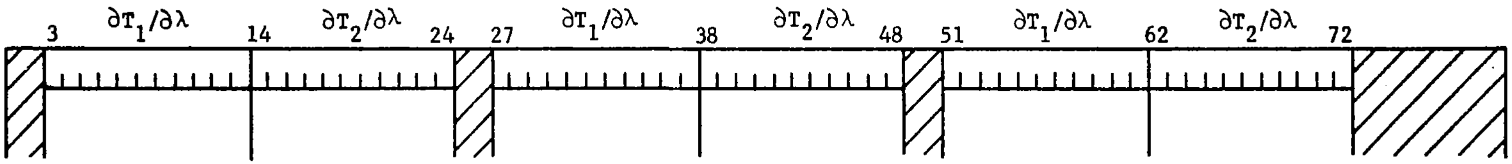


FIGURE 4. STANDARD PREBUCKLING DATA

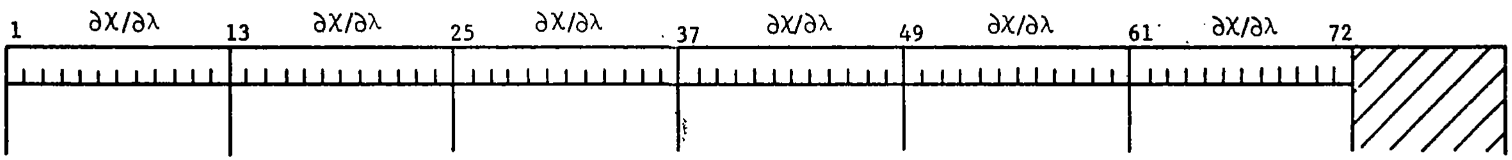
LINEAR PERTURBATION RING STRESS RESULTANT CARDS [FORMAT 6(2X,E11.4)]



LINEAR PERTURBATION SHELL STRESS RESULTANT CARDS [FORMAT 3(2X,2E11.4)]



LINEAR PERTURBATION SHELL ROTATION CARDS [FORMAT 6E12.4]



PRESSURE FIELD CARDS [FORMAT 6E12.4]

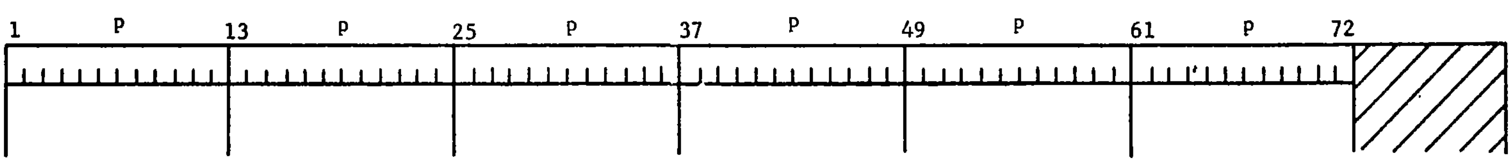


FIGURE 4. STANDARD PREBUCKLING DATA - (Concluded)

INITIAL POSTBUCKLING OF SHELLS OF REVOLUTION

SHEET D

(TO BE USED ONLY IF COLUMNS 16 AND 76, SHEET A, CONTAIN A 1)

RING BENDING MOMENT CARDS [FORMAT 4(2E10.0)]

1	11	21	31	41	51	61	71	80
M_y	$\partial M_y/\partial\lambda$	M_y	$\partial M_y/\partial\lambda$	M_y	$\partial M_y/\partial\lambda$	M_y	$\partial M_y/\partial\lambda$	

SHELL BENDING MOMENT CARDS [FORMAT 2(4E10.0)]

1	11	21	31	41		61	71	80
M_1	$\partial M_1/\partial\lambda$	M_2	$\partial M_2/\partial\lambda$	M_1	$\partial M_1/\partial\lambda$	M_2	$\partial M_2/\partial\lambda$	

