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USNASC ltr, 26 Oct 1971

Report No. MSD-P69-144

Contract No. 00019-68-C-0247

AD859287

COLLOCATION FLUTTER ANALYSIS STUDY

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VOLUME III.

AICs - COMPUTER PROGRAM TO CALCULATE UNSTEADY AERODYNAMIC INFLUENCE COEFFICIENTS FOR SUBSONIC, TRANSONIC AND SUPERSONIC FLIGHT

APRIL 1969

SEP 25 1969

MISSILE SYSTEMS DIVISION

HUGHES

HUGHES AIRCRAFT COMPANY

COFA

COLLOCATION FLUTTER ANALYSIS STUDY

VOLUME III

AICs - COMPUTER PROGRAM TO CALCULATE
UNSTEADY AERODYNAMIC INFLUENCE COEFFICIENTS FOR
SUBSONIC, TRANSONIC, AND SUPERSONIC FLIGHT

Prepared by Dynamics & Environments Section Personnel
Hughes Aircraft Company, Missile Systems Division
Contract No.00019-68-C-0247

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ABSTRACT

Subsonic Kernel function, transonic box, and supersonic box methods for computing unsteady aerodynamics are applied to the problem of interaction of a general trapezoidal wing with a downstream rectangular control surface lying in the wake of the wing. The unsteady aerodynamic forces are related to a set of collocation stations through a series of matrix transformations, interpolations, and differentiations. The resulting matrix is a set of aerodynamic influence coefficients (AICs) that are directly applicable to flutter analysis.

The transformation of the unsteady aerodynamics into AICs is presented as a separate discussion; followed by discussions for the developments of analytical techniques for each flight regime. The analytical developments and a discussion of the basic single-planar-surface are presented, followed by the complete two-surface solutions for the general aerodynamic forces. Each of the three numerical methods is developed by detailing the complete set of equations necessary to compute airloads on the configurations considered. A computer program to determine the AIC matrix for each flight regime is presented with a complete discussion of usage and logical flow. Also included are program listings, flow charts and sample input and output problems.

PART I - INTRODUCTION

The requirements for determination of flutter margins of safety for the lifting surfaces of advanced guided missiles have precipitated a need for accurate methods of analysis of unsteady aerodynamic loading in the high subsonic, transonic, and supersonic flight regimes. These methods must not only account for the high degree of chordwise and spanwise deformation of the surfaces, but also include the interference effects between tandem lifting surfaces. Recent developments in lifting surface theory in the three Mach number regimes have permitted extensions (Refs. 2 and 3) to determine airloads on typical missile wings with downstream control surfaces. These extensions account for the interaction and wake effects as well as for the three-dimensionality of the flow for a trapezoidal wing planform and a coplanar rectangular control surface placed at an arbitrary distance downstream of the unswept trailing edge of the wing. An underlying assumption in these methods is that the missile body diameter is large enough compared to the spans of the surfaces that the body surface acts as a reflection plane for distrubances at the line of its intersection with the lifting surfaces.

The present study extends the methods of Ref. 3 to obtain aerodynamic influence coefficients (AIC's) that relate the forces on the surfaces at a discrete set of points (control or collocation points) to the tranverse deflections of the same set of points. Subsonic kernel function, transonic box, and supersonic box methods for computing the oscillatory AIC's are applied to the interference problem of a general trapezoidal wing with a downstream rectangular control surface lying in the wake of the wing. Highly efficient numerical methods for computation by the kernel function and Mach box techniques have been employed, along with the techniques for the newly developed transonic box method, to obtain AIC's which account for all interference effects within the framework of linearized theory.

Discussion of the derivation of the AIC's is given in Part III for the three Mach number regimes. The analytical basis of the theories are outlined in Appendices to Part III. Each of the three numerical methods is discussed and the basic equations necessary to compute airloads on the configurations considered are summarized.

The three computer programs are presented in Parts IV, V, and VI, for the subsonic, sonic, and supersonic cases, respectively. In addition to a technical outline of the methods employed, each Part is a manual containing a complete discussion of usage and logical flow accompanied by program listings, flow charts and sample input and output. Each Part also presents results computed by operation of the program for typical planforms.

PART II - NOMENCLATURE

a	Free-stream acoustic velocity
$a_{n,m}$	Coefficients of Kernel function pressure series
b	L cal semi-chord
b_r	Reference semi-chord
C_h	Element of dimensionless AIC matrix
C_p	Pressure coefficient
$D_{n,m}$	Element of Kernel function matrix
G	Supersonic source influence function
h	AIC control point displacement.
K	Kernel function
k	Local reduced frequency $\sim \frac{\omega b}{U}$
k_r	Reference reduced frequency $\sim \frac{\omega b_r}{U}$
M	Mach number
p	Complex amplitude of pressure
S	Planform area
s	Semi-span
U	Free-stream fluid velocity
U_k	Chebyshev polynomial

$[W]$	Substantial derivative matrix
w	Complex amplitude of downwash
X,Y,Z	Cartesian coordinate system
β^2	$1-M^2$ for $M<1$; M^2-1 for $M>1$
Δ	Box length
ξ,η,ζ	Cartesian coordinate system variables
$\tilde{\xi},\eta$	Special coordinates for collocation and integration points
ϕ	Complex amplitude of velocity potential
ψ	Transonic doublet influence function
ρ	Atmospheric density
ω	Angular frequency of harmonic oscillation ~ rad/sec
AR	Aspect ratio ~ $2s^2/S$

PART III

DISCUSSION OF THE DERIVATION OF AERODYNAMIC INFLUENCE COEFFICIENTS

DERIVATION OF SUBSONIC AERODYNAMIC INFLUENCE COEFFICIENTS

The subsonic kernel function procedure was developed by Watkins, Woolston and Cunningham,[1] extended to a wing-tail combination by Moore and Park,[2] and refined by Andrew.[3] The present study extends the method of Ref. 3 to obtain aerodynamic influence coefficients (AICs). Oscillatory AICs have been defined in Ref. 4 to relate control point forces to control point deflections through the matrix equation.

$$\{F\} = \rho\omega^2 b_r^2 s [C_h] \{h\} \qquad (3.1)$$

The derivation of the AICs requires a review of the technique of Refs. 1 - 3. (NOTE: These references are outlined in Part IV, Section A). The starting point is an assumed series for the lifting pressure distribution. It is chosen in the form[3]

$$C_p(\xi,\eta) = \frac{\sqrt{s^2 - \eta^2}}{b(\eta)} \sum_{n=0}^{N} \sum_{m=0}^{M} a_{nm} P_m(\eta) f_n(\tilde{\xi}) \qquad (3.2)$$

where the chordwise pressure functions are

$$f_o(\tilde{\xi}) = \sqrt{(1 - \tilde{\xi})/(1 + \tilde{\xi})} \qquad (3.3a)$$

$$f_n(\tilde{\xi}) = \sqrt{1 - \tilde{\xi}^2}\, U_{n-1}(\tilde{\xi}),\ 1 \leq n \qquad (3.3b)$$

the spanwise pressure functions are

$$P_o(\eta) = 1.0 \qquad (3.4a)$$

$$P_m(\eta) = \eta^2 U_{m-1}(\eta), \quad 1 \leq m \tag{3.4b}$$

and the Chebyshev polynomial recurrence relation is

$$U_k(x) = 2x\, U_{k-1}(x) - U_{k-2}(x) \tag{3.5}$$

when $U_0(x) = 1.0$ and $U_1(x) = 2x$. The numerical procedures of Refs. 1 - 3 lead to a matrix formulation of the aerodynamic lifting surface integral equation as an equation between the control point downwashes and the amplitudes of the assumed pressure modes

$$\{w/U\} = [D_{nm}]\{a_{nm}\} \tag{3.6}$$

The solution of Eq. 3.6 by least-squares methods is given by Ref. 3 which we write in the form

$$\{a_{nm}\} = [A_{M<1}]\{w/U\} \tag{3.7}$$

In order to find the AICs it is necessary to define a grid of control points. We find it convenient to divide the surface into NS strips and to locate the control points on the centerline of each strip. We further choose NC control points on each strip located at the same fractional chord location on each strip. A typical distribution of control points is shown in Figure 3.1 for a wing-tail combination.

The downwashes required in Eq. 3.7 are obtained by a substantial differentiation of the AIC control point deflections

$$\{w/U\} = [W]\{h\} \tag{3.8}$$

Since the downwashes required in Ref. 3 are at an optimum set of points different from the AIC control points, the matrix [W] is seen to be an interpolation as well as a substantial differentiation matrix.

TYPICAL DISTRIBUTION OF CONTROL POINTS

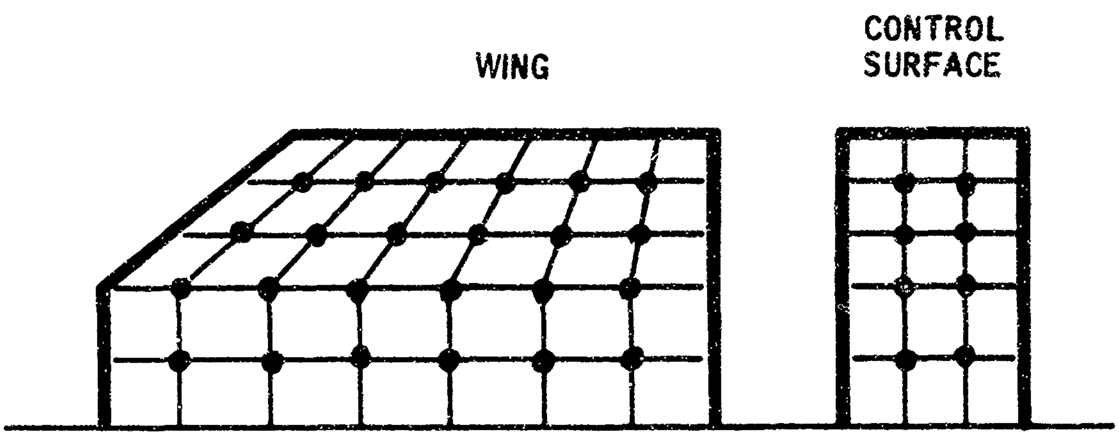


Figure 3.1

From the pressure modes and their amplitudes the forces may be found by an integration procedure. The NC forces on each strip may be found by integration of the pressure on the strip in the region of each of the NC forces to obtain equivalent concentrated forces. This leads to a relationship between the forces and the pressure mode amplitudes

$$\{F\} = qs^2 [B] \{a_{nm}\} \tag{3.9}$$

We designate the matrix [B] as the integration matrix.

Combining Eqs. 3.7, 3.8 and 3.9, and identifying the result with Eq. 3.1 leads to the subsonic oscillatory AICs.

$$[C_h] = (s/2k_r^2) [B] [A_{M<1}] [W] \tag{3.10}$$

Ref. 3 provides $[A_{M<1}]$; the extension to obtain AICs requires the development of the matrices [W] and [B]. These are discussed next.

THE SUBSTANTIAL DIFFERENTIATION MATRIX [W]

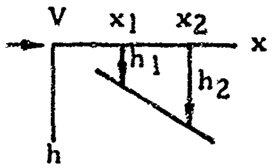
The substantial differentiation matrix is derived by surface fitting techniques. For maximum accuracy we fit the surface "in-the-small," i.e., locally. Rather than use a surface fit per se, we shall fit curves in the chordwise direction and then fit similar curves spanwise along lines of constant chord fraction. A higher order polynomial is not well behaved between points, so we choose to connect a series of parabolas. A number of options exists as the number of points is increased so it is well to develop the equations systematically.

