

E39348

1

NASA Technical Memorandum 78759

NASA-TM-78759:

SPINEQ: A Program for Determining
Aircraft Equilibrium Spin
Characteristics Including Stability

William M. Adams, Jr.

NOVEMBER 1978

NASA



LM136736E

M78-18937

NASA Technical Memorandum 78759

**SPINEQ: A Program for Determining
Aircraft Equilibrium Spin
Characteristics Including Stability**

William M. Adams, Jr.
Langley Research Center
Hampton, Virginia

NASA

National Aeronautics
and Space Administration

**Scientific and Technical
Information Office**

1978

CONTENTS

SUMMARY	1
INTRODUCTION	1
SYMBOLS	1
MATHEMATICAL MODEL AND SOLUTION TECHNIQUE	4
Coordinate Systems and Transformations	4
Mathematical Characterization of an Equilibrium Spin	6
System Linearized About an Equilibrium Spin Condition	10
PROGRAM DESCRIPTION	11
Overview of Program Flow	11
Functional Description of Major Subroutines and Definition of Key Parameters	12
SPINEQ Input Requirements	21
SPINEQ Output Identification	23
PROGRAM CHANGES FOR NEW CONFIGURATIONS	28
SPINEQ (Main Program)	29
AERO	29
STABLE	29
POTENTIAL SPINEQ APPLICATIONS AND MODIFICATIONS	29
PROGRAM AVAILABILITY	30
APPENDIX - INPUT AND OUTPUT FOR A SAMPLE CASE	31
REFERENCES	82

SUMMARY

A computer program, SPINEQ, is described which can algebraically solve the nonlinear equations of motion for equilibrium spin conditions. Linear characteristics of the airplane about the equilibrium points are also determined.

The theoretical basis of the program is outlined, computational flow is shown, the functions of major subroutines are described, and key parameters directing the computations are identified. Program input and output are described and illustrated by means of a test case. The program is available from COSMIC.

INTRODUCTION

This paper describes a computer program that was written to determine equilibrium spin characteristics. It is a modified version of the program that was employed to obtain the results presented in reference 1. Prior to the method described in reference 1, the analytical methods described in the literature for determining airplane equilibrium spin characteristics were the numerical integration of nonlinear equations of motion until approximately steady conditions were achieved (refs. 2, 3, 4, and 5) and the solution of a simplified set of equations for approximate equilibrium spin conditions (refs. 6, 7, and 8). In reference 1, a technique for determining equilibrium spin conditions by utilizing nonlinear programming techniques was described which, for a rigid airplane and given nonlinear aerodynamic data, could determine precise equilibrium spin conditions. Stability characteristics were also determined by linearization of the equations of motion about an equilibrium spin condition.

Included herein are brief descriptions of the mathematical model and the solution technique; a flow chart of the program; a description of the function of major subroutines, including key parameters controlling program operation; a description of input and output; and a test case, including sample input and output.

SYMBOLS

A, B	matrices in linearized state equation $\dot{\xi} = A\xi + Bu$
b	wing span
\bar{c}	mean aerodynamic chord
\vec{F}	external force vector
\vec{F}_A	aerodynamic force vector

f	vector of nonlinear functions yielding $f^T = (\dot{\alpha}, \dot{\beta}, \dot{V}/V, \dot{p}, \dot{q}, \dot{r})$
G	vector of nonlinear functions yielding $G^T = (\dot{\alpha}, \dot{\beta}, \dot{V}/V_0, \dot{p}, \dot{q}, \dot{r}, \dot{\theta}, \dot{\phi})$
g	acceleration due to gravity (assumed constant)
g_i	constraint function
g_u, g_l	upper and lower limits, respectively, on constrained variables
g_η	gradient of constraint functions with respect to η
\bar{g}	maximum ($g - g_u, g_l - g$)
h	aircraft altitude
\vec{I}	inertia tensor with moments and products of inertia computed about center of mass
J	function to be minimized in order to find equilibrium spin condition
J_η	vector of partial derivatives of J with respect to vector η
$J_{\eta\eta}$	matrix of second partial derivatives with respect to η
\bar{J}	augmented function, $\bar{J} = J + g^T K g$
K	diagonal matrix of weights that multiply constraint violations (described in discussion of DAVIDN subroutine)
M_X	rolling moment about X body axis
M_Y	pitching moment about Y body axis
M_Z	yawing moment about Z body axis
m	mass of airplane
p, q, r	angular rates about body axes
q_∞	dynamic pressure, $\frac{1}{2}\rho V^2$
$\hat{R}, \hat{T}, \hat{Z}_I$	unit vectors in cylindrical coordinates; \hat{Z}_I is directed toward center of Earth (fig. 3)
R	radius of helical path of airplane
S	wing area
T_1, T_2	matrices displaying coordinate system transformations (see figs. 1 and 2)

t	time
U	control vector, $U^T = (\delta_e, \delta_a, \delta_r)$
u	deviation from nominal control vector, $U(t) - U_N(t)$
u, v, w	components of velocity vector (see fig. 2)
V	airspeed
X, Y, Z	axes
x, y, z	position triple (when devoid of subscripts, a body-axis coordinate system is referred to)
α	angle of attack
β	angle of sideslip
γ	flight-path angle, $\tan^{-1}\left(\frac{\dot{h}}{V_H}\right)$
$\delta_e, \delta_a, \delta_r$	elevator, aileron, and rudder deflections (positive δ_e is trailing edge down, positive δ_a is right trailing edge down, positive δ_r is trailing edge left)
η^T	$= (\theta, \phi, \gamma, R, \dot{\psi}, \psi')$
Ξ^T	$= (\alpha, \beta, V/V_0, p, q, r, \theta, \phi)$
ξ	deviation from nominal value of Ξ
ρ	atmospheric density
ψ, θ, ϕ	angles defining transformation between inertial and body axes (see fig. 1)
ψ'	angle from horizontal projection of airplane longitudinal axis to horizontal component of \vec{V} , positive counterclockwise when looking up (see fig. 3)
ω	angular rate about center of mass, $\sqrt{p^2 + q^2 + r^2}$

Subscripts:

H	horizontal component
I	referred to inertial coordinate system
N	nominal value
o	evaluated at initial time

s stall angle
w referred to wind axis system

Special symbols:

- ($\hat{}$) unit vector
- ($\vec{}$) vector
- (\leftrightarrow) tensor of second rank
- ($\dot{}$) derivative with respect to time
- ()^T transpose of matrix
- ()^{*} value which minimizes J
- { } column vector,

MATHEMATICAL MODEL AND SOLUTION TECHNIQUE

The airplane equations of motion and an algebraic method of solving them for equilibrium spin conditions by using nonlinear programming techniques are discussed in this section. The solutions that are obtained satisfy the requirements of a steady developed spin if the equilibrium points are stable. Solutions having linear representations that are unstable either correspond to oscillatory spin conditions or are not actual developed spin conditions.

Coordinate Systems and Transformations

Three coordinate systems are employed in this analysis. These are an inertial set, a set fixed in the body, and a wind axis set. The rotations involved in transforming from one set of axes to another are shown in figures 1 and 2.

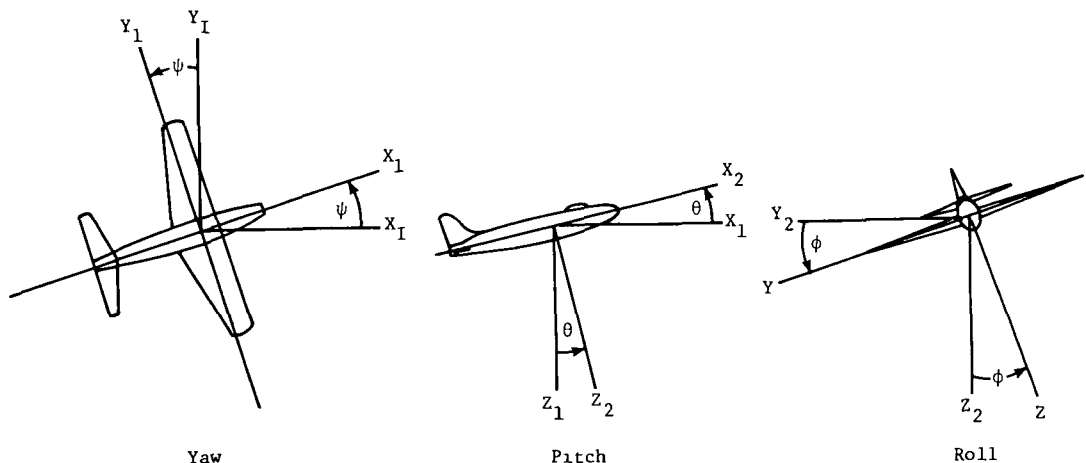


Figure 1.- Inertial axes to body axes transformation (numbered subscripts refer to intermediate axes).

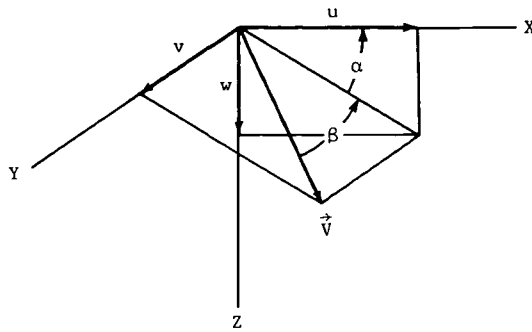


Figure 2.- Wind axes to body axes transformation.

In figure 1, the airplane is viewed toward the origin from a point on a positive axis. Transformations are as follows:

- (a) Inertial axes to body axes (\hat{Z}_I is in the direction of the force due to gravity)

$$\begin{Bmatrix} \hat{x} \\ \hat{y} \\ \hat{z} \end{Bmatrix} = T_1(\psi, \theta, \phi) \begin{Bmatrix} \hat{x}_I \\ \hat{y}_I \\ \hat{z}_I \end{Bmatrix}$$

$$T_1 = \begin{bmatrix} \cos \psi \cos \theta & \sin \psi \cos \theta & -\sin \theta \\ \cos \psi \sin \theta \sin \phi & \cos \psi \cos \phi & \cos \theta \sin \phi \\ -\sin \psi \cos \phi & +\sin \psi \sin \theta \sin \phi & \\ \cos \psi \sin \theta \cos \phi & \sin \psi \sin \theta \cos \phi & \cos \theta \cos \phi \\ +\sin \psi \sin \phi & -\cos \psi \sin \phi & \end{bmatrix}$$

- (b) Body axes to wind axes

$$\begin{Bmatrix} \hat{x}_w \\ \hat{y}_w \\ \hat{z}_w \end{Bmatrix} = T_2(\alpha, \beta) \begin{Bmatrix} \hat{x} \\ \hat{y} \\ \hat{z} \end{Bmatrix}$$

where α (angle of attack) and β (angle of sideslip) are wind incidence angles positive as shown in figure 2 and

$$T_2 = \begin{bmatrix} \cos \beta & \sin \beta & 0 \\ -\sin \beta & \cos \beta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos \alpha & 0 & \sin \alpha \\ 0 & 1 & 0 \\ -\sin \alpha & 0 & \cos \alpha \end{bmatrix}$$

Mathematical Characterization of an Equilibrium Spin

Equilibrium spin conditions can be stated mathematically as follows. Figure 3 will aid in the interpretation of some of the terms.

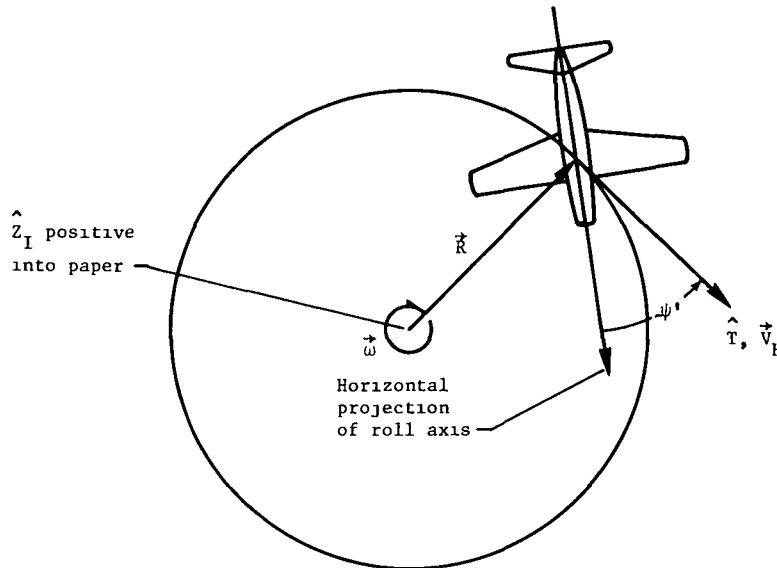


Figure 3.- Top view of helical path.

$$\alpha > \alpha_S \quad \left(\text{Angle of attack is above stall} \right) \quad (1)$$

$$\vec{\omega} = \dot{\psi} \hat{Z}_I \quad \left(\text{Angular velocity of airplane about its center of mass is vertical} \right) \quad (2)$$

$$\vec{V} = R\dot{\psi} \hat{T} - h\dot{Z}_I \quad \left(\text{Trajectory is along a helical path with vertical helix axis } \left(\hat{T} = \hat{Z}_I \times \hat{R} \right) \right) \quad (3)$$

$$\vec{\dot{\omega}} = \begin{Bmatrix} \dot{p} \\ \dot{q} \\ \dot{r} \end{Bmatrix} = \{0\} \quad \left(\text{Constant angular velocity} \right) \quad (4)$$

$$\vec{F} = -mR\omega^2 \hat{R} \quad \left(\text{Force is such that helical motion persists} \right) \quad (5)$$

In these equations, thrust effects have been ignored and variation of density with altitude has been neglected.

The aerodynamic forces in SPINEQ are expressed relative to a body-fixed nonprincipal set of axes for which the equations of motion are given by

$$m\dot{\vec{V}} + \vec{\omega} \times m\vec{V} = \vec{F} = \vec{F}_A + mg\hat{Z}_I \quad (6)$$

$$\dot{\vec{I}} \cdot \vec{\omega} + \vec{\omega} \times (\vec{I} \cdot \vec{\omega}) = \vec{M} \quad (7)$$

Here \vec{F} is composed of forces of aerodynamic and gravitational origin. The moments \vec{M} are due to aerodynamic forces only. The aerodynamic force coefficients and their derivatives are defined in the tabulations that follow:

Rolling moment	Yawing moment	Y body axis force component
$C_l = \frac{M_X}{q_\infty S b}$	$C_n = \frac{M_Z}{q_\infty S b}$	$C_Y = \frac{F_{AY}}{q_\infty S}$
$C_{l\delta_a} = \frac{\partial C_l}{\partial \delta_a}$	$C_{n\delta_a} = \frac{\partial C_n}{\partial \delta_a}$	$C_{Y\delta_a} = \frac{\partial C_Y}{\partial \delta_a}$
$C_{l\delta_e} = \frac{\partial C_l}{\partial \delta_e}$	$C_{n\delta_e} = \frac{\partial C_n}{\partial \delta_e}$	$C_{Y\delta_e} = \frac{\partial C_Y}{\partial \delta_e}$
$C_{l\delta_r} = \frac{\partial C_l}{\partial \delta_r}$	$C_{n\delta_r} = \frac{\partial C_n}{\partial \delta_r}$	$C_{Y\delta_r} = \frac{\partial C_Y}{\partial \delta_r}$
$C_{l_p} = \frac{\partial C_l}{\partial \frac{pb}{2V}}$	$C_{n_p} = \frac{\partial C_n}{\partial \frac{pb}{2V}}$	$C_{Y_p} = \frac{\partial C_Y}{\partial \frac{pb}{2V}}$
$C_{l_r} = \frac{\partial C_l}{\partial \frac{rb}{2V}}$	$C_{n_r} = \frac{\partial C_n}{\partial \frac{rb}{2V}}$	$C_{Y_r} = \frac{\partial C_Y}{\partial \frac{rb}{2V}}$

Pitching moment
$C_m = \frac{M_Y}{q_\infty S \bar{c}}$
$C_{m\delta_e} = \frac{\partial C_m}{\partial \delta_e}$
$C_{mq} = \frac{\partial C_m}{\partial \frac{q\bar{c}}{2V}}$

X body axis force component
$C_X = \frac{F_{AX}}{q_\infty S}$
$C_{X\delta_e} = \frac{\partial C_X}{\partial \delta_e}$

Z body axis force component
$C_Z = \frac{F_{AZ}}{q_\infty S}$
$C_{Z\delta_e} = \frac{\partial C_Z}{\partial \delta_e}$

These coefficients are assumed to be nonlinear functions of α (angle of attack) and, in some cases, of β (angle of sideslip). A precise definition of the form assumed for these coefficients is given as follows. Instructions are given in a later section for modification of this form when necessary.

$$C_X = C_X(\alpha, \beta, U=0) + C_{X\delta_e}(\alpha, \beta) \delta_e$$

$$C_Y = C_Y(\alpha, \beta, U=0) + C_{Y\delta_e}(\alpha, \beta) \delta_e + C_{Y\delta_a}(\alpha, \beta) \delta_a + C_{Y\delta_r}(\alpha, \beta) \delta_r + \frac{b}{2V} [C_{Yp}(\alpha) p + C_{Yr}(\alpha) r]$$

$$C_Z = C_Z(\alpha, \beta, U=0) + C_{Z\delta_e}(\alpha, \beta) \delta_e$$

$$C_l = C_l(\alpha, \beta, U=0) + C_{l\delta_e}(\alpha, \beta) \delta_e + C_{l\delta_a}(\alpha, \beta) \delta_a + C_{l\delta_r}(\alpha, \beta) \delta_r + \frac{b}{2V} [C_{lp}(\alpha) p + C_{lr}(\alpha) r]$$

$$C_m = C_m(\alpha, \beta, U=0) + C_{m\delta_e}(\alpha, \beta) \delta_e + \frac{\bar{c}}{2V} C_{mq}(\alpha) q$$

$$C_n = C_n(\alpha, \beta, U=0) + C_{n\delta_e}(\alpha, \beta) \delta_e + C_{n\delta_a}(\alpha, \beta) \delta_a + C_{n\delta_r}(\alpha, \beta) \delta_r + \frac{b}{2V} [C_{np}(\alpha) p + C_{nr}(\alpha) r]$$

In SPINEQ, the force equations have been transformed to the wind axis system and solved for $\dot{\alpha}$, $\dot{\beta}$, and \dot{V} . A search is then made for the aircraft state which meets the helical motion requirements of equations (2) and (3) and the following conditions for equilibrium:

$$\begin{pmatrix} \dot{\alpha} \\ \dot{\beta} \\ \dot{V} \\ \dot{p} \\ \dot{q} \\ \dot{r} \end{pmatrix} = \{0\}$$

The number of independent variables required to specify this state is reduced from 12 to 6 by satisfying the equality constraints of equations (2) and (3) explicitly and by arbitrarily setting $\psi(t^*) = 0$. A search is made over the set of variables

$$\eta = \begin{pmatrix} \theta \\ \phi \\ \gamma \\ R \\ \dot{\psi} \\ \psi' \end{pmatrix}$$

where R and ψ' are defined in figure 3 and γ is the flight-path angle. The search, therefore, is for a vector η^* for which

$$\begin{pmatrix} \dot{\alpha}^* \\ \dot{\beta}^* \\ \frac{\dot{V}^*}{V^*} \\ \dot{p}^* \\ \dot{q}^* \\ \dot{r}^* \end{pmatrix} = f(\eta^*) = \{0\}$$

The search for η^* is made by finding the $\eta = \eta^*$ which minimizes

$$J(\eta) = \sum_{i=1}^6 f_i^2 = \dot{\alpha}^2 + \dot{\beta}^2 + \frac{\dot{V}^2}{V} + \dot{p}^2 + \dot{q}^2 + \dot{r}^2$$

subject to the previously mentioned constraints. If $\alpha > \alpha_S$ and $J(\eta^*) = 0$, an equilibrium spin has been found.

The solution for η^* is obtained in an iterative manner, beginning with an initial estimate η_1 . The method of search is initially equivalent to a gradient procedure, but second-order information is accumulated during the iterations and quadratic convergence is approached near the end of the iterations. Thus, the method initially has the sureness of convergence toward a local minimum of a gradient procedure. Near the solution, the rapidness of convergence of a second-order method is approached without computing and inverting the matrix of the second partial derivatives at each point. The method employed is Davidon's (ref. 9), as modified by Fletcher and Powell (ref. 10). A refinement phase is then entered which uses the accumulated second-order information to perform a search by using Newton's method. The program which served as the basis for SPINEQ is described in reference 11.

The user may occasionally encounter convergence difficulties. A local minimum may be found for which $J(\eta^*) \neq 0$, in which case an alternate initial guess should be employed. The program may also fail to converge as a result of discontinuities in slope which arise from the interpolation routine chosen to find the aerodynamic coefficients. Three options for performing the interpolation are provided. One of these is a cubic spline technique which produces continuous first derivatives.

System Linearized About an Equilibrium Spin Condition

A linearized representation of the airplane equations of motion is developed in order to obtain some information about the stability of the equilibrium spin conditions. The linear representation neglects density variation with altitude and only includes those states which effect the forces and moments. Define \bar{E} such that

$$\bar{E}^T(t) = (\alpha, \beta, V/V_0, p, q, r, \theta, \phi)$$

where

$$\dot{\bar{E}}(t) = G[\bar{E}(t), U(t)]$$

to first order

$$\dot{\xi}(t) = \dot{\Xi}(t) - \dot{\Xi}_N(t) = \left(\vec{V}_{\Xi G} \right)_N^T \xi + \left(\vec{V}_{UG} \right)_N^T [U(t) - U_N(t)]$$

or

$$\dot{\xi}(t) = A(t)\xi(t) + B(t)u(t)$$

The elements of A and B are shown explicitly in appendix C of reference 1. For an equilibrium condition, A and B are constant matrices.

All stable eigenvalues indicate a return to the equilibrium spin conditions for sufficiently small deviations. Additional analysis would be required to determine whether a solution with an unstable linear representation is an oscillatory or a no-spin solution.

PROGRAM DESCRIPTION

Overview of Program Flow

Mathematical statement.- The mathematical statement of the problem solved is as follows:

Object: Find the η^* which minimizes

$$J(\eta) \quad \eta \text{ is } N \times 1$$

subject to the constraints

$$\bar{g}(\eta) \leq \{0\} \quad \bar{g} \text{ is } m \times 1$$

where m is the number of elements of \bar{g} .

Approach: Form

$$\bar{J} = J + \sum_{i=1}^m K_1 \left[\max(\bar{g}_i, 0) \right]^2$$

Find the $\eta = \eta^*$ which minimizes \bar{J} as $K_1 \rightarrow \infty$ for $i = 1, m$. The η^* which minimizes $\bar{J}(\eta)$ as $K_1 \rightarrow \infty$ solves the problem (ref. 12).

Numerical implementation.- The computations performed in obtaining a solution are indicated in figure 4. This figure presents an overview of the computational flow. Some subroutines that are contained in the program are not shown.

Functional Description of Major Subroutines
and Definition of Key Parameters

SPINEQ (Main Program)

Purpose:

- (1) Directs computation
- (2) Input of all data here (i.e., aerodynamic tables, mass, inertia, geometric characteristics, weights, tolerances, and boundaries associated with constraints and initial solution estimate)
- (3) Decides upon the number of DAVIDN phases and whether to refine the solution by using Newton's method
- (4) Calls STABLE to get linear characteristics

Subroutines called:

Name	Information obtained
DAVIDN	$\left\{ \begin{array}{l} \text{Minimum of augmented function} \\ H \approx (\bar{J}_{\eta\eta})^{-1} \end{array} \right.$
FFXGGX	Full output of information of interest at end of DAVIDN phase
NEWT	Solution for $\bar{J}_{\eta} = \{0\}$, $\bar{g} = \{0\}$; treating all violated constraints as equality constraints
AT62	Density at altitude specified by input (ref. 13)
STABLE	$\left\{ \begin{array}{l} \text{Linear representation of system about an equilibrium point} \\ \text{Eigenvalues and eigenvectors of linear system} \end{array} \right.$

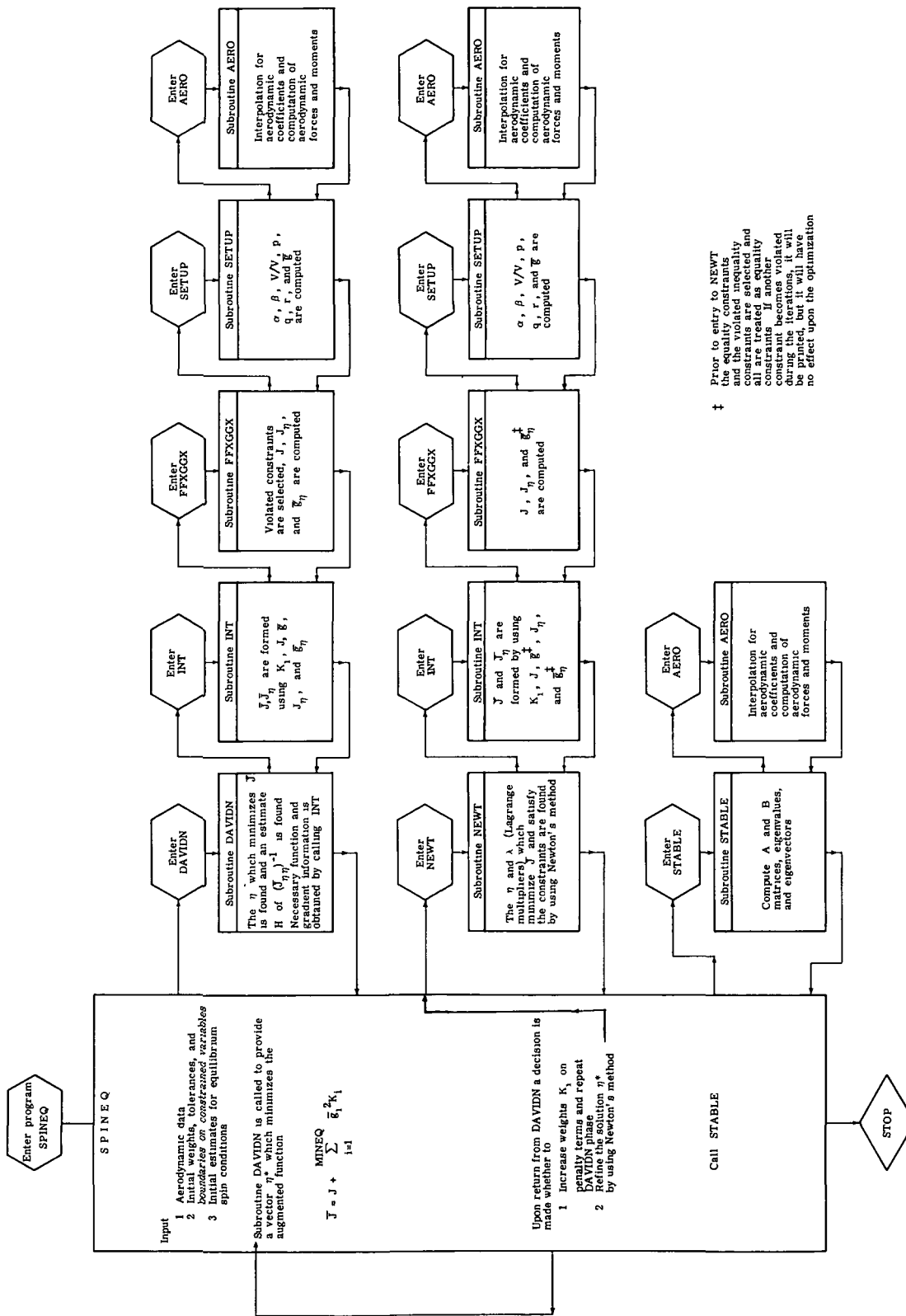


Figure 4.- SPINEQ flow chart.