2ND - ORDER PERTURBATION RING STRESS RESULTANT CARDS [FORMAT 6(2X,E11.4)]

3–13	16–26	29–39	42–52	55–65	68–78
$\partial^2 T_\phi/\partial\lambda^2$	$\partial^2 T_\phi/\partial\lambda^2$	$\partial^2 T_\phi/\partial\lambda^2$	$\partial^2 T_\phi/\partial\lambda^2$	$\partial^2 T_\phi/\partial\lambda^2$	$\partial^2 T_\phi/\partial\lambda^2$

2ND - ORDER PERTURBATION SHELL STRESS RESULTANT CARDS [FORMAT 3(2X,2E11.4)]

3	14	24	27	38	48	51	62	72
$\partial^2 T_1/\partial\lambda^2$	$\partial^2 T_2/\partial\lambda^2$		$\partial^2 T_1/\partial\lambda^2$	$\partial^2 T_2/\partial\lambda^2$		$\partial^2 T_1/\partial\lambda^2$	$\partial^2 T_2/\partial\lambda^2$	

2ND - ORDER PERTURBATION SHELL ROTATION CARDS [FORMAT 6E12.4]

1	13	25	37	49	61	72
$\partial^2\chi/\partial\lambda^2$	$\partial^2\chi/\partial\lambda^2$	$\partial^2\chi/\partial\lambda^2$	$\partial^2\chi/\partial\lambda^2$	$\partial^2\chi/\partial\lambda^2$	$\partial^2\chi/\partial\lambda^2$	

STRUCTURAL STIFFNESS CARD [FORMAT 2E12.4]

1	13	24
K_0	$\partial K_0/\partial\lambda$	

FIGURE 5. OPTIONAL PREBUCKLING DATA

SHEET E

INITIAL POSTBUCKLING OF SHELLS OF REVOLUTION

(ALWAYS REQUIRED FOR EACH CASE)