With two control points the curve, of course, is a straight line. Its equation may be written in matrix form.

$$h(x) = \lfloor 1 \;\; x \rfloor \begin{bmatrix} 1 & x_1 \\ 1 & x_2 \end{bmatrix}^{-1} \begin{Bmatrix} h_1 \\ h_2 \end{Bmatrix} \tag{3.11}$$

With three control points the parabola is given by

$$h(x) = \begin{bmatrix} 1 & x & x^2 \end{bmatrix} \begin{bmatrix} 1 & x_1 & x_1^2 \\ 1 & x_2 & x_2^2 \\ 1 & x_3 & x_3^2 \end{bmatrix}^{-1} \begin{Bmatrix} h_1 \\ h_2 \\ h_3 \end{Bmatrix} \tag{3.12}$$



In the case of four points we fit two parabolas that are tangent half-way between the second and third points. For $x < x_{2-3} = (x_2 + x_3)/2$ we write

$$h(x) = a_0 + a_1 x + a_2 x^2 \tag{3.13}$$

and for $x > x_{2-3}$

$$h(x) = b_0 + b_1 x + b_2 x^2 \tag{3.14}$$

At $x = x_{2-3}$ the deflections and slopes must be equal.

$$a_0 + a_1 x_{2-3} + a_2 x_{2-3}^2 = b_0 + b_1 x_{2-3} + b_2 x_{2-3}^2 \tag{3.15}$$

$$a_1 + 2a_2 x_{2-3} = b_1 + 2b_2 x_{2-3} \tag{3.16}$$

The unknown coefficients are determined by the solution of the matrix equation

$$\begin{bmatrix} 1 & x_1 & x_1^2 & 0 & 0 & 0 \\ 1 & x_2 & x_2^2 & 0 & 0 & 0 \\ 1 & x_{2-3} & x_{2-3}^2 & -1 & -x_{2-3} & -x_{2-3}^2 \\ 0 & 1 & 2x_{2-3} & 0 & -1 & -2x_{2-3} \\ 0 & 0 & 0 & 0 & x_3 & x_3^2 \\ 0 & 0 & 0 & 0 & x_4 & x_4^2 \end{bmatrix} \begin{Bmatrix} a_0 \\ a_1 \\ a_2 \\ b_0 \\ b_1 \\ b_2 \end{Bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} h_1 \\ h_2 \\ h_3 \\ h_4 \end{Bmatrix} \tag{3.17}$$

Solving for the coefficients leads to the equations for the curve.

$$h(x) = \begin{bmatrix} 1 & x & x^2 & 0 & 0 & 0 \end{bmatrix} \begin{Bmatrix} a_0 \\ a_1 \\ a_2 \\ b_0 \\ b_1 \\ b_2 \end{Bmatrix} \quad \text{for } x \le x_{2-3} \tag{3.18a}$$

$$= \begin{bmatrix} 0 & 0 & 0 & 1 & x & x^2 \end{bmatrix} \begin{Bmatrix} a_0 \\ a_1 \\ a_2 \\ b_0 \\ b_1 \\ b_2 \end{Bmatrix} \quad \text{for } x \ge x_{2-3} \tag{3.18b}$$

The case of five points leads to the general pattern. We use two parabolas at the ends as in the four point case and one intermediate parabola that goes through one point and is tangent to the other parabolas. For $x < x_{2-3} = (x_2 + x_3)/2$

$$h(x) = a_0 + a_1 x + a_2 x^2 \tag{3.19}$$

$$h'(x) = a_1 + 2a_2 x \tag{3.20}$$

For $x_{2-3} < x < x_{3-4} = (x_3 + x_4)/2$

$$h(x) = b_0 + b_1 x + b_2 x^2 \tag{3.21}$$

$$h'(x) = b_1 + 2b_2 x \tag{3.22}$$

Finally, for $x > x_{3-4}$

$$h(x) = c_0 + c_1 x + c_2 x^2 \tag{3.23}$$

$$h'(x) = c_1 + 2c_2 x \tag{3.24}$$

The nine coefficients are found from the solution of

$$\begin{bmatrix} 1 & x_1 & x_1^2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & x_2 & x_2^2 & 0 & 0 & 0 & 0 & 0 & 0 \\ \hline 1 & x_{2-3} & x_{2-3}^2 & -1 & -x_{2-3} & -x_{2-3}^2 & 0 & 0 & 0 \\ 0 & 1 & 2x_{2-3} & 0 & -1 & -2x_{2-3} & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 1 & x_3 & x_3^2 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 1 & x_{3-4} & x_{3-4}^2 & -1 & -x_{3-4} & -x_{3-4}^2 \\ 0 & 0 & 0 & 0 & 1 & 2x_{3-4} & 0 & -1 & -2x_{3-4} \\ \hline 0 & 0 & 0 & 0 & 0 & 0 & 1 & x_4 & x_4^2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & x_5 & x_5^2 \end{bmatrix} \begin{Bmatrix} a_0 \\ a_1 \\ a_2 \\ b_0 \\ b_1 \\ b_2 \\ c_0 \\ c_1 \\ c_2 \end{Bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 1 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} h_1 \\ h_2 \\ h_3 \\ h_4 \\ h_5 \end{Bmatrix} \tag{3.25}$$

The general pattern is indicated by the partitioning. The equations for six or more points may be written by inspection. The equation for the curve may be written in the form

$$\begin{Bmatrix} h(x < x_{2-3}) \\ h(x_{2-3} < x < x_{3-4}) \\ h(x \geq x_{3-4}) \end{Bmatrix} = \begin{bmatrix} 1 & x & x^2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & x & x^2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & x & x^2 \end{bmatrix} \begin{Bmatrix} a_0 \\ a_1 \\ a_2 \\ b_1 \\ b_2 \\ b_3 \\ c_0 \\ c_1 \\ c_2 \end{Bmatrix} \qquad (3.26)$$

The curves that are obtained from this procedure resemble the deflection curve of a beam over multiple deflected supports. If only one support is deflected the curve damps out as the distance from the deflected support is increased. Some examples of the surface fits are shown in Figures 3.2 - 3.4.

The foregoing procedure may be summarized formally by rewriting Eq. 3.25 as

$$[T(x_a)]\{a_n\} = [B(x_a)]\{h_a\} \qquad (3.27)$$

and Eq. 3.26 as

$$\{h(x)\} = [C(x)]\{a_n\} \qquad (3.28)$$

The deflection at an arbitrary location is found in terms of the AIC control point deflections by combining Eqs. 3.27 and 3.28.