Key parameters:

Name	Description
N,MEQ,MINEQ	Number of independent variables, equality constraints, and inequality constraints, respectively
ISOFA = 1	See discussion of FFXGGX
I5	Dummy variable used to decide when to end run (if I5 = 999 execution is ended)
IALPHA,IBETA	Type of interpolation to perform in determining the aerodynamic coefficients
DELF	Convergence criterion for DAVIDN
IPART	$IPART = \begin{cases} 1 & \text{Evaluation of gradient and full output} \\ 0 & \text{Evaluation of gradient and reduced output} \\ -1 & \text{No gradient evaluation and reduced output} \end{cases}$
IPERM	$IPERM = \begin{cases} \leq 0 & \text{Reordering of } \bar{g} \text{ array (violations moved to top)} \\ > 0 & \text{No reordering of } \bar{g} \text{ (some reordering could have been done previously)} \end{cases}$
NUMB	Number of cases that have been studied so far in a given run

DAVIDN

Purpose:

- (1) Finds the minimum of the augmented function \bar{J} , given a set of weights associated with the constraint violations
- (2) Determines an estimate of the inverse of the second derivative of the augmented function \bar{J}

$$H = \bar{J}_{\eta\eta}^{-1}$$

- (3) Outputs descriptive parameters

Subroutines called:

Name	Information obtained
INT	Value of augmented function at particular points Augmented gradient at start of each one-dimensional minimization
CUBIC	Coefficients are determined which fit a cubic through last four points evaluated during a one-dimensional search Point (lying between the data points) at which this function has a minimum
MATIN	Determinant of H to check that it remains positive definite. This is an expensive bit of information which could, perhaps, be deleted except when convergence difficulties are occurring

An overview of DAVIDN operation:

- (1) An initial step size for the one-dimensional search is selected (CCAY).
- (2) A direction of search $(-H\bar{J}_\eta)$ is defined.
- (3) A one-dimensional search is performed which finds the scalar α such that $\bar{J}(\eta - \alpha H\bar{J}_\eta)$ is the minimum of \bar{J} in the direction of $d^1 = -H\bar{J}_\eta$.
- (4) The metric H is augmented. (See ref. 10.)
- (5) Several stopping criteria are examined:
 - (a) If the number of one-dimensional minimizations performed is less than N, the dimension of η , continue the iterations.
 - (b) If the number of one-dimensional minimizations performed is greater than 120, stop (failure to converge).
 - (c) If $|\bar{J}(\eta - \alpha H\bar{J}_\eta) - \bar{J}(\eta)| < 10^{-10}$, a minimum has been found.
 - (d) If $|\bar{J}(\eta - \alpha H\bar{J}_\eta) - \bar{J}(\eta)| / \bar{J}(\eta) < \text{DELF}$, a minimum has been found.

Other stopping criteria are suggested in reference 10 and could easily be added.

- (6) If another one-dimensional minimization is required, the initial step is taken to be equal to the α found in the previous one-dimensional search and steps (2) to (5) are repeated.

Key parameters:

Name	Description
N	Number of variables in η vector
CCAY	Initial step size taken at the start of each one-dimensional minimization
ICNT	Number of one-dimensional minimizations performed
ITT	Total number of function (\bar{J}) evaluations made during a particular Davidon phase
DELF	Stopping criteria referring to relative change in \bar{J} between succeeding one-dimensional minimizations
CAYMIN	Scalar which defines the step, in a specified direction, which minimizes \bar{J}
P	<div style="display: flex; align-items: center;"> <div style="font-size: 3em; margin-right: 10px;">{</div> <div> <p>Below statement 2003, this is a vector in the direction of one-dimensional search</p> <p>Below statement 31 in DAVIDN, P is actual step made</p> </div> </div>
IPART	Defined previously in description of SPINEQ
IPERM	Defined previously in description of SPINEQ (>0 is not allowed because it would prevent the effect of a new constraint violation from entering)

CUBIC

Purpose:

- (1) Fits a cubic equation to data generated during the one-dimensional search
- (2) Finds the value of α , the scalar search parameter, for which this cubic has a minimum in the vicinity of the four data points used to construct the cubic

Subroutine called:

Name	Information obtained
MATIN	Coefficients of cubic equation

MATIN

Purpose:

- (1) Finds the inverse of a square matrix and its determinant
- (2) Solves a matrix equation $Ax = y$

INT

Purpose:

- (1) Evaluation of the augmented function \bar{J}
- (2) Evaluation of the gradient of the augmented function \bar{J}_η if a one-dimensional search is being initiated

Subroutine called:

Name	Information obtained	
FFXGGX	{	Value of unaugmented function
		Constraint violations
		Gradient of unaugmented function
		Gradient of constraint violations

Key parameters:

Name	Description
N	Number of elements of η
MC	Number of constraint violations
IPART	Previously defined in SPINEQ

FFXGGX

Purpose:

- (1) Determines the values of the constraint and unaugmented function values

- (2) Reorders the elements of the constraint vector when required to move those that are violated to the top portion of the constraint vector array
- (3) Computes, when required, the gradient of the unaugmented function and of the constraints

Subroutine called:

Name	Information obtained
SETUP	$\left\{ \begin{array}{l} \text{Vector of constraints } \bar{g} \\ \text{Vector } f \text{ used to compute unaugmented} \\ \text{function value} \end{array} \right.$

Key parameters:

Name	Description
ISOFA	$ISOFA = \left\{ \begin{array}{l} 1 \text{ Increment is defined in elements} \\ \text{of } \eta \text{ for perturbing for genera-} \\ \text{tion of numerical partials} \\ 2 \text{ Increment has been defined; not done} \\ \text{again} \end{array} \right.$
Iperm	$Iperm = \left\{ \begin{array}{l} \leq 0 \text{ All constraint violations are moved} \\ \text{to top of } \bar{g} \text{ array} \\ > 0 \text{ } \bar{g} \text{ is not reordered from what it was} \\ \text{before this entry into FFXGGX. It} \\ \text{may have been reordered previously.} \end{array} \right.$

SETUP

Purpose:

Takes the vector η and determines f and \bar{g} .

Subroutine called:

Name	Information obtained
AERO	Aerodynamic forces and moments

Key parameters:

Name	Description
η	Vector of variables
Inertial and geometric data	See list of symbols
ρ	Atmospheric density
g_u, g_l	Upper and lower limits, respectively, on constrained variables

AERO

Purpose:

- (1) Interpolates aerodynamic tables for aerodynamic force and moment coefficients
- (2) Computes aerodynamic forces and moments

Subroutines called:

Name	Information obtained
IUNI	Interpolated aerodynamic coefficients that are a function of α only for linear or quadratic fit
CSIUNI	Interpolated aerodynamic coefficients that are a function of α only for cubic spline fit
IBI	Interpolated aerodynamic coefficients that are a function of α and β for linear or quadratic fit
CSIBI	Interpolated aerodynamic coefficients that are a function of α and β for cubic spline fits

Key parameters:

Name	Description
IALPHA, IBETA	Variables defining the type of interpolation:
IALPHA, IBETA =	{
	1 Linear
	2 Quadratic
	3 Cubic spline

NEWT

Purpose:

Determine variables and Lagrange multipliers at which the first derivative of the augmented function vanishes and at which the constraint violations (all taken to be equality constraints) vanish.

Subroutines called:

Name	Information obtained								
MATIN	Inverse of $\bar{g}H\bar{g}^T$								
FFXGGX	<table border="0" style="font-size: 3em; vertical-align: middle;"> <tr><td style="font-size: 1.5em;">{</td><td>Value of unaugmented function</td></tr> <tr><td></td><td>Values of gradient of unaugmented function</td></tr> <tr><td></td><td>Values of selected constraint variables</td></tr> <tr><td></td><td>Values of gradient of these violations</td></tr> </table>	{	Value of unaugmented function		Values of gradient of unaugmented function		Values of selected constraint variables		Values of gradient of these violations
{	Value of unaugmented function								
	Values of gradient of unaugmented function								
	Values of selected constraint variables								
	Values of gradient of these violations								

Key parameters:

Name	Description
MC	Number of violated constraints (remains constant throughout the Newton-Raphson phase ($0 < MC < N$))
IPERM	Must be >0 , which means that if a new constraint violation occurs during iterations, it will not be considered
IPART	Defined in SPINEQ; -1 is not allowed

STABLE

Purpose:

- (1) Gets linearized representation of the system about an equilibrium point
- (2) Gets eigenvalues and eigenvectors of the resulting system matrix

Subroutines called:

Name	Information obtained
AERO	<ul style="list-style-type: none"> { Aerodynamic forces and moments { Aerodynamic force and moment coefficients
REQR	Eigenvalues and eigenvectors of system matrix

SPINEQ Input Requirements

Variables	Format	Description
IALPHA, IBETA, IAEROUT, IDEG	4I5	IALPHA, IBETA Type of fit with respect to α and β
		<ul style="list-style-type: none"> IALPHA, IBETA = { 1 Linear { 2 Quadratic { 3 Cubic spline
		<ul style="list-style-type: none"> IAEROUT = { 0 No aerodynamic output { 1 Aerodynamic tables output
		<ul style="list-style-type: none"> IDEG = { 0 ALPHAT, BETAT are input in radians { 1 Convert ALPHAT, BETAT to radians
ALPHAT(I), I=1, NPTSA	9F8.5	Tabular array of α at which aerodynamic data are given
BETAT(I), I=1, NPTSB	9F8.5	Tabular array of β at which aerodynamic data are given
((CD(I, J, K), I=1, NPTSA), J=1, NPTSB), K=1, NTABD)	9F8.5	NTABD tables of aerodynamic coefficients that are function of both α and β

Variables	Format	Description
((CS(I,J), I=1,NPTSA), J=1,NTABS)	9F8.5	NTABS tables of aerodynamic coefficients that are functions of α
NOTE: See the listing of subroutine AERO to find the necessary correspondence between CD and CS and the physically meaningful coefficients (e.g., C_X, C_Y, C_Z) and arrange your tables to correspond.		
B,ELL,S,EM	4E20.8	Span, mean aerodynamic chord, wing area or appropriate reference area, total mass
EIX,EIY,EIZ,EIXZ	4E20.8	$I_{XX}, I_{YY}, I_{ZZ}, I_{XZ}$ about the center of mass
GRAV,CONFAC1, CONFAC2	4E20.8	GRAV Acceleration of gravity CONFAC1 Factor to convert H_0 to feet for AT62, default is 1 CONFAC2 Factor to convert density in slugs/ft ³ output by AT62 to desired units, default is 1
(SU(I), I=1,9)	4E16.8	Upper limits on variables which may be constrained $SU(1) = \gamma_{max}$ $SU(6) = V_{max}$ $SU(2) = \alpha_{max}$ $SU(7) = \delta_{e,max}$ $SU(3) = \omega_{max}$ $SU(8) = \delta_{a,max}$ $SU(4) = \beta_{max}$ $SU(9) = \delta_{r,max}$ $SU(5) = \psi'_{max}$
(SL(I), I=1,9)	4E16.8	Lower limits on the previously defined variables which may be constrained

NOTE: In SPINEQ runs to date, constraints have generally been placed only upon γ . The user may wish to redefine the constraint variables, in which case changes would be required in both SPINEQ and SETUP. This would very likely be the case if the program were modified to compute trim conditions for maneuvers.

Variables	Format	Description
(CKAY(I), I=1,9)	4E16.8	Weights corresponding to previous constraint possibilities
(GEPSS(I), I=1,9)	4E16.8	Tolerances on violations of constraints
N,MEQ,MINEQ	3I5	Number of variables, equality constraints, and inequality constraints, respectively
NOTE: No provision has been made in SPINEQ for equality constraints so MEQ must be zero. If it is desired in a modification to include equality constraints, changes would be required in SPINEQ and SETUP.		
HO	E20.8	Altitude at which equilibrium spin conditions are desired
I5	I5	Stopping parameter at the beginning of a loop for multiple cases. If I5 ≠ 999, another case is to be run
(XBARO(I), I=1,6)	3E20.9	Initial estimate for equilibrium spin conditions
DE,DA,DR	3E20.8	Fixed control settings for elevator, ailerons, and rudder, respectively

An example of the input for a test case is presented in the appendix. The core required for this run was 105 000 octal to load and 72 000 octal for job execution. Job execution time was 18 sec on a Control Data CYBER 173 Computer System. Job execution cost was two dollars.

SPINEQ Output Identification

The outputs from each subroutine are listed in the order that they occur within that subroutine. This does not, in all cases, correspond to the actual order of output.

SPINEQ

(1) IALPHA, IBETA

Types of aerodynamic fit:

$$IALPHA, IBETA = \begin{cases} 1 & \text{Linear} \\ 2 & \text{Quadratic} \\ 3 & \text{Cubic spline} \end{cases}$$

(2) IDEG, IAEROUT

$$IDEG = \begin{cases} 1 & \text{Convert } \alpha \text{ and } \beta \text{ to radians} \\ 0 & \alpha \text{ and } \beta \text{ have been input in} \\ & \text{radians} \end{cases}$$

$$IAEROUT = \begin{cases} 1 & \text{Output aerodynamic tables} \\ 0 & \text{No aerodynamic table outputs} \end{cases}$$

If IAEROUT = 0, skip (3).

(3) ALPHAT ARRAY
BETAT ARRAY
FUNCTIONS of α and β
FUNCTIONS of β

Output α and β values where aerodynamic data are defined and then output the aerodynamic data

(4) B, L, S, MASS

Span, mean aerodynamic chord, wing area, and mass, respectively

(5) IX, IY, IZ, IXZ

$I_{XX}, I_{YY}, I_{ZZ}, I_{XZ}$, respectively, about center of mass

(6) GAMMA, ALPHA, OMEGA,
BETA, PSIPR, V

Upper and lower constraints on γ , α , ω , β , ψ' , and V , respectively

(7) DEMAX, DAMAX, DRMAX

Upper limits on δ_e , δ_a , and δ_r , respectively

(8) DEMIN, DAMIN, DRMIN

Lower limits on δ_e , δ_a , and δ_r , respectively

(9) HO, GRAV

Altitude and gravitational acceleration, respectively

(10) CONFAC1, CONFAC2

Conversion factors; defined in list of input; related to input to and resulting output from AT62

- | | |
|---|---|
| (11) DENSITY | Density at which an equilibrium spin condition is sought |
| (12) N,MEQ,MINEQ | Number of variables, equality constraints, and inequality constraints, respectively |
| (13) THETA,PHI,GAMMA,
RADIUS,PSIDT,PSI | Initial estimate for equilibrium spin conditions ($\theta, \phi, \gamma, R, \psi, \psi'$) |
| (14) DE,DA,DR | Fixed control setting for elevator, aileron, and rudder, respectively |
| (15) GBAR,TOLERANCE,WEIGHT | Constraints, tolerances, and weights, respectively |
| (16) FXX | H matrix at the end of a DAVIDN phase |

FFXGGX

- | | |
|----------------------|--|
| (1) (GBAR(I),I=1,MC) | Output of constraints (only output if IPART > 0) |
| (2) (FX(I),I=1,N) | Gradient of unaugmented function (only output if IPART \geq 0) |

SETUP (No output unless IPART > 0)

- | | |
|---------------------------|--|
| (1) RA,PSIDT,GAMMAH,THETA | $R, \dot{\psi}, \gamma, \theta$ |
| (2) PHI,VH,VV,V | ϕ, V_H, V_V, V |
| (3) P,Q,R | p, q, r |
| (4) ALPHAD,BETAD | α and β (in degrees) |
| (5) E1,E2,E3 | $\dot{\alpha}, \dot{\beta}, \dot{V}/V$ |
| (6) E4,E5,E6 | $\dot{p}, \dot{q}, \dot{r}$ |

DAVIDN

- | | |
|----------------------|--|
| (1) CYCLE | Number of one-dimensional iterations performed in this Davidon phase |
| (2) (ALPHA(I),I=1,N) | Current estimate of the η which minimizes the function |

(3) DFDK	Inner product of \bar{J}_η and vector defining the direction of search
(4) (FX(I), I=1,N)	Gradient of the augmented function
(5) KMIN	Scalar at which $\bar{J}(\eta + KMIN*P)$ is a minimum in direction of vector P (P is not normalized)
(6) F1	Value of \bar{J} before current one-dimensional minimization
(7) F2	Value of \bar{J} at new η after one-dimensional minimization has been performed
(8) DELXFX	Inner product of previous direction of search and gradient evaluated at point where one-dimensional minimum was found. Product should be zero if determination of the one-dimensional minimum were precise
(9) DETERM	<div style="display: flex; align-items: center;"> <div style="font-size: 4em; margin-right: 10px;">{</div> <div> <p>The first time, this is the (1,1) element of the H matrix, which should be positive</p> <p>The second time, it is the determinant of H which should be positive</p> </div> </div>
(10) IT	Number of function evaluations called for to date in DAVIDN
(11) H	Matrix which approximates the inverse of second partial derivatives of augmented function

NEWT

If MC = 0, skip down to output (12). The variable MC is the number of equality constraints plus violated inequality constraints at the end of the DAVIDN phase.

(1) AMBDA	Initial estimate of the Lagrange multiplier. AMBDA(I) = KBAR(I)*GBAR(I)
(2) FALPHA	Gradient of \bar{J} with respect to η

(3) ALPHA	Initial estimate of η^* (the minimizing η upon entry into NEWT)
(4) GBAR	The vector of violated constraints, all of which are treated as equality constraints
(5) ICOUNT	Counter of the number of iterations performed in NEWT
(6) D	Product of $(\bar{g} \ H \ \bar{g}^T)(\bar{g} \ H \ \bar{g}^T)^{-1}$; computed to check on goodness of inverse
(7) ALPHA	Current estimate of η^*
(8) F	\bar{J}
(9) AMDA	Current estimate of Lagrange multipliers
(10) FALPHA	\bar{J}_η
(11) GBAR	Current values for constraint violations

Sequence (7) to (11) is repeated until convergence is achieved. One skips from the beginning to output (12) if $MC = 0$.

(12) FALPHA	Initial value of \bar{J}_η
(13) ALPHA	Initial estimate of η^* upon entry into NEWT
(14) ICOUNT	Counter of the number of iterations within NEWT
(15) ALPHA	Current estimate of η^*
(16) F	Current value of J
(17) FALPHA	J_η

Sequence (14) to (17) is repeated until convergence is achieved.

STABLE

(1) CONTROLS	$\delta_e, \delta_a, \delta_r$
(2) THETA, PHI, GAMMA	θ, ϕ, γ

(3) RADIUS, PSIDT, PSI PRIME	$R, \dot{\psi}, \psi'$
(4) ALPHA, BETA, V	α, β, v
(5) P, Q, R	p, q, r
(6) X, Y, Z	Coordinates of R
(7) TRANSPOSE OF THE GRADIENT OF F WITH RESPECT TO CONTROLS	F_U^T
(8) TRANSPOSE OF THE GRADIENT OF F WITH RESPECT TO STATE	F_η^T
(9) ROOTS OF FX	Eigenvalues of F_η
(10) ROOTS IN POLAR FORM	Eigenvalues of F_η expressed in polar form
(11) EIGENVECTORS IN POLAR FORM	Eigenvectors expressed in polar form

AERO

(1) ALPHA, BETA	α and β values at initial call to AERO
(2) ALPHAT	α points at which data are avail- able. This is output only for the initial call to AERO
(3) BETAT	β points at which data are avail- able. This is output only for the initial call to AERO
(4) COEFF	Values of the aerodynamic coeffi- cients at the initial call to AERO

Outputs 1 to 4 are debugging aids and could be deleted whenever desired. Output for a test case configuration is presented in the appendix.

PROGRAM CHANGES FOR NEW CONFIGURATIONS

When a new configuration is to be analyzed, some changes will typically be necessary in the program. The changes arise because of differences in the complexity of the aerodynamic model for a new configuration. An effort has been

made to limit the resulting programing changes to a few specific locations. These locations and the types of changes required will now be described.

SPINEQ (Main Program)

Specific values, which are dimensions required for the aerodynamic data, are assigned to several variables. No changes in dimension or common statements are required.

NTABD	Number of coefficients that are a function of both α and β
NTABS	Number of coefficients that are only a function of α
NPTSA	Number of values of α at which aerodynamic data are available
NPTSB	Number of values of β at which aerodynamic data are available

AERO

Currently it is assumed that there are 25 aerodynamic coefficients that define the aerodynamic representation. A specific correspondence is made in AERO between these coefficients and the elements of an array given the name COEFF. It might well be that only 20 coefficients will be available for a new configuration. The user will have to make the proper correspondence between variables such as C_z and C_{m_q} and his COEFF array and then zero out the physical coefficients that are either not available or are neglected.

If new coefficients other than those now considered are to be added, the new coefficients will have to be defined in AERO and passed to STABLE through COMMON/CFUN/.

STABLE

If new coefficients other than those now considered are to be added, the new coefficients will have to be defined in AERO and passed to STABLE through COMMON/CFUN/.

POTENTIAL SPINEQ APPLICATIONS AND MODIFICATIONS

SPINEQ can provide rapid, accurate solutions of the nonlinear airplane equations of motion for equilibrium spin conditions. In addition, the stability characteristics of a linear representation of the aircraft are determined about an equilibrium condition. Of course, the realism of the solutions is

dependent upon the accuracy of the aerodynamic data. The program can be utilized to study the sensitivity of equilibrium spin conditions to variations in selected aerodynamic or inertial data. It can also be used to aid in evaluating the adequacy of aerodynamic data in the spin region when accompanying experimental spin tests are available.

The aerodynamic data available vary from configuration to configuration insofar as the number of coefficients measured are concerned as well as their functional dependence upon angles of attack and sideslip. For example, for one configuration, a coefficient may be a nonlinear function of α and β whereas for a new configuration, it may be assumed to be a function of α only. For these reasons, a few minor changes will typically be required each time a new configuration is to be analyzed. The required changes are discussed in an earlier section entitled "Program Changes for New Configurations."

SPINEQ could be employed to compute equilibrium conditions for steady maneuvers. This would require the addition of thrust and control deflections as design variables. Generalization of the relationships between the body axis angular rates and the Euler angle angular rates would be required. Alternate choices for the design variable set and the set of constrained functions would also be necessary.

PROGRAM AVAILABILITY

The program is available through COSMIC.

Langley Research Center
National Aeronautics and Space Administration
Hampton, VA 23665
August 28, 1978

APPENDIX

INPUT AND OUTPUT FOR A SAMPLE CASE

```

IALPHA= 1 IBETA= 1
IDEG= 1 IAEROUT= 1

ALPHA ARRAY
0.
-.1000000E+02 -.5000000E+01 .1000000E+02 .1250000E+02 .1500000E+02 .1750000E+02
.2000000E+02 .2250000E+02 .2500000E+02 .3000000E+02 .3500000E+02 .4000000E+02
.5000000E+02 .5500000E+02 .6000000E+02 .6500000E+02 .7000000E+02 .7500000E+02
.9000000E+02 .1000000E+03 .1100000E+03

BETAT ARRAY
-.4000000E+02 -.3000000E+02 -.2000000E+02 -.1500000E+02 -.1000000E+02 -.5000000E+01 0.
.1000000E+02 .1500000E+02 .2000000E+02 .3000000E+02 .4000000E+02

```

FUNCTIONS OF ALPHA AND BETA

TABLE -- 1

```

BETA= -.4000000E+02
-.1790000E-01 -.1450000E-01 -.1100000E-01 -.7500000E-02 -.4100000E-02 -.2400000E-02 -.6000000E-03 .1100000E-02
.2800000E-02 .4600000E-02 .6300000E-02 .1010000E-01 .1390000E-01 .1480000E-01 .1310000E-01 .1390000E-01
.1690000E-01 .2470000E-01 .1430000E-01 .9900000E-02 .1480000E-01 .1360000E-01 .7500000E-02 .1090000E-01
.2310000E-01 .4030000E-01 .5800000E-01

BETA= -.3000000E+02
-.3270000E-01 -.2690000E-01 -.2110000E-01 -.1530000E-01 -.9500000E-02 -.6700000E-02 -.3800000E-02 -.9000000E-03
.2000000E-02 .4900000E-02 .7800000E-02 .1060000E-01 .1330000E-01 .6900000E-02 .4700000E-02 -.9100000E-02
.9800000E-02 -.4100000E-02 -.4600000E-02 -.3100000E-02 .5500000E-02 .1700000E-01 .2260000E-01 .1950000E-01
.2530000E-01 .4040000E-01 .6180000E-01

BETA= -.2000000E+02
-.1670000E-01 -.2810000E-01 -.3270000E-01 -.2680000E-01 -.1360000E-01 -.9400000E-02 -.6100000E-02 -.5000000E-02
-.7700000E-02 -.1770000E-01 -.2840000E-01 -.3310000E-01 -.3630000E-01 -.1260000E-01 -.1340000E-01 -.3900000E-02
-.6000000E-03 -.2200000E-02 -.2000000E-03 .2600000E-02 .1700000E-02 -.1000000E-03 .1080000E-01 .1340000E-01
.2350000E-01 .4160000E-01 .5540000E-01

BETA= -.1500000E+02
-.1720000E-01 -.3750000E-01 -.4430000E-01 -.2710000E-01 -.1250000E-01 -.5900000E-02 -.7400000E-02 -.1530000E-01
-.2000000E-01 -.3770000E-01 -.3880000E-01 -.4160000E-01 -.4560000E-01 -.2440000E-01 -.2070000E-01 -.1580000E-01
-.1000000E-01 .2900000E-02 .1270000E-01 .1020000E-01 .4400000E-02 .7500000E-02 .1040000E-01 .1590000E-01
.2560000E-01 .3680000E-01 .4280000E-01

BETA= -.1000000E+02
-.2450000E-01 -.3870000E-01 -.4010000E-01 -.2740000E-01 -.1490000E-01 -.1180000E-01 -.1060000E-01 -.1870000E-01
-.3060000E-01 -.4550000E-01 -.4650000E-01 -.5240000E-01 -.5190000E-01 -.2920000E-01 -.2970000E-01 -.2580000E-01
-.1060000E-01 .1700000E-02 .1800000E-01 .1360000E-01 .9400000E-02 .3900000E-02 .3900000E-02 .1980000E-01 .2230000E-01