EIGENVALUE CARD

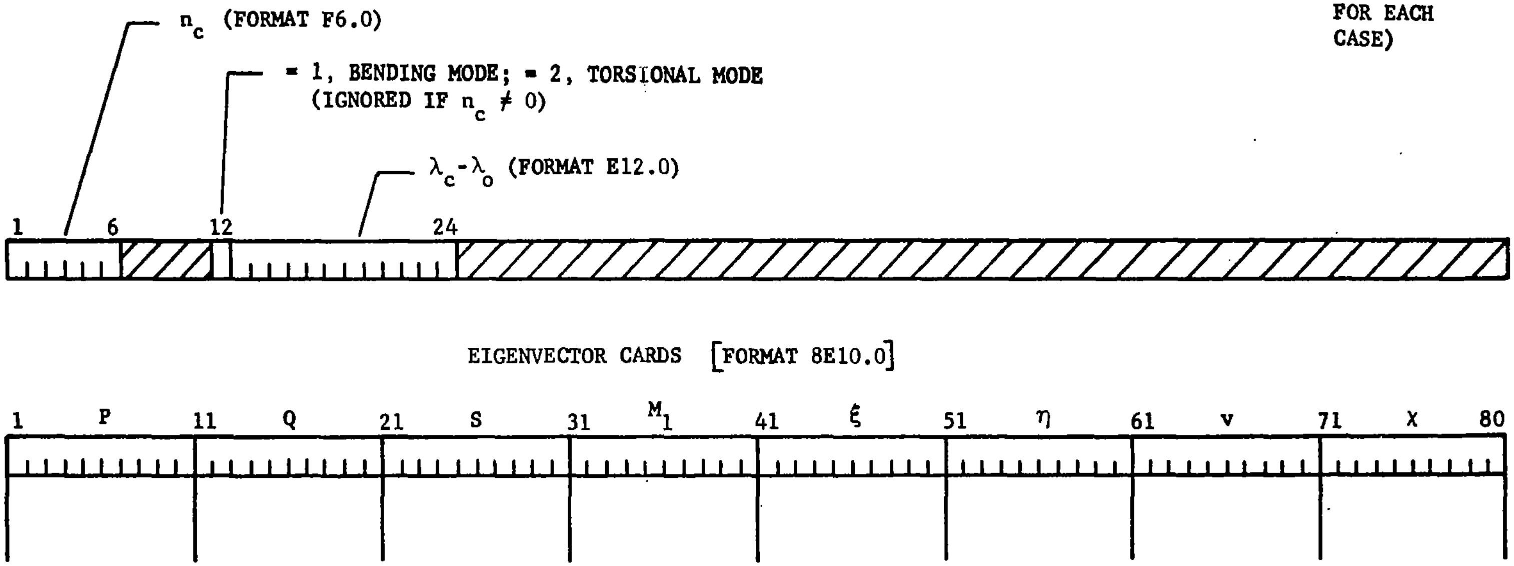


FIGURE 6. BUCKLING MODE DATA

SHEET F

INITIAL POSTBUCKLING OF SHELLS OF REVOLUTION

(TO BE USED ONLY IF COLUMN 5, SHEET B, CONTAINS A 1)

NOTE: ALL NUMBERS IN COLUMNS 1-72 HAVE FORMAT E12.4

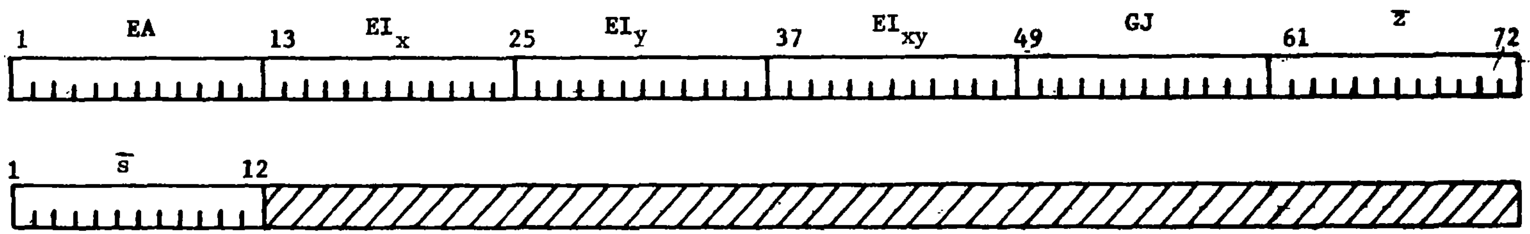


FIGURE 7. RING DATA

SHEET G

INITIAL POSTBUCKLING OF SHELLS OF REVOLUTION

(TO BE USED ONLY IF COLUMN 5, SHEET B, CONTAINS A 2)