TYPICAL (W) MATRIX DEFLECTION PATTERN

FOR A UNIT DISPLACEMENT AT A

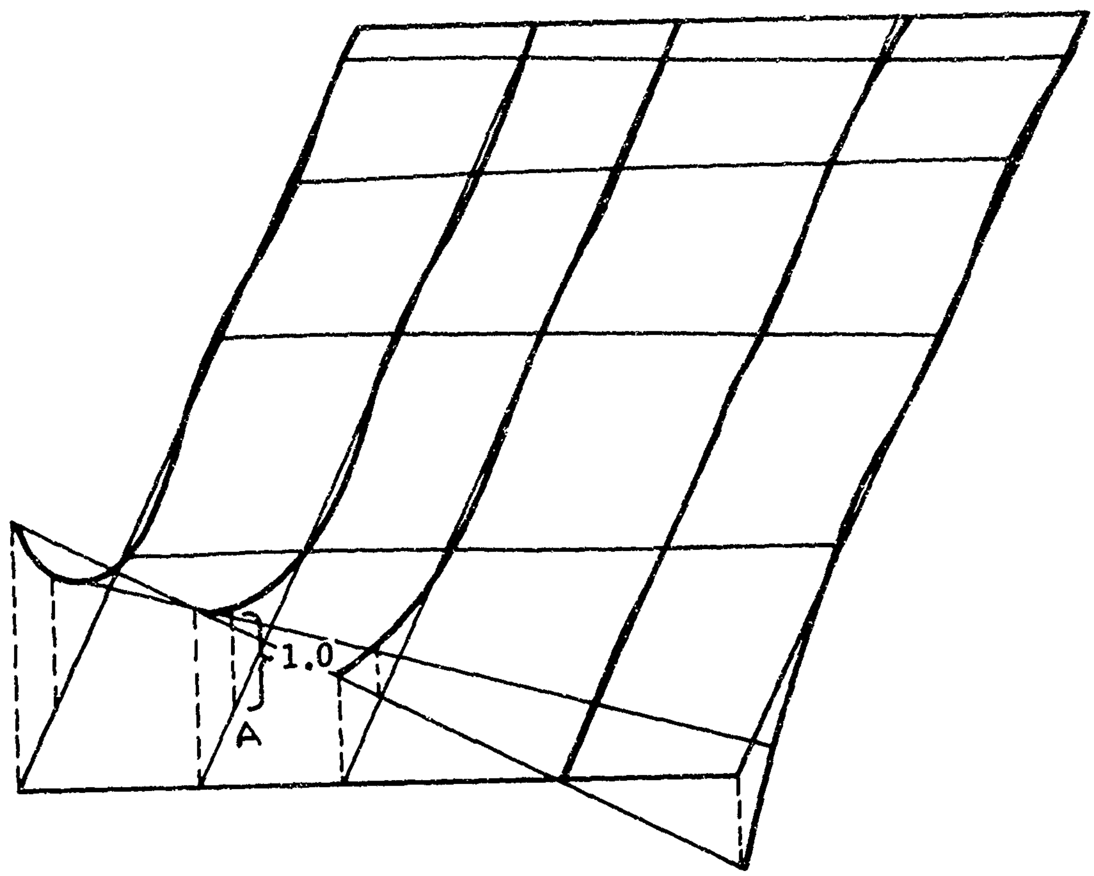


Figure 3.2

TYPICAL (W) MATRIX DEFLECTION PATTERN

FOR A UNIT DISPLACEMENT AT B

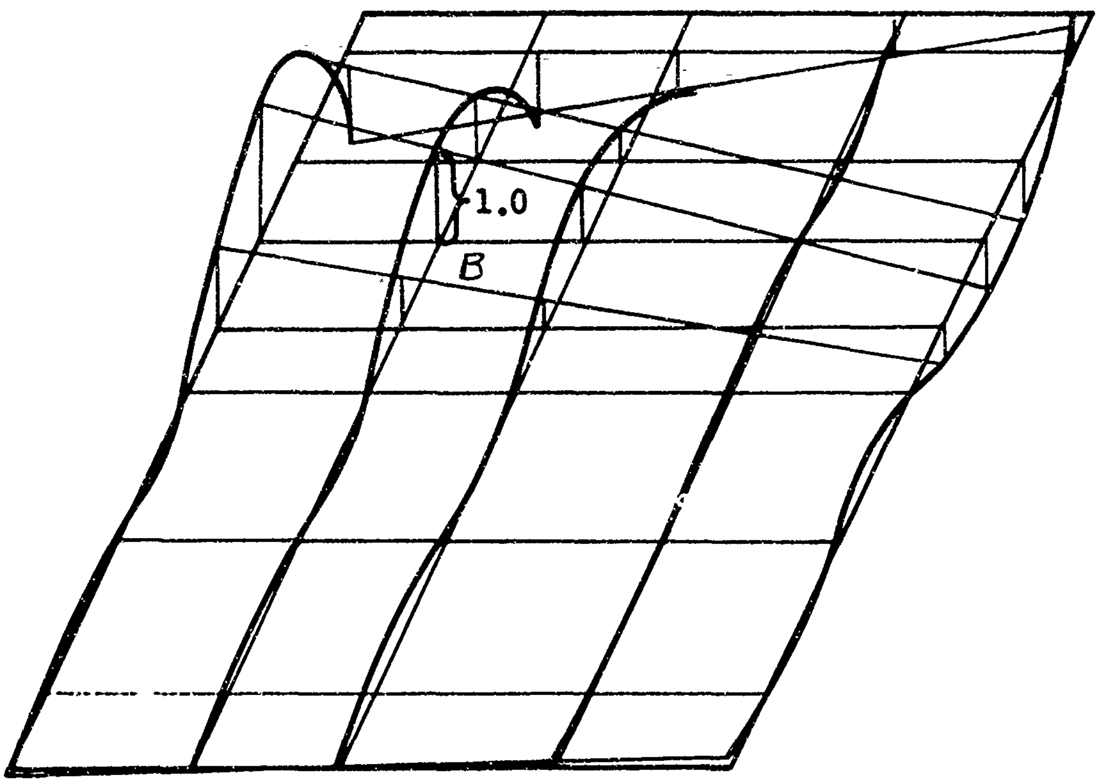


Figure 3.3

TYPICAL (W) MATRIX DEFLECTION PATTERN

FOR A UNIT DISPLACEMENT AT C

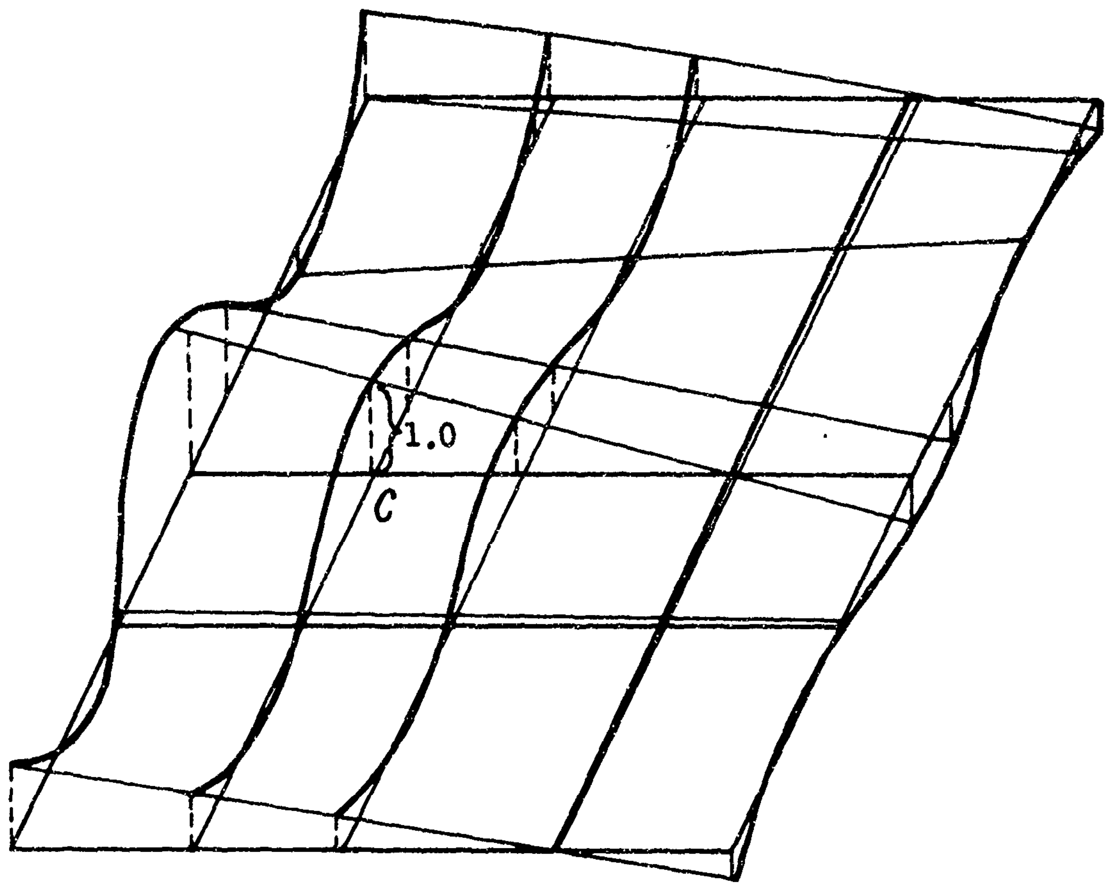


Figure 3.4

$$\{h(x)\} = [C(x)]\,[T(x_a)]^{-1}\,[B(x_a)]\,\{h_a\} \tag{3.29}$$

The downwash is the substantial derivative of Eq. 3.29.

$$\left\{\frac{w(x)}{U}\right\} = \frac{\partial}{\partial x}\{h(x)\} + i\,\frac{\omega}{U}\,\{h(x)\} \tag{3.30a}$$

$$= \frac{\partial}{\partial x}\{h(x)\} + i\,\frac{k_r}{b_r}\,\{h(x)\} \tag{3.30b}$$

The derivative of Eq. 3.29 is

$$\frac{\partial}{\partial x}\{h(x)\} = [C'(x)]\,[T(x_a)]^{-1}\,[B(x_a)]\,\{h_a\} \tag{3.31}$$

where $[C'(x)]$ is the matrix of derivatives of $C(x)$.

We next consider the interpolation in the spanwise direction. We have already defined $\{h_a\}$ as the set of AIC control point deflections. Since the collocation points in the lifting surface theory have different chordwise and spanwise locations, we introduce the matrix $\{h_b\}$ of deflections on the AIC strip centerline at the fractional chord locations of the lifting surface theory collocation points. Interpolation among the $\{h_b\}$ on all of the strips then leads to the lifting surface theory collocation point deflections $\{h_c\}$. The substantial derivative matrix is then defined by

$$[W]\,\{h_a\} = \frac{\partial}{\partial x}\,\{h_c\} + i\,\frac{k_r}{b_r}\,\{h_c\} \tag{3.32}$$

The chordwise interpolation leads to

$$\{h_b\} = [C(x_b)]\,[T(x_a)]^{-1}\,[B(x_a)]\,\{h_a\} \tag{3.33}$$

and

$$\frac{\partial}{\partial x}\{h_b\} = [C'(x_b)]\,[T(x_a)]^{-1}\,[B(x_a)]\,\{h_a\} \tag{3.34}$$

Then the spanwise interpolation leads to

$$\{h_c\} = [C(y_c)]\,[T(y_a)]^{-1}\,[B(y_a)]\,\{h_b\} \tag{3.35}$$

and

$$\frac{\partial}{\partial x}\{h_c\} = [C(y_c)]\,[T(y_a)]^{-1}\,[B(y_a)]\,\frac{\partial}{\partial x}\{h_b\} \tag{3.36}$$

The required matrix $[W] = [W_R] + i\,[W_I]$ is found by combining Eqs. 3.32 - 3.36. The real and imaginary parts appear formally as

$$[W_R] = [C(y_c)]\,]T(y_a)]^{-1}\,[B(y_a)]\,[C'(x_b)]\,[T(x_a)]^{-1}\,[B(x_a)] \tag{3.37}$$

and

$$[W_I] = (k_r/b_r)\,[C(y_c)]\,[T(y_a)]^{-1}\,[B(y_a)]\,[C(x_b]\,[T(x_a)]^{-1}\,[B(x_a)] \tag{3.38}$$

The formalism may be illustrated simply by considering two strips with 4 AIC points and 4 aerodynamic collocation points as shown in Figure 3.5.

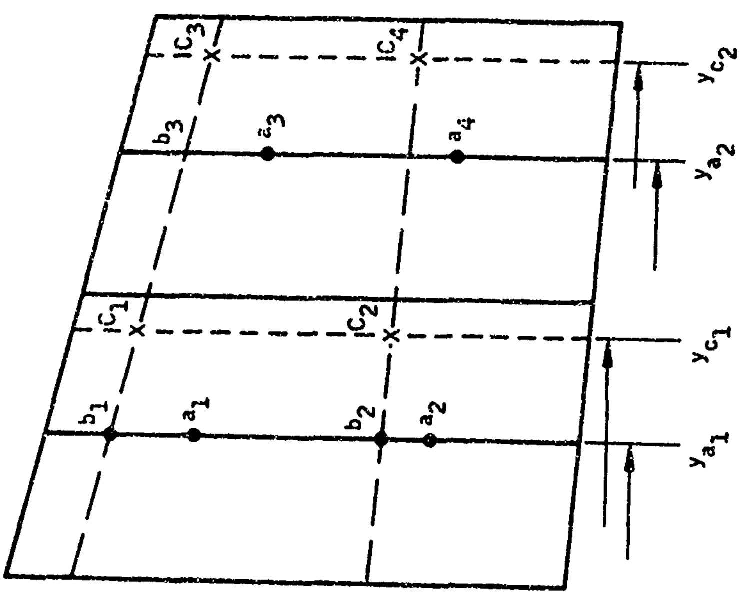


Figure 3.5

On the two strips

$$\begin{Bmatrix} h_{b_1} \\ h_{b_2} \end{Bmatrix} = \begin{bmatrix} 1 & x_{b_1} \\ 1 & x_{b_2} \end{bmatrix} \begin{bmatrix} 1 & x_{a_1} \\ 1 & x_{a_2} \end{bmatrix}^{-1} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{Bmatrix} h_{a_1} \\ h_{a_2} \end{Bmatrix}$$

$$= \left[X_{12}\right] \begin{Bmatrix} h_{a_1} \\ h_{a_2} \end{Bmatrix}$$

$$\begin{Bmatrix} h_{b_3} \\ h_{b_4} \end{Bmatrix} = \begin{bmatrix} 1 & x_{b_3} \\ 1 & x_{b_4} \end{bmatrix} \begin{bmatrix} 1 & x_{a_3} \\ 1 & x_{a_4} \end{bmatrix}^{-1} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{Bmatrix} h_{a_3} \\ h_{a_4} \end{Bmatrix}$$

$$= \left[X_{34}\right] \begin{Bmatrix} h_{a_3} \\ h_{a_4} \end{Bmatrix}$$

The slopes on the two strips are

$$\frac{\partial}{\partial x} \begin{Bmatrix} h_{b_1} \\ h_{b_2} \end{Bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & x_{a_1} \\ 1 & x_{a_2} \end{bmatrix}^{-1} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{Bmatrix} h_{a_1} \\ h_{a_2} \end{Bmatrix}$$

$$\frac{\partial}{\partial x} \begin{Bmatrix} h_{b_3} \\ h_{b_4} \end{Bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & x_{a_3} \\ 1 & x_{a_4} \end{bmatrix}^{-1} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{Bmatrix} h_{a_3} \\ h_{a_4} \end{Bmatrix}$$

Combining the deflections yields a partitioned form

$$\begin{Bmatrix} h_{b_1} \\ h_{b_2} \\ h_{b_3} \\ h_{b_4} \end{Bmatrix} = \left[\begin{array}{c|c} X_{12} & 0 \\ \hline 0 & X_{34} \end{array}\right] \begin{Bmatrix} h_{a_1} \\ h_{a_2} \\ h_{a_3} \\ h_{a_4} \end{Bmatrix}$$

The spanwise interpolation on the two spanwise lines gives

$$\begin{Bmatrix} h_{c_1} \\ h_{c_3} \end{Bmatrix} = \begin{bmatrix} 1 & y_{c_1} \\ 1 & y_{c_2} \end{bmatrix} \begin{bmatrix} 1 & y_{a_1} \\ 1 & y_{a_2} \end{bmatrix}^{-1} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{Bmatrix} h_{b_1} \\ h_{b_3} \end{Bmatrix}$$

$$= \left[Y_{13}\right] \begin{Bmatrix} h_{b_1} \\ h_{b_3} \end{Bmatrix}$$

on the forward line and

$$\begin{Bmatrix} h_{c_2} \\ h_{c_4} \end{Bmatrix} = \left[Y_{13}\right] \begin{Bmatrix} h_{b_2} \\ h_{b_4} \end{Bmatrix}$$

on the aft line. Combining the deflections leads to another partitioned form but also requires a row rearrangement matrix to order the $\{h_b\}$ properly

$$
\begin{Bmatrix} h_{c_1} \\ h_{c_2} \\ h_{c_3} \\ h_{c_4} \end{Bmatrix} = \left[\begin{array}{c|c} Y_{13} & 0 \\ \hline 0 & Y_{13} \end{array}\right] \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} h_{b_1} \\ h_{b_2} \\ h_{b_3} \\ h_{b_4} \end{Bmatrix}
$$

$$
= \left[Y\right] \left[R\right] \begin{Bmatrix} h_{b_1} \\ h_{b_2} \\ h_{b_3} \\ h_{b_4} \end{Bmatrix}
$$

The same procedure is used for the slopes. We note that Eqs. 3.37 and 3.38 must be generalized to include the row rearrangement matrix, and the formal equations for the real and imaginary parts of the substantial differentiation matrix become

$$
\left[W_R\right] = \left[C(y_c)\right] \left[T(y_a)\right]^{-1} \left[B(y_a)\right] \left[R\right] \left[C'(x_b)\right] \left[T(x_a)\right]^{-1} \left[B(x_a)\right]
$$

and

$$
\left[W_I\right] = (k_r/b_r) \left[C(y_c)\right] \left[T(y_a)\right]^{-1} \left[B(y_a)\right] \left[R\right] \left[C(x_b)\right] \left[T(x_a)\right]^{-1} \left[B(x_a)\right]
$$

where the format of each factor is illustrated in the above example.