```

APPENDIX

.2430000E-01 .2600000E-01 .1770000E-01
 BETA= -.5000000E+01
 -.2810000E-01 -.4420000E-01 -.4530000E-01 -.1570000E-01 -.1280000E-01 -.1230000E-01 -.1860000E-01
 -.3790000E-01 -.5100000E-01 -.4810000E-01 -.5370000E-01 -.3750000E-01 -.3920000E-01 -.2720000E-01
 -.1380000E-01 -.3100000E-02 .1420000E-01 .1550000E-01 .1480000E-01 .1440000E-01 .1530000E-01 .1690000E-01
 .1830000E-01 .2310000E-01 .2650000E-01
 BETA= 0.
 -.3340000E-01 -.4690000E-01 -.4770000E-01 -.1730000E-01 -.1430000E-01 -.1770000E-01 -.2770000E-01
 -.5420000E-01 -.5080000E-01 -.5270000E-01 -.5140000E-01 -.4300000E-01 -.4210000E-01 -.3590000E-01
 -.1730000E-01 -.2400000E-02 .1560000E-01 .1700000E-01 .1560000E-01 .1650000E-01 .2310000E-01 .2540000E-01
 .2270000E-01 .2210000E-01 .2210000E-01 .2210000E-01
 BETA= .5000000E+01
 -.3010000E-01 -.4360000E-01 -.4770000E-01 -.1470000E-01 -.1180000E-01 -.1130000E-01 -.2780000E-01
 -.4430000E-01 -.5020000E-01 -.5120000E-01 -.5120000E-01 -.4970000E-01 -.4740000E-01 -.3490000E-01
 -.1850000E-01 -.1550000E-02 .1030000E-01 .2150000E-01 .1240000E-01 .1740000E-01 .1910000E-01 .2120000E-01
 .2250000E-01 .2300000E-01 .3410000E-01 .3410000E-01
 BETA= .1000000E+02
 -.2580000E-01 -.4120000E-01 -.3990000E-01 -.1120000E-01 -.4100000E-02 -.1050000E-01 -.2140000E-01
 -.3000000E-01 -.4250000E-01 -.4760000E-01 -.5010000E-01 -.4390000E-01 -.3940000E-01 -.3200000E-01
 -.1300000E-01 -.5100000E-02 .8300000E-02 .9900000E-02 .9900000E-02 .2200000E-01 .1950000E-01 .1960000E-01
 .2380000E-01 .2820000E-01 .3350000E-01 .3350000E-01
 BETA= .1500000E+02
 -.2900000E-01 -.3200000E-01 -.3480000E-01 -.2570000E-01 -.1090000E-01 -.8800000E-02 -.5200000E-02 -.1040000E-01
 -.2040000E-01 -.3010000E-01 -.3460000E-01 -.3690000E-01 -.4260000E-01 -.3570000E-01 -.3360000E-01 -.2890000E-01
 -.1550000E-01 -.2300000E-02 .8500000E-02 .9600000E-02 .5600000E-02 .1840000E-01 .2310000E-01 .2560000E-01
 .3270000E-01 .1480000E-01 .3970000E-01 .3970000E-01
 BETA= .2000000E+02
 -.1620000E-01 -.2700000E-01 -.3240000E-01 -.2750000E-01 -.1210000E-01 -.9800000E-02 -.7300000E-02 -.6000000E-02
 -.2500000E-02 -.7900000E-02 -.1950000E-01 -.2170000E-01 -.2060000E-01 -.2720000E-01 -.2410000E-01 -.2000000E-01
 -.1140000E-01 -.2900000E-02 .4900000E-02 .4700000E-02 .1200000E-02 .1320000E-01 .1770000E-01 .2390000E-01
 .3010000E-01 .4520000E-01 .4590000E-01 .4590000E-01
 BETA= .3000000E+02
 -.2840000E-01 -.2340000E-01 -.1840000E-01 -.1340000E-01 -.8400000E-02 -.5900000E-02 -.3400000E-02 -.9000000E-03
 .1600000E-02 .4100000E-02 .6600000E-02 .7000000E-02 .7300000E-02 .7300000E-02 .2400000E-02 -.5600000E-02 -.3000000E-03
 .4100000E-02 -.9000000E-02 .8900000E-02 .3400000E-02 .7500000E-02 .1290000E-01 .2210000E-01 .2010000E-01
 .3040000E-01 .2950000E-01 .6730000E-01 .6730000E-01
 BETA= .4000000E+02
 -.1570000E-01 -.1230000E-01 -.8900000E-02 -.8900000E-02 -.5500000E-02 -.2100000E-02 -.5000000E-03 .1200000E-02 .5900000E-02
 .4600000E-02 .6300000E-02 .8000000E-02 .8000000E-02 .1120000E-01 .1430000E-01 .1480000E-01 .1150000E-01 .7600000E-02
 .1270000E-01 .7600000E-02 .1900000E-02 .1900000E-02 .2800000E-02 .5300000E-02 .5300000E-02 .1000000E-01 .2590000E-01 .2140000E-01
 .3340000E-01 .2970000E-01 .4560000E-01 .4560000E-01

APPENDIX

TABLE -- 2

BETA= -.400000E+02	.4891000E+00	.4673000E+00	.4564000E+00	.4455000E+00	.4346000E+00
.5545000E+00	.3828000E+00	.3636000E+00	.3536000E+00	.3224000E+00	.2929000E+00
.4237000E+00	.1525000E+00	.1455000E+00	.1585000E+00	.1795000E+00	.1989000E+00
.2651000E+00	.3037000E+00	.3130000E+00	.3437000E+00	.3345000E+00	.3253000E+00
.2147000E+00	.4830000E-01	.3350000E-01	.2643000E+00	.2165000E+00	.1761000E+00
BETA= -.3000000E+02	.3712000E+00	.2903000E+00	.2941000E+00	.3345000E+00	.3253000E+00
.4262000E+00	.2941000E+00	.2903000E+00	.2643000E+00	.2165000E+00	.1761000E+00
.3161000E+00	.4830000E-01	.3350000E-01	.1300000E-02	.2600000E-02	.5780000E-01
.8600000E-01	.3712000E+00	.2903000E+00	.2941000E+00	.3345000E+00	.3253000E+00
.9010000E-01	.2941000E+00	.2903000E+00	.2643000E+00	.2165000E+00	.1761000E+00
BETA= -.2000000E+02	.2421000E+00	.2507000E+00	.2539000E+00	.2530000E+00	.2359000E+00
.2370000E+00	.1406000E+00	.1183000E+00	.1213000E+00	.8120000E-01	.6620000E-01
.2001000E+00	.2010000E-01	.2650000E-01	0.	.7900000E-02	.1900000E-01
.3161000E+00	.2421000E+00	.2507000E+00	.2539000E+00	.2530000E+00	.2359000E+00
.5920000E-01	.1406000E+00	.1183000E+00	.1213000E+00	.8120000E-01	.6620000E-01
.2980000E-01	.2010000E-01	.2650000E-01	.2539000E+00	.2530000E+00	.2359000E+00
BETA= -.1500000E+02	.1689000E+00	.1651000E+00	.1741000E+00	.1754000E+00	.1612000E+00
.1849000E+00	.8500000E-01	.6790000E-01	.6070000E-01	.4390000E-01	.3730000E-01
.1405000E+00	.9000000E-03	.2760000E-01	.1770000E-01	.1650000E-01	.3400000E-02
.2440000E-01	.1689000E+00	.1651000E+00	.1741000E+00	.1754000E+00	.1612000E+00
-.3000000E-02	.8500000E-01	.6790000E-01	.6070000E-01	.4390000E-01	.3730000E-01
BETA= -.1000000E+02	.1012000E+00	.9740000E-01	.9620000E-01	.1039000E+00	.9580000E-01
.1150000E+00	.4250000E-01	.4250000E-01	.3770000E-01	.2900000E-01	.1240000E-01
.8350000E-01	.2200000E-02	.2250000E-01	.4030000E-01	.1350000E-01	.1410000E-01
.3800000E-02	.1012000E+00	.9740000E-01	.9620000E-01	.1039000E+00	.9580000E-01
-.1530000E-01	.4250000E-01	.4250000E-01	.3770000E-01	.2900000E-01	.1240000E-01
BETA= -.5000000E+01	.3950000E-01	.3680000E-01	.3500000E-01	.3700000E-01	.3460000E-01
.4740000E-01	.2720000E-01	.2650000E-01	.3090000E-01	.1420000E-01	.5100000E-02
.3350000E-01	.1040000E-01	.2660000E-01	.4150000E-01	.2480000E-01	.2980000E-01
.1000000E-01	.3950000E-01	.3680000E-01	.3500000E-01	.3700000E-01	.3460000E-01
-.3560000E-01	.2720000E-01	.2650000E-01	.3090000E-01	.1420000E-01	.5100000E-02
BETA= 0.	.1280000E-01	.7700000E-02	.7100000E-02	.8500000E-02	.6900000E-02
-.2200000E-01	.3600000E-02	.5000000E-03	.1600000E-01	.8000000E-03	.1460000E-01
-.8600000E-02	.2900000E-02	.1130000E-01	.2330000E-01	.2560000E-01	.5800000E-02
-.5100000E-02	.1280000E-01	.7700000E-02	.7100000E-02	.8500000E-02	.6900000E-02
-.3270000E-01	.3600000E-02	.5000000E-03	.1600000E-01	.8000000E-03	.1460000E-01
BETA= .5000000E+01	.6680000E-01	.5940000E-01	.6200000E-01	.6150000E-01	.5490000E-01
-.8710000E-01	.2400000E-01	.2350000E-01	.1740000E-01	.2750000E-01	.5440000E-01
-.5440000E-01	.1910000E-01	.5500000E-02	.1050000E-01	.1790000E-01	.2990000E-01
-.3510000E-01	.6680000E-01	.5940000E-01	.6200000E-01	.6150000E-01	.5490000E-01
-.8710000E-01	.2400000E-01	.2350000E-01	.1740000E-01	.2750000E-01	.5440000E-01
-.5440000E-01	.1910000E-01	.5500000E-02	.1050000E-01	.1790000E-01	.2990000E-01

APPENDIX

-.1486000E+01	-.1489000E+01	-.1523000E+01	-.1539000E+01	-.1587000E+01	-.1646000E+01	-.1652000E+01	-.1676000E+01
-.1690000E+01	-.1707000E+01	-.1724000E+01	-.1740000E+01	-.1757000E+01	-.1774000E+01	-.1791000E+01	-.1808000E+01
BETA= -.1500000E+02							
.4550000E+00	.1110000E+00	-.1370000E+00	-.3710000E+00	-.6580000E+00	-.7940000E+00	-.8810000E+00	-.9810000E+00
-.1069000E+01	.1109000E+01	-.1186000E+01	-.1233000E+01	-.1244000E+01	-.1232000E+01	-.1343000E+01	-.1393000E+01
-.1464000E+01	-.1521000E+01	-.1551000E+01	-.1563000E+01	-.1605000E+01	-.1638000E+01	-.1661000E+01	-.1683000E+01
-.1685000E+01	-.1700000E+01	-.1699000E+01	-.1700000E+01	-.1700000E+01	-.1700000E+01	-.1700000E+01	-.1700000E+01
BETA= -.1000000E+02							
.4500000E+00	.1400000E+00	-.7700000E-01	-.3910000E+00	-.6630000E+00	-.8260000E+00	-.9270000E+00	-.9950000E+00
-.1050000E+01	-.1083000E+01	-.1140000E+01	-.1194000E+01	-.1244000E+01	-.1267000E+01	-.1362000E+01	-.1404000E+01
-.1487000E+01	-.1534000E+01	-.1580000E+01	-.1535000E+01	-.1580000E+01	-.1626000E+01	-.1622000E+01	-.1648000E+01
-.1684000E+01	-.1670000E+01	-.1694000E+01	-.1694000E+01	-.1694000E+01	-.1694000E+01	-.1694000E+01	-.1694000E+01
BETA= -.5000000E+01							
.4690000E+00	.1670000E+00	-.9300000E-01	-.3980000E+00	-.6730000E+00	-.8130000E+00	-.9230000E+00	-.9990000E+00
-.1030000E+01	-.1056000E+01	-.1107000E+01	-.1197000E+01	-.1260000E+01	-.1289000E+01	-.1362000E+01	-.1397000E+01
-.1476000E+01	-.1527000E+01	-.1589000E+01	-.1543000E+01	-.1537000E+01	-.1579000E+01	-.1601000E+01	-.1605000E+01
-.1622000E+01	-.1636000E+01	-.1663000E+01	-.1663000E+01	-.1663000E+01	-.1663000E+01	-.1663000E+01	-.1663000E+01
BETA= 0.							
.4700000E+00	.1660000E+00	-.1220000E+00	-.4190000E+00	-.6970000E+00	-.8160000E+00	-.9420000E+00	-.1002000E+01
-.1016000E+01	-.1053000E+01	-.1139000E+01	-.1193000E+01	-.1262000E+01	-.1313000E+01	-.1375000E+01	-.1406000E+01
-.1469000E+01	-.1525000E+01	-.1600000E+01	-.1558000E+01	-.1556000E+01	-.1572000E+01	-.1562000E+01	-.1556000E+01
-.1566000E+01	-.1626000E+01	-.1668000E+01	-.1668000E+01	-.1668000E+01	-.1668000E+01	-.1668000E+01	-.1668000E+01
BETA= .5000000E+01							
.4700000E+00	.1650000E+00	-.1200000E+00	-.4120000E+00	-.7000000E+00	-.8390000E+00	-.9550000E+00	-.1010000E+01
-.1045000E+01	-.1065000E+01	-.1126000E+01	-.1192000E+01	-.1253000E+01	-.1312000E+01	-.1362000E+01	-.1409000E+01
-.1455000E+01	-.1525000E+01	-.1586000E+01	-.1617000E+01	-.1572000E+01	-.1571000E+01	-.1596000E+01	-.1589000E+01
-.1557000E+01	-.1633000E+01	-.1670000E+01	-.1670000E+01	-.1670000E+01	-.1670000E+01	-.1670000E+01	-.1670000E+01
BETA= .1000000E+02							
.4180000E+00	.1050000E+00	-.1200000E+00	-.3790000E+00	-.7030000E+00	-.8210000E+00	-.9410000E+00	-.1008000E+01
-.1069000E+01	-.1124000E+01	-.1185000E+01	-.1229000E+01	-.1254000E+01	-.1278000E+01	-.1342000E+01	-.1391000E+01
-.1485000E+01	-.1513000E+01	-.1581000E+01	-.1546000E+01	-.1571000E+01	-.1592000E+01	-.1621000E+01	-.1625000E+01
-.1651000E+01	-.1652000E+01	-.1685000E+01	-.1685000E+01	-.1685000E+01	-.1685000E+01	-.1685000E+01	-.1685000E+01
BETA= .1500000E+02							
.3780000E+00	.1090000E+00	-.1510000E+00	-.4370000E+00	-.6970000E+00	-.8060000E+00	-.9040000E+00	-.1012000E+01
-.1083000E+01	-.1154000E+01	-.1190000E+01	-.1227000E+01	-.1246000E+01	-.1257000E+01	-.1340000E+01	-.1420000E+01
-.1476000E+01	-.1514000E+01	-.1556000E+01	-.1573000E+01	-.1586000E+01	-.1608000E+01	-.1638000E+01	-.1666000E+01
-.1658000E+01	-.1699000E+01	-.1716000E+01	-.1716000E+01	-.1716000E+01	-.1716000E+01	-.1716000E+01	-.1716000E+01
BETA= .2000000E+02							
.3440000E+00	.7900000E-01	-.1550000E+00	-.4600000E+00	-.7020000E+00	-.7990000E+00	-.9200000E+00	-.1014000E+01
-.1099000E+01	-.1180000E+01	-.1237000E+01	-.1286000E+01	-.1275000E+01	-.1244000E+01	-.1329000E+01	-.1404000E+01
-.1482000E+01	-.1520000E+01	-.1549000E+01	-.1570000E+01	-.1615000E+01	-.1633000E+01	-.1658000E+01	-.1669000E+01

APPENDIX

- .1683000E+01	- .1712000E+01	- .1732000E+01	- .2370000E+00	- .4490000E+00	- .5550000E+00	- .6600000E+00	- .7660000E+00
BETA= .3000000E+02	- .2600000E-01	- .2600000E-01	- .1145000E+01	- .1206000E+01	- .1289000E+01	- .1320000E+01	- .1390000E+01
.3970000E+00	.1850000E+00	.1083000E+01	- .1554000E+01	- .1608000E+01	- .1639000E+01	- .1689000E+01	- .1688000E+01
- .8720000E+00	- .9770000E+01	- .1513000E+01	- .1360000E+00	- .8450000E+00	- .1031000E+01	- .1116000E+01	- .1161000E+01
- .1498000E+00	- .1474000E+01	- .1706000E+01	- .1461000E+01	- .1497000E+01	- .1588000E+01	- .1604000E+01	- .1637000E+01
- .1650000E+01	- .1726000E+01						
BETA= .4000000E+02	.2200000E-01	.2200000E-01	- .1360000E+00	- .2950000E+00	- .3740000E+00	- .4530000E+00	- .5320000E+00
.3390000E+00	.1800000E+00	.7700000E+00	- .8450000E+00	- .9200000E+00	- .1031000E+01	- .1116000E+01	- .1161000E+01
- .6120000E+00	- .6910000E+00	- .1408000E+01	- .1461000E+01	- .1497000E+01	- .1588000E+01	- .1604000E+01	- .1637000E+01
- .1272000E+01	- .1366000E+01	- .1601000E+01					
- .1641000E+01	- .1649000E+01						
BETA= -.4000000E+02	- .1560000E-01	- .1560000E-01	.3000000E-03	.1630000E-01	.2430000E-01	.3220000E-01	.4020000E-01
- .4750000E-01	- .3150000E-01	.6410000E-01	.6620000E-01	.7230000E-01	.8540000E-01	.9930000E-01	.1075000E+00
.4820000E-01	.5610000E-01	.1044000E+00	.1016000E+00	.1035000E+00	.1093000E+00	.1149000E+00	.1195000E+00
.1110000E+00	.1135000E+00	.1211000E+00					
.1212000E+00	.1211000E+00						
BETA= -.3000000E+02	- .7600000E-02	- .7600000E-02	.8000000E-03	.9200000E-02	.1340000E-01	.1760000E-01	.2180000E-01
- .2440000E-01	- .1600000E-01	.3440000E-01	.3840000E-01	.4230000E-01	.6010000E-01	.6740000E-01	.7340000E-01
.2600000E-01	.3020000E-01	.7480000E-01	.7550000E-01	.7670000E-01	.8030000E-01	.8100000E-01	.8430000E-01
.7020000E-01	.7470000E-01	.9510000E-01					
.8630000E-01	.8980000E-01						
BETA= -.2000000E+02	.8100000E-02	.8100000E-02	.2610000E-01	.3550000E-01	.3200000E-01	.2570000E-01	.1880000E-01
- .1090000E-01	- .4200000E-02	.1600000E-02	.1900000E-02	.1690000E-01	.3170000E-01	.3900000E-01	.4250000E-01
.9500000E-02	.8100000E-02	.5080000E-01	.5410000E-01	.5440000E-01	.5810000E-01	.5750000E-01	.5930000E-01
.5040000E-01	.5070000E-01	.6300000E-01					
.6070000E-01	.6380000E-01						
BETA= -.1500000E+02	.1180000E-01	.1180000E-01	.2360000E-01	.2970000E-01	.2810000E-01	.1650000E-01	.1260000E-01
- .6200000E-02	- .7000000E-03	- .5900000E-02	- .5700000E-02	.4200000E-02	.2190000E-01	.2850000E-01	.3500000E-01
.8300000E-02	.2700000E-02	- .4600000E-02	.4200000E-01	.4290000E-01	.4440000E-01	.4570000E-01	.4730000E-01
.4130000E-01	.4030000E-01	.3250000E-01					
.4740000E-01	.4970000E-01	.3350000E-01					
BETA= -.1000000E+02	.6700000E-02	.6700000E-02	.1540000E-01	.2120000E-01	.2120000E-01	.1840000E-01	.6400000E-02
- .1000000E-02	.1100000E-02	- .4600000E-02	- .2000000E-02	- .1600000E-02	.8600000E-02	.2310000E-01	.3010000E-01
.2500000E-02	- .5400000E-02	.3250000E-01	.2840000E-01	.3040000E-01	.3470000E-01	.3230000E-01	.3320000E-01
.2930000E-01	.2980000E-01						
.3350000E-01	.3400000E-01						
BETA= -.5000000E+01	.3700000E-02	.3700000E-02	.4800000E-02	.8200000E-02	.1110000E-01	.6400000E-02	.6000000E-03
- .8000000E-03	- .5000000E-03	- .1500000E-02	- .2200000E-02	- .2600000E-02	.5100000E-02	.2150000E-01	.1860000E-01
.2900000E-02	- .1800000E-02						

TABLE --- 4

APPENDIX

.1780000E-01	.1800000E-01	.1940000E-01	.1680000E-01	.1810000E-01	.?100000E-01	.2020000E-01	.2170000E-01
.2160000E-01	.2190000E-01	.1700000E-01					
BETA= 0.							
-.1000000E-03	.1100000E-02	-.1800000E-02	-.2600000E-02	-.2800000E-02	-.3400000E-02	-.4800000E-02	-.4300000E-02
-.7200000E-02	.1000000E-03	-.2000000E-03	-.8000000E-03	-.1300000E-02	.2300000E-02	.1030000E-01	.9700000E-02
.4300000E-02	.4900000E-02	.6200000E-02	.6900000E-02	.5400000E-02	.4700000E-02	.3500000E-02	.2500000E-02
.4700000E-02	.3100000E-02	.2200000E-02					
BETA= .5000000E+01							
.1400000E-02	.2000000E-02	-.5600000E-02	-.1110000E-01	-.1540000E-01	-.1700000E-01	-.1410000E-01	-.6800000E-02
-.6200000E-02	.3000000E-03	-.1100000E-02	-.2400000E-02	-.2700000E-02	.3100000E-02	.1300000E-02	-.1400000E-02
-.5600000E-02	-.6400000E-02	-.6800000E-02	-.8600000E-02	-.9000000E-02	-.9000000E-02	-.1200000E-01	-.1090000E-01
-.1060000E-01	-.1110000E-01	-.8400000E-02					
BETA= .1000000E+02							
.1100000E-02	-.1800000E-02	-.9400000E-02	-.2070000E-01	-.2750000E-01	-.2620000E-01	-.1960000E-01	-.9800000E-02
-.9000000E-02	.3000000E-02	.4400000E-02	.1000000E-02	-.2400000E-02	.?200000E-02	-.9800000E-02	-.1600000E-01
-.1910000E-01	-.1890000E-01	-.2150000E-01	-.2030000E-01	-.2090000E-01	-.2230000E-01	-.2400000E-01	-.2410000E-01
-.2690000E-01	-.2290000E-01	-.2140000E-01					
BETA= .1500000E+02							
.5800000E-02	-.8000000E-03	-.1100000E-01	-.2790000E-01	-.3130000E-01	-.2580000E-01	-.2100000E-01	-.1670000E-01
-.1000000E-01	-.3400000E-02	.1000000E-03	-.2400000E-02	-.1200000E-01	-.7700000E-02	-.1530000E-01	-.3130000E-01
-.3240000E-01	-.3110000E-01	-.3370000E-01	-.3200000E-01	-.3200000E-01	-.3420000E-01	-.3560000E-01	-.3590000E-01
-.3570000E-01	-.3660000E-01	-.3680000E-01					
BETA= .2000000E+02							
.1140000E-01	.3300000E-02	-.1100000E-01	-.3120000E-01	-.3630000E-01	-.3350000E-01	-.2890000E-01	-.2140000E-01
-.9100000E-02	-.1440000E-01	-.1150000E-01	-.1030000E-01	-.1750000E-01	-.2090000E-01	-.2750000E-01	-.3410000E-01
-.4190000E-01	-.4370000E-01	-.4320000E-01	-.4410000E-01	-.4600000E-01	-.4650000E-01	-.4800000E-01	-.4990000E-01
-.4940000E-01	-.5100000E-01	-.5230000E-01					
BETA= .3000000E+02							
.2160000E-01	.1570000E-01	.9800000E-02	.3900000E-02	-.2000000E-02	-.5000000E-02	-.8000000E-02	-.1090000E-01
-.1390000E-01	-.1680000E-01	-.1980000E-01	-.2840000E-01	-.3700000E-01	-.4480000E-01	-.5650000E-01	-.5620000E-01
-.5870000E-01	-.6190000E-01	-.6520000E-01	-.6780000E-01	-.6770000E-01	-.7160000E-01	-.7190000E-01	-.7440000E-01
-.7580000E-01	-.8040000E-01	-.8160000E-01					
BETA= .4000000E+02							
.3840000E-01	.2520000E-01	.1190000E-01	-.1400000E-02	-.1460000E-01	-.2130000E-01	-.2790000E-01	-.3450000E-01
-.4110000E-01	-.4780000E-01	-.5440000E-01	-.5790000E-01	-.6140000E-01	-.8130000E-01	-.9270000E-01	-.9850000E-01
-.1002000E+00	-.9820000E-01	-.9510000E-01	-.9290000E-01	-.9210000E-01	-.9380000E-01	-.9610000E-01	-.9920000E-01
-.1008000E+00	-.1108000E+00	-.1160000E+00					
TABLE -- 5							
RFTA= -.4000000E+02							
.2292000E+00	.2042000E+00	.1791000E+00	.1540000E+00	.1290000E+00	.1164000E+00	.1039000E+00	.9140000E-01

APPENDIX

.7890000E-01	.6630000E-01	.5380000E-01	.2110000E-01	-.1150000E-01	-.5200000E-01	-.1002000E+00	-.1540000E+00
-.1863000E+00	-.2252000E+00	-.2557000E+00	-.2760000E+00	-.3193000E+00	-.3413000E+00	-.4000000E+00	-.4521000E+00
-.4657000E+00	-.4918000E+00	-.5147000E+00					
BETA= -.3000000E+02							
.8280000E-01	.6020000E-01	.3750000E-01	.1480000E-01	-.7800000E-02	-.1920000E-01	-.3050000E-01	-.4180000E-01
-.5310000E-01	-.6450000E-01	-.7580000E-01	-.1201000E+00	-.1644000E+00	-.2054000E+00	-.2261000E+00	-.2421000E+00
-.2737000E+00	-.2977000E+00	-.3352000E+00	-.3701000E+00	-.3975000E+00	-.4101000E+00	-.4324000E+00	-.5004000E+00
-.5349000E+00	-.6076000E+00	-.6603000E+00					
BETA= -.2000000E+02							
.1450000E-01	.1080000E-01	.2790000E-01	-.4480000E-01	-.6300000E-01	-.7030000E-01	-.8440000E-01	-.1025000E+00
-.1174000E+00	-.1390000E+00	-.1590000E+00	-.1655000E+00	-.1595000E+00	-.1988000E+00	-.2341000E+00	-.2503000E+00
-.2687000E+00	-.2850000E+00	-.3369000E+00	-.4000000E+00	-.4612000E+00	-.5248000E+00	-.5493000E+00	-.5773000E+00
-.6084000E+00	-.6662000E+00	-.7248000E+00					
BETA= -.1500000E+02							
.2440000E-01	.4600000E-02	.2090000E-01	-.3320000E-01	-.4710000E-01	-.5500000E-01	-.5910000E-01	-.7870000E-01
-.9330000E-01	-.1175000E+00	-.1316000E+00	-.1417000E+00	-.1438000E+00	-.1869000E+00	-.2252000E+00	-.2412000E+00
-.2668000E+00	-.2848000E+00	-.3184000E+00	-.3925000E+00	-.4650000E+00	-.5140000E+00	-.5517000E+00	-.5825000E+00
-.6090000E+00	-.6705000E+00	-.7342000E+00					
BETA= -.1000000E+02							
.2640000E-01	.1400000E-02	.1060000E-01	-.2480000E-01	-.4050000E-01	-.5030000E-01	-.5290000E-01	-.5830000E-01
-.7660000E-01	-.9350000E-01	-.1096000E+00	-.1213000E+00	-.1354000E+00	-.1735000E+00	-.2124000E+00	-.2399000E+00
-.2706000E+00	-.2867000E+00	-.3103000E+00	-.3870000E+00	-.4415000E+00	-.5089000E+00	-.5234000E+00	-.5642000E+00
-.6086000E+00	-.6693000E+00	-.7494000E+00					
BETA= -.5000000E+01							
.3430000E-01	.1060000E-01	.4300000E-02	-.1990000E-01	-.3730000E-01	-.4570000E-01	-.4110000E-01	-.6000000E-01
-.6030000E-01	-.7720000E-01	-.9000000E-01	-.1155000E+00	-.1341000E+00	-.1847000E+00	-.2248000E+00	-.2388000E+00
-.2521000E+00	-.2846000E+00	-.3090000E+00	-.3891000E+00	-.4359000E+00	-.4894000E+00	-.5181000E+00	-.5498000E+00
-.5877000E+00	-.6585000E+00	-.7400000E+00					
BETA= 0.							
.3730000E-01	.1130000E-01	.5200000E-02	-.2030000E-01	-.3840000E-01	-.4600000E-01	-.4280000E-01	-.4110000E-01
-.5480000E-01	-.7930000E-01	-.1003000E+00	-.1109000E+00	-.1333000E+00	-.1952000E+00	-.2274000E+00	-.2430000E+00
-.2646000E+00	-.2871000E+00	-.3129000E+00	-.3883000E+00	-.4304000E+00	-.4783000E+00	-.5053000E+00	-.5293000E+00
-.5707000E+00	-.66661000E+00	-.7344000E+00					
BETA= .5000000E+01							
.3130000E-01	.5100000E-02	.8000000E-02	-.1173000E+00	-.3810000E-01	-.4630000E-01	-.4950000E-01	-.5560000E-01
-.7800000E-01	-.8770000E-01	-.9990000E-01	-.1130000E+00	-.1320000E+00	-.2026000E+00	-.2298000E+00	-.2454000E+00
-.2629000E+00	-.2929000E+00	-.3156000E+00	-.3396000E+00	-.4397000E+00	-.4751000E+00	-.5104000E+00	-.5407000E+00
-.5666000E+00	-.6664000E+00	-.7326000E+00					
BETA= .1000000E+02							
.2270000E-01	.3700000E-02	.1440000E-01	-.2910000E-01	-.4650000E-01	-.5210000E-01	-.5750000E-01	-.7570000E-01
-.9090000E-01	-.1201000E+00	-.1266000E+00	-.1364000E+00	-.1414000E+00	-.1857000E+00	-.2165000E+00	-.2408000E+00