NOTE: ALL NUMBERS IN COLUMNS 1-48 HAVE FORMAT E12.4

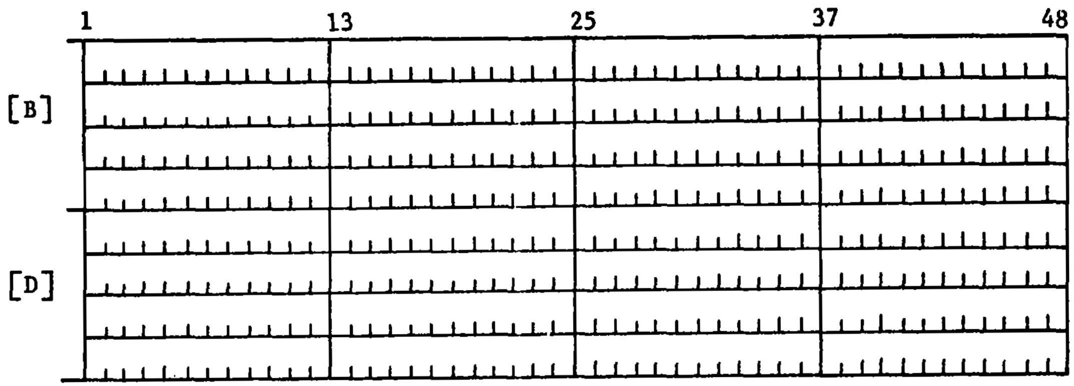


FIGURE 8. PRESCRIBED [B] AND [D] MATRICES

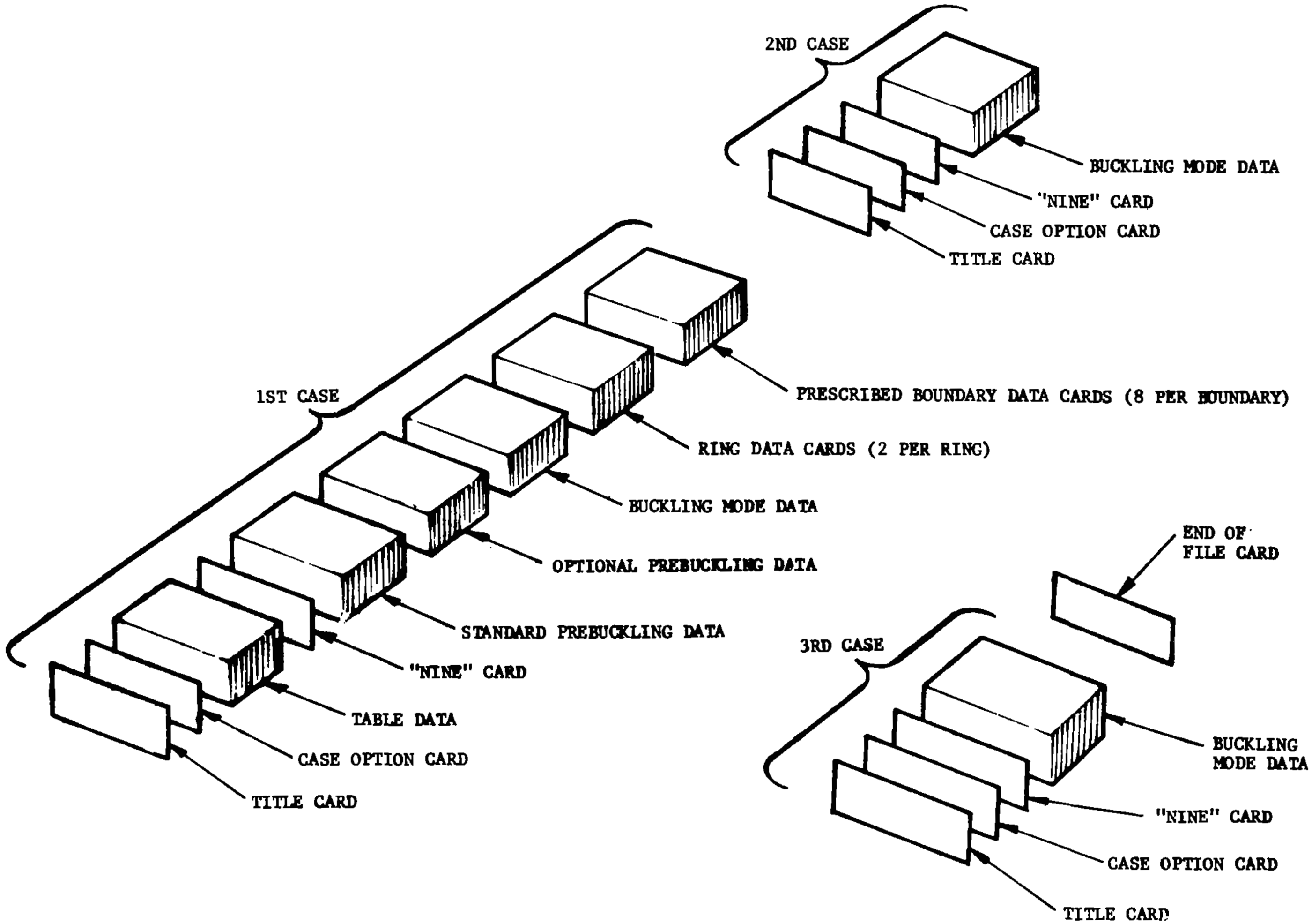