THE INTEGRATION MATRIX [B]

The integration matrix converts the pressure distribution on each strip into an equivalent system of concentrated forces at the AIC control points by integrating the pressure spanwise and chordwise in the region of each AIC control point.

The integration of the pressure coefficient, Eq.3.2 in the region of the AIC point leads to the force

$$F_s = q \iint C_p (\xi , \eta) \, d\xi \, d\eta \qquad (3.39)$$

Letting $\eta = \cos \phi$ and $\xi = \cos \theta$ in Eqs. 3.2 and 3.7 we obtain

$$F_s = q_s^2 \sum \sum a_{nm} \int_{\theta_f}^{\theta_a} \int_{\phi_i}^{\phi_o} \sin^2\phi \, \sin \theta \, P_m (\eta) f_n (\xi) \, d\phi \, d\theta \qquad (3.39A)$$

where θ_f and θ_a denote the chordwise angular measure of the forward and aft locations, respectively, of the pressure region, and ϕ_i and ϕ_o denote the spanwise angular measure of the inboard and outboard end, respectively, of the strip. If we define the spanwise integral

$$I_m (\eta_i, \eta_o) = \int_{\phi_i}^{\phi_o} \sin^2\phi \, P_m (\eta) \, d\phi \qquad (3.39B)$$

and the chordwise integral

$$J_n (\tilde{\xi}_f, \tilde{\xi}_a) = \int_{\theta_f}^{\theta_a} \sin \theta \, f_n (\tilde{\xi}) \, d\theta \qquad (3.39C)$$

then the force from the nm mode is

$$F_{s_{nm}} = q s^2 \, a_{nm} I_m J_n \qquad (3.39D)$$

and in matrix form

$$F_s = q s^2 \left\lfloor I_m J_n \right\rfloor \left\{ a_{nm} \right\} \qquad (3.39E)$$

so that the integration matrix $\lfloor B \rfloor$ is given by

$$\lfloor B \rfloor = \left\lfloor I_m (\eta_i, \eta_o) J_n (\tilde{\xi}_f, \tilde{\xi}_a) \right\rfloor \qquad (3.39F)$$

The integrals are easily evaluated. Consider first the spanwise integration. In terms of the spanwise angular coordinate ϕ we note

$$P_o(\eta) = 1.0 \tag{3.40}$$

$$P_m(\eta) = \eta^2 \; U_{m-1}(\eta)$$

$$= \cos^2\phi \quad \sin m\phi / \sin\phi \, , \; 1 \leq m \tag{3.40A}$$

Then

$$I_o(\eta_i, \eta_o) = \int_{\phi_i}^{\phi_o} \sin^2\phi \; d\phi$$

$$= \tfrac{1}{2}\left(\cos^{-1}\eta_o - \cos^{-1}\eta_i - \eta_o \quad 1 - \eta_o^2 + \eta_i \quad 1 - \eta_i^2\right) \tag{3.40B}$$

For $m \geq 1$

$$I_m = \int_{\phi_i}^{\phi_o} \sin\phi \cos^2\phi \sin m\phi \; d\phi \tag{3.40C}$$

from which

$$I_1 = \int_{\phi_i}^{\phi_o} \sin^2\phi \cos^2\phi \; d\phi$$

$$= \tfrac{1}{4}\left[\eta_o (1 - \eta_o^2)^{3/2} - \eta_i (1 - \eta_i^2)^{3/2} + I_o\right] \tag{3.40C}$$

and for $m \cdot 1, \neq 3$,

$$I_m = \frac{1}{8}\Big\{\frac{1}{m-1}\Big|\sin(m-1)\phi_o - \sin(m-1)\phi_i\Big| \tag{3.40D}$$

$$- \frac{1}{m+1}\Big|\sin(m+1)\phi_o - \sin(m+1)\phi_i\Big|$$

$$+ \frac{1}{m-3}\Big|\sin(m-3)\phi_o - \sin(m-3)\phi_i\Big|$$

$$- \frac{1}{m+3}\Big|\sin(m+3)\phi_o - \sin(m+3)\phi_i\Big|\Big\}$$

NOTE: $\sin n\phi = 2\cos\phi \sin(n-1)\phi - \sin(n-2)\phi$ (3.40E)

so that $\sin n\phi_o = 2\eta_o \sin(n-1)\phi_o - \sin(n-2)\phi_o$

and $\sin n\phi_i = 2\eta_i \sin(n-1)\phi_i - \sin(n-2)\phi_i$

Finally,

$$I_3 = 3I_1 - \frac{2}{3}\left[\eta_o(1-\eta_o^2)^{5/2} - \eta_i(1-\eta_i^2)^{5/2}\right] \tag{3.40D}$$

$$- \left\{\frac{1}{4}\cos^{-1}\eta_o - \frac{1}{4}\cos^{-1}\eta_i - \frac{1}{4}\left(\eta_o\sqrt{1-\eta_o^2} - \eta_i\sqrt{1-\eta_i^2}\right)\right.$$

$$\left. - \frac{1}{6}\left[\eta_o(1-\eta_o^2)^{3/2} - \eta_i(1-\eta_i^2)^{3/2}\right]\right\}$$

Consider next the chordwise integral. In terms of the chordwise angular coordinate ϕ we note

$$f_o(\tilde{\xi}) = \frac{1-\cos\phi}{\sin\phi} \tag{3.41}$$

$$f_n(\tilde{\xi}) = \sin n\phi, \; n \geq 1 \tag{3.42}$$

$$J_o(\tilde{\xi}_{f1}, \tilde{\xi}_a) = \int_{\phi_f}^{\phi_a} (1-\cos\phi)\, d\phi \tag{3.43}$$

$$= \cos^{-1}\tilde{\xi}_a - \cos^{-1}\xi_f - \sqrt{1-\tilde{\xi}_a^2} + \sqrt{1-\tilde{\xi}_f^2}$$

For $n > 1$

$$J_n = \frac{1}{2(n-1)}\left[\sin(n-1)\phi_a - \sin(n-1)\phi_f\right] \tag{3.44}$$

$$- \frac{1}{2(n+1)}\left[\sin(n+1)\phi_a - \sin(n+1)\phi_f\right]$$

and for $n = 1$

$$J_1 = \frac{1}{2}\left[\cos^{-1}\tilde{\xi}_a - \cos^{-1}\tilde{\xi}_f - \tilde{\xi}_a\sqrt{1-\tilde{\xi}_a^2} + \tilde{\xi}_f\sqrt{1-\tilde{\xi}_f^2}\right] \tag{3.45}$$

To illustrate the format of $[B]$ consider the s^{th} strip

$$[B_s] = \begin{bmatrix} I_m(\eta_s)\,J_n(\tilde{\xi}_1) \\ I_m(\eta_s)\,J_n(\tilde{\xi}_2) \\ I_m(\eta_s)\,J_n(\tilde{\xi}_{NC}) \end{bmatrix} \tag{3.46}$$

where η_s denotes the midpoint of the s^{th} strip, and $\tilde{\xi}_1$, $\tilde{\xi}$, ..., $\tilde{\xi}_{NC}$ denote the first through NC chordwise forces on the strip. Generalizing to NS strips and illustrating the dependence on n and m we have

$$[B] = \tag{3.47}$$

$$\begin{bmatrix} I_o(\eta_1)\,J_o(\tilde{\xi}_1) & I_1(\eta_1)\,J_1(\tilde{\xi}_1) \;\ldots\ldots\; I_{NS}(\eta_1)\,J_{NS}(\tilde{\xi}_1) \\ I_o(\eta_1)\,J_o(\tilde{\xi}_2) & I_1(\eta_1)\,J_1(\tilde{\xi}\;) \\ & \\ I_o(\eta_1)\,J_o(\tilde{\xi}_{NC}) & I_1(\eta_1)\,J_1(\tilde{\xi}_{NC}) \\ I_o(\eta_2)\,J_o(\tilde{\xi}_1) & I_1(\eta_2)\,J_1(\tilde{\xi}_1) \\ & \\ I_o(\eta_2)\,J_o(\tilde{\xi}_{NC}) & I_1(\eta_2)\,J_1(\tilde{\xi}_{NC}) \\ & \\ I_o(\eta_{NS})\,J_o(\tilde{\xi}_1) & I_1(\eta_{NS})\,J_1(\tilde{\xi}_1) \\ & \\ I_o(\eta_{NS})\,J_o(\tilde{\xi}_{NC}) & I_1(\eta_{NS})\,J_1(\tilde{\xi}_{NC}) \qquad I_{NS}(\eta_{NS})\,J_{NS}(\tilde{\xi}_{NC}) \end{bmatrix}$$

DERIVATION OF SONIC AND SUPERSONIC AERODYNAMIC INFLUENCE COEFFICIENTS

The supersonic Mach box method was developed by Zartarian and Hsu[4] and extended to intersecting planar lifting surfaces by Moore and Andrew[5]. The sonic box method was developed by Rodemich and Andrew[6]. A further extension to the wing-tail combination was made by Moore and Park[2] and refined by Andrew[3]. (NOTE: These references are outlined in Part I, Section A for the sonic case, and in Part VI, Section A for the supersonic case.

The box methods lead to the velocity potentials whose streamwise substantial derivative gives the pressure coefficient. The solution for the velocity potentials may be written [cf. Eq. (7)]

$$\{\phi\} = \left[A_{M\geq 1}\right] \{w/V\} \tag{3.48}$$

The pressure coefficients are given by

$$\left\{C_p\right\} = (2/a\ M) \left[W_a\right] \left\{\phi\right\} \tag{3.49}$$

where $\left[W_a\right]$ is the substantial derivative evaluated at the box centers. Since the boxes are all small the aerodynamic force on the boxes are approximately given by the product of the box pressure and its area. The forces on a strip (assumed to be narrow) are regarded as acting at the strip centerline and at the chordwise centerline of each spanwise line of boxes, and are found by summing spanwise the contribution of each box to the strip.

$$\left\{F_a\right\} = q\ [A]\ \left\{C_p\right\} \tag{3.50}$$

The elements of the diagonal area matrix $\left[A\right]$ consist of the appropriate box area or fractions thereof lying on the strip from each spanwise line of boxes.

The box forces are converted into AIC control point forces by the static equivalence of the box forces in the region of each control point, i.e., the control points are assumed to be connected by a series of simple beams, hinged at each control point, so that the AIC control point forces are the reactions to the box forces distributed along the series of beams. This leads to approximate generalized forces since this method of representing the chordwise deflections is not consistent with that used in the $\left[W\right]$ matrix. However, it leads to a more physically meaningful distribution of AIC forces, and the resulting approximation to the generalized forces in an arbitrary vibration mode is sufficiently accurate. Denoting the statically equivalent transformation matrix by $\left[T\right]$ we have the AIC forces

$$\left\{F\right\} = \left[T\right] \left\{F_a\right\} \tag{3.51a}$$

$$= q \left[T\right] \left[A\right] \left\{C_p\right\} \tag{3.51b}$$

If the foregoing equations are combined, including Eq. 3.8, the AIC control forces are related to the control point deflections through

$$\left\{F\right\} = (2q/a\ M) \left[T\right] \left[A\right] \left[W_a\right] \left[A_{M \geq 1}\right] \left[W\right] \left\{h\right\} \tag{3.52}$$

and leads to the AIC's by comparison with Eq. 3.1.

$$\left[C_h\right] = (1/a\ M\ k_r^2 s) \left[T\right] \left[A\right] \left[W_a\right] \left[A_{M \geq 1}\right] \left[W\right] \tag{3.53}$$

PART IV - SECTION A

TECHNICAL DISCUSSION OF THE SUBSONIC KERNEL FUNCTION METHOD

INTRODUCTION

In defining aerodynamic influence coefficients, the aerodynamic loads are first derived by the well documented "Kernel function" method, and the resulting loads are then converted to aerodynamic influence coefficients. The procedure followed uses results from any of the pertinent papers, and extends the analysis to cover the problem of tandem surfaces.