APPENDIX

--.2606000E+00	--.2892000E+00	--.3108000E+00	--.3819000E+00	--.4429000E+00	--.4827000E+00	--.5215000E+00	--.5499000E+00
--.5943000E+00	--.6696000E+00	--.7427000E+00					
BETA= .1500000E+02							
.1200000E-01	--.1120000E-01	--.2570000E-01	--.4330000E-01	--.6010000E-01	--.6150000E-01	--.7730000E-01	--.9820000E-01
--.1099000E+00	--.1438000E+00	--.1497000E+00	--.1509000E+00	--.1548000E+00	--.1877000E+00	--.2239000E+00	--.2504000E+00
--.2697000E+00	--.2889000E+00	--.3122000E+00	--.3774000E+00	--.4454000E+00	--.4938000E+00	--.5335000E+00	--.5697000E+00
--.5941000E+00	--.6731000E+00	--.7446000E+00					
BETA= .2000000E+02							
.2300000E-02	--.2240000E-01	--.3640000E-01	--.5820000E-01	--.7360000E-01	--.8570000E-01	--.1021000E+00	--.1217000E+00
--.1330000E+00	--.1560000E+00	--.1866000E+00	--.1933000E+00	--.1888000E+00	--.1979000E+00	--.2354000E+00	--.2584000E+00
--.2764000E+00	--.2973000E+00	--.3264000E+00	--.3809000E+00	--.4637000E+00	--.5119000E+00	--.5517000E+00	--.5739000E+00
--.6062000E+00	--.6640000E+00	--.7233000E+00					
BETA= .3000000E+02							
.3990000E-01	.1350000E-01	--.1290000E-01	--.3930000E-01	--.6570000E-01	--.7890000E-01	--.9200000E-01	--.1052000E+00
--.1184000E+00	--.1316000E+00	--.1448000E+00	--.1760000E+00	--.2072000E+00	--.2339000E+00	--.2397000E+00	--.2626000E+00
--.2872000E+00	--.2931000E+00	--.3355000E+00	--.3662000E+00	--.3882000E+00	--.4388000E+00	--.4743000E+00	--.5374000E+00
--.5705000E+00	--.6350000E+00	--.6723000E+00					
BETA= .4000000E+02							
.1969000E+00	.1675000E+00	.1381000E+00	.1087000E+00	.7930000E-01	.6470000E-01	.5000000E-01	.3530000E-01
.2060000E-01	.5900000E-02	--.8800000E-02	--.4110000E-01	--.7330000E-01	--.1274000E+00	--.1734000E+00	--.1964000E+00
--.2344000E+00	--.2594000E+00	--.2886000E+00	--.3239000E+00	--.3502000E+00	--.3978000E+00	--.4299000E+00	--.4833000E+00
--.4922000E+00	--.5443000E+00	--.5578000E+00					
BETA= .4000000E+02							
.5740000E-01	--.5550000E-01	--.5350000E-01	--.5150000E-01	--.4960000E-01	--.4860000E-01	--.4760000E-01	--.4660000E-01
--.4570000E-01	--.4470000E-01	--.4370000E-01	--.3430000E-01	--.2480000E-01	--.2470000E-01	--.2070000E-01	--.1490000E-01
--.8600000E-02	--.1000000E-03	--.6000000E-02	--.6000000E-02	--.6800000E-02	--.1840000E-01	--.2320000E-01	--.2470000E-01
--.3490000E-01	--.5190000E-01	--.6460000E-01					
BETA= .3000000E+02							
.6590000E-01	--.5870000E-01	--.5140000E-01	--.4410000E-01	--.3690000E-01	--.3330000E-01	--.2960000E-01	--.2600000E-01
--.2240000E-01	--.1870000E-01	--.1510000E-01	--.1050000E-01	--.5800000E-02	.3200000E-02	.1600000E-01	.3260000E-01
.5290000E-01	.3870000E-01	.3910000E-01	.3900000E-01	.3190000E-01	.1510000E-01	.1100000E-02	.5000000E-02
--.2200000E-02	--.2350000E-01	--.4790000E-01					
BETA= .2000000E+02							
.4930000E-01	--.4910000E-01	--.5050000E-01	--.5430000E-01	--.5770000E-01	--.5840000E-01	--.5390000E-01	--.4190000E-01
--.1730000E-01	.1070000E-01	.3060000E-01	.4130000E-01	.4440000E-01	.4100000E-01	.4760000E-01	.4810000E-01
.4270000E-01	.3500000E-01	.3250000E-01	.3520000E-01	.4190000E-01	.5100000E-01	.5060000E-01	.4300000E-01
.2640000E-01	--.3000000E-03	--.1360000E-01					
BETA= .1500000E+02							
--.3490000E-01	--.3490000E-01	--.3490000E-01	--.3650000E-01	--.3590000E-01	--.3780000E-01	--.3610000E-01	--.2660000E-01

TABLE -- 6

APPENDIX

- .1290000E-01	. 2240000E-01	. 3370000E-01	. 4330000E-01	. 4680000E-01	. 4640000E-01	. 3880000E-01
. 3500000E-01	. 3290000E-01	. 2900000E-01	. 3470000E-01	. 3340000E-01	. 4390000E-01	. 3930000E-01
. 3060000E-01	. 9400000E-02	- .9000000E-03				
BETA= -.1000000E+02						
- .2120000E-01	- .2070000E-01	- .2080000E-01	- .2090000E-01	- .1970000E-01	- .1870000E-01	- .1360000E-01
- .4200000E-02	. 1460000E-01	. 2490000E-01	. 3190000E-01	. 3930000E-01	. 3170000E-01	. 2240000E-01
. 2460000E-01	. 1770000E-01	. 1850000E-01	. 3290000E-01	. 2220000E-01	. 4260000E-01	. 4100000E-01
. 3550000E-01	. 1620000E-01	. 4900000E-02				
BETA= -.5000000E+01						
- .7600000E-02	- .7300000E-02	- .7000000E-02	- .6500000E-02	- .4900000E-02	- .4100000E-02	- .2200000E-02
- .4000000E-03	. 4600000E-02	. 9500000E-02	. 1450000E-01	. 1970000E-01	. 2380000E-01	. 1450000E-01
. 5800000E-02	. 4100000E-02	. 1150000E-01	. 2260000E-01	. 1410000E-01	. 3710000E-01	. 4160000E-01
. 3980000E-01	. 2290000E-01	. 1600000E-01				
BETA= 0.						
. 3500000E-02	. 3500000E-02	. 3400000E-02	. 2500000E-02	. 1400000E-02	. 7000000E-03	. 5000000E-03
. 3000000E-02	- .1900000E-02	- .1800000E-02	- .1800000E-02	- .4300000E-02	- .2200000E-02	. 3900000E-02
. 3800000E-02	. 8000000E-03	. 1800000E-02	. 3700000E-02	. 2200000E-02	. 4700000E-02	. 2490000E-01
. 1520000E-01	. 1990000E-01	. 1540000E-01				
BETA= .5000000E+01						
. 1660000E-01	. 1660000E-01	. 1510000E-01	. 1360000E-01	. 1140000E-01	. 9700000E-02	. 6300000E-02
. 5500000E-02	- .6500000E-02	- .1260000E-01	- .2030000E-01	- .2330000E-01	- .1670000E-01	- .3200000E-02
- .3900000E-02	- .5300000E-02	- .4100000E-02	. 1500000E-02	- .3900000E-02	- .4100000E-02	- .2380000E-01
- .1480000E-01	- .1700000E-01	- .8200000E-02				
BETA= .1000000E+02						
. 3170000E-01	. 3190000E-01	. 3050000E-01	. 3120000E-01	. 2920000E-01	. 2730000E-01	. 1960000E-01
. 1350000E-01	- .2120000E-01	- .3010000E-01	- .3850000E-01	- .4210000E-01	- .2680000E-01	- .1100000E-01
- .2700000E-02	- .7800000E-02	- .1220000E-01	- .2480000E-01	- .1520000E-01	- .3910000E-01	- .4170000E-01
- .3560000E-01	- .1800000E-01	- .6400000E-02				
BETA= .1500000E+02						
. 4640000E-01	. 4560000E-01	. 4700000E-01	. 4890000E-01	. 5010000E-01	. 4680000E-01	. 3630000E-01
. 1590000E-01	- .2300000E-01	- .3490000E-01	- .4590000E-01	- .4890000E-01	- .4460000E-01	- .3070000E-01
- .2540000E-01	- .2040000E-01	- .2160000E-01	- .3020000E-01	- .2210000E-01	- .4160000E-01	- .3810000E-01
- .2880000E-01	- .1440000E-01	- .6000000E-03				
BETA= .2000000E+02						
. 5980000E-01	. 5950000E-01	. 6270000E-01	. 6480000E-01	. 6580000E-01	. 5870000E-01	. 4000000E-01
. 9100000E-02	- .5400000E-02	- .2340000E-01	- .3290000E-01	- .4210000E-01	- .4850000E-01	- .4350000E-01
- .3610000E-01	- .3400000E-01	- .2990000E-01	- .3010000E-01	- .3120000E-01	- .4870000E-01	- .3440000E-01
- .3360000E-01	- .7800000E-02	. 9400000E-02				
BETA= .3000000E+02						
. 7930000E-01	. 6910000E-01	. 5900000E-01	. 4890000E-01	. 3870000E-01	. 2860000E-01	. 2350000E-01
. 1840000E-01	. 1340000E-01	. 8300000E-02	. 1800000E-02	- .4700000E-02	- .3090000E-01	- .4460000E-01

APPENDIX

--.4880000E-01	--.4000000E-01	--.3730000E-01	--.3590000E-01	--.2120000E-01	--.1900000E-01	--.8900000E-02	--.2100000E-01
--.1230000E-01	.1430000E-01	.3620000E-01					
BETA=	.4000000E+02						
.6500000E-01	.6090000E-01	.5690000E-01	.5290000E-01	.4880000E-01	.4680000E-01	.4480000E-01	.4280000E-01
.4070000E-01	.3870000E-01	.3670000E-01	.2780000E-01	.1890000E-01	.1680000E-01	.8200000E-02	.8000000E-03
--.1240000E-01	--.8500000E-02	--.1900000E-01	--.1570000E-01	--.1330000E-01	--.7700000E-02	.1200000E-02	.4100000E-02
.2280000E-01	.4880000E-01	.5880000E-01					
TABLE --	7						
BETA=	--.4000000E+02						
.1760000E-02	.1570000E-02	.1380000E-02	.1190000E-02	.1000000E-02	.9000000E-03	.8000000E-03	.7100000E-03
.6100000E-03	.5200000E-03	.4200000E-03	.1800000E-03	--.7000000E-04	--.4800000E-03	--.3900000E-03	--.6500000E-03
--.7800000E-03	--.1360000E-02	--.1790000E-02	--.1700000E-02	--.1770000E-02	--.1890000E-02	--.1880000E-02	--.1800000E-02
--.1770000E-02	--.2050000E-02	--.2180000E-02					
BETA=	--.3000000E+02						
.9200000E-03	.7700000E-03	.6000000E-03	.4400000E-03	.2900000E-03	.2000000E-03	.1200000E-03	.4000000E-04
--.4000000E-04	--.1200000E-03	--.2000000E-03	--.2400000E-03	--.2900000E-03	--.4900000E-03	--.1050000E-02	--.2140000E-02
--.1800000E-02	--.1570000E-02	--.1700000E-02	--.1930000E-02	--.1870000E-02	--.2470000E-02	--.225500000E-02	--.2610000E-02
--.2500000E-02	--.2570000E-02	--.2810000E-02					
BETA=	--.2000000E+02						
.6800000E-03	.4500000E-03	.6500000E-03	.5600000E-03	.7600000E-03	.4700000E-03	.5300000E-03	.3700000E-03
.1600000E-03	--.1000000E-04	--.3800000E-03	--.5600000E-03	--.6200000E-03	--.6800000E-03	--.2200000E-03	--.1070000E-02
--.1300000E-02	--.1380000E-02	--.1540000E-02	--.1840000E-02	--.2170000E-02	--.2470000E-02	--.2550000E-02	--.2610000E-02
--.2750000E-02	--.2830000E-02	--.3040000E-02					
BETA=	--.1500000E+02						
.1100000E-02	.3600000E-03	.4200000E-03	.7700000E-03	.9100000E-03	.9100000E-03	.7900000E-03	.3200000E-03
.3800000E-03	--.2400000E-03	--.1300000E-03	--.2900000E-03	--.5300000E-03	--.6100000E-03	--.8000000E-03	--.1140000E-02
--.1480000E-02	--.1250000E-02	--.1320000E-02	--.1730000E-02	--.2110000E-02	--.2430000E-02	--.2680000E-02	--.2660000E-02
--.2750000E-02	--.3180000E-02	--.3450000E-02					
BETA=	--.1000000E+02						
.1110000E-02	.8200000E-03	.8500000E-03	.6900000E-03	.1020000E-02	.9500000E-03	.9300000E-03	.6900000E-03
.4900000E-03	.1600000E-03	.1100000E-03	--.1500000E-03	--.2600000E-03	--.3700000E-03	--.1060000E-02	--.1180000E-02
--.1280000E-02	--.1220000E-02	--.1060000E-02	--.1780000E-02	--.2170000E-02	--.2720000E-02	--.2490000E-02	--.2590000E-02
--.2800000E-02	--.3070000E-02	--.4130000E-02					
BETA=	--.5000000E+01						
.1270000E-02	.1310000E-02	.1020000E-02	.1130000E-02	.1180000E-02	.1150000E-02	.1180000E-02	.1040000E-02
.8100000E-03	.4200000E-03	.4100000E-03	.1000000E-04	--.1000000E-03	--.5200000E-03	--.9700000E-03	--.8700000E-03
--.1220000E-02	--.1260000E-02	--.1390000E-02	--.1850000E-02	--.2210000E-02	--.2300000E-02	--.2450000E-02	--.2460000E-02
--.2700000E-02	--.3010000E-02	--.3430000E-02					
BETA=	0.						
.1090000E-02	.1190000E-02	.1020000E-02	.1180000E-02	.1140000E-02	.1040000E-02	.1200000E-02	.9000000E-03

APPENDIX

.7100000E-03	.4500000E-03	.2700000E-03	.1800000E-03	.9000000E-04	-.5800000E-03	-.8500000E-03	-.9200000E-03
-.1130000E-02	-.1400000E-02	-.1370000E-02	-.2010000E-02	-.2240000E-02	-.2290000E-02	-.2400000E-02	-.2490000E-02
-.2610000E-02	-.2980000E-02	-.3550000E-02					
BETA= .5000000E+01							
.1090000E-02	.8000000E-03	.6000000E-03	.7000000E-03	.8100000E-03	.6900000E-03	.7400000E-03	.3900000E-03
.3200000E-03	.7000000E-04	.9000000E-04	-.2000000E-04	-.1000000E-03	-.9300000E-03	-.1050000E-02	-.8800000E-03
-.1150000E-02	-.1400000E-02	-.1490000E-02	-.1550000E-02	-.2290000E-02	-.2250000E-02	-.2410000E-02	-.2460000E-02
-.2520000E-02	-.2920000E-02	-.3010000E-02					
BETA= .1000000E+02							
.9200000E-03	.5300000E-03	.6100000E-03	.7000000E-03	.9600000E-03	.7700000E-03	.5500000E-03	.3600000E-03
.3000000E-03	-.2000000E-04	-.1900000E-03	-.3100000E-03	-.3100000E-03	-.6900000E-03	-.9200000E-02	-.1040000E-02
-.1080000E-02	-.1390000E-02	-.1560000E-02	-.1910000E-02	-.2200000E-02	-.2250000E-02	-.2430000E-02	-.2390000E-02
-.2640000E-02	-.3000000E-02	-.3320000E-02					
BETA= .1500000E+02							
.5000000E-03	.7500000E-03	.7300000E-03	.7100000E-03	.7300000E-03	.6100000E-03	.5400000E-03	.4100000E-03
.1800000E-03	-.1900000E-03	-.2200000E-03	-.4800000E-03	-.5500000E-03	-.7300000E-03	-.9000000E-02	-.1240000E-02
-.1210000E-02	-.1130000E-02	-.1430000E-02	-.1810000E-02	-.2290000E-02	-.2270000E-02	-.2450000E-02	-.2570000E-02
-.2740000E-02	-.3530000E-02	-.3300000E-02					
BETA= .2000000E+02							
.8400000E-03	.8400000E-03	.9300000E-03	.7500000E-03	.7900000E-03	.5400000E-03	.3900000E-03	.1900000E-03
.1700000E-03	0.	-.3200000E-03	-.4300000E-03	-.3200000E-03	-.7600000E-03	-.1000000E-02	-.1380000E-02
-.1310000E-02	-.1440000E-02	-.1630000E-02	-.1970000E-02	-.2300000E-02	-.2240000E-02	-.2530000E-02	-.2530000E-02
-.2820000E-02	-.3010000E-02	-.3680000E-02					
BETA= .3000000E+02							
.1300000E-02	.1090000E-02	.8800000E-03	.6700000E-03	.4600000E-03	.3600000E-03	.2600000E-03	.1500000E-03
.5000000E-04	-.6000000E-04	-.1600000E-03	-.2000000E-03	-.2300000E-03	-.1020000E-02	-.1290000E-02	-.1400000E-02
-.1620000E-02	-.1730000E-02	-.1810000E-02	-.1900000E-02	-.1970000E-02	-.2350000E-02	-.2500000E-02	-.2470000E-02
-.2500000E-02	-.3610000E-02	-.3020000E-02					
BETA= .4000000E+02							
.1660000E-02	.1430000E-02	.1210000E-02	.9900000E-03	.7600000E-03	.6500000E-03	.5400000E-03	.4200000E-03
.3100000E-03	.2000000E-03	.9000000E-04	-.1600000E-03	-.4100000E-03	-.6600000E-03	-.7700000E-03	-.1140000E-02
-.1510000E-02	-.1660000E-02	-.1470000E-02	-.1840000E-02	-.1866000E-02	-.2500000E-02	-.1740000E-02	-.2110000E-02
-.2140000E-02	-.3100000E-02	-.3350000E-02					
TABLE -- 8							
BETA= -.4000000E+02							
-.6000000E-03	-.6700000E-03	-.7400000E-03	-.8100000E-03	-.8800000E-03	-.9100000E-03	-.9500000E-03	-.9800000E-03
-.1010000E-02	-.1050000E-02	-.1090000E-02	-.1120000E-02	-.1170000E-02	-.1270000E-02	-.1660000E-02	-.2150000E-02
-.1960000E-02	-.2590000E-02	-.3070000E-02	-.3450000E-02	-.2000000E-02	-.2080000E-02	-.1130000E-02	.3000000E-04
.1020000E-02	.2440000E-02	.2470000E-02					
BETA= -.3000000E+02							

APPENDIX

```

--.1160000E-02 --.1200000E-02 --.1250000E-02 --.1290000E-02 --.1340000E-02 --.1360000E-02 --.1380000E-02 --.1400000E-02
--.1430000E-02 --.1450000E-02 --.1470000E-02 --.1390000E-02 --.1300000E-02 --.1500000E-02 --.1500000E-02 --.1250000E-02
--.2460000E-02 --.1770000E-02 --.2160000E-02 --.2430000E-02 --.2420000E-02 --.2180000E-02 --.1300000E-02 --.1300000E-02
.5000000E-04 .8500000E-03 .1650000E-02 .1290000E-02 .1340000E-02 .1360000E-02 .1380000E-02 .1400000E-02
BETA= -.2000000E+02
--.1200000E-03 --.1700000E-03 --.1700000E-03 --.2500000E-03 --.1400000E-03 --.1000000E-04 .2700000E-03 .4700000E-03
.5000000E-03 .1200000E-03 --.2300000E-03 .1500000E-03 .1600000E-03 .1300000E-03 .2200000E-03 .5200000E-03
.1240000E-02 .4000000E-03 --.3500000E-03 --.1610000E-02 --.1370000E-02 --.1590000E-02 --.2270000E-02 --.5000000E-03
.4900000E-03 .1040000E-02 .8800000E-03 .1700000E-03 .1700000E-03 .1400000E-03 .1000000E-04 .2700000E-03 .4700000E-03
BETA= -.1500000E+02
.4100000E-03 --.7000000E-04 --.2500000E-03 --.1000000E-03 --.4600000E-03 --.1000000E-03 .1000000E-03 --.6000000E-04
.2900000E-03 --.2400000E-03 .1500000E-03 .4000000E-04 .1000000E-03 .7000000E-04 .2400000E-03 .3800000E-03
--.5000000E-04 .1500000E-03 .8600000E-03 --.5400000E-03 --.1090000E-02 --.1410000E-02 --.1330000E-02 --.2500000E-03
.4900000E-03 .8700000E-03 .8000000E-03 .2000000E-03 --.1200000E-03 --.4400000E-03 .6900000E-04 .1800000E-03
BETA= -.1000000E+02
--.7000000E-04 --.3400000E-03 --.2000000E-03 .2000000E-04 --.1000000E-03 --.4400000E-03 --.6000000E-04 .1800000E-03
.9000000E-04 .2700000E-03 .3000000E-03 .8000000E-04 .1000000E-04 --.1800000E-03 --.5300000E-03 --.1000000E-04
--.2000000E-04 .1280000E-02 .1750000E-02 --.5900000E-03 --.3500000E-03 --.4200000E-03 --.7500000E-03 .1200000E-03
.7200000E-03 .5900000E-03 .5400000E-03 .5400000E-03 .1200000E-03 --.1200000E-03 --.4400000E-03 .6900000E-04 .1800000E-03
BETA= -.5000000E+01
.1200000E-03 --.1600000E-03 --.1300000E-03 --.5200000E-03 --.4000000E-03 --.4800000E-03 --.6200000E-03 --.3400000E-03
.5000000E-04 .3600000E-03 --.2000000E-04 --.7000000E-04 --.2000000E-03 --.6000000E-04 --.6000000E-02 --.2400000E-03
.6200000E-03 .8400000E-03 .1000000E-02 --.4700000E-03 --.1000000E-03 --.3500000E-03 --.6600000E-03 .7000000E-04
.6100000E-03 .6700000E-03 .3700000E-03 .3700000E-03 .1900000E-03 --.2600000E-03 --.1100000E-03 --.3000000E-04
BETA= 0.
--.1600000E-03 --.1300000E-03 --.3000000E-03 --.1600000E-03 --.2400000E-03 --.1500000E-03 --.1300000E-03 --.1900000E-03
--.9000000E-04 --.3800000E-03 --.4100000E-03 --.3600000E-03 --.1100000E-03 --.6000000E-04 .6000000E-03 --.4600000E-03
--.2400000E-03 .1000000E-04 --.1900000E-03 --.2600000E-03 --.2600000E-03 --.1100000E-03 --.1100000E-03 --.3000000E-04
--.1500000E-03 .6000000E-03 .7200000E-03 .7200000E-03 .3000000E-03 --.3000000E-03 --.2400000E-03 --.1500000E-03 --.1900000E-03
BETA= .5000000E+01
--.3300000E-03 --.1600000E-03 .3000000E-04 .1300000E-03 .1300000E-03 .1600000E-03 .1800000E-03 --.7000000E-04
--.6300000E-03 --.5200000E-03 --.6700000E-03 --.4600000E-03 --.3500000E-03 --.4000000E-03 --.3500000E-03 --.1070000E-02
--.3400000E-03 --.2300000E-03 --.3000000E-03 --.9100000E-03 .1500000E-03 .1500000E-03 .1700000E-03 --.2600000E-04
.1700000E-03 --.7700000E-03 --.7100000E-03 --.7100000E-03 .1700000E-03 --.1700000E-03 --.1700000E-03 --.5000000E-04
BETA= .1000000E+02
--.5700000E-03 --.2600000E-03 .2000000E-03 --.4200000E-03 --.2000000E-03 --.1800000E-03 .3000000E-04 .1700000E-03 --.5000000E-03
--.6600000E-03 --.6100000E-03 --.5300000E-03 --.2000000E-03 --.1800000E-03 --.1800000E-03 .1800000E-03 .1400000E-03 --.1500000E-02
--.1160000E-02 --.5000000E-03 --.1300000E-02 --.1300000E-02 --.1300000E-03 .2900000E-03 .2900000E-03 .6000000E-03 --.2000000E-03
--.6000000E-03 --.6900000E-03 --.6000000E-03 --.6000000E-03 .6000000E-03 .6000000E-03 .6000000E-03 .6000000E-03
BETA= .1500000E+02
.1000000E-03 --.3100000E-03 --.9000000E-04 .1000000E-04 --.2800000E-03 --.1000000E-03 --.1000000E-03 --.6700000E-03 --.7700000E-03

```

--.2600000E-03	.2000000E-03	--.2800000E-03	--.6000000E-04	--.4300000E-03	--.1800000E-03	--.2400000E-03	--.1900000E-03
--.6000000E-03	--.1780000E-02	--.1890000E-02	--.1000000E-04	.3900000E-03	.9400000E-03	.1240000E-02	--.6000000E-04
--.1050000E-02	--.7900000E-03	--.3100000E-03					
BETA=	.2000000E+02						
--.3400000E-03	.2000000E-04	--.5100000E-03	--.4000000E-04	--.1400000E-03	.5000000E-04	--.5500000E-03	--.4800000E-03
--.6000000E-04	--.1100000E-03	.2000000E-04	--.5400000E-03	--.5200000E-03	--.2000000E-03	--.5200000E-03	--.8600000E-03
--.1070000E-02	--.4000000E-03	--.8000000E-03	--.3000000E-04	.9600000E-03	.1410000E-02	.9300000E-03	.3100000E-03
--.5800000E-03	--.8900000E-03	--.5000000E-03					
BETA=	.3000000E+02						
.4600000E-03	.5200000E-03	.5700000E-03	.6200000E-03	.6800000E-03	.7000000E-03	.7300000E-03	.7600000E-03
.7900000E-03	.8100000E-03	.8400000E-03	.7300000E-03	.6300000E-03	.3400000E-03	.5300000E-03	--.1000000E-04
--.5200000E-03	.9200000E-03	.1100000E-02	.1720000E-02	.1590000E-02	.1600000E-02	.1100000E-02	0.
--.8700000E-03	.3640000E-02	--.1670000E-02					
BETA=	.4000000E+02						
.3400000E-03	.3200000E-03	.3100000E-03	.3000000E-03	.2900000E-03	.2800000E-03	.2800000E-03	.2700000E-03
.2600000E-03	.2600000E-03	.2500000E-03	.6300000E-03	.1020000E-02	.7300000E-03	.7000000E-03	.9300000E-03
.1280000E-02	.2230000E-02	.1800000E-02	.1970000E-02	.1230000E-02	.1270000E-02	.1260000E-02	--.4000000E-03
--.9700000E-03	--.2530000E-02	--.2860000E-02					