FIGURE 9. ILLUSTRATING DECK SET-UP FOR EVALUATION OF THREE BUCKLING MODES BASED ON SAME PREBUCKLING STATE

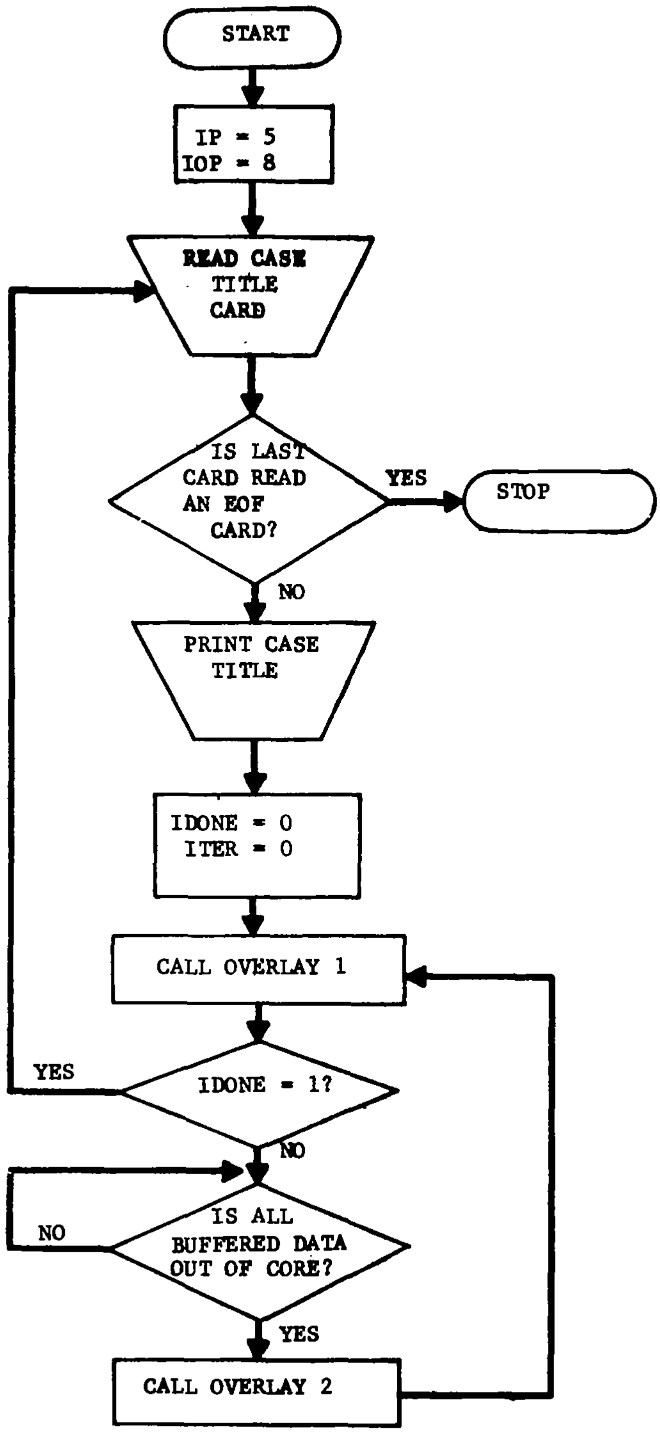


FIGURE 10. FLOW CHART OF MAIN