The first published numerical procedure for solving the subsonic pressure distribution problem for isolated planar lifting surfaces undergoing simple harmonic motion was developed at NASA's Langley Research Center by Watkins, Runyan, and Woolston (Reference 1). Hsu (Reference 7) significantly advanced the logical development of the method when he established an optimum set of collocation and integration points. Rodemich (Reference 8), and later Landahl (Reference 9), have presented expressions for the kernel that are very much simpler than those previously used, and they take less time to evaluate. A further advance was made by Rodden and Revell (Reference 10), who described the matching of the boundary conditions with the least squared error. Rowe (Reference 11) has shown that to obtain sufficiently accurate results using Hsu's procedure, an extremely large number of collocation points must be used and when this is done, using the spanwise pressure function that Hsu and Watkins used, the downwash matrix becomes ill-conditioned. Rowe overcame this problem by using a Fourier series for the spanwise pressure function.

The present method uses Hsu's set of collocation points, Rodemich's expression for the kernel, Rodden and Revell's idea for matching the boundary conditions, and, like Rowe does, it uses an orthogonal set of functions for the spanwise pressure function. However, the present method utilizes these developments in a way that has not been previously published. The techniques employed result in speeds and accuracy not previously attained.

TANDEM SURFACE VIBRATION IN SUBSONIC FLOW

The method presented herein was developed for application to a missile with a very low aspect ratio, trapezoidal wing and a downstream rectangular control surface lying in the wake of the wing.
The diameter of the body of the missile is considered large enough to act as a reflection plane for acoustic signals that emanate from points on the lifting surfaces.

The problem to be considered is that of determining the air loads on the wing and control surface which are induced by a simple harmonic motion. The surrounding fluid is assumed to be compressible, inviscid isentropic, and irrotational. The perturbation potential is used, and the problem is further linearized by applying boundary conditions at the mean ($z = 0$) surface. Thickness effects are ignored. With these hypothesis, it is well known that an integral relation exists between the pressure discontinuity over the surface $z = 0$ and the downwash over the same plane. If the downwash and pressure difference are representable in the form

$$\begin{aligned} W_1 (x, y, 0, t) &= W (x, y) e^{i\omega t} \\ \Delta P_1 (x, y, 0, t) &= \Delta P (x, y) e^{i\omega t} \end{aligned} \qquad (4.1)$$

The integral relation becomes

$$\frac{W(x, y)}{U} = -\frac{1}{8\pi} \not\!\!\iint \frac{\Delta P(\xi, \eta)}{\frac{1}{2}\rho U^2} K\left(\frac{\omega}{U}, M, x-\xi, y-\eta\right) d\xi \, d\eta \qquad (4.2)$$

The integral extends over the plane $z = 0$, but the integrand is zero except over the wing and control surface. The kernel function K is strongly singular and integration in a spanwise direction requires the use of the finite part concept. This is indicated by the cross on the integration sign. Equation (4.2) then represents the integral equation of the system wherein, given W (x, y) over the wing and control surface, ΔP must then be determined.

The function $K\,(k, M, x-\xi\,, y-\eta\,)$ is represented here in the form

$$K\left(\frac{\omega}{U}, M, x-\xi\,, y-\eta\,\right) = e^{-i\frac{\omega}{U}(x-\xi\,)}\,\frac{K_1}{(y-\eta\,)^2} \qquad (4.3)$$

where

$$K_1 = -k_1\,K_1\,(k_1) - \frac{(x-\xi\,)}{R}\,e^{-i\,k_1\,u_1} + i\,k_1\int_0^1 \frac{W\,e^{-k_1W}}{\sqrt{1-W^2}}\,dW + i\,k_1\int_0^{u_1}\frac{u\,e^{-i\,k_1\,u}}{\sqrt{1+u^2}}\,du \qquad (4.4)$$

and $R = \sqrt{(x-\xi\,)^2 + \beta^2\,r_1^{\;2}}$

$r_1 = |y-\eta|$

$k_1 = \dfrac{\omega\,r_1}{U}$

$u_1 = \dfrac{MR-(x-\xi\,)}{\beta^2\,r_1}$

M = Mach number

$\beta^2 = 1 - M^2$

$K_1\,(k_1)$ is the modified Bessel function of the second kind of order one and argument k_1.

This form for the kernel function has been used in References 8 and 9. While it is not identical to that of Reference 1, it may be obtained directly from that equation by substitution of the integral representation of the modified Bessel and Struve functions. The second order singularity in the spanwise variable in Equation (4.3) requires the use of the "finite part" technique of Hadamard.

PRESSURE DISTRIBUTION

As in many earlier studies, the pressure distribution is approximated as the sum of a series of functions which have the proper behavior as inferred from steady state and two-dimensional solutions. This behavior includes a Kutta condition at the trailing edge, a square root singularity at the leading edge, and a half ordered zero at the top for each surface. The pressure distribution on each surface is then approximated in the form

$$\frac{\overline{\Delta p}(\xi, \eta)}{\frac{1}{2}\rho U^2} = \frac{\sqrt{s^2 - \eta^2}}{b(\eta)} \sum_{n=0}^{N} \sum_{m=0}^{M} a_{nm} P_m(\underline{\eta}) f_n(\tilde{\xi}) \qquad (4.5)$$

where

$$f_o(\tilde{\xi}) = \sqrt{\frac{1 - \tilde{\xi}}{1 + \tilde{\xi}}} \qquad f_n(\tilde{\xi}) = \sqrt{1 - \tilde{\xi}^2}\, U_{n-1}(\tilde{\xi});\ 1 \le n$$

$$P_o(\underline{\eta}) = 1.0 \qquad P_m(\underline{\eta}) = \underline{\eta}^2\, U_{m-1}(\underline{\eta});\ 1 \le m$$

$$U_o(x) = 1.0$$

$$U_1(x) = 2x \qquad (4.6)$$

$$U_k(x) = 2xU_{k-1}(x) - U_{k-2}(x);\ 2 \le k$$

$$\tilde{\xi} = \frac{\xi - \bar{\xi}}{b(\eta)} \quad \text{and} \quad \bar{\xi} = \frac{1}{2}(\xi_{l.e.} + \xi_{t.e.})$$

$$\underline{\eta} = \frac{\eta}{s}$$

The functions U_n are Chebyshev Polynomials and are introduced for purposes of convenience.

For a trapezoidal wing, the lines $\tilde{\xi}$ = constant and $\underline{\eta}$ = constant are not orthogonal. This transformation maps each surface into a square in its ($\tilde{\xi}$, $\underline{\eta}$) plane.

The fundamental integral Equation (4.2) is inverted by substituting Equation (4.5) into Equation (4.1), and determining the coefficient a_{nm} so that Equation (4.2) is equilibrated at a designated set of collocation points. This equilibrium is represented schematically in the form

$$\begin{Bmatrix} \left\{ \frac{W^{W}}{U} \right\} \\ \\ \left\{ \frac{W^{C}}{U} \right\} \end{Bmatrix} = \begin{bmatrix} D^{ww}_{nm} & D^{wc}_{nm} \\ \\ D^{cw}_{nw} & D^{cc}_{nm} \end{bmatrix} \begin{Bmatrix} \left\{ a_{nm}{}^{(w)} \right\} \\ \\ \left\{ a_{nm}{}^{c} \right\} \end{Bmatrix} \qquad (4.7)$$

The left hand side of Equation (47) represents the prescribed downwash at the chosen set of collocation points. D_{nm} a_{nm} is the effect on downwash of the corresponding term in the pressure series expansion. The superscripts W and C designate wing and control surface, respectively. The left superscript on the D's indicate the surface on which the collocation point is located, the right superscript, the surface over which the integral is taken. Then D_{nm} (x, y) is given by

$$D_{nm}(x,y) = -\frac{s^2}{8\pi} \int_{-1}^{1} \sqrt{1-\underline{\eta}^2}\; P_m(\underline{\eta}) \int_{-1}^{1} f_n(\tilde{\xi})\, \frac{K_1(x-\xi,\ y-\eta)}{(y-\eta)^2}\, d\xi d\underline{\eta} \qquad (4.8)$$

The integrals involved in Equation (4.8) are evaluated by following the methods of Hsu. In this procedure, the Gauss-Mehler quadrature is used, and the collocation points are selected by a method which is analogous to using the Gauss-Mehler quadrature on the inverse problem.

In brief, this technique is concerned with a numerical evaluation of an integral in the form

$$\int^{b} W(x)\ f(x)\ dx = \sum_{j=1}^{n} H_j\ f(x_j)$$

Where $W(x)$ is a given weighting function, $f(x)$ an arbitrary function, and H_i are weighting numbers. The first choice of points X_i is taken to be that corresponding to which the approximate integration would be exact for a polynomial of degree less than or equal to $2n-1$. The integration points and weighting numbers are listed in Kopel (Reference 12) page 283. They are; for

$$W(x) = (1-x)^{\alpha}(1+x)^{\beta} \qquad (\alpha,\beta) = \pm \tfrac{1}{2}) \quad (a,b) = (-1,+1)$$

$$\begin{aligned}
&\alpha = \beta = \tfrac{1}{2} && x_j = \cos\left(\frac{\pi j}{n+1}\right), && H_j = \frac{\pi(1-x_j^2)}{n+1}\\
&\alpha = \beta = -\tfrac{1}{2} && x_j = \cos\left(\frac{2j-1}{2n}\right)\pi, && H_j = \frac{\pi}{n}\\
&\alpha = -\beta = \tfrac{1}{2} && x_j = \cos\frac{2\pi j}{2n+1}, && H_j = \frac{2\pi(1-x_j)}{2n+1}\\
&\alpha = -\beta = -\tfrac{1}{2} && x_j = \cos\frac{(2j-1)\pi}{2n+1}, && H_j = \frac{2\pi(1+x_j)}{2n+1}
\end{aligned} \tag{4.9}$$

where $j = 1, 2, \ldots, n$

The inner integral of Equation (4.8) is then evaluated by using the third of Equation (4.9), With the previously defined notation then

$$\int_{-1}^{+1} \sqrt{\frac{1 - \tilde{\xi}}{1 + \tilde{\xi}}} F_n(\tilde{\xi}) d\tilde{\xi} = \frac{2\pi}{2L + 1} \sum_{k=1}^{L} H_k F_n(\tilde{\xi}_k) \tag{4.10}$$

where $H_k = 1 - \tilde{\xi}_k$

$$\tilde{\xi}_k = -\cos\left(\frac{2k - 1}{2L + 1}\pi\right)$$

Hsu pointed out that if the collocation points are interdigitated according to the formula

$$\tilde{x}_i = -\cos\left(\frac{2j}{2L + 1}\pi\right)$$

the inner integral is evaluated with the least squared error by Equation (4.10).

This minimization was of course achieved for a single surface, but the convention was retained for the tandem surface model.

Hsu did not take advantage of the fact that the number of collocation points does not need to be as great as the number of integration points. In the present method the computer program user may specify the number of integration points to be any positive integer times the number of chordwise collocation points, so long as the number of integration points is 40 or less. Sixteen, or more, chordwise integration points are recommended. Accurate results can be assured only if the user specified a sufficient number of quadrature points for the integral.