TABLE -- 9

BETA=	--.4000000E+02						
--.3670000E-02	--.3760000E-02	--.3900000E-02	--.4050000E-02	--.4140000E-02	--.4190000E-02	--.4240000E-02	--.4290000E-02
--.4330000E-02	--.4430000E-02	--.4480000E-02	--.4050000E-02	--.3620000E-02	--.3760000E-02	--.3240000E-02	--.3000000E-02
--.2100000E-02	--.4000000E-02	--.3000000E-02	--.1900000E-02	--.2290000E-02	--.2670000E-02	--.2140000E-02	--.2900000E-02
--.1140000E-02	.3300000E-03	.5200000E-03					
BETA=	--.3000000E+02						
--.1760000E-02	--.2000000E-02	--.2240000E-02	--.2480000E-02	--.2710000E-02	--.2810000E-02	--.2950000E-02	--.3050000E-02
--.3190000E-02	--.3290000E-02	--.3430000E-02	--.4380000E-02	--.5290000E-02	--.4760000E-02	--.3950000E-02	--.1430000E-02
--.2900000E-02	--.2620000E-02	--.3430000E-02	--.4050000E-02	--.4050000E-02	--.3100000E-02	--.2140000E-02	--.2900000E-02
--.2290000E-02	--.2620000E-02	--.1810000E-02					
BETA=	--.2000000E+02						
--.4140000E-02	--.2330000E-02	--.3670000E-02	--.2900000E-02	--.3900000E-02	--.4670000E-02	--.5240000E-02	--.4570000E-02
--.4950000E-02	--.4190000E-02	--.4480000E-02	--.3670000E-02	--.3140000E-02	--.4900000E-02	--.4480000E-02	--.4380000E-02
--.4570000E-02	--.2620000E-02	--.3950000E-02	--.2760000E-02	--.2000000E-02	--.4330000E-02	--.2190000E-02	--.2190000E-02
--.1900000E-02	--.2810000E-02	--.2430000E-02					
BETA=	--.1500000E+02						
--.3430000E-02	--.4100000E-02	--.6430000E-02	--.5620000E-02	--.6520000E-02	--.6290000E-02	--.5330000E-02	--.5100000E-02
--.5290000E-02	--.5000000E-02	--.4140000E-02	--.4570000E-02	--.3430000E-02	--.5000000E-02	--.4810000E-02	--.3900000E-02
--.3570000E-02	--.5290000E-02	--.4140000E-02	--.2810000E-02	--.2620000E-02	--.1860000E-02	--.2570000E-02	--.2570000E-02
--.2000000E-02	--.1900000E-02	--.1240000E-02					
BETA=	--.1000000E+02						

APPENDIX

```

--.4810000E-02 --.6520000E-02 --.4330000E-02 --.5950000E-02 --.4430000E-02 --.6100000E-02 --.5190000E-02 --.6000000E-02
--.5140000E-02 --.4240000E-02 --.4100000E-02 --.4430000E-02 --.5620000E-02 --.5620000E-02 --.6520000E-02 --.5050000E-02
--.5950000E-02 --.5100000E-02 --.5670000E-02 --.2480000E-02 --.3950000E-02 --.3000000E-02 --.3800000E-03 --.1000000E-02
--.2100000E-02 --.1330000E-02 --.2330000E-02 --.2330000E-02

BETA= -.5000000E+01
--.5100000E-02 --.4480000E-02 --.3860000E-02 --.5480000E-02 --.5480000E-02 --.5380000E-02 --.5760000E-02 --.5520000E-02
--.5330000E-02 --.4860000E-02 --.4100000E-02 --.5480000E-02 --.5620000E-02 --.6000000E-02 --.5480000E-02 --.4950000E-02
--.5950000E-02 --.6140000E-02 --.7810000E-02 --.3290000E-02 --.2000000E-02 --.2430000E-02 --.2050000E-02 --.1710000E-02
--.1900000E-02 --.1620000E-02 --.2100000E-02 --.2100000E-02

BETA= 0.
--.5710000E-02 --.5900000E-02 --.5190000E-02 --.6520000E-02 --.6810000E-02 --.5570000E-02 --.6810000E-02 --.6290000E-02
--.5430000E-02 --.4670000E-02 --.5760000E-02 --.5620000E-02 --.5140000E-02 --.7860000E-02 --.6190000E-02 --.5290000E-02
--.5000000E-02 --.6140000E-02 --.7620000E-02 --.3950000E-02 --.2050000E-02 --.2240000E-02 --.1570000E-02 --.1330000E-02
--.2240000E-02 --.2570000E-02 --.2290000E-02 --.2290000E-02

BETA= .5000000E+01
--.2330000E-02 --.4050000E-02 --.4950000E-02 --.4380000E-02 --.4570000E-02 --.4760000E-02 --.5430000E-02 --.5140000E-02
--.5100000E-02 --.4290000E-02 --.3910000E-02 --.3710000E-02 --.4380000E-02 --.7710000E-02 --.6860000E-02 --.6620000E-02
--.4620000E-02 --.5670000E-02 --.6950000E-02 --.6860000E-02 --.2810000E-02 --.1670000E-02 --.2380000E-02 --.2950000E-02
--.3330000E-02 --.2000000E-02 --.2240000E-02 --.2240000E-02

BETA= .1000000E+02
--.4810000E-02 --.6190000E-02 --.3100000E-02 --.3050000E-02 --.6100000E-02 --.3860000E-02 --.4330000E-02 --.4950000E-02
--.3860000E-02 --.3430000E-02 --.3670000E-02 --.3900000E-02 --.3100000E-02 --.6480000E-02 --.5570000E-02 --.4290000E-02
--.6140000E-02 --.4810000E-02 --.6480000E-02 --.3760000E-02 --.2620000E-02 --.1810000E-02 --.2290000E-02 --.1520000E-02
--.2100000E-02 --.1570000E-02 --.2000000E-02 --.2000000E-02

BETA= .1500000E+02
--.4240000E-02 --.2950000E-02 --.4810000E-02 --.6380000E-02 --.5000000E-02 --.4860000E-02 --.4100000E-02 --.5140000E-02
--.4330000E-02 --.3860000E-02 --.3810000E-02 --.2900000E-02 --.3240000E-02 --.5290000E-02 --.5670000E-02 --.4900000E-02
--.4810000E-02 --.4190000E-02 --.4710000E-02 --.3570000E-02 --.2190000E-02 --.1950000E-02 --.1710000E-02 --.2380000E-02
--.2240000E-02 --.1480000E-02 --.3000000E-02 --.3000000E-02

BETA= .2000000E+02
--.2670000E-02 --.3520000E-02 --.3240000E-02 --.5900000E-02 --.5050000E-02 --.4330000E-02 --.4480000E-02 --.5100000E-02
--.5100000E-02 --.4430000E-02 --.4290000E-02 --.4190000E-02 --.2620000E-02 --.4620000E-02 --.5050000E-02 --.3620000E-02
--.4430000E-02 --.4330000E-02 --.4050000E-02 --.2570000E-02 --.3190000E-02 --.2290000E-02 --.2610000E-02 --.2000000E-02
--.1480000E-02 --.2620000E-02 --.1760000E-02 --.1760000E-02

BETA= .3000000E+02
--.3480000E-02 --.3810000E-02 --.4100000E-02 --.4380000E-02 --.4710000E-02 --.4660000E-02 --.4950000E-02 --.5140000E-02
--.5290000E-02 --.5430000E-02 --.5570000E-02 --.5950000E-02 --.6330000E-02 --.4860000E-02 --.3950000E-02 --.3860000E-02
--.3100000E-02 --.3290000E-02 --.3860000E-02 --.4050000E-02 --.3430000E-02 --.3190000E-02 --.2810000E-02 --.2860000E-02
--.2480000E-02 --.3670000E-02 --.1570000E-02 --.1570000E-02

BETA= .4000000E+02
--.2190000E-02 --.2240000E-02 --.2240000E-02 --.2240000E-02 --.2290000E-02 --.2290000E-02 --.2330000E-02 --.2330000E-02

```


-.2360000E-02 -.2380000E-02 -.2380000E-02 -.2380000E-02 -.2570000E-02 -.2810000E-02 -.4620000E-02 -.3290000E-02 -.1860000E-02
 -.2620000E-02 -.1330000E-02 -.1760000E-02 -.1760000E-02 -.3100000E-02 -.2480000E-02 -.2760000E-02 -.2140000E-02 -.2760000E-02
 -.1190000E-02 -.5200000E-03 0. 0. 0. 0. 0. 0. 0.

TABLE -- 10

BETA= -.4000000E+02
 .5000000E-04 .7000000E-04 .6000000E-04 .9000000E-04 .1100000E-03 .1100000E-03 .1100000E-03 .1200000E-03 .1300000E-03
 .1400000E-03 .1400000E-03 .1500000E-03 .1600000E-03 .1800000E-03 .1800000E-03 .3400000E-03 .1700000E-03 0.
 -.1800000E-03 -.1000000E-03 -.2400000E-03 -.3200000E-03 -.1600000E-03 -.1000000E-03 -.1000000E-03 -.2000000E-04 .1300000E-03
 .2400000E-03 .4200000E-03 .3400000E-03 .3400000E-03 .3400000E-03 .3400000E-03 .3400000E-03 .3400000E-03 .3400000E-03

BETA= -.3000000E+02
 -.1900000E-03 -.1200000E-03 -.6000000E-04 .1000000E-04 .8000000E-04 .1100000E-03 .1100000E-03 .1400000E-03 .1800000E-03
 .2100000E-03 .2400000E-03 .2800000E-03 .2600000E-03 .2500000E-03 .1800000E-03 .1800000E-03 .6000000E-04 -.5000000E-04
 -.2100000E-03 -.1500000E-03 -.2000000E-03 -.1800000E-03 -.1400000E-03 -.1300000E-03 -.1300000E-03 -.1200000E-03 .1000000E-03
 .1800000E-03 .3700000E-03 .4900000E-03 .4900000E-03 .4900000E-03 .4900000E-03 .4900000E-03 .4900000E-03 .4900000E-03

BETA= -.2000000E+02
 -.4200000E-03 -.2900000E-03 -.1900000E-03 -.2300000E-03 -.1100000E-03 -.5000000E-04 -.8000000E-04 -.8000000E-04
 -.9000000E-04 -.1200000E-03 -.1300000E-03 -.1300000E-03 -.1000000E-04 .2000000E-04 .5000000E-04 0. .2000000E-04
 -.1500000E-03 -.1900000E-03 -.1700000E-03 -.2200000E-03 -.1800000E-03 -.1800000E-03 -.9000000E-04 -.1000000E-03
 .1400000E-03 .3400000E-03 .2200000E-03 .2200000E-03 .2200000E-03 .2200000E-03 .2200000E-03 .2200000E-03 .2200000E-03

BETA= -.1500000E+02
 -.2000000E-03 -.1300000E-03 -.9000000E-04 -.9000000E-04 -.1600000E-03 -.1900000E-03 -.1900000E-03 .1100000E-03 .9000000E-04
 .1000000E-03 -.1800000E-03 -.1800000E-03 -.1500000E-03 .5000000E-04 .5000000E-04 .2000000E-04 -.2100000E-03
 -.1100000E-03 -.1500000E-03 -.7000000E-04 -.7000000E-04 -.1100000E-03 -.1400000E-03 -.1400000E-03 .1000000E-03 .2000000E-04
 .1000000E-03 .3000000E-03 .1400000E-03 .1400000E-03 .1400000E-03 .1400000E-03 .1400000E-03 .1400000E-03 .1400000E-03

BETA= -.1000000E+02
 -.1400000E-03 -.1700000E-03 -.1100000E-03 -.1100000E-03 -.5000000E-04 -.5000000E-04 -.5000000E-04 .1400000E-04 .7000000E-04
 .1500000E-03 -.1400000E-03 -.2200000E-03 -.2200000E-03 .1900000E-03 .1900000E-03 .1900000E-03 .3000000E-03 .3000000E-03
 -.6000000E-04 -.1000000E-04 .1900000E-03 .1900000E-03 .1700000E-03 .1700000E-03 .1700000E-03 .1700000E-03 .1700000E-03
 .2000000E-04 .1400000E-03 .1200000E-03 .1200000E-03 .1200000E-03 .1200000E-03 .1200000E-03 .1200000E-03 .1200000E-03

BETA= -.5000000E+01
 .3000000E-04 -.1500000E-03 -.1200000E-03 -.1200000E-03 -.1100000E-03 -.1000000E-03 .2000000E-04 .3000000E-04 .1000000E-03
 .6000000E-04 -.1000000E-03 .8000000E-04 .8000000E-04 .8000000E-04 .8000000E-04 .7000000E-04 .4200000E-03 .5000000E-03
 -.6000000E-04 .1300000E-03 .1000000E-03 .1000000E-03 .7000000E-04 .2000000E-04 .5000000E-04 .5000000E-04 .5000000E-04
 .1000000E-04 .5000000E-04 .5000000E-04 .5000000E-04 .5000000E-04 .5000000E-04 .5000000E-04 .5000000E-04 .5000000E-04

BETA= 0.
 -.1000000E-03 0. -.7000000E-04 .1800000E-03 -.1300000E-03 -.4000000E-04 .7000000E-03 .7000000E-04 .7000000E-04
 -.4000000E-04 0. -.4000000E-04 -.9000000E-04 -.3000000E-04 -.3000000E-04 .4000000E-04 .4000000E-04 .4000000E-04 .4000000E-04
 -.6000000E-04 .1000000E-03 .1000000E-03 .1000000E-03 .1000000E-03 .1000000E-03 .1000000E-03 .1000000E-03 .1000000E-03
 .7000000E-04 .1000000E-03 .7000000E-04 .7000000E-04 .7000000E-04 .7000000E-04 .7000000E-04 .7000000E-04 .7000000E-04

BETA= .5000000E+01

APPENDIX

0.	-.1300000E-03	-.1400000E-03	-.1100000E-03	-.1600000E-03	-.3000000E-04	.1200000E-03
-.1300000E-03	0.	0.	-.2000000E-04	-.1100000E-03	.1000000E-03	0.
-.1300000E-04	.2000000E-04	.4000000E-04	.2000000E-04	.2000000E-04	-.5000000E-04	.9000000E-04
.8000000E-04	-.8000000E-04	-.8000000E-04	-.8000000E-04	-.8000000E-04	-.8000000E-04	-.8000000E-04
BETA= .1000000E+02						
-.1500000E-03	.1000000E-04	-.1300000E-03	-.1900000E-03	-.7000000E-04	.1000000E-03	0.
-.2000000E-04	.1600000E-03	.6000000E-04	.7000000E-04	-.1700000E-03	-.1000000E-04	.1300000E-03
0.	-.2000000E-03	.5000000E-04	-.2000000E-04	.7000000E-04	.1000000E-04	0.
-.1200000E-03	-.3000000E-04	-.3000000E-04	-.2000000E-04	.7000000E-04	.1000000E-04	0.
BETA= .1500000E+02						
-.1000000E-03	-.8000000E-04	-.2300000E-03	-.1000000E-03	-.6000000E-04	-.8000000E-04	-.3000000E-04
-.3000000E-04	-.4000000E-04	-.9000000E-04	-.3000000E-04	-.6000000E-04	-.4000000E-04	.2000000E-04
.7000000E-04	.4000000E-04	.3000000E-04	.6000000E-04	.1000000E-03	.5000000E-04	.3000000E-04
-.5000000E-04	-.1300000E-03	-.1200000E-03	-.1200000E-03	.1000000E-04	.5000000E-04	.3000000E-04
BETA= .2000000E+02						
-.6000000E-04	-.2000000E-04	-.1700000E-03	-.3000000E-04	-.1000000E-03	-.8000000E-04	-.2000000E-04
.5000000E-04	.1000000E-04	.3000000E-04	0.	-.1800000E-03	-.1000000E-03	0.
.4000000E-04	-.1000000E-04	.8000000E-04	0.	.1600000E-03	.3000000E-04	-.4000000E-04
-.1400000E-03	-.2200000E-03	-.1400000E-03	-.1400000E-03	.1600000E-03	.3000000E-04	-.4000000E-04
BETA= .3000000E+02						
.1400000E-03	.7000000E-04	.3000000E-04	0.	-.2000000E-04	-.5000000E-04	-.6000000E-04
-.8000000E-04	-.1200000E-03	-.1700000E-03	-.2200000E-03	-.1300000E-03	-.1000000E-03	.2000000E-04
.1400000E-03	.9000000E-04	-.1000000E-04	.9000000E-04	.8000000E-04	.8000000E-04	-.1000000E-03
-.2200000E-03	-.3600000E-03	-.3600000E-03	-.3600000E-03	.8000000E-04	.8000000E-04	-.1000000E-03
BETA= .4000000E+02						
.3300000E-03	.1200000E-03	.2000000E-04	-.9000000E-04	-.1400000E-03	-.1900000E-03	-.2400000E-03
-.3000000E-03	-.4000000E-03	-.4600000E-03	-.5200000E-03	-.6000000E-03	-.4600000E-03	-.1800000E-03
-.1700000E-03	.9000000E-04	-.1000000E-04	.3000000E-04	.4000000E-04	0.	-.2200000E-03
-.1800000E-03	-.5300000E-03	-.5300000E-03	-.5300000E-03	.4000000E-04	0.	-.2200000E-03
TABLE -- 11						
BETA= -.4000000E+02						
-.2690000E-02	-.2990000E-02	-.3290000E-02	-.3900000E-02	-.4050000E-02	-.4200000E-02	-.4350000E-02
-.4500000E-02	-.4650000E-02	-.4800000E-02	-.4500000E-02	-.4140000E-02	-.4310000E-02	-.4320000E-02
-.3700000E-02	-.3370000E-02	-.3200000E-02	-.3580000E-02	-.3770000E-02	-.3860000E-02	-.4340000E-02
-.3440000E-02	-.1950000E-02	-.6300000E-03	-.6300000E-03	-.3770000E-02	-.3860000E-02	-.4340000E-02
BETA= -.3000000E+02						
-.7800000E-03	-.1230000E-02	-.1700000E-02	-.2610000E-02	-.2850000E-02	-.3080000E-02	-.3310000E-02
-.3540000E-02	-.3770000E-02	-.4000000E-02	-.5890000E-02	-.5410000E-02	-.4620000E-02	-.3400000E-02
-.3350000E-02	-.3970000E-02	-.4740000E-02	-.4370000E-02	-.4850000E-02	-.3680000E-02	-.3460000E-02
-.2780000E-02	-.2390000E-02	-.2270000E-02	-.2270000E-02	-.4850000E-02	-.3680000E-02	-.3460000E-02

APPENDIX

BETA= -.200000E+02
-.495000E-02 -.437000E-02 -.621000E-02 -.606000E-02 -.547000E-02 -.475000E-02 -.437000E-02 -.610000E-02 -.623000E-02
-.599000E-02 -.559000E-02 -.410000E-02 -.458000E-02 -.468000E-02 -.532000E-02 -.468000E-02 -.462000E-02 -.442000E-02
-.377000E-02 -.280000E-02 -.408000E-02 -.521000E-02 -.419000E-02 -.360000E-02 -.408000E-02 -.375000E-02 -.330000E-02
-.280000E-02 -.290000E-02 -.246000E-02 -.695000E-02 -.695000E-02 -.695000E-02 -.705000E-02 -.694000E-02 -.660000E-02
BETA= -.150000E+02
-.554000E-02 -.560000E-02 -.625000E-02 -.695000E-02 -.625000E-02 -.583000E-02 -.568000E-02 -.625000E-02 -.694000E-02
-.613000E-02 -.557000E-02 -.456000E-02 -.470000E-02 -.568000E-02 -.568000E-02 -.456000E-02 -.470000E-02 -.622000E-02
-.353000E-02 -.350000E-02 -.320000E-02 -.425000E-02 -.386000E-02 -.320000E-02 -.425000E-02 -.414000E-02 -.366000E-02
-.319000E-02 -.257000E-02 -.175000E-02 -.730000E-02 -.730000E-02 -.730000E-02 -.743000E-02 -.730000E-02 -.732000E-02
BETA= -.100000E+02
-.630000E-02 -.645000E-02 -.650000E-02 -.729000E-02 -.650000E-02 -.637000E-02 -.650000E-02 -.730000E-02 -.732000E-02
-.678000E-02 -.559000E-02 -.561000E-02 -.470000E-02 -.526000E-02 -.561000E-02 -.470000E-02 -.481000E-02 -.456000E-02
-.388000E-02 -.289000E-02 -.246000E-02 -.392000E-02 -.386000E-02 -.246000E-02 -.392000E-02 -.472000E-02 -.311000E-02
-.335000E-02 -.259000E-02 -.254000E-02 -.769000E-02 -.769000E-02 -.769000E-02 -.794000E-02 -.804000E-02 -.777000E-02
BETA= -.500000E+01
-.685000E-02 -.710000E-02 -.540000E-02 -.548000E-02 -.560000E-02 -.676000E-02 -.560000E-02 -.580000E-02 -.777000E-02
-.741000E-02 -.596000E-02 -.170000E-02 -.354000E-02 -.354000E-02 -.540000E-02 -.354000E-02 -.443000E-02 -.443000E-02
-.321000E-02 -.275000E-02 -.170000E-02 -.689000E-02 -.689000E-02 -.689000E-02 -.794000E-02 -.794000E-02 -.777000E-02
-.339000E-02 -.271000E-02 -.245000E-02 -.560000E-02 -.560000E-02 -.560000E-02 -.443000E-02 -.401000E-02 -.357000E-02
BETA= 0.
-.699000E-02 -.744000E-02 -.687000E-02 -.823000E-02 -.723000E-02 -.687000E-02 -.823000E-02 -.876000E-02 -.840000E-02
-.722000E-02 -.626000E-02 -.595000E-02 -.667000E-02 -.533000E-02 -.595000E-02 -.667000E-02 -.580000E-02 -.485000E-02
-.368000E-02 -.209000E-02 -.125000E-02 -.408000E-02 -.311000E-02 -.125000E-02 -.408000E-02 -.335000E-02 -.349000E-02
-.345000E-02 -.288000E-02 -.214000E-02 -.805000E-02 -.805000E-02 -.805000E-02 -.823000E-02 -.876000E-02 -.840000E-02
BETA= .500000E+01
-.603000E-02 -.628000E-02 -.631000E-02 -.692000E-02 -.629000E-02 -.631000E-02 -.692000E-02 -.687000E-02 -.731000E-02
-.606000E-02 -.532000E-02 -.471000E-02 -.671000E-02 -.478000E-02 -.471000E-02 -.671000E-02 -.654000E-02 -.561000E-02
-.372000E-02 -.302000E-02 -.138000E-02 -.395000E-02 -.104000E-02 -.138000E-02 -.395000E-02 -.399000E-02 -.429000E-02
-.284000E-02 -.277000E-02 -.220000E-02 -.667000E-02 -.667000E-02 -.667000E-02 -.542000E-02 -.542000E-02 -.688000E-02
BETA= .100000E+02
-.604000E-02 -.601000E-02 -.564000E-02 -.695000E-02 -.615000E-02 -.564000E-02 -.695000E-02 -.651000E-02 -.688000E-02
-.617000E-02 -.528000E-02 -.499000E-02 -.441000E-02 -.500000E-02 -.499000E-02 -.441000E-02 -.544000E-02 -.450000E-02
-.359000E-02 -.292000E-02 -.208000E-02 -.400000E-02 -.343000E-02 -.208000E-02 -.400000E-02 -.421000E-02 -.334000E-02
-.332000E-02 -.266000E-02 -.237000E-02 -.630000E-02 -.630000E-02 -.630000E-02 -.620000E-02 -.620000E-02 -.630000E-02
BETA= .150000E+02
-.540000E-02 -.481000E-02 -.532000E-02 -.636000E-02 -.576000E-02 -.532000E-02 -.636000E-02 -.630000E-02 -.630000E-02
-.567000E-02 -.562000E-02 -.505000E-02 -.420000E-02 -.463000E-02 -.505000E-02 -.420000E-02 -.530000E-02 -.450000E-02
-.351000E-02 -.298000E-02 -.257000E-02 -.390000E-02 -.347000E-02 -.257000E-02 -.390000E-02 -.379000E-02 -.363000E-02
-.308000E-02 -.228000E-02 -.298000E-02 -.630000E-02 -.630000E-02 -.630000E-02 -.415000E-02 -.415000E-02 -.630000E-02
BETA= .200000E+02

APPENDIX

--.4550000E-02	--.4460000E-02	--.5060000E-02	--.5800000E-02	--.6250000E-02	--.6110000E-02	--.6030000E-02	--.6030000E-02
--.5980000E-02	--.3680000E-02	--.5560000E-02	--.4850000E-02	--.3970000E-02	--.4890000E-02	--.5200000E-02	--.4210000E-02
--.3780000E-02	--.6000000E-02	--.3970000E-02	--.3580000E-02	--.4470000E-02	--.4340000E-02	--.4060000E-02	--.3090000E-02
--.2600000E-02	--.2820000E-02	--.1890000E-02					
BETA=	.3000000E+02						
--.3140000E-02	--.3460000E-02	--.3780000E-02	--.4100000E-02	--.4420000E-02	--.4580000E-02	--.4730000E-02	--.4890000E-02
--.5050000E-02	--.5210000E-02	--.5370000E-02	--.5810000E-02	--.6250000E-02	--.5000000E-02	--.6240000E-02	--.3990000E-02
--.4060000E-02	--.3700000E-02	--.4480000E-02	--.4400000E-02	--.3890000E-02	--.4540000E-02	--.4160000E-02	--.3690000E-02
--.3270000E-02	--.2600000E-02	--.1680000E-02					
BETA=	.4000000E+02						
--.1220000E-02	--.1580000E-02	--.1940000E-02	--.2300000E-02	--.2650000E-02	--.2830000E-02	--.3000000E-02	--.3190000E-02
--.3360000E-02	--.3540000E-02	--.3720000E-02	--.3880000E-02	--.4020000E-02	--.4580000E-02	--.3800000E-02	--.3300000E-02
--.2840000E-02	--.2270000E-02	--.2960000E-02	--.3960000E-02	--.3810000E-02	--.5020000E-02	--.3340000E-02	--.4340000E-02
--.3110000E-02	--.1590000E-02	--.4400000E-02					
TABLE --	12						
BETA=	--.4000000E+02						
.2100000E-03	.2600000E-03	.3000000E-03	.3500000E-03	.4000000E-03	.4200000E-03	.4400000E-03	.4600000E-03
.4800000E-03	.5000000E-03	.5300000E-03	.5800000E-03	.6200000E-03	.6500000E-03	.8000000E-03	.9900000E-03
.9900000E-03	.1220000E-02	.1090000E-02	.1360000E-02	.1160000E-02	.1070000E-02	.9300000E-03	.2700000E-03
--.3500000E-03	--.7800000E-03	--.1030000E-02					
BETA=	--.3000000E+02						
.8300000E-03	.8300000E-03	.8300000E-03	.8400000E-03	.8400000E-03	.8400000E-03	.8400000E-03	.8400000E-03
.8400000E-03	.8500000E-03	.8500000E-03	.7700000E-03	.7000000E-03	.7200000E-03	.6600000E-03	.6000000E-03
.1030000E-02	.1050000E-02	.1420000E-02	.1280000E-02	.9300000E-03	.1410000E-02	.8800000E-03	.1000000E-04
--.2000000E-03	--.1000000E-02	--.8400000E-03					
BETA=	--.2000000E+02						
--.6000000E-04	.1000000E-04	.7000000E-04	.9000000E-04	.7000000E-04	.7000000E-04	.1200000E-03	--.3300000E-03
--.2500000E-03	--.4000000E-04	.1800000E-03	--.1200000E-03	--.2500000E-03	--.1600000E-03	--.2500000E-03	--.3900000E-03
--.1000000E-04	0.	.2100000E-03	.7800000E-03	.9700000E-03	.9800000E-03	.1300000E-03	.5000000E-04
--.4800000E-03	--.9900000E-03	--.7100000E-03					
BETA=	--.1500000E+02						
.1300000E-03	.1000000E-04	--.1000000E-03	--.6000000E-04	--.1600000E-03	--.1000000E-04	.9000000E-04	.1100000E-03
.2400000E-03	--.1000000E-04	.8000000E-04	.9000000E-04	.1000000E-03	.2000000E-03	.1600000E-03	.3000000E-04
.1500000E-03	.3300000E-03	.5500000E-03	--.4700000E-03	--.6300000E-03	--.6000000E-03	--.7300000E-03	.1200000E-03
.3100000E-03	.5900000E-03	.6000000E-03					
BETA=	--.1000000E+02						
--.1800000E-03	--.3000000E-04	--.4000000E-04	.2000000E-04	.1100000E-03	.1900000E-03	.3000000E-04	--.8000000E-04
--.9000000E-04	--.2500000E-03	--.2100000E-03	--.2000000E-03	--.1600000E-03	--.1700000E-03	--.1200000E-03	--.1300000E-03
--.1600000E-03	--.9300000E-03	--.1330000E-02	.3600000E-03	.3200000E-03	.4000000E-03	--.1300000E-03	--.2600000E-03
--.4500000E-03	--.5400000E-03	--.5300000E-03					