Substitution of Equation (4.10) into Equation (4.8) gives

$$D_{nm} = \frac{-s^2}{8\pi} \oint_{-1}^{+1} \frac{\sqrt{1-\eta^2}}{(y-\eta)^2} G_{nm}(x, y-\eta)\, d\eta \qquad (4.11)$$

where

$$G_{nm} = \frac{2\pi}{2L+1} P_m(\eta) \sum_{k=1}^{L} (1-\tilde{\xi}_k^{\,2})\, U_{n-1}(\tilde{\xi}_k)\, K_1(x-\xi_k,\, y-\eta);\ 1 \le n$$

The integral for D_{nm} is singular. The Gauss-Mehler technique is again followed. This time the first of Equations (4.9) is used to perform the integration, and the finite part modification is introduced. With these constraints, Hsu has shown that the evaluation for D_{nm} becomes

$$D_{nm} = -\frac{1}{8\pi}\left\{\frac{\pi S^2}{M+1} \sum_{p=1}^{M+1} \frac{(1-\eta_p)^2}{(y-\eta_p)^2}\, G_{nm}(x, y-\eta_p) - \pi(M+1)\, G_{nm}(x,0)\right\}$$

and

$$G_{nm}(x, 0) = -2\int_{-1}^{x} P_m(y) f_n(\tilde{\xi}) e^{-i\frac{\omega}{U}(x - \xi)} d\tilde{\xi}$$

When the collocation point lies on the control surface this integral is taken over the wing, from the leading edge ($\tilde{\xi} = -1$) to the trailing edge ($\tilde{\xi} = +1$), and over the control surface, from the leading edge to the collocation point ($\tilde{\xi} = x$). The integrand of this expression does not vary widely over the region of integration and is evaluated with sufficient accuracy by a six-point quadrature formula. It has been made a part of the computer program and may not be controlled by the user.

PART IV - SECTION B

SUBSONIC AIC COMPUTER PROGRAM DESCRIPTION

A FORTRAN IV computer program is presented which computes subsonic unsteady aerodynamic influence coefficients for a variety of tandem coplanar lifting surface configurations. The computer solution is based on a kernel function formulation which satisfies the linearized equations of motion of an inviscid, isentropic, compressible and irrotational fluid. The analysis is extended to include interaction effects between tandem surfaces and wake effects on the trailing surface.

The various configurations which can be analyzed are shown in Figure 4.1. The vehicle body is considered as a reflection plane for acoustic signals emanating from the aerodynamic surfaces thereby giving the surfaces a plane of symmetry, parallel to the free-stream flow. The upstream surface (wing) must have an unswept trailing edge and the rectangular trailing surface must have the same spanwise dimension as the trailing edge of the wing. The downstream surface lies in the wake of the wing; any non-negative value may be used for the gap dimension. A single surface cannot be analyzed, however, an option is provided which eliminates interaction effects. Thus it is possible to generate AIC's for individual surfaces isolated from disturbances in the flow field.

The program allows up to 40 AIC control points, 20 per surface. The AIC stations must satisfy the following requirements:

(1) Both surfaces must have the same number of spanwise rows of control points. The chordwise location of respective rows on the surfaces need not be the same.

(2) The chordwise rows must be parallel to the flow stream.

(3) The chordwise rows on a surface must have the same number of control points.

(4) The control points in each spanwise row must have the same fractional chord location.

(5) The minimum number of chordwise or spanwise control points for a surface is two and the maximum number is ten.

(6) The origin for the AIC station coordinates and the geometric coordinates for the planform must be at the leading edge root of the wing.

Examples of acceptable AIC control point patterns for the subsonic program are illustrated in Figure 4.2.

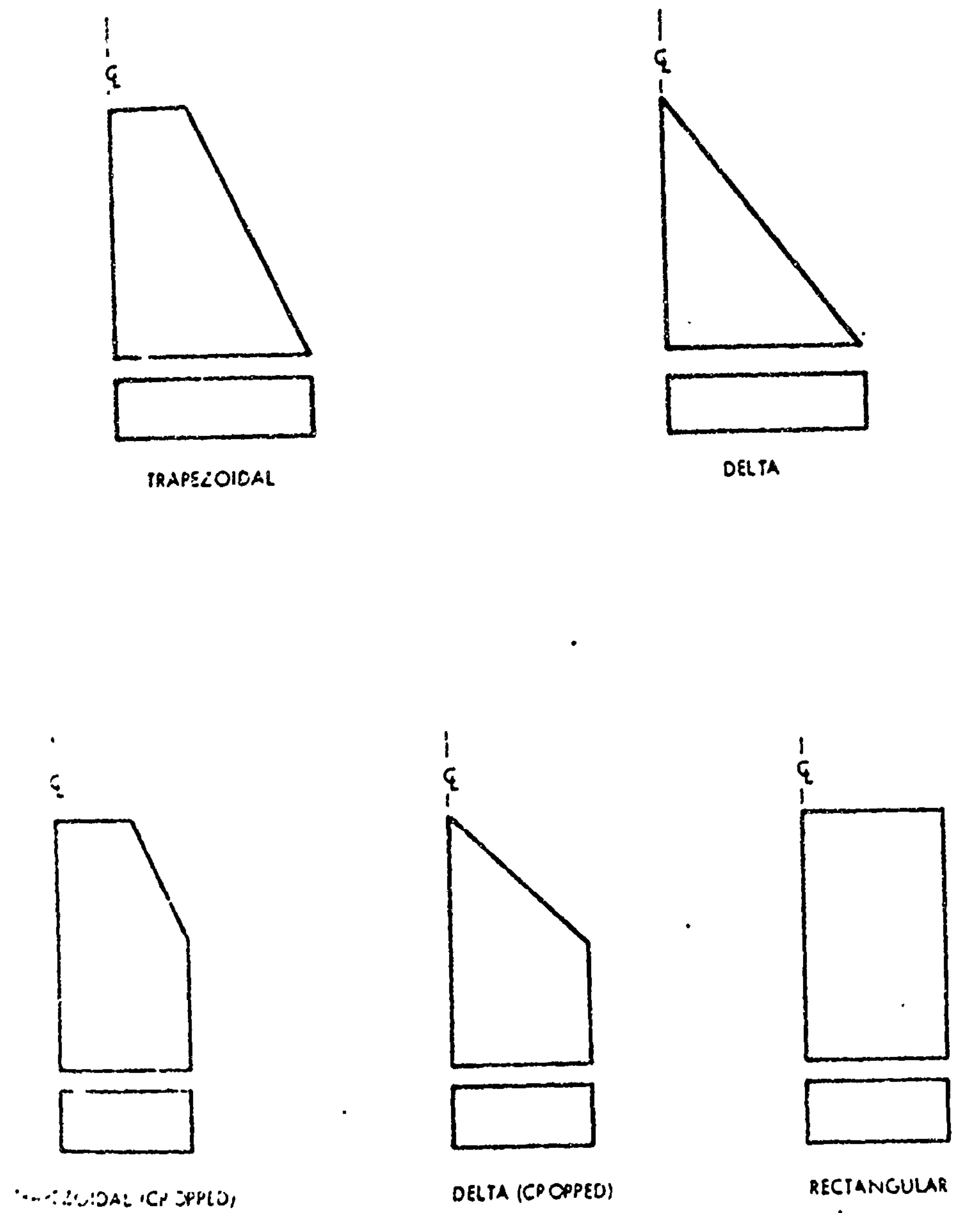


FIGURE 4.1 - TANDEM COPLANAR CONFIGURATIONS AT SUBSONIC MACH NUMBER

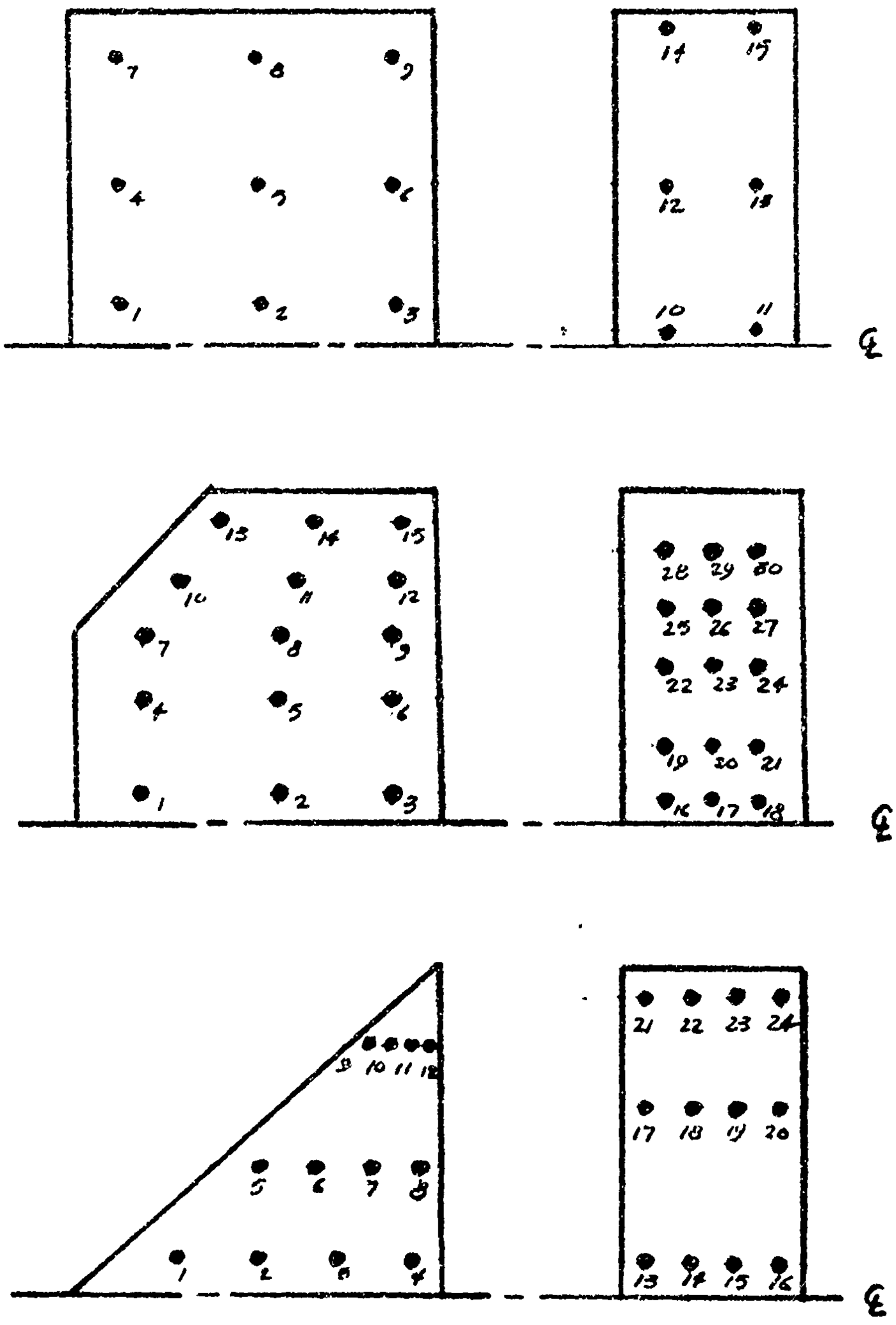


FIGURE 4.2 - EXAMPLES OF ACCEPTABLE AIC CONTROL POINT PATTERNS FOR THE SUBSONIC PROGRAM

The computer program consists of a main program (MAIN) and 24 subroutines and functions subprograms. Execution begins with MAIN calling KFDA which reads input data and stores this information in core. The program then calls TRAMP which generates the substantial derivative matrix, $\left[W\right]$. The $\left[W\right]$ matrix serves two functions. It relates the collocation stations of the unsteady aerodynamics to the control stations of the AIC matrix and it serves as a substantial derivative operator. Subroutines called by TRAMP are CMAT, SMAT, TMAT, BMAT, RMAT and MINV.

The next item computed is the kernel function matrix, $\left[D\right]$. The subroutine CORD is called for each unsteady aerodynamic collocation station and constructs the kernel function matrix which is dependent only on the relative location of the collocation stations and the Mach number-reduced frequency combination.

The pressure coefficients $\left\{a_{nm}\right\}$ are found from the relation

$$\left\{a_{nm}\right\} = \left[D\right]^{-1} \left[W\right]$$

The program has been written such that the number of spanwise and chordwise pressure coefficient terms and the number of spanwise and chordwise collocation stations for the unsteady aerodynamics matches the respective number of AIC control points on each surface. Thus the Kernel function matrix is square and its inverse is computed directly. The subroutines employed for this operation are CGRED and XLSQ.

After deriving the pressure coefficients, the pressure terms are integrated spanwise and chordwise to obtain the force acting at each AIC control station. The resulting matrix, after it is multiplied by a non-dimensionalizing factor, is the final AIC matrix, $\left[C_h\right]$. By definition the AIC matrix relates forces to displacements through the equation

$$\left\{F\right\} = \rho\omega^2 b_r^2 s \left[C_h\right] \left\{h\right\}$$

The semi-chord of the wing root is used as the reference chord, b_r. s is the semi-span of the wing (and tail) and ω is the oscillatory frequency in radians/sec. This final phase of the subsonic AIC development uses the subroutines AICS, FORCE, ARCCOS, MINTS, and MINTC.

1.0 PROCESSING REQUIREMENTS

The input and output files used by the program are 05 and 06, respectively. All read and write statements are contained in the main program (MAIN) and the subroutines KFDA and KOUT. Peripheral tape and disc units are not used by the program. Approximately 40,000 cells of core storage is required. A standard input form of six 12-column fields per card is used by the program. Floating point numbers (6E12.5 format) may lie anywhere within the appropriate field, but fixed point numbers (6I12 format) must be right adjusted. Detailed instructions for data input are given and listings of data for sample problems are provided.

2.0 INPUT INSTRUCTIONS

Instructions for preparing input data for the subsonic AIC computer program are presented here. The field location and format for each input quantity is specified. Any set of units may be used for geometric dimensions and acoustic velocity as long as they are consistent, e.g., if feet is used for length then the acoustic velocity must have dimensions of feet per second.

1. Streamwise Coordinates (6E12.5 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	X(1)	X(2)	X(3)	X(4)	X(5)	
Item	(1)	(2)	(3)	(4)	(5)	

(1) X(1) Wing root leading edge streamwise coordinate
(2) X(2) Wing tip leading edge streamwise coordinate
(3) X(3) Wing trailing edge streamwise coordinate
(4) X(4) Control surface leading edge streamwise coordinate
(5) X(5) Control surface trailing edge streamwise coordinate

The technique for generating various configurations is shown in Table 4.1.

The origin for the planform and AIC station coordinates must be at the leading edge root of the wing therefore X(1) and Y(1), described below, must always be 0.0.

2. Spanwise Coordinates and Acoustic Velocity (6E12.5 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	Y(1)	Y(2)	Y(3)	SOUND		
Item	(1)	(2)	(3)	(4)		

(1) Y(1) Wing root spanwise coordinate
(2) Y(2) Wing leading edge spanwise coordinate
(3) Y(3) Wing (and control surface) tip spanwise coordinate
(4) SOUND Acoustic velocity for altitude at which analysis is performed

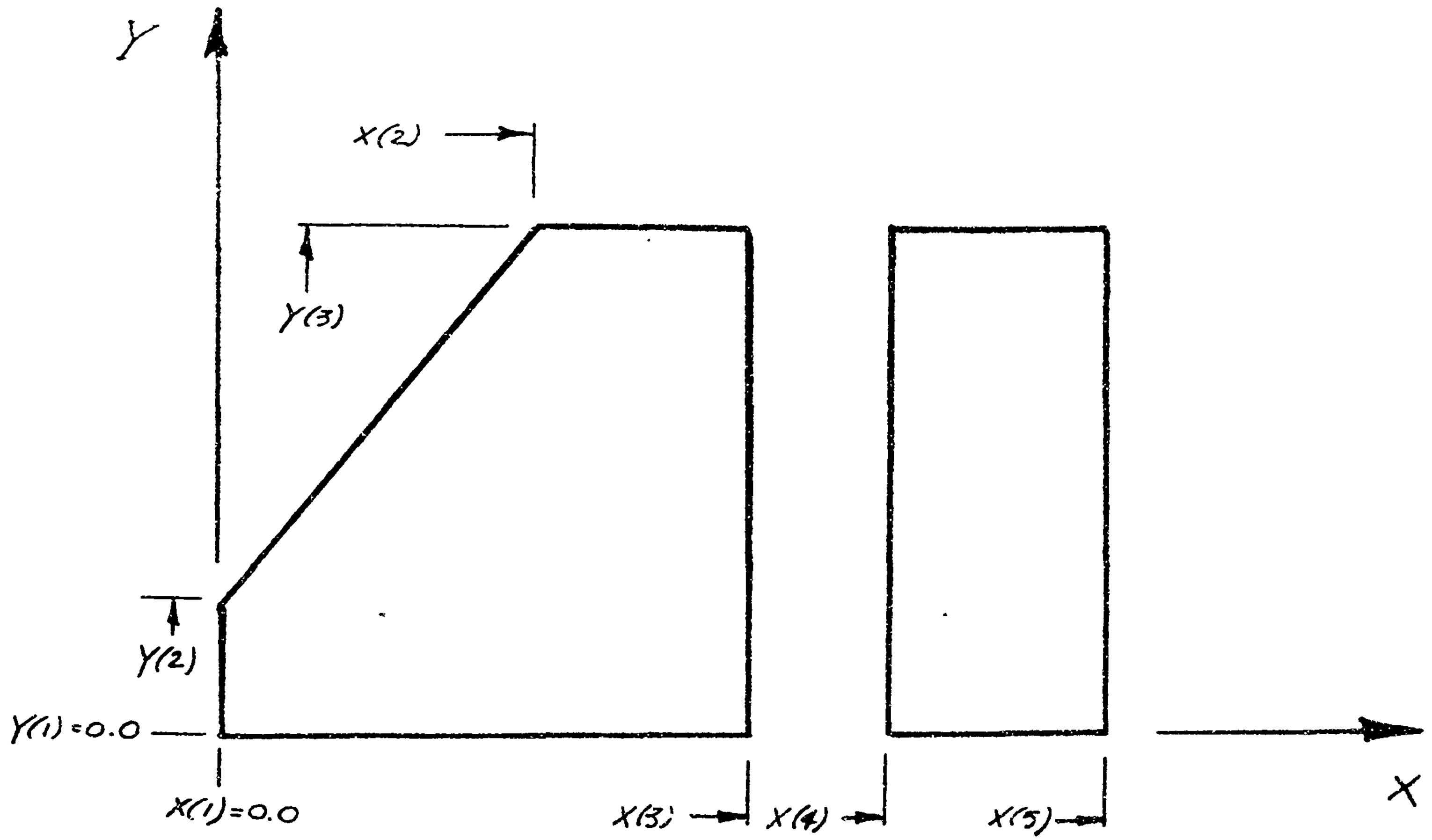


FIGURE 1.3 – GEOMETRY DESCRIPTION

TABLE 4.1 - OPTIONAL CONFIGURATIONS

Configuration	Chordwise Coordinates	Spanwise Coordinates
Rectangular	X(1) = 0.0 X(2) = 0.0 X(3) > 0.0 X(4) > X(3) X(5) > X(4)	Y(1) = 0.0 Y(2) = 0.0 Y(3) > 0.0
Delta	X(1) = 0.0 X(2) > 0.0 X(3) = X(2) X(4) > X(3) X(5) > X(4)	Y(1) = 0.0 Y(2) = 0.0 Y(3) > 0.0
Trapezoidal	X(1) = 0.0 X(2) > 0.0 X(3) = X(2) X(4) > X(3) X(5) > X(4)	Y(1) = 0.0 Y(2) > 0.0 Y(3) > Y(2)
Trapezoidal (Cropped)	X(1) = 0.0 X(2) > X(1) X(3) > X(2) X(4) > X(3) X(5) > X(4)	Y(1) = 0.0 Y(2) > 0.0 Y(3) > Y(2)
Delta (Cropped)	X(1) = 0.0 X(2) > 0.0 X(3) > X(2) X(4) > X(3) X(5) > X(4)	Y(1) = 0.0 Y(2) = 0.0 Y(3) > Y(2)

3. General Information (6I12 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	NMACH	KF	NFREQ	LCOLL	LPUNCH	
Item	(1)	(2)	(3)	(4)	(5)	

(1) NMACH Number of Mach numbers (max. 6)

(2) KF Option to input either frequencies or reduced frequencies:
KF = 0 frequencies
KF = 1 reduced frequencies

(3) NFREQ Number of frequencies or reduced frequencies at each Mach number (max. 10)

(4) LCOLL Option to print aerodynamic and AIC collocation station coordinates:
LCOLL = 0 do not print
LCOLL = 1 print collocation station coordinates

(5) LPUNCH Option to punch AIC matrix on cards:
LPUNCH = 0 do not punch
LPUNCH = 1 punch AIC matrix for wing only
LPUNCH = 2 punch AIC matrix for control surface only
LPUNCH = 3 punch individual AIC matrix for wing and control surface
LPUNCH = 4 punch total AIC matrix of combined wing and control surface

The AIC matrix is punched by rows with a 1P6E12.5 format. Each row of the matrix begins on a new card.

4. General Information (6I12 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	NWCX	NCCX	NIONCX	NIY	ISOLAT	
Item	(1)	(2)	(3)	(4)	(5)	

(1) NWCX Number of chordwise collocation stations on wing ($2 \le NWCX \le 10$)

(2) NCCX Number of chordwise collocation stations on control surface ($2 \le NCCX \le 10$)

(3) NIONCX Factor for number of chordwise integration stations. Set NIONCX such that NIONCX*NWCX and NIONCX*NCCX are greater than 15 (but less than 40) to insure sufficient quadrature points for accurate integration of the Kernel function. If AIC's are desired for, say, the wing only, set NIONCX such that NIONCX*NWCX is greater than 15 and set NCCX equal to 2 to minimize computing time.

(4) NIY Number of spanwise collocation stations (wing and control surface)

(5) ISOLAT Option to isolate wing and control surface:
ISOLAT = 0 interference and gap effects considered
ISOLAT = 1 surfaces are isolated. AIC's will be for individual surfaces with no coupling effects.

5. Mach Numbers (6E12.5 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	FMACH(1)	FMACH(2)	FMACH(3)	FMACH(4)	FMACH(5)	FMACH(6)
Item	(1)	(2)	(3)	(4)	(5)	(6)

(1) FMACH (1) Mach number

(2) FMACH (2) Mach number

. . . .
. . . .
. . . .

(NMACH) FMACH(NMACH) Mach number

NMACH values of Mach number must be input (see Part 3, Item 1). Mach numbers must be greater than zero and less than 0.95.

6. Frequencies or Reduced Frequencies (6E12.5 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	FREQ(1)	FREQ(2)	FREQ(3)	FREQ(4)	FREQ(5)	FREQ(6)
Item	(1)	(2)	(3)	(4)	(5)	(6)

If KF=0, input NFREQ values of frequency (cps). If KF=1, input NFREQ values of reduced frequency ($k_r = \omega b_r/U$ where b_r = semi-chord of wing root, U = free stream velocity, and ω = oscillatory angular frequency in radians/sec). Frequencies (and reduced frequencies) may not be zero.

(1) FREQ(1) f(cps) or k_r

(2) FREQ(2) "

. . . "

. . . "

. . . "

(NFREQ) FREQ(NFREQ)

For NFREQ > 6, continue input on new card.

7. Spanwise Location of AIC Stations on Wing (6E12.5 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	YAIC(1,W)	YAIC(2,W)	YAIC(3,W)	YAIC(4,W)	YAIC(5,W)	YAIC(6,W)
Item	(1)	(2)	(3)	(4)	(5)	(6)

(1) YAIC(1,W) Spanwise coordinate of first row of AIC collocation stations on wing.