APPENDIX

BETA= -.500000E+01
 -.100000E-03 -.700000E-04 .11000000E-03 .13000000E-03 .12000000E-03 .5000000E-04
 -.170000E-03 -.330000E-03 -.13000000E-03 -.11000000E-03 -.29000000E-03 -.30000000E-04
 -.750000E-03 -.970000E-03 .32000000E-03 .21000000E-03 .23000000E-03 .19000000E-03
 -.400000E-03 -.370000E-03 -.31000000E-03 .60000000E-04 .20000000E-04 .80000000E-04 .5000000E-04
 BETA= 0.
 -.400000E-04 .600000E-04 .100000E-03 .60000000E-04 0. -.20000000E-04 .80000000E-04
 -.300000E-04 .600000E-04 .100000E-03 .60000000E-04 -.10000000E-04 -.25000000E-03 0.
 -.380000E-03 -.360000E-03 .34000000E-03 .34000000E-03 .70000000E-03 .16000000E-03 .40000000E-04
 -.140000E-03 -.250000E-03 .38000000E-03 .14000000E-03 .70000000E-03 .16000000E-03 0.
 BETA= .500000E+01
 .170000E-03 .100000E-03 0. -.11000000E-03 -.10000000E-03 .30000000E-04 0.
 .310000E-03 .250000E-03 .400000E-03 .19000000E-03 .25000000E-03 .15000000E-03 .10000000E-04
 .730000E-03 .790000E-03 .70000000E-04 .17000000E-03 .23000000E-03 .14000000E-03 .10000000E-03
 .550000E-03 .240000E-03 .41000000E-03 .17000000E-03 .17000000E-03 .11000000E-03 .33000000E-03
 BETA= .100000E+02
 .140000E-03 .700000E-04 .60000000E-04 .60000000E-04 .50000000E-04 .80000000E-04 .15000000E-03
 .230000E-03 .280000E-03 .27000000E-03 .16300000E-03 .15000000E-03 .17000000E-04 .56000000E-03
 .940000E-03 .129000E-02 .123000E-02 .51000000E-03 .25000000E-03 .28000000E-03 .21000000E-03
 .500000E-03 .560000E-03 .37000000E-03 .60000000E-04 .60000000E-04 .60000000E-04 .21000000E-03
 BETA= .150000E+02
 -.100000E-04 0. -.300000E-04 .10000000E-03 .10000000E-03 .34000000E-03 .33000000E-03
 .290000E-03 -.240000E-03 .100000E-03 .100000E-03 .170000E-03 .230000E-03 .600000E-04
 .340000E-03 .690000E-03 .135000E-02 .800000E-04 .800000E-04 .28000000E-03 .18000000E-03
 .220000E-03 .640000E-03 .500000E-03 .30000000E-04 .30000000E-04 .200000E-03 .27000000E-03
 BETA= .200000E+02
 .300000E-04 .130000E-03 .200000E-04 .900000E-04 .70000000E-04 .50000000E-04 .70000000E-04
 -.100000E-03 -.100000E-04 .210000E-03 .70000000E-03 .21000000E-03 .16000000E-03 .33000000E-03
 .280000E-03 .360000E-03 .430000E-03 .520000E-03 .610000E-03 .48000000E-03 .19000000E-03
 .460000E-03 .690000E-03 .560000E-03 .900000E-04 .900000E-04 .200000E-03 .200000E-03
 BETA= .300000E+02
 .230000E-03 .300000E-03 .370000E-03 .440000E-03 .510000E-03 .540000E-03 .610000E-03
 .650000E-03 .680000E-03 .710000E-03 .690000E-03 .600000E-03 .600000E-03 .580000E-03
 -.100000E-03 -.660000E-03 .910000E-03 .830000E-03 .830000E-03 .650000E-03 .830000E-03
 .410000E-03 .115000E-02 .960000E-03 .960000E-03 .960000E-03 .960000E-03 .960000E-03 .500000E-04
 BETA= .400000E+02
 .740000E-03 .690000E-03 .640000E-03 .590000E-03 .590000E-03 .540000E-03 .540000E-03
 -.440000E-03 -.410000E-03 .390000E-03 .510000E-03 .510000E-03 .630000E-03 .630000E-03 .680000E-03
 .650000E-03 .690000E-03 .130000E-02 .117000E-02 .117000E-02 .800000E-03 .800000E-03 .680000E-03
 .530000E-03 .131000E-02 .109000E-02 .109000E-02 .109000E-02 .109000E-02 .109000E-02 .100000E-04

TABLE -- 13

APPENDIX

BETA= -.400000E+02
 -.410000E-03 -.440000E-03 -.460000E-03 -.480000E-03 -.510000E-03 -.520000E-03 -.530000E-03 -.540000E-03
 -.550000E-03 -.570000E-03 -.580000E-03 -.600000E-03 -.620000E-03 -.640000E-03 -.660000E-03 -.680000E-03
 -.700000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04
 .230000E-03 .400000E-04 .420000E-03 .420000E-03 .420000E-03 .420000E-03 .420000E-03 .420000E-03

BETA= -.300000E+02
 .100000E-04 -.200000E-04 -.200000E-04 -.200000E-04 -.200000E-04 -.200000E-04 -.200000E-04 -.200000E-04
 .170000E-03 -.180000E-03 -.180000E-03 -.180000E-03 -.180000E-03 -.180000E-03 -.180000E-03 -.180000E-03
 -.440000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03
 -.160000E-03 -.120000E-03 -.120000E-03 -.120000E-03 -.120000E-03 -.120000E-03 -.120000E-03 -.120000E-03

BETA= -.200000E+02
 -.190000E-03 -.110000E-03 -.110000E-03 -.110000E-03 -.110000E-03 -.110000E-03 -.110000E-03 -.110000E-03
 -.700000E-04 .700000E-04 .700000E-04 .700000E-04 .700000E-04 .700000E-04 .700000E-04 .700000E-04
 -.330000E-03 .700000E-03 .700000E-03 .700000E-03 .700000E-03 .700000E-03 .700000E-03 .700000E-03
 .160000E-03 -.150000E-03 -.150000E-03 -.150000E-03 -.150000E-03 -.150000E-03 -.150000E-03 -.150000E-03

BETA= -.150000E+02
 .200000E-03 -.130000E-03 -.130000E-03 -.130000E-03 -.130000E-03 -.130000E-03 -.130000E-03 -.130000E-03
 -.100000E-03 -.270000E-03 -.270000E-03 -.270000E-03 -.270000E-03 -.270000E-03 -.270000E-03 -.270000E-03
 .700000E-04 .250000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03
 -.140000E-03 -.200000E-03 -.200000E-03 -.200000E-03 -.200000E-03 -.200000E-03 -.200000E-03 -.200000E-03

BETA= -.100000E+02
 .140000E-03 -.150000E-03 -.150000E-03 -.150000E-03 -.150000E-03 -.150000E-03 -.150000E-03 -.150000E-03
 .160000E-03 -.140000E-03 -.140000E-03 -.140000E-03 -.140000E-03 -.140000E-03 -.140000E-03 -.140000E-03
 .230000E-03 -.800000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04
 -.200000E-04 -.400000E-04 .400000E-03 .400000E-03 .400000E-03 .400000E-03 .400000E-03 .400000E-03

BETA= -.500000E+01
 .800000E-04 -.130000E-03 -.130000E-03 -.130000E-03 -.130000E-03 -.130000E-03 -.130000E-03 -.130000E-03
 .390000E-03 .220000E-03 .220000E-03 .220000E-03 .220000E-03 .220000E-03 .220000E-03 .220000E-03
 .210000E-03 -.800000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04 .800000E-04
 .150000E-03 -.100000E-03 -.100000E-03 -.100000E-03 -.100000E-03 -.100000E-03 -.100000E-03 -.100000E-03

BETA= 0.
 .900000E-04 -.140000E-03 -.140000E-03 -.140000E-03 -.140000E-03 -.140000E-03 -.140000E-03 -.140000E-03
 .320000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03 .250000E-03
 .280000E-03 0. 0. 0. 0. 0. 0. 0. 0.
 .800000E-04 .100000E-03 .100000E-03 .100000E-03 .100000E-03 .100000E-03 .100000E-03 .100000E-03

BETA= .500000E+01
 .180000E-03 .140000E-03 .140000E-03 .140000E-03 .140000E-03 .140000E-03 .140000E-03 .140000E-03
 -.150000E-03 .300000E-04 .300000E-04 .300000E-04 .300000E-04 .300000E-04 .300000E-04 .300000E-04
 0. .400000E-04 .400000E-04 .400000E-04 .400000E-04 .400000E-04 .400000E-04 .400000E-04
 .280000E-03 .220000E-03 .220000E-03 .220000E-03 .220000E-03 .220000E-03 .220000E-03 .220000E-03

APPENDIX

BETA= -.1500000E+02	-4.800000E-03	-4.900000E-03	-5.400000E-03	-4.200000E-03	-4.400000E-03	-4.700000E-03
-.4500000E-03	-1.900000E-03	-2.400000E-03	-2.700000E-03	-5.000000E-04	-1.000000E-04	-6.000000E-04
-.3300000E-03	.1000000E-04	.2000000E-04	.2000000E-04	-1.500000E-04	.4000000E-04	.4000000E-04
0.	.3000000E-04					
.4000000E-04	.5000000E-04					
BETA= -.1000000E+02	-.3900000E-03	-6.200000E-03	-6.200000E-03	-6.200000E-03	-4.400000E-03	-5.100000E-03
-.3600000E-03	-.2800000E-03	-1.400000E-03	-1.300000E-03	-2.000000E-04	.8000000E-04	-7.000000E-04
-.3700000E-03	.4000000E-04	-1.200000E-03	.7000000E-04	.4000000E-04	.3000000E-04	.5000000E-04
.1000000E-04	0.					
.2000000E-04	.5000000E-04					
BETA= -.5000000E+01	-4.400000E-03	-7.800000E-03	-7.200000E-03	-5.600000E-03	-4.500000E-03	-4.200000E-03
-.4300000E-03	-.2300000E-03	-2.300000E-03	-1.800000E-03	-1.000000E-04	.1600000E-03	-8.000000E-04
-.2800000E-03	0.	-.9000000E-04	.5000000E-04	.3000000E-04	.2000000E-04	.2000000E-04
0.	.4000000E-04					
.3000000E-04	.4000000E-04					
BETA= 0.	-.7700000E-03	-7.500000E-03	-6.400000E-03	-5.700000E-03	-5.000000E-03	-3.600000E-03
-.6700000E-03	-.2700000E-03	-2.200000E-03	-2.000000E-03	-1.800000E-03	.7000000E-04	-2.000000E-04
-.4600000E-03	0.	.3000000E-04	.7000000E-04	.4000000E-04	-7.000000E-04	-8.000000E-04
-.6000000E-04	-.4000000E-04					
-.5000000E-04						
BETA= .5000000E+01	-7.800000E-03	-2.900000E-03	-2.400000E-03	-5.500000E-03	-3.700000E-03	-2.200000E-03
-.7100000E-03	-.2700000E-03	.2900000E-03	.2400000E-03	-1.600000E-03	0.	-7.000000E-04
-.4100000E-03	.7000000E-04	.4000000E-04	.1000000E-03	.6000000E-04	.5000000E-04	.1000000E-04
-.7000000E-04	-.2000000E-04					
0.						
BETA= .1000000E+02	-7.100000E-03	-8.300000E-03	-5.400000E-03	-5.000000E-03	-4.200000E-03	-4.700000E-03
-.7200000E-03	-.1600000E-03	-1.200000E-03	-1.000000E-03	-1.000000E-03	0.	-3.000000E-04
-.5400000E-03	.4000000E-04	.1200000E-03	.5000000E-04	.8000000E-04	.2000000E-04	.5000000E-04
.4000000E-04	-.1000000E-04					
.3000000E-04						
BETA= .1500000E+02	-6.400000E-03	-8.400000E-03	-5.400000E-03	-5.300000E-03	-4.500000E-03	-5.500000E-03
-.7400000E-03	-.1800000E-03	-1.800000E-03	-9.000000E-04	-1.100000E-03	0.	-1.100000E-03
-.6600000E-03	.2000000E-04	.1400000E-03	.5000000E-04	.8000000E-04	.1000000E-04	.7000000E-04
0.						
.5000000E-04	.2000000E-04					
BETA= .2000000E+02	-6.900000E-03	-8.400000E-03	-5.000000E-03	-5.100000E-03	-4.100000E-03	-3.500000E-03
-.6600000E-03	-.4200000E-03	-1.400000E-03	-1.600000E-03	-1.600000E-03	-8.000000E-04	-6.000000E-04
-.3700000E-03	.4000000E-04	.5000000E-04	.2000000E-04	.7000000E-04	.1000000E-04	.4000000E-04
.3000000E-04	0.					
.2000000E-04	.2000000E-04					

APPENDIX

BETA=	.3000000E+02	-.6400000E-03	-.5600000E-03	-.4800000E-03	-.4400000E-03	-.4000000E-03	-.3600000E-03
	-.800000E-03	-.7200000E-03	-.6000000E-03	-.3500000E-03	-.1800000E-03	-.3300000E-03	-.6000000E-04
	-.3200000E-03	-.2800000E-03	.1000000E-04	.7000000E-04	.5000000E-04	.7000000E-04	.4000000E-04
	.1000000E-04	.3000000E-04	.1000000E-04				
	.8000000E-04						
BETA=	.4000000E+02	-.4600000E-03	-.4200000E-03	-.3700000E-03	-.3500000E-03	-.3300000E-03	-.3100000E-03
	-.5400000E-03	-.5000000E-03	-.2900000E-03	-.3400000E-03	-.3500000E-03	-.2800000E-03	-.1700000E-03
	-.2800000E-03	-.2700000E-03	-.2000000E-04	-.1000000E-04	.9000000E-04	.1200000E-03	.7000000E-04
	-.1400000E-03	-.5000000E-04	.1100000E-03				
	.1100000E-03	-.1000000E-04					
TABLE -- 15							
BETA=	-.4000000E+02	.1000000E-03	.1400000E-03	.1900000E-03	.2100000E-03	.2400000E-03	.2600000E-03
	0.	.3300000E-03	.1700000E-03	.2000000E-04	-.2200000E-03	-.1000000E-03	.1200000E-03
	.2800000E-03	.3100000E-03	-.1800000E-03	-.1500000E-03	-.4000000E-04	-.1400000E-03	.1300000E-03
	.2300000E-03	.1800000E-03	.1000000E-03				
	.3000000E-04	.2500000E-03	.1000000E-03				
BETA=	-.3000000E+02	.2300000E-03	.2200000E-03	.2100000E-03	.2000000E-03	.1900000E-03	.1900000E-03
	.2500000E-03	.2400000E-03	.5000000E-04	-.7000000E-04	.1000000E-04	.1000000E-04	-.5000000E-04
	.1800000E-03	.1800000E-03	.1100000E-03	.2000000E-04	.7600000E-03	.2700000E-03	.3000000E-04
	-.1500000E-03	-.1800000E-03	.9000000E-04				
	.1300000E-03	.1700000E-03	.1800000E-03				
BETA=	-.2000000E+02	.1000000E-03	.4000000E-04	.1400000E-03	.1100000E-03	.1100000E-03	.4000000E-04
	.6000000E-04	.1100000E-03	.9000000E-04	.7000000E-04	-.1000000E-04	0.	.4000000E-04
	.1200000E-03	.3000000E-04	.3000000E-03	.1400000E-03	.3400000E-03	-.2500000E-03	.2400000E-03
	.2000000E-03	.1400000E-03	.1900000E-03				
	.1600000E-03	.6000000E-04	.1300000E-03				
BETA=	-.1500000E+02	.2000000E-04	.7000000E-04	.1200000E-03	.6000000E-04	.4000000E-04	.1700000E-03
	.2000000E-04	.9000000E-04	.1300000E-03	.2700000E-03	.1500000E-03	.1500000E-03	.2100000E-03
	.8000000E-04	.9000000E-04	.3200000E-03	.2500000E-03	.3000000E-03	.2800000E-03	.3000000E-04
	.1600000E-03	.2200000E-03	.1600000E-03				
	.1500000E-03	.2500000E-03	.1700000E-03				
BETA=	-.1000000E+02	-.1000000E-04	-.3000000E-04	.5000000E-04	.9000000E-04	.9000000E-04	.1600000E-03
	-.4000000E-04	.5000000E-04	.1100000E-03	.1700000E-03	.1700000E-03	.1200000E-03	.1300000E-03
	.2200000E-03	.1800000E-03	.1600000E-03	.1800000E-03	.1400000E-03	.3000000E-04	.1700000E-03
	.2100000E-03	.2300000E-03	.1600000E-03				
	.2600000E-03	.2000000E-03	.1100000E-03				
BETA=	-.5000000E+01	.1000000E-04	-.1000000E-03	.4000000E-04	.8000000E-04	.1100000E-03	.1500000E-03
	-.3000000E-04	.2000000E-04	.2000000E-03	.1700000E-03	.6000000E-04	-.2000000E-04	.2500000E-03
	.1800000E-03	.1000000E-03	.1500000E-03	.1000000E-03	.2700000E-03	.7000000E-04	.9000000E-04
	.3000000E-03	.2100000E-03	.2100000E-03				
	.2700000E-03	.2200000E-03	.2100000E-03				

APPENDIX

BETA= 0.

0.	.4000000E-04	.1000000E-04	.7000000E-04	.1100000E-03	.1500000E-03	.1500000E-03
0.	.2700000E-03	.1900000E-03	.1900000E-03	.1600000E-03	.1100000E-03	.2500000E-03
0.	.2000000E-03	.1700000E-03	.8000000E-04	.1300000E-03	.2400000E-03	.2400000E-03
0.	.1700000E-03	.3400000E-03	-.7000000E-04	-.8000000E-04	-.8000000E-04	-.8000000E-04

BETA= .5000000E+01

-.1000000E-04	-.4000000E-04	-.1100000E-03	-.9000000E-04	.7000000E-04	.1300000E-03	.1200000E-03
.2400000E-03	.2100000E-03	.2800000E-03	.2200000E-03	.3000000E-03	.8000000E-04	.2600000E-03
.1000000E-03	.1700000E-03	.1500000E-03	.3000000E-03	.3000000E-04	.2700000E-03	.1500000E-03
.5400000E-03	.1600000E-03	.2900000E-03	-.8000000E-04	-.8000000E-04	.2700000E-03	.1500000E-03

BETA= .1000000E+02

.2000000E-04	-.3000000E-04	-.9000000E-04	-.4000000E-04	.9000000E-04	.1800000E-03	.1300000E-03
.2900000E-03	.1200000E-03	.2700000E-03	.1300000E-03	.2000000E-03	.9000000E-04	.3600000E-03
.1700000E-03	.2200000E-03	.1700000E-03	-.3700000E-03	.1800000E-03	.9000000E-04	.1000000E-04
.2400000E-03	.1900000E-03	.2500000E-03	-.2400000E-03	.1600000E-03	.9000000E-04	.1000000E-04

BETA= .1500000E+02

.5000000E-04	.7000000E-04	.6000000E-04	.6000000E-04	.1400000E-03	.2100000E-03	.3200000E-03
.3700000E-03	.4000000E-04	.1400000E-03	.1200000E-03	.1600000E-03	.1600000E-03	.1600000E-03
.1500000E-03	.1500000E-03	.1000000E-03	-.2400000E-03	.1600000E-03	.1800000E-03	.1200000E-03
.8000000E-04	.2900000E-03	.2100000E-03	-.2400000E-03	.1600000E-03	.1800000E-03	.1200000E-03

BETA= .2000000E+02

.2000000E-03	.2600000E-03	.2500000E-03	.2700000E-03	.2500000E-03	.1700000E-03	.2000000E-04
.8000000E-04	.1000000E-03	.9000000E-04	.1300000E-03	.2500000E-03	.1000000E-03	.2100000E-03
.1900000E-03	.1100000E-03	.1300000E-03	.4000000E-04	.2000000E-04	.1700000E-03	.3700000E-03
.1400000E-03	.1000000E-03	.1800000E-03	-.2000000E-04	.2000000E-04	-.1400000E-03	-.1400000E-03

BETA= .3000000E+02

.1700000E-03	.1400000E-03	.1000000E-03	.6000000E-04	.1000000E-03	.1000000E-04	-.3000000E-04
-.5000000E-04	-.6000000E-04	-.8000000E-04	-.4000000E-04	-.4000000E-04	.9000000E-04	.5000000E-04
.6000000E-04	.1600000E-03	.3000000E-04	-.2000000E-04	.1900000E-03	.1900000E-03	-.1000000E-03
-.1000000E-03	.1300000E-03	.1500000E-03	-.2000000E-04	.2000000E-03	.1900000E-03	-.1000000E-03

BETA= .4000000E+02

-.6000000E-04	-.5000000E-04	-.4000000E-04	-.3000000E-04	-.2000000E-04	-.1000000E-04	-.1000000E-04
-.1000000E-04	0.	0.	.3000000E-04	.6000000E-04	.1300000E-03	.2400000E-03
.1500000E-03	.4700000E-03	.1100000E-03	.8000000E-04	.1300000E-03	.2100000E-03	-.9000000E-04
.1200000E-03	.3700000E-03	.1200000E-03	-.3000000E-04	.1300000E-03	.2100000E-03	-.9000000E-04

TABLE -- 16

BETA= -.4000000E+02

.1150000E-02	.1130000E-02	.1100000E-02	.1060000E-02	.1050000E-02	.1040000E-02	.1020000E-02
.1010000E-02	.1000000E-02	.9900000E-03	.7400000E-03	.5000000E-03	.6700000E-03	.8000000E-03
.6200000E-03	.4600000E-03	.8600000E-03	.5200000E-03	.1400000E-03	.1500000E-03	.1400000E-03

APPENDIX

BETA=	.1500000E+02	.1500000E-02	.1750000E-02	.1530000E-02	.1640000E-02	.1710000E-02
	.1800000E-02	.1480000E-02	.5200000E-03	.8000000E-04	.9000000E-04	-.1300000E-03
	.8400000E-03	.7100000E-03	-.1400000E-03	-.9000000E-04	-.6000000E-04	.4200000E-03
	.3000000E-04	.2000000E-04				
	-.3000000E-04	.3000000E-04				
BETA=	.2000000E+02	.1970000E-02	.1740000E-02	.2040000E-02	.1780000E-02	.1480000E-02
	.1870000E-02	.1920000E-02	.5100000E-03	.3100000E-03	.1800000E-03	-.8000000E-04
	.7700000E-03	.1030000E-02	.1400000E-03	.5000000E-04	.4400000E-03	-.3800000E-03
	-.2900000E-03	-.2100000E-03				
	.1800000E-03	.3500000E-03				
BETA=	.3000000E+02	.1530000E-02	.1260000E-02	.1200000E-02	.1130000E-02	.1070000E-02
	.1800000E-02	.1660000E-02	.8500000E-03	.8300000E-03	.6400000E-03	.4600000E-03
	.1000000E-02	.9300000E-03	-.6600000E-03	-.1300000E-03	.7000000E-04	.8800000E-03
	.1400000E-03	-.3000000E-04				
	.4700000E-03	-.2940000E-02				
BETA=	.4000000E+02	.1690000E-02	.1440000E-02	.1370000E-02	.1310000E-02	.1250000E-02
	.1940000E-02	.1820000E-02	.1520000E-02	.1340000E-02	.1590000E-02	.1280000E-02
	.1180000E-02	.1120000E-02	.4100000E-03	.5400000E-03	-.8000000E-04	.1080000E-02
	.1090000E-02	.3600000E-03				
	.1160000E-02	.1370000E-02				
TABLE --	17					
BETA=	-.4000000E+02	0.	-.2000000E-04	-.2000000E-04	-.2000000E-04	-.2000000E-04
	.1000000E-04	0.	-.6000000E-04	-.1100000E-03	-.4000000E-04	.3000000E-04
	-.3000000E-04	-.3000000E-04	-.3000000E-04	.7000000E-04	.2000000E-04	.2000000E-04
	.3000000E-04	-.6000000E-04				
	.5000000E-04	-.2000000E-04				
BETA=	-.3000000E+02	-.1000000E-04	-.2000000E-04	-.2000000E-04	-.2000000E-04	-.3000000E-04
	0.	-.3000000E-04	-.2400000E-03	-.3000000E-04	.6000000E-04	.4000000E-04
	.7000000E-04	0.	-.5000000E-04	-.3000000E-04	0.	-.5000000E-04
	.1000000E-04	0.				
BETA=	-.2000000E+02	.2100000E-03	.2200000E-03	.1100000E-03	.1300000E-03	.4000000E-04
	.3100000E-03	.2100000E-03	.1700000E-03	-.1500000E-03	.8000000E-04	-.3000000E-04
	.1000000E-04	.1200000E-03	.5000000E-04	.1000000E-04	-.2000000E-04	.2000000E-04
	-.7000000E-04	.9000000E-04				
	.3000000E-04	-.2000000E-04				
BETA=	-.1500000E+02	.1400000E-03	.2300000E-03	.2400000E-03	.1400000E-03	.1600000E-03
	.2800000E-03	.2200000E-03	.9000000E-04	.5000000E-04	.2000000E-04	-.3000000E-04
	.1400000E-03	.1000000E-03	.3000000E-04	.7000000E-04	.6000000E-04	0.
	.5000000E-04	.3000000E-04				

APPENDIX

-	.100000E-04	-	.400000E-04	-	.200000E-04								
BETA=	-	.100000E+02											
	.190000E-03	.240000E-03	.220000E-03	.210000E-03	.190000E-03	.190000E-03	.230000E-03	.230000E-03	.230000E-03	.230000E-03	.230000E-03	.330000E-03	.330000E-03
	.150000E-03	.140000E-03	.120000E-03	.700000E-04	.700000E-04	.700000E-04	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.500000E-04	.500000E-04
	0.	-	.100000E-04	0.	.110000E-03	.400000E-04	-	.300000E-04	-	.300000E-04	.500000E-04	.200000E-04	.200000E-04
	.300000E-04	0.	.300000E-04										
BETA=	-	.500000E+01											
	.160000E-03	.260000E-03	.170000E-03	.210000E-03	.210000E-03	.150000E-03	.110000E-03	.110000E-03	.110000E-03	.140000E-03	.140000E-03	.160000E-03	.160000E-03
	.700000E-04	.110000E-03	.600000E-04	.700000E-04	.700000E-04	.800000E-04	.800000E-04	.800000E-04	.800000E-04	.800000E-04	.800000E-04	0.	0.
	-	.200000E-04	0.	.100000E-04	.200000E-04	0.	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.200000E-04
	.400000E-04	0.	.600000E-04										
BETA=	0.												
	.180000E-03	.150000E-03	.220000E-03	.200000E-03	.200000E-03	.170000E-03	.100000E-03	.100000E-03	.100000E-03	.110000E-03	.110000E-03	.800000E-04	.800000E-04
	.600000E-04	.400000E-04	.300000E-04	.600000E-04	.600000E-04	.400000E-04	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.700000E-04	.700000E-04
	.500000E-04	0.	.300000E-04	.200000E-04	.200000E-04	-	.100000E-04	-	.100000E-04	.200000E-04	.200000E-04	.900000E-04	.900000E-04
	.400000E-04	.500000E-04	.200000E-04										
BETA=	.500000E+01												
	.210000E-03	.190000E-03	.210000E-03	.210000E-03	.210000E-03	.130000E-03	.200000E-03	.200000E-03	.200000E-03	.113000E-02	.113000E-02	-	.300000E-04
	.700000E-04	.110000E-03	.700000E-04	.700000E-04	.700000E-04	.400000E-04	.800000E-04	.800000E-04	.800000E-04	.800000E-04	.800000E-04	.800000E-04	.800000E-04
	.400000E-04	-	.100000E-04	-	.100000E-04	0.	.300000E-04	.300000E-04	.300000E-04	.400000E-04	.400000E-04	.100000E-04	.100000E-04
	0.	-	.100000E-04	-	.100000E-04								
BETA=	.100000E+02												
	.260000E-03	.250000E-03	.270000E-03	.260000E-03	.260000E-03	.300000E-03	.170000E-03	.170000E-03	.170000E-03	.700000E-04	.700000E-04	.500000E-04	.500000E-04
	.120000E-03	.400000E-04	.300000E-03	.100000E-04	.100000E-04	.200000E-04	.500000E-04	.500000E-04	.500000E-04	.400000E-04	.400000E-04	.100000E-04	.100000E-04
	-	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.400000E-04	.100000E-04	.100000E-04	.100000E-04	.400000E-04	.400000E-04	-	.300000E-04
	.200000E-04	.200000E-04	.200000E-04										
BETA=	.150000E+02												
	.300000E-03	.270000E-03	.260000E-03	.230000E-03	.230000E-03	.200000E-03	.600000E-04	.600000E-04	.600000E-04	.160000E-03	.160000E-03	.160000E-03	.160000E-03
	.400000E-04	.200000E-04	.900000E-04	.800000E-04	.800000E-04	.300000E-04	.800000E-04	.800000E-04	.800000E-04	.200000E-04	.200000E-04	.800000E-04	.800000E-04
	.100000E-04	-	.300000E-04	-	.120000E-03	0.	-	.100000E-04	-	.100000E-04	.100000E-04	0.	0.
	.100000E-04	.200000E-04	.300000E-04										
BETA=	.200000E+02												
	.240000E-03	.240000E-03	.240000E-03	.290000E-03	.290000E-03	.200000E-03	.180000E-03	.180000E-03	.180000E-03	.200000E-03	.200000E-03	.700000E-04	.700000E-04
	.100000E-04	.140000E-03	.400000E-04	.700000E-04	.700000E-04	.130000E-03	.100000E-03	.100000E-03	.100000E-03	.600000E-04	.600000E-04	.700000E-04	.700000E-04
	.500000E-04	-	.300000E-04	-	.400000E-04	-	.200000E-04	-	.200000E-04	.400000E-04	.400000E-04	.600000E-04	.600000E-04
	.200000E-04	.100000E-04	.200000E-04										
BETA=	.300000E+02												
	.280000E-03	.240000E-03	.190000E-03	.140000E-03	.140000E-03	.100000E-03	.800000E-04	.800000E-04	.800000E-04	.600000E-04	.600000E-04	.300000E-04	.300000E-04
	.100000E-04	-	.400000E-04	-	.400000E-04	-	.200000E-03	.200000E-03	.200000E-03	.140000E-03	.140000E-03	.300000E-04	.300000E-04
	-	.100000E-04	.200000E-04	.200000E-04	.200000E-04	.600000E-04	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.200000E-04	.800000E-04	.800000E-04
	.700000E-04	.900000E-04	.900000E-04										

APPENDIX

TABLE -- 2
 .2890000E-01
 -.7560000E-01
 -.9610000E-01
 .6127000E+00

TABLE -- 3
 -.4900000E-02
 .2894000E+00
 -.6646000E+00
 -.1158000E+01

TABLE -- 4
 -.6000000E-01
 .5000000E+00
 .3000000E-01
 0.

TABLE -- 5
 -.3500000E+00
 -.6000000E+00
 -.4000000E-01
 .2300000E+00

TABLE -- 6
 .7200000E+00
 .5000000E+00
 -.3400000E+00
 -.1000000E+01

TABLE -- 7
 -.4800000E+01
 -.5400000E+01
 -.6000000E+01
 -.2600000E+01

B = .38410E+02
 IX = .26108E+05
 VARIABLES WHICH MAY REQUIRE CONSTRAINTS AND TYPICAL BOUNDARIES
 ALPHA OMEGA BETA
 .15650000E+01 .10000000E+02 .52400000E+00
 .2200000E+00 .1000000E-01 -.52400000E+00
 .30000000E+02 DAMAX = .30000000E+02 DRMAX = .30000000E+02
 .30000000E+02 DAMIN = -.30000000E+02 DRMIN = -.30000000E+02
 L = .16042E+02 S = .53000E+03 MASS = .11247E+04
 .11622E+06 IZ = .13163E+06 IYZ = 0.
 PSIPR PSIPR V
 .31300000E+01 .10000000E+04
 -.31300000E+01 -.50000000E+02

HO = .4000000E+05 GRAV = .3217400E+02
 CONFAC1 = .1000000E+01 CONFAC2 = .1000000E+01
 DENSITY = .58727681E-03
 THETA PHI
 -.18000000E+00 0.
 GAMMA RADIUS PSI
 -.15650000E+01 .10000000E+01 .30000000E+01 -.15600000E+01
 PSIIPR PSIDT PSI
 .31300000E+01 .10000000E+01 .50000000E+02
 -.31300000E+01 -.50000000E+02

APPENDIX

```

DE          DA          DR
-.21000000E+02  0.          -.30000000E+02

GBAR( 1) = 0.          TOLERANCE= .10000000E+00  WEIGHT= .50000000E+03

CYCLE = 0
ALPHA IS
RA= -.18000000E+00  0.          PSIDT= -.15650000E+01  .10000000E+01  .30000000E+01  -.15600000E+01
PHI = 0.          .10000000E+01  .30000000E+01  GAMMA H = -.89667895E+02  THETA= -.10313240E+02
P = .53708872E+00  0.          .30000000E+01  VV = .51756337E+03  V = .51757206E+03
.29515311E+01  R = .29515311E+01

IN SUB. AERD
ALPHA= .1390734E+01  BETA= -.5795989E-02

ALPHAT ARRAY IS
.1745329E+00  -.8726646E-01  0.          .8726646E-01
.1745329E+00  .2181662E+00  .2617994E+00  .3054326E+00
.3490658E+00  .3926991E+00  .4363323E+00  .4799655E+00
.5235988E+00  .6108652E+00  .6981317E+00  .7853982E+00
.8726646E+00  .9599311E+00  .1047198E+01  .1134464E+01
.1221730E+01  .1308997E+01  .1396263E+01  .1483530E+01
.1570796E+01  .1745329E+01  .1919862E+01

BETAT ARRAY IS
-.6981317E+00  -.5235988E+00  -.3490658E+00  -.2617994E+00
-.1745329E+00  -.8726646E-01  0.          .8726646E-01
.1745329E+00  .2617994E+00  .3490658E+00  .5235988E+00
.6981317E+00

COEFF ARRAY IS
.1956445E-01  -.2548109E-01  -.1565089E+01  .4683521E-02
-.5044321E+00  .1061606E-01  -.2396182E-02  -.1929578E-03
-.1643114E-02  -.8622123E-04  -.3438787E-02  .1568368E-03
-.15931389E-03  -.5747316E-04  .2230436E-03  .2020983E-03
.3755645E-05  -.1028976E-03  -.1826152E+00  .8871395E+00
-.3068627E+00  .2000000E-01  -.3468317E+00  -.8809905E+00
-.3249308E+01

ALPHAD= .79683174E+02  BETAD= -.33208571E+00
E1 = -.71633382E-02  E2 = -.97639184E-02  E3 = -.44728194E-01
E4 = .30255053E+00  E5 = -.10479346E+01  E6 = -.12038426E+00

GBAR IS
FX = .22916202E+02  -.63733447E+01  -.18681847E+04  .10859411E+02  .16107227E+01  -.33773726E-01
F = .120633172E+01

```

APPENDIX

CYCLE = 1
 DFDK = -.349080051E+07
 ABNORMAL RETURN FROM IBI IN SUB. AERO.IER= -3
 ALPHA IS
 RA = .18002309E+00 .64220689E-05 -.15631175E+01 .9998906E+00 .29999984E+01 -.15600000E+01
 PHI = .9998906E+00 PSIDT = .29999984E+01 GAMMA H = -.89560038E+02 THETA = -.10314563E+02
 P = .3679574E-03 VH = .29999655E+01 VV = .39067420E+03 V = .39068571E+03
 .53715658E+00 Q = .18954846E-04 R = .29515171E+01
 ALPHAD = .79680687E+02 BETAD = -.43957483E+00
 E1 = .45017556E-02 E2 = -.90613179E-02 E3 = .16616420E-02
 E4 = .16725451E+00 E5 = .22361545E-01 E6 = -.11016950E+00
 GBAR IS
 FX = .18824670E-02
 KMIN = .74579398E-01 -.30306084E+01 -.30484542E+00 .14425282E-01 .54043837E-01 .11362956E-02
 F1 = .100764500E-05
 F2 = .120633172E+01
 DFDK AT CAYMIN = .407165608E-01
 DELXFX = .590775404E+03
 DETERM IS .999850489E+00
 DETERM IS .100764233E-05
 FX = .74579E-01 -.30306E+01 -.30485E+00 .14425E-01 .54044E-01 .11363E-02
 IT = 26

CYCLE = 2
 DFDK = -.918931434E+01
 ALPHA IS
 RA = .18033193E+00 .13228944E-01 -.15631455E+01 .99993399E+00 .29997637E+01 -.15600049E+01
 PHI = .99993399E+00 PSIDT = .29997637E+01 GAMMA H = -.89561639E+02 THETA = -.10332259E+02
 P = .75796267E+00 VH = .29995657E+01 VV = .39204944E+03 V = .39206091E+03
 .53802601E+00 Q = .39039065E-01 R = .29508619E+01
 ALPHAD = .79663167E+02 BETAD = .30732576E+00
 E1 = .43249947E-02 E2 = -.79624716E-02 E3 = .10546927E-02
 E4 = .15816737E-01 E5 = .76777613E-02 E6 = -.14312028E+00
 GBAR IS
 FX = .18545122E-02
 KMIN = .23029022E-01 .59154977E-02 .23439428E+01 -.16713385E-01 .27672272E-01 .14371664E-02
 F1 = .436379476E-02
 F2 = .407165608E-01
 DFDK AT CAYMIN = .208757517E-01
 DELXFX = -.121401991E-06
 DETERM IS .999813230E+00

```

DETERM IS      439543623E-08
FX = .23029E-01  .59155E-02  .23439E+01  -.16713E-01  .27672E-01  .14372E-02
IT = 43

CYCLE = 3
DFDK = -.356805328E-02
      .419069551E-17
ALPHA IS
RA = -.18195593E+00  .13211836E-01  -.15631656E+01  .10000314E+01  .29988326E+01  -.15600487E+01
PHI = .10000314E+01  PSIDT = .29988326E+01  GAMMA H = -.89562792E+02  THETA = -.10425307E+02
P = .75698244E+00  VH = .29989270E+01  VV = .39299909E+03  V = .39301054E+03
ALPHAD = .54264945E+00  Q = .38964889E-01  R = .29490694E+01
E1 = .40872944E-02  E2 = .79300464E-02  E3 = .69424142E-03
E4 = .14659122E-01  E5 = .14886539E-01  E6 = -.14248934E+00
GBAR IS
      -.18344001E-02
FX = -.11703865E+00  .29204972E-01  .78569426E+01  -.58896707E-01  .27647980E-01  .16304584E-02
KMIN = .314169990E-01
F1 = .208757517E-01
F2 = .208199121E-01
DFDK AT CAYMIN = 0.
DELXFX = -.246389051E-07
DETERM IS      .521687631E-01
DETERM IS      .909016910E-10
FX = -.11704E+00  .29205E-01  .78569E+01  -.58897E-01  .27648E-01  .16305E-02
IT = 51

CYCLE = 4
DFDK = -.121930426E-02
      -.880914265E-15
ALPHA IS
RA = -.24311090E+00  .89677688E-02  -.15635426E+01  .11516690E+01  .24899526E+01  -.15826325E+01
PHI = .11516690E+01  PSIDT = .24899526E+01  GAMMA H = -.89584392E+02  THETA = -.13929228E+02
P = .51381530E+00  VH = .28676011E+01  VV = .39532116E+03  V = .39533156E+03
ALPHAD = .59938936E+00  Q = .21672408E-01  R = .24166354E+01
E1 = .76076050E+02  BETAD = .83138456E-01
E2 = -.55303024E-02  E3 = -.59996538E-02  E4 = .12151833E-02
E5 = .26278373E-01  E6 = -.37439530E-01  E7 = -.94229565E-01
GBAR IS
      -.14573978E-02
FX = .53571743E+00  -.24466811E+00  -.30322024E+02  .19264490E+00  .17526642E-01  .10991565E-03
KMIN = .195546219E+02
F1 = .208199121E-01
F2 = .110395692E-01

```

APPENDIX

```

DFDK AT CAYMIN = 0.
DELXFX = -.750978811E-07
DETERM IS .249178915E+00
DETERM IS .757469622E-09
FX = .53572E+00 -.24467E+00 -.30322E+02 .19264E+00 .17527E-01 .10992E-03
IT = 64

CYCLE = 5
DFDK = -.566106566E-03
      -.386294729E-13
ALPHA IS
RA = -.29356054E+00 .12261680E-01 -.15635743E+01 .12716221E+01 .22503743E+01 -.15996024E+01
PHI = .12716221E+01 PSIDT = .22503743E+01 GAMMA H = -.89586208E+02 THETA = -.16819780E+02
P = .70254254E+00 VH = .28616257E+01 VV = .39622803E+03 V = .396223836E+03
ALPHAD = .65117342E+00 Q = .26412255E-01 R = .21539406E+01
E1 = .73192413E+02 BETAD = .25891007E+00
E2 = -.11239806E-01 E3 = -.42247459E-02 E4 = .23546747E-02
E5 = -.92264885E-02 E6 = -.16691211E-01 E7 = -.86546314E-03
GBAR IS
FX = .14257163E-02
KNIN = .17057365E+00 .17449059E+00 -.11564394E+02 .64740034E-01 .44509641E-03 -.30523640E-03
F1 = .140689611E+02
F2 = .110395692E-01
DFDK AT CAYMIN = 0.
DELXFX = .484417769E-08
DETERM IS .455224684E+00
DETERM IS .474529530E-08
FX = .17057E+00 .17449E+00 -.11564E+02 .64740E-01 .44510E-03 -.30524E-03
IT = 72

CYCLE = 6
DFDK = -.313876220E-03
      .322199475E-15
ALPHA IS
RA = -.29139457E+00 .12239576E-01 -.15635254E+01 .12685382E+01 .22802440E+01 -.15986178E+01
PHI = .12685382E+01 PSIDT = .22802440E+01 GAMMA H = -.89583409E+02 THETA = -.16695679E+02
P = .70127605E+00 VH = .28925767E+01 VV = .39782252E+03 V = .39783303E+03
ALPHAD = .65508739E+00 Q = .26732016E-01 R = .21839548E+01
E1 = .73316193E+02 BETAD = .25932472E+00
E2 = -.1085884E-01 E3 = -.43385306E-02 E4 = .16371322E-02
E5 = -.10594134E-01 E6 = -.42847709E-02 E7 = -.70123858E-02
GBAR IS
FX = .14745683E-02
      .78957203E-01 .20685643E+00 -.26406310E+01 .14073964E-01 .20950492E-03 -.30812688E-03

```

APPENDIX

```

KMIN = .122977292E+01
F1 = .514199846E-03
F2 = .319186036E-03
DFDK AT CAYMIN = 0.
DELXFX = -.705198966E-09
DETERM IS .138423137E+00
DETERM IS .144600806E-08
FX = .78957E-01 .20686E+00 -.26406E+01 .14074E-01 .20950E-03 -.30813E-03
IT = 79

CYCLE = 7
DFDK = -.236094373E-03
      -.234561555E-16
ALPHA IS
      -.29459247E+00 .1190937E-01 -.15635040E+01 .12779636E+01 .22732816E+01 -.15993408E+01
RA = .12779636E+01 PSIDI = .22732816E+01 GAMMA H = -.89582182E+02 THETA = -.16878905E+02
PHI = .68703007E+00 VH = .29031712E+01 VV = .39838207E+03 V = .39839266E+03
P = .66004710E+00 Q = .26083858E-01 R = .21751935E+01
ALPHAD = .73133329E+02 BETAD = .23982836E+00
E1 = -.1141630E-01 E2 = -.42770258E-02 E3 = .15260869E-02
E4 = -.74966431E-02 E5 = .67201268E-03 E6 = .19508499E-02
GBAR IS
      -.14959685E-02
FX = -.19448678E-01 .12796316E+00 .68769919E+00 -.47599172E-02 .20940022E-04 .11798586E-03
KMIN = .970052005E+00
F1 = .319186036E-03
F2 = .209214880E-03
DFDK AT CAYMIN = 0.
DELXFX = .192776282E-09
DETERM IS .665774773E-01
DETERM IS .883407875E-09
FX = -.19449E-01 .12796E+00 .68770E+00 -.47599E-02 .20940E-04 .11799E-03
IT = 85

CYCLE = 8
DFDK = -.874045634E-04
      .768174180E-17
ALPHA IS
      -.29336585E+00 .11105887E-01 -.15635048E+01 .12751034E+01 .22767627E+01 -.15989487E+01
RA = .12751034E+01 PSIDI = .22767627E+01 GAMMA H = -.89582225E+02 THETA = -.16808625E+02
PHI = .63632043E+00 VH = .29031078E+01 VV = .39814009E+03 V = .39815068E+03
P = .65838492E+00 Q = .24204673E-01 R = .21793558E+01
ALPHAD = .73203498E+02 BETAD = .19156392E+00
E1 = -.11007030E-01 E2 = -.43909554E-02 E3 = .15887761E-02
E4 = .54436743E-05 E5 = .23055483E-03 E6 = -.40055698E-03

```

APPENDIX

```

GBAR IS
FX = -.14952180E-02
-.18622003E-02 -.15250278E-03 .10282134E+00 -.87761488E-03 -.95411710E-04 .12331245E-03
KMIN = .141745978E+01
F1 = .205214880E-03
F2 = .143173030E-03
DFDK AT CAYMIN = 0.
DELXFX = -.284564372E-11
DETERM IS .701426669E-01
DETERM IS .125109081E-08
FX = -.18622E-02 -.15250E-03 .10282E+00 -.87761E-03 -.95412E-04 .12331E-03
IT = 91

CYCLE = 9
DFDK = -.770834488E-07
.326711196E-17
ALPHA IS
-.29330979E+00 .11129488E-01 -.15634884E+01 .12783945E+01 .22774550E+01 -.16013093E+01
RA = .12783945E+01 PSIDT = .22774550E+01 GAMMA H = -.89581286E+02 THETA = -.16808851E+02
PHI = .63767268E+00 VH = .29114859E+01 VV = .39839308E+03 V = .39840372E+03
P = .65859368E+00 Q = .24263456E-01 R = .21800153E+01
ALPHAD = .73204288E+02 BETAD = .19195082E+00
E1 = -.10983854E-01 E2 = -.43511026E-02 E3 = .14865556E-02
E4 = -.47253646E-04 E5 = -.64189184E-03 E6 = -.44157637E-03
GBAR IS
-.15116166E-02
FX = .73535088E-02 .14842040E-02 -.52056730E+00 .26833889E-02 -.81136948E-04 .10369038E-03
KMIN = .201811336E+02
F1 = .143173030E-03
F2 = .142396242E-03
DFDK AT CAYMIN = 0.
DELXFX = -.145911014E-11
DETERM IS .699930351E-01
DETERM IS .125579424E-08
FX = .73536E-02 .14842E-02 -.52057E+00 .26834E-02 -.81137E-04 .10369E-03
IT = 100

CYCLE = 10
DFDK = -.732495089E-07
.300242687E-15
ALPHA IS
-.29399782E+00 .11517865E-01 -.15628555E+01 .13899554E+01 .23423070E+01 -.16756952E+01
RA = .13899554E+01 PSIDT = .23423070E+01 GAMMA H = -.89545027E+02 THETA = -.16844834E+02
PHI = .65992506E+00 VH = .32557023E+01 VV = .40998927E+03 V = .41000220E+03
P = .67875563E+00 Q = .25820245E-01 R = .22416570E+01

```

ALPHAD = .73203260E+02 BETAD = .17929768E+00
 E1 = -.99790757E-02 E2 = -.30536526E-02 E3 = -.31031000E-02
 E4 = -.11645351E-04 E5 = .89614673E-04 E6 = -.55213004E-03
 GBAR IS
 -.21444515E-02
 FX = .90217153E-03 .98532750E-03 -.17634136E+00 .73305959E-03 .51966220E-03 .49789733E-04
 KMIN = .642853004E+03
 F1 = .142396242E-03
 F2 = .118848990E-03
 DFDK AT CAYMIN = 0.
 DELXFX = -.907126106E-12
 DETERM IS .644009656E-01
 DETERM IS .931250487E-07
 FX = .90217E-03 .98533E-03 -.17634E+00 .73306E-03 .51966E-03 .49790E-04
 IT = 109

CYCLE = 11
 DFDK = -.648007623E-07
 -.319194202E-15
 ALPHA IS
 -.29435295E+00 .11535837E-01 -.15628182E+01 .13975972E+01 .23414917E+01 -.16803019E+01
 RA = .13975972E+01 PSIDT = .23414917E+01 GAMMA H = -.89542886E+02 THETA = -.16865182E+02
 PHI = .66095478E+00 VH = .32724622E+01 VV = .41016951E+03 V = .41018256E+03
 P = .67931518E+00 Q = .25848749E-01 R = .22406352E+01
 ALPHAD = .73185237E+02 BETAD = .17831936E+00
 E1 = -.99482097E-02 E2 = -.29513776E-02 E3 = -.31620599E-02
 E4 = .17097268E-03 E5 = -.20933244E-03 E6 = .36339883E-03
 GBAR IS
 -.21818205E-02
 FX = -.94863918E-03 -.43851639E-02 -.40289035E+00 .20398710E-02 .52649491E-03 .78463039E-04
 KMIN = .299929791E+02
 F1 = .118848990E-03
 F2 = .117881240E-03
 DFDK AT CAYMIN = 0.
 DELXFX = -.701093437E-12
 DETERM IS .857188679E-01
 DETERM IS .130806563E-06
 FX = -.94864E-03 -.43852E-02 -.40289E+00 .20399E-02 .52649E-03 .78463E-04
 IT = 117

CYCLE = 12
 DFDK = -.617662383E-07
 -.117806291E-13
 ALPHA IS
 -.29448407E+00 .11843307E-01 -.15623409E+01 .14826341E+01 .23438895E+01 -.17364117E+01

APPENDIX

RA = .14826341E+01 PSI DT = .23438895E+01 GAMMA H = -.89515540E+02 THETA = -.16872695E+02
 PHI = .67857153E+00 VH = .34751306E+01 VV = .41098453E+03 V = .41099922E+03
 P = .68030495E+00 Q = .26563796E-01 R = .22428325E+01
 ALPHAD = .73207699E+02 BETAD = .17180480E+00
 E1 = -.90408758E-02 E2 = -.17174711E-02 E3 = -.34935826E-02
 E4 = -.10211622E-03 E5 = -.29736592E-02 E6 = -.81779674E-03
 GBAR IS
 -.26590956E-02
 FX = .35966286E-01 .58194145E-02 -.21716820E+01 .12142461E-01 .56582535E-03 -.98010067E-04
 KMIN = .375434179E+03
 F1 = .117881240E-03
 F2 = .106414131E-03
 DFDK AT CAYMIN = 0.
 DELXFX = -.706959246E-11
 DETERM IS .774954360E-01
 DETERM IS .152080916E-06
 FX = .35966E-01 .58194E-02 -.21717E+01 .12142E-01 .56583E-03 -.98010E-04
 IT = 127

CYCLE = 13
 DFDK = -.615750251E-07
 .733201119E-11
 ALPHA IS
 -.29672688E+00 .12674919E-01 -.15609887E+01 .17241877E+01 .23107127E+01 -.16898631E+01
 RA = .17241877E+01 PSI DT = .23107127E+01 GAMMA H = -.89438064E+02 THETA = -.17001198E+02
 PHI = .72621937E+00 VH = .39841024E+01 VV = .40621149E+03 V = .40623103E+03
 P = .67563319E+00 Q = .28007417E-01 R = .22095539E+01
 ALPHAD = .73175758E+02 BETAD = .16156101E+00
 E1 = -.69322567E-02 E2 = .22848809E-02 E3 = -.16054704E-02
 E4 = -.19619698E-02 E5 = -.44806029E-03 E6 = .57730064E-03
 GBAR IS
 -.40113098E-02
 FX = .42034666E-03 .35735447E-01 -.30807104E+00 .14601709E-02 .27016531E-03 -.28710083E-03
 KMIN = .134929318E+04
 F1 = .106414131E-03
 F2 = .602377586E-04
 DFDK AT CAYMIN = 0.
 DELXFX = -.346382869E-12
 DETERM IS .102553333E+00
 DETERM IS .613077480E-06
 FX = .42035E-03 .35735E-01 -.30807E+00 .14602E-02 .27017E-03 -.28710E-03
 IT = 135

CYCLE = 14
 DFDK = -.613880522E-07


```

-.367362729E-12
ALPHA IS
RA = .29647992E+00 .12441028E-01 -.15610258E+01 .17169155E+01 .22823154E+01 -.18838725E+01
PHI = .17169155E+01 PSIDT = .22823154E+01 GAMMA H = -.89440191E+02 THETA = -.16987048E+02
P = .71281842E+00 VH = .39185428E+01 VV = .40104500E+03 V = .40106414E+03
ALPHAD = .66679105E+00 Q = .27154828E-01 R = .21825709E+01
E1 = .73186059E+02 BETAD = .14974755E+00
E2 = -.68596739E-02 E3 = .20978560E-02 E4 = .43834447E-03
E4 = .42363917E-04 E5 = -.40046104E-03 E6 = .30578893E-03
GBAR IS
FX = -.39741929E-02
KMIN = .13655843E-02 -.75722486E-03 -.27096158E+00 .13919727E-02 -.21592295E-04 -.17716769E-03
F1 = .274161758E+03
F2 = .602377586E-04
DFDK AT CAYMIN = .519039512E-04
DELXFX = .265719820E-11
DETERM IS .105650534E+00
DETERM IS .646020972E-05
FX = .13656E-02 -.75722E-03 -.27096E+00 .13920E-02 -.21592E-04 -.17717E-03
IT = 141

```

```

CYCLE = 15
DFDK = -.590311913E-07
-.440457133E-16
ALPHA IS
RA = .29648663E+00 .12493180E-01 -.15608547E+01 .17466105E+01 .22834502E+01 -.19028447E+01
PHI = .17466105E+01 PSIDT = .22834502E+01 GAMMA H = -.89430384E+02 THETA = -.16987432E+02
P = .71580649E+00 VH = .39882980E+01 VV = .40115650E+03 V = .40117633E+03
ALPHAD = .66713723E+00 Q = .27282155E-01 R = .21836503E+01
E1 = .73198964E+02 BETAD = .14675064E+00
E2 = -.66249663E-02 E3 = .26267006E-02 E4 = .38609761E-03
E4 = .44052028E-04 E5 = -.10230196E-03 E6 = -.27249239E-03
GBAR IS
FX = -.61453459E-02
KMIN = .13729311E-02 .40757351E-03 -.10081329E+00 .43871992E-03 -.15983623E-04 -.22310394E-03
F1 = .297004903E+02
F2 = .519039512E-04
DFDK AT CAYMIN = .510254640E-04
DELXFX = .200450436E-11
DETERM IS .887771929E-01
DETERM IS .416968847E-04
FX = .13729E-02 .40757E-03 -.10081E+00 .43872E-03 -.15984E-04 -.22310E-03
IT = 148

```

APPENDIX

CYCLE = 16
 DFDK = -.462010911E-07
 .776254874E-16
 ALPHA IS
 -.29636066E+00 .12452159E-01 -.15609100E+01 .17363511E+01 .22864814E+01 -.18957125E+01
 .17363511E+01 PSIDT= .22864814E+01 GAMMA H = -.89433557E+02 THETA= -.16980215E+02
 PHI = .71345613E+00 VH = .39701346E+01 VV = .40156650E+03 V = .40158613E+03
 P = .66774738E+00 Q = .27229724E-01 R = .218666342E+01
 ALPHAD= .73201319E+02 BETAD= .14620526E+00
 E1 = -.66815695E-02 E2 = .24307985E-02 E3 = .22143494E-03
 E4 = .21609115E-03 E5 = .17383320E-03 E6 = -.38158445E-03
 GBAR IS
 -.40899691E-02
 FX = -.88332372E-03 -.26794573E-02 .35408262E-01 -.32978098E-03 .74408476E-05 -.20242776E-03
 KMIN = .86945554E+01
 F1 = .510254640E-04
 F2 = .508237060E-04
 DFDK AT CAYMIN = 0.
 DELXFX = -.125416288E-11
 DETERM IS .118703658E+00
 DETERM IS .973849989E-04
 FX = -.88332E-03 -.26795E-02 .35408E-01 -.32978E-03 .74408E-05 -.20243E-03
 IT = 154

CYCLE = 17
 DFDK = -.337908085E-07
 -.157137317E-16
 ALPHA IS
 -.29630662E+00 .12464318E-01 -.15609279E+01 .17329118E+01 .22830007E+01 -.18915005E+01
 .17329118E+01 PSIDT= .22830007E+01 GAMMA H = -.89434578E+02 THETA= -.16977119E+02
 PHI = .71529875E+00 VH = .39562389E+01 VV = .40088363E+03 V = .40090315E+03
 P = .66661286E+00 Q = .27258936E-01 R = .21833407E+01
 ALPHAD= .73201828E+02 BETAD= .14481831E+00
 E1 = -.66711379E-02 E2 = .23297295E-02 E3 = .49314544E-03
 E4 = -.10564500E-03 E5 = .41028678E-03 E6 = -.46342535E-03
 GBAR IS
 -.40721492E-02
 FX = -.29341477E-02 .31222770E-02 .18121054E+00 -.11833583E-02 -.30706406E-04 -.21118591E-03
 KMIN = .150687105E+02
 F1 = .508237060E-04
 F2 = .505691713E-04
 DFDK AT CAYMIN = 0.
 DELXFX = -.514822344E-12
 DETERM IS .124409619E+00
 DETERM IS .182580772E-03
 FX = -.29341E-02 .31223E-02 .18121E+00 -.11834E-02 -.30706E-04 -.21119E-03

IT = 160

CYCLE = 18
 DFDK = -.295865258E-07
 .37152711E-14
 ALPHA IS
 -.29580516E+00 .12572657E-01 -.15609280E+01 .17319223E+01 .22860569E+01 -.18705236E+01
 RA = .17319223E+01 PSIDT = .22860569E+01 GAMMA H = .89434589E+02 THETA = -.16948387E+02
 PHI = .72036016E+00 VH = .39592728E+01 VV = .40119899E+03 V = .40121853E+03
 P = .66640874E+00 Q = .27492762E-01 R = .21865954E+01
 ALPHAD = .73219270E+02 BETAD = .14948188E+00
 E1 = -.64796892E-02 E2 = .16843636E-02 E3 = .35644368E-03
 E4 = -.46690913E-03 E5 = -.51889547E-03 E6 = -.14550372E-02
 GBAR IS
 -.40719540E-02
 FX = .12017547E-01 .12455923E-01 -.29770142E+00 .15293190E-02 -.10674174E-04 -.26880959E-03
 KMIN = .154928660E+03
 F1 = .505691713E-04
 F2 = .482686400E-04
 DFDK AT CAYMIN = 0.
 DELXFX = .209247856E-13
 DETERM IS .121020413E+00
 DETERM IS .193499068E-03
 FX = .12018E-01 .12456E-01 -.29770E+00 .15293E-02 -.10674E-04 -.26881E-03
 IT = 168

CYCLE = 19
 DFDK = -.293841373E-07
 -.100758703E-13
 ALPHA IS
 -.29636030E+00 .14396404E-01 -.15588099E+01 .21058522E+01 .22867037E+01 -.17195313E+01
 RA = .21058522E+01 PSIDT = .22867037E+01 GAMMA H = .89313231E+02 THETA = -.16980195E+02
 PHI = .82485320E+00 VH = .48154600E+01 VV = .40172491E+03 V = .40175377E+03
 P = .66781151E+00 Q = .31484087E-01 R = .21867899E+01
 ALPHAD = .73122770E+02 BETAD = .11013813E+00
 E1 = -.99477914E-03 E2 = -.51294906E-03 E3 = .20716782E-03
 E4 = -.26260949E-03 E5 = .31721329E-03 E6 = .98776320E-03
 GBAR IS
 -.61900581E-02
 FX = -.86962859E-02 .22092790E-02 .13399731E+00 -.81249188E-03 -.25285939E-04 .73875957E-04
 KMIN = .283331453E+04
 F1 = .482686400E-04
 F2 = .244088493E-05
 DFDK AT CAYMIN = 0.
 DELXFX = .149505095E-12

APPENDIX

DETERM IS .121042327E+00
 DETERM IS .342541366E-02
 FX = -.86963E-02 .13400E+00 -.81249E-03 -.25286E-04 .73876E-04
 IT = 178

CYCLE = 20
 DFK = -.292005290E-07
 .239933670E-13
 ALPHA IS
 -.29626070E+00 .14572039E-01 -.15584234E+01 .21733087E+01 .22899473E+01 -.17340775E+01
 RA = .21733087E+01 PSIDT = .22899473E+01 GAMMA H = -.89291084E+02 THETA = -.16974488E+02
 PHI = .83491633E+00 VH = .49767623E+01 VV = .40220980E+03 V = .40224059E+03
 P = .66854063E+00 Q = .31914337E-01 R = .21899528E+01
 ALPHAD = .73142025E+02 BETAD = .99549323E-01
 E1 = -.17437065E-03 E2 = .31342499E-04 E3 = .31401369E-05
 E4 = .25560783E-03 E5 = -.19711836E-04 E6 = .10308080E-04
 GBAR IS
 -.65765896E-02
 FX = .13831461E-03 -.46351628E-02 -.16196846E-01 .10627255E-03 -.39997218E-06 .73260595E-05
 KMIN = .159188500E+03
 F1 = .244088493E-05
 F2 = .972275155E-07
 DFK AT CAYMIN = 0.
 DELXFX = -.575449329E-13
 DETERM IS .12315213E+00
 DETERM IS .717003535E-01
 FX = .13831E-03 -.46352E-02 -.16197E-01 .10627E-03 -.39997E-06 .73261E-05
 IT = 186

CYCLE = 21
 DFK = -.253582526E-07
 .108826793E-15
 ALPHA IS
 -.29625815E+00 .14658589E-01 -.15583486E+01 .21864339E+01 .22901722E+01 -.17301720E+01
 RA = .21864339E+01 PSIDT = .22901722E+01 GAMMA H = -.89286798E+02 THETA = -.16974342E+02
 PHI = .83987527E+00 VH = .50073102E+01 VV = .40224652E+03 V = .40227769E+03
 P = .66860071E+00 Q = .32107055E-01 R = .21901669E+01
 ALPHAD = .73140136E+02 BETAD = .99610820E-01
 E1 = .13230778E-04 E2 = -.41939322E-04 E3 = -.10538706E-04
 E4 = .24477213E-04 E5 = -.44058262E-05 E6 = -.21271604E-06
 GBAR IS
 -.66513919E-02
 FX = .52807285E-04 -.44783008E-03 -.26608246E-02 .17092282E-04 .15506210E-05 .33211582E-05
 KMIN = .745331213E+01
 F1 = .972275155E-07

APPENDIX

```

F2 = .266361504E-08
DFDK AT CAYMIN = 0.
DELXFX = -.192575926E-13
DETERM IS .117734452E+00
DETERM IS .440271325E+00
FX = .52897E-04 -.44783E-03 -.26608E-02 .17092E-04 .15506E-05 .33212E-05
IT = 194

CYCLE = 22
DFDK = -.446675148E-08
.59901112E-19
ALPHA IS
RA = -.29627017E+00 .14056070E-01 -.15583517E+01 .21859152E+01 .22899681E+01 -.17316124E+01
PHI = .21859152E+01 PSIDT = .22899681E+01 GAMMA H = -.89286977E+02 THETA = -.16975030E+02
P = .83973098E+00 VH = .50056762E+01 VV = .40221580E+03 V = .40224695E+03
ALPHAD = .66856747E+00 Q = .32098562E-01 R = .21899638E+01
E1 = .73140431E+02 BETAD = .99813709E-01 .14724318E-05
E2 = -.18744673E-05 E3 = -.28169957E-05 E4 = .14724318E-05
E5 = .10125338E-06 E6 = .39549584E-05 E7 = -.59049450E-05
GBAR IS
FX = -.66482808E-02
KMIN = -.10098825E-04 .81735416E-05 .17484226E-02 -.10000209E-04 -.20130902E-06 -.76553507E-07
F1 = .116334193E+01
F2 = .266361504E-08
DFDK AT CAYMIN = 0.
DELXFX = -.592606123E-14
DETERM IS .130643430E+00
DETERM IS .504462743E+00
FX = -.10099E-04 .81735E-05 .17484E-02 -.10000E-04 -.20131E-06 -.76554E-07
IT = 201

CYCLE = 23
DFDK = -.673551687E-10
-.656285098E-20
ALPHA IS
RA = -.29627354E+00 .14656967E-01 -.15583503E+01 .21861708E+01 .22899796E+01 -.17316860E+01
PHI = .21861708E+01 PSIDT = .22899796E+01 GAMMA H = -.89286898E+02 THETA = -.16975229E+02
P = .83978236E+00 VH = .50062867E+01 VV = .40222036E+03 V = .40225152E+03
ALPHAD = .66857841E+00 Q = .32100653E-01 R = .21899724E+01
E1 = .73140297E+02 BETAD = .99792882E-01 .14724318E-05
E2 = .44417979E-06 E3 = -.14323986E-06 E4 = -.26218788E-06
E5 = .48145810E-06 E6 = .33659338E-05 E7 = .10590165E-06
GBAR IS
-.66496570E-02

```

APPENDIX

```

FX= -.35724485E-04 -.11364029E-04 .14267781E-02 -.80867090E-05 .37021481E-07 .14270621E-06
KMIN = .15483289E+01
F1 = .64137472E-10
F2 = .11994120E-10
DFDK AT CAYMIN = 0.
DELXFX = .163722542E-14
DETERM IS .145523257E+00
DETERM IS .595447805E+00
FX= -.357244E-04 -.113644E-04 .14268E-02 -.80867E-05 .37021E-07 .14271E-06
IT = 207
ESTIMATE OF THE INVERSE OF FX
.14552326E+00 -.24053239E-01 -.43000631E-01 -.80838257E+01 .48579756E+00 .60084218E+01
-.24053239E-01 .59078453E-01 .70567344E-01 .12487116E+02 -.68655440E-01 .11608003E+01
-.43000631E-01 .70567344E-01 .99866674E-01 .17686882E+02 -.12404975E+00 -.18094787E+00
-.80838257E+01 .12487116E+02 .17686882E+02 .31344434E+04 -.23388163E+02 -.49567748E+02
.48579756E+00 -.68655440E-01 -.12404975E+00 -.23388163E+02 .10123585E+03 .15178012E+02
.60084218E+01 .11608003E+01 -.18094787E+00 -.49567748E+02 .15178012E+02 .62075278E+03
RA= .21861708E+01 PSIDI= .2289796E+01 GAMMA H = -.69286898E+02 THETA= -.16975229E+02
PHI = .83978236E+00 VH = .50062867E+01 VV = .40222036E+03 V = .40225152E+03
P = .66857841E+00 O = .32100653E-01 R = .21899724E+01
ALPHAD= .73140297E+02 BETAD=
E1 = .4417979E-06 E2 = -.14323986E-06 E3 = -.26218788E-06
E4 = .48145810E-06 E5 = .33859338E-05 E6 = .10590165E-06
GBAR IS
FX= -.66496570E-02
FX= -.35724485E-04 -.11364029E-04 .14267781E-02 -.80867090E-05 .37021481E-07 .14270621E-06
FALPHA IS
-.35724485E-04 -.11364029E-04 .14267781E-02 -.80867090E-05 .37021481E-07 .14270621E-06
ALPHA IS
-.29627364E+00 .14656912E-01 -.15583505E+01 .21861439E+01 .22899782E+01 -.17316900E+01
NEWTON-RAPHSON ITERATION NO.= 1
FX= -.12092620E-04 -.18428037E-05 .47611407E-03 -.2709514E-05 .40289159E-07 .45669053E-07

```

APPENDIX

F IS EQUAL TO .139447707E-11

FALPHA IS

-.12092620E-04 -.16428037E-05 .47611407E-03 -.27095414E-05 .40289159E-07 .45669053E-07
 NEWTON-RAPHSON ITERATION NO.= 2

ALPHA IS

-.29627361E+00 .14656916E-01 -.15583505E+01 .21861443E+01 .22899748E+01 -.17316923E+01
 FX= -.42043180E-05 -.71738422E-06 .16601659E-03 -.94439842E-06 .14066326E-07 .15814954E-07

F IS EQUAL TO .169664235E-12

FALPHA IS

-.42043180E-05 -.71738422E-06 .16601659E-03 -.94439842E-06 .14066326E-07 .15814954E-07
 NEWTON-RAPHSON ITERATION NO.= 3

ALPHA IS

-.29627362E+00 .14656917E-01 -.15583505E+01 .21861443E+01 .22899737E+01 -.17316930E+01
 FX= -.14672469E-05 -.24815170E-06 .57913790E-04 -.32946110E-06 .49090008E-08 .55229879E-08

F IS EQUAL TO .206475956E-13

FALPHA IS

-.14672469E-05 -.24815170E-06 .57913790E-04 -.32946110E-06 .49090008E-08 .55229879E-08
 NEWTON-RAPHSON ITERATION NO.= 4

APPENDIX

ALPHA IS
 -.29627362E+00 .14656918E-01 -.15583505E+01 .21861443E+01 .22899733E+01 -.17316933E+01
 FX= -.51182958E-06 -.86654561E-07 .20203448E-04 -.11493324E-06 .17125708E-08 .19264371E-08

F IS EQUAL TO .251280668E-14

FALPHA IS
 -.51182958E-06 -.86654561E-07 .20203448E-04 -.11493324E-06 .17125708E-08 .19264371E-08
 NEWTON-RAPHSON ITERATION NO.= 5

ALPHA IS
 -.29627362E+00 .14656918E-01 -.15583505E+01 .21861442E+01 .22899731E+01 -.17316934E+01
 FX= -.17855703E-06 -.30226605E-07 .70481447E-05 -.40095463E-07 .59744359E-09 .67206268E-09

F IS EQUAL TO .305814113E-15

FALPHA IS
 -.17855703E-06 -.30226605E-07 .70481447E-05 -.40095463E-07 .59744359E-09 .67206268E-09
 NEWTON-RAPHSON ITERATION NO.= 6

ALPHA IS
 -.29627362E+00 .14656918E-01 -.15583505E+01 .21861442E+01 .22899731E+01 -.17316934E+01
 FX= -.62298014E-07 -.10544635E-07 .24590952E-05 -.13989298E-07 .20841829E-09 .23447178E-09

F IS EQUAL TO .372260768E-16

o

FALPHA IS

-.62298014E-07 -.10544635E-07 .24590952E-05 -.13989298E-07 .20841829E-09 .23447178E-09
 NEWTON-RAPHSON ITERATION NO.= 7

ALPHA IS

-.29627362E+00 .14656918E-01 -.15583505E+01 .21861442E+01 .22899730E+01 -.17316934E+01
 FX= -.21735785E-07 -.36790595E-08 .85797668E-06 -.46808568E-08 .72716091E-10 .81807671E-10

F IS EQUAL TO .453155269E-17

FALPHA IS

-.21735785E-07 -.36790595E-08 .85797668E-06 -.46808568E-08 .72716091E-10 .81807671E-10
 NEWTON-RAPHSON ITERATION NO.= 8

ALPHA IS

-.29627362E+00 .14656918E-01 -.15583505E+01 .21861442E+01 .22899730E+01 -.17316934E+01
 RA= .21861442E+01 PSIDI= .22899730E+01 GAMMA H = -.89286907E+02 THETA = -.16975228E+02
 PHI = .83977954E+00 VH = .50062114E+01 VV = .40221970E+03 V = .40225085E+03
 P = .66857644E+00 Q = .32100453E-01 R = .21899561E+01
 ALPHAD= .73140302E+02 BETAD= .99800457E-01
 E1 = .26968650E-10 E2 = -.56470384E-10 E3 = -.18082250E-09
 E4 = .39314996E-10 E5 = .71657524E-09 E6 = .26970537E-10
 GBAR IS
 -.66494906E-02
 FX= -.75889636E-08 -.12833339E-08 .29957328E-06 -.17042165E-08 .25365914E-10 .28555949E-10

F IS EQUAL TO .5523666148E-18

FALPHA IS

APPENDIX

TL= -.75889636E-08 -.12833359E-08 .29957328E-06 -.17042165E-08 .28555949E-10
.41474415E-01TH= -.13292986E+01TN= .14693190E-01 .25365914E-10

```

CONTROLS DE= -.21000000E+02 DA= 0. DR= -.30000000E+02
THETA= -.16975228E+02 PHI= .83977954E+00 GAMMA= -.89286907E+02
RADIUS= .21861442E+01 PSIDT= .22899730E+01 PSI PRIME= -.99218723E+02
ALPHA= .73140302E+02 BETA= .99800457E-01 V= .40225085E+03
X= .66857644E+00 Q= .32100453E-01 R= .21899661E+01
P= -.21579079E+01 Y= .35022853E+00 Z= 0.
TRANSPOSE OF THE GRADIENT OF F WITH RESPECT TO CONTROLS
.85989125E-04 0.
.16495658E-05 -.38643093E-05 .83252683E-05
-.15213583E-03 -.67658776E-08 .14548907E-07
-.11253782E-02 .19127983E-02 .33495762E-03
-.13166367E-01 0.
-.83829987E-04 .37211275E-03 -.15535288E-03

TRANSPOSE OF GRADIENT WITH RESPECT TO STATE
-.3479206E-02 -.2290611E+01 -.2778474E-01 -.5051867E-03 .1000000E+01 -.1666980E-02 .7998415E-01 -.3251854E-03
.2266075E+01 .9395918E-02 -.2154831E-02 .9544494E+00 0. -.2912974E+00 .3419825E-03 .7649359E-01
-.3524844E-01 -.9024867E-02 -.1599498E+00 -.4473841E-05 0. -.2209125E-05 .1594751E-03 -.9397841E-03
-.6191978E+00 -.6512179E+01 .2285020E+00 -.3120312E+00 -.1292020E+01 .9858221E-02 0.
-.1259890E+01 .2020131E-01 -.2653449E+01 .1988252E+01 -.1603812E+00 .6069951E+00 0.
-.2345094E+01 -.1349813E+00 .4767509E-01 .1244540E+00 -.4577253E+00 -.5305512E-01 0.
0. 0. .9998926E+00 -.1465639E-01 0. .9998926E+00 -.1465639E-01 0.
0. 0. 0. .1000000E+01 -.4473981E-02 -.3052252E+00 0. .2394290E+01 0.
ROOTS OF FX
-.4666460E+00 0. -.1670094E+00 0. -.7959922E-01 .2288675E+01 -.7959922E-01 -.2288675E+01
.9325989E-01 .2658988E+01 .9525969E-01 -.2658988E+01 -.3858318E-01 .2909763E+01 .2909763E-01 -.3858318E-01

PRESENTATION OF ROOTS IN FORM INDICATING THEIR AMPLITUDE AND PHASE
ROOT(1) ROOT(2) ROOT(3) ROOT(4) ROOT(5) ROOT(6) ROOT(7) ROOT(8)
R= .46665E+00 R= .16701E+00 R= .22901E+01 R= .22901E+01 R= .26607E+01 R= .26607E+01 R= .29100E+01 R= .29100E+01
PHE= .180E+03PHE= .180E+03PHE= .920E+02PHE= .920E+02PHE= -.920E+02PHE= -.920E+02PHE= .879E+02PHE= -.879E+02PHE= .908E+02PHE= -.908E+02

PRESENTATION OF EIGENVECTORS IN FORM INDICATING THE PHASES AND RELATIVE AMPLITUDES OF EACH VECTOR
PHE= .18854E+00 R= .62818E-01 R= .15850E+00 R= .15850E+00 R= .15514E+00 R= .15514E+00 R= .53098E-01 R= .53098E-01
.180E+03PHE= .180E+03PHE= -.126E+03PHE= .126E+03PHE= .164E+03PHE= .164E+03PHE= .109E+03PHE= .109E+03PHE=
R= .59320E-03 R= .28109E-02 R= .73169E-01 R= .73169E-01 R= .24117E+00 R= .24117E+00 R= .30288E+00 R= .30288E+00
PHE= .180E+03PHE= .180E+03PHE= -.312E+02PHE= .312E+02PHE= .130E+03PHE= .130E+03PHE= .115E+03PHE= .115E+03PHE=
R= .21558E-01 R= .31609E+00 R= .22627E-02 R= .22627E-02 R= .28327E-02 R= .28327E-02 R= .16798E-02 R= .16798E-02
PHE= .180E+03PHE= .180E+03PHE= -.173E+02PHE= .173E+02PHE= .580E+02PHE= .580E+02PHE= -.155E+03PHE= .155E+03PHE=
R= .14182E+00 R= .15632E+00 R= .53314E+00 R= .53314E+00 R= .10000E+01 R= .10000E+01 R= .10000E+01 R= .10000E+01
PHE= 0. PHE= .180E+03PHE= .565E+02PHE= -.565E+02PHE= -.235E+02PHE= .235E+02PHE= .146E+03PHE= .146E+03PHE=
R= .98877E-01 R= .17128E-02 R= .58154E+00 R= .58154E+00 R= .85526E+00 R= .85526E+00 R= .72208E+00 R= .72208E+00
PHE= 0. PHE= .180E+03PHE= -.368E+02PHE= .368E+02PHE= .107E+03PHE= .107E+03PHE= .127E+03PHE= .127E+03PHE=
R= .10000E+01 R= .10000E+01 R= .22856E+00 R= .22856E+00 R= .28127E+00 R= .28127E+00 R= .17580E+00 R= .17580E+00
PHE= .180E+03PHE= .180E+03PHE= -.409E+01PHE= .409E+01PHE= -.497E+02PHE= .497E+02PHE= -.162E+03PHE= .162E+03PHE=
R= .18879E+00 R= .62276E-01 R= .79410E+00 R= .79410E+00 R= .13583E+00 R= .13583E+00 R= .30839E-01 R= .30839E-01
PHE= .180E+03PHE= .180E+03PHE= .108E+03PHE= .108E+03PHE= -.169E+03PHE= .169E+03PHE= .110E+03PHE= .110E+03PHE=
R= .11608E-01 R= .11611E-02 R= .10000E+01 R= .10000E+01 R= .25215E+00 R= .25215E+00 R= .32031E+00 R= .32031E+00

```

APPENDIX

PHE= 0. PHE= 0. PHE= .699E+01PHE= -.699E+01PHE= -.124E+03PHE= .124E+03PHE= .120E+03PHE= -.120E+03

REFERENCES

1. Adams, William M., Jr.: Analytic Prediction of Airplane Equilibrium Spin Characteristics. NASA TN D-6926, 1972.
2. Scher, Stanley H.; Anglin, Ernie L.; and Lawrence, George F.: Analytical Investigation of Effect of Spin Entry Technique on Spin and Recovery Characteristics for a 60° Delta-Wing Airplane. NASA TN D-156, 1959.
3. Grantham, William D.; and Scher, Stanley H.: Analytical Investigation and Prediction of Spin and Recovery Characteristics of the North American X-15 Airplane. NASA TM X-294, 1960.
4. Grantham, William D.; and Grafton, Sue B.: Effects of Aircraft Relative Density on Spin and Recovery Characteristics of Some Current Configurations. NASA TN D-2243, 1965.
5. Anglin, Ernie L.: Relationship Between Magnitude of Applied Spin Recovery Moment and Ensuing Number of Recovery Turns. NASA TN D-4077, 1967.
6. Wenglinski, T. H.: Model F-101A Results of a Steady State Spin Analysis. Rep. No. 6687 (Contract No. AF 42(600)-19284), McDonnell Aircraft Corp., Apr. 22, 1960.
7. Carter, C. V.: A Discussion of Theoretical Methods for Prediction of Spin Characteristics. Rep. No. 10732, Chance Vought Aircraft, Inc., Feb. 8, 1957.
8. Anglin, Ernie L.; and Scher, Stanley H.: Analytical Study of Aircraft-Developed Spins and Determination of Moments Required for Satisfactory Spin Recovery. NASA TN D-2181, 1964.
9. Davidon, William C.: Variable Metric Method for Minimization. ANL-5990 Rev. (Contract W-31-109-eng-38), Argonne Nat. Lab., Nov. 1959.
10. Fletcher, R.; and Powell, M. J. D.: A Rapidly Convergent Descent Method for Minimization. Computer J., vol. 6, no. 2, July 1963, pp. 163-168.
11. Kelley, Henry J.; Denham, Walter F.; Johnson, Ivan L.; and Wheatley, Patrick O.: An Accelerated Gradient Method for Parameter Optimization With Non-Linear Constraints. J. Astronaut. Sci., vol. XIII, no. 4, July-Aug. 1966, pp. 166-169.
12. Courant, R.: Variational Methods for the Solution of Problems of Equilibrium and Vibrations. Bull. American Math. Soc., vol. 49, Jan. 1943, pp. 1-23.
13. U.S. Standard Atmosphere, 1962. NASA, U.S. Air Force, and U.S. Weather Bur., Dec. 1962.

1 Report No NASA TM-78759		2 Government Accession No		3 Recipient's Catalog No	
4 Title and Subtitle SPINEQ: A PROGRAM FOR DETERMINING AIRCRAFT EQUILIBRIUM SPIN CHARACTERISTICS INCLUDING STABILITY				5 Report Date November 1978	
				6 Performing Organization Code	
7 Author(s) William M. Adams, Jr.				8 Performing Organization Report No L-12328	
9 Performing Organization Name and Address NASA Langley Research Center Hampton, VA 23665				10 Work Unit No 505-07-33-04	
				11 Contract or Grant No	
12 Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546				13 Type of Report and Period Covered Technical Memorandum	
				14 Sponsoring Agency Code	
15 Supplementary Notes					
16 Abstract A computer program, SPINEQ, is described which can algebraically solve the non-linear equations of motion for equilibrium spin conditions. Linear characteristics of the airplane about the equilibrium points are also determined. The theoretical basis of the program is outlined, computational flow is shown, the functions of major subroutines are described, and key parameters directing the computations are identified. Program input and output are described and illustrated by means of a test case. The program is available from COSMIC.					
17 Key Words (Suggested by Author(s)) Aircraft spin Stability Nonlinear programing			18 Distribution Statement Unclassified - Unlimited Subject Category 08		
19 Security Classif (of this report) Unclassified		20 Security Classif (of this page) Unclassified		21 No of Pages 84	22 Price* \$6.00

National Aeronautics and
Space Administration

THIRD-CLASS BULK RATE

Postage and Fees Paid
National Aeronautics and
Space Administration
NASA-451



Washington, D.C.
20546

Official Business
Penalty for Private Use, \$300

6 2 10, A, 101678 S90844HU
MCDONNELL DOUGLAS CORP
ATTN: PUBLICATIONS GROUP PR 15246-A
P O BOX 516
ST LOUIS MO 63166

NASA

POSTMASTER: If Undeliverable (Section
Postal Manual) Do Not

Dr. Ho [unclear] 240/32/240
[unclear] [unclear] [unclear]