(2) YAIC(2,W) Spanwise coordinate of second row of AIC collocation stations on wing.

. . .

. . .

. . .

(NIY) YAIC(NIY,W) Spanwise coordinate of last row of AIC collocation stations on wing

Collocation station rows are numbered from root to tip. For NIY > 6, continue input of YAIC (7,W) to YAIC(NIY,W) on new card(s).

8. Spanwise Location of AIC Stations on Control Surface (6E12.5 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	YAIC(1,CS)	YAIC(2,CS)	YAIC(3,CS)	YAIC(4,CS)	YAIC(5,CS)	YAIC(6,CS)
Item	(1)	(2)	(3)	(4)	(5)	(6)

(1) YAIC(1,CS) Spanwise coordinate of first row of AIC collocation stations on control surface.

(2) YAIC(2,CS) .... second.........

. . . .

. . . .

. .. . .

(NIY) YAIC(NIY,CS) .... last...........

Collocation station rows are numbered from root to tip. If NIY > 6, continue input of YAIC(7,CS) to YAIC(NIY,CS) on new card(s).

9. Streamwise Location of AIC Stations on Wing (6E12.5 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	XATC(W,1,1)	XAIC(W,1,2)	XAIC(W,1,3)	...	...	...
Item	(1)	(2)	(3)	(4)	(5)	(6)

(1) XAIC(W,1,1) Streamwise coordinate of first AIC collocation station in first row on wing.

(2) XAIC(W,1,2) .... second.........

. . . .

. . . .

(NXWING*NYWING)
XAIC(W,NYWING,NXWING)..................... last........last row.....

Streamwise numbering sequence if from leading edge to trailing (see Figure 4.2). Continue input of values for each row immediately after the last value of the preceding row, do not begin input of each new row on new card.

10. Chordwise Location of AIC Stations on Control Surface (6E12.5 format)

Column	1-12	13-24	25-36	37-48	49-60	61-72
Name	XAIC(CS,1,1)	XAIC(CS,1,2)	XAIC(CS,1,3)	...	...	...
Item	(1)	(2)	(3)	(4)	(5)	(6)

Procedure to input streamwise coordinate location of AIC stations on control surface is the same as wing.

3.0 Sample Problems

Three sample problems are given to demonstrate the operation of the subsonic AIC program and to illustrate the options available. Trapezoidal, cropped trapezoidal, and delta configurations are analyzed. Explanation of input parameters and computer listings of input data cards and computer output are given for each problem.

Sample Problem 1

A cropped Delta wing-rectangular control surface combination is analyzed for M = 0.5 and k_r = 0.10. The planform geometry and AIC control station locations are shown in Figure 4.4. The dimensional unit used for length is feet for this particular case, therefore the acoustic velocity is entered with units of feet per second. NIONCX is set equal to 8 which makes NIONCX*NWCX and NIONCX*NCCX greater than 15, thereby insuring sufficient chordwise quadrature points for accurate chordwise integration of the kernel function.

The surfaces have 5 spanwise collocation stations and the wing has 3 chordwise stations while the control surface has 2 chordwise stations. Summarized below are input parameters. A listing of the data input cards and computer output follows.

X(1) = 0.0' X(2) = 1.0' X(3) = 2.0' X(4) = 3.0' X(5) = 4.0'

Y(1) = 0.0' Y(2) = 0.0' Y(3) = 2.0'

SOUND = 1116.87 ft/sec	(analysis for sea level)
NMACH = 1	number of Mach numbers
KF = 1	Input reduced frequency
NFREQ = 1	Number of reduced frequencies
LCOLL = 1	Print collocation station coordinates
LPUNCH = 4	Punch total AIC matrix on cards
NWCX = 3	Number of chordwise AIC collocation stations on wing
NCCX = 2	Number of chordwise AIC collocation stations on control surface
NIONCX = 8	Factor for determining number of chordwise integration stations
NIY = 5	Number of spanwise AIC collocation stations
ISOLAT = 0	Surfaces are not isolated
FMACH(1) = 0.5	Mach number
FREQ(1) = 0.1	Reduced frequency

YAIC(1,W) = 0.2'	YAIC(2,W) = 0.6'	YAIC(3,W) = 1.0'
YAIC(4,W) = 1.4'	YAIC(5,W) = 1.8'	
YAIC(1,CS) = 0.1'	YAIC(2,CS) = 0.5'	YAIC(3,CS) = 1.0'
YAIC(4,CS) = 1.5'	YAIC(5,CS) = 1.9'	
XAIC(1,1,W) = 0.575'	XAIC(1,2,W) = 1.050'	XAIC(1,3,W) = 1.525'
XAIC(2,1,W) = 0.725'	XAIC(2,2,W) = 1.150'	XAIC(2,3,W) = 1.575'
XAIC(3,1,W) = 0.875'	XAIC(3,2,W) = 1.250'	XAIC(3,3,W) = 1.625'
XAIC(4,1,W) = 1.025'	XAIC(4,2,W) = 1.350'	XAIC(4,3,W) = 1.675'
XAIC(5,1,W) = 1.175'	XAIC(5,2,W) = 1.450'	XAIC(5,3,W) = 1.725'
XAIC(1,1,CS) = 3.25'	XAIC(1,2,CS) = 3.75'	
XAIC(2,1,CS) = 3.25'	XAIC(2,2,CS) = 3.75'	
XAIC(3,1,CS) = 3.25'	XAIC(3,2,CS) = 3.75'	
XAIC(4,1,CS) = 3.25'	XAIC(4,2,CS) = 3.75'	
XAIC(5,1,CS) = 3.25'	XAIC(5,2,CS) = 3.75'	

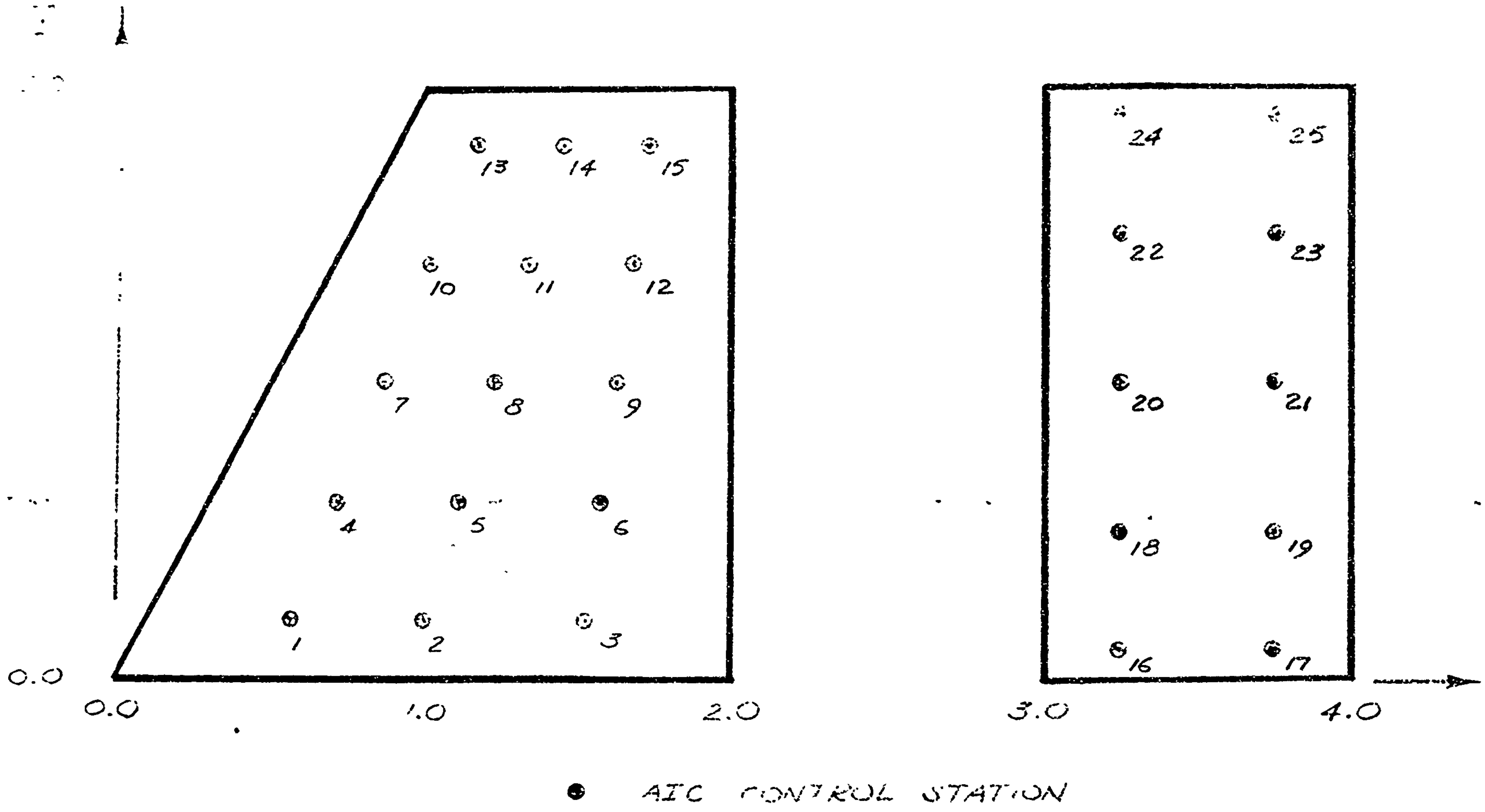


FIGURE 4.4 - SUBSONIC SAMPLE PROBLEM 1.

```
                           DATA CARD COLUMN NUMBER
********************************************************************************
         111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************


0.5       1.0       2.0       3.0       4.0
0.0       0.0       2.0       1116.87
         1         1         1         1         4
         3         5         8         5         0
0.5                                                                 MACH NO.
0.1                                                                 RED FREQ
0.200     0.600     1.000     1.400     1.800                       Y-WING
0.100     0.500     1.000     1.500     1.900                       Y-TAIL
0.575     1.050     1.525     0.725     1.150     1.575             X-WING
0.875     1.250     1.325     1.025     1.350     1.675             X-WING
1.175     1.450     1.725                                           X-WING
3.250     3.750     3.250     3.750     3.250     3.750             X-TAIL
3.250     3.750     3.25      3.75                                  X-TAIL


********************************************************************************
         111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
                           DATA CARD COLUMN NUMBER
```

FIGURE 4.5 - LISTING OF INPUT DATA CARDS FOR SUBSONIC SAMPLE PROBLEM 1.

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM

FLIGHT CONDITIONS AND GEOMETRY

MACH NUMBER = 0.50000   SPEED OF SOUND = 1116.870 L/T   RHO=0.10000000E 01

	WING	TAIL
L.E. STATION (L)	0.	3.000
ROOT CHORD (L)	2.000	1.000
L.E. SPAN (L)	0.	2.000
T.E. SPAN (L)	2.000	2.000
TIP CHORD (L)	1.000	1.000
TOTAL AREA (L*L)	6.000	4.000
SPAN COLL. STA.	5	5
CHORD COLL. STA.	3	2
CHORD INTG. STA.	24	16
SPAN PRES MODES	5	5
CHORD PRES MODES	3	2

UNSTEADY AERO COLLOCATION STATION COORDINATES ON THE WING

S STA NO	YC	XC VALUES--		
1	0.	0.481607E 00	0.146254E 01	0.199795E 01
2	0.618034E 00	0.716212E 00	0.154558E 01	0.199826E 01
3	0.117557E 01	0.927852E 00	0.160049E 01	0.199855E 01
4	0.161803E 01	0.109581E 01	0.167995E 01	0.199878E 01
5	0.190211E 01	0.120365E 01	0.171812E 01	0.199892E 01

INTEGRATION STATION COORDINATES ON THE WING

S STA NO	YI	XI VALUES--			
1	0.312869E 00	0.158328E 00	0.173433E 00	0.203394E 00	0.247720E 00
		0.305682E 00	0.376329E 00	0.458502E 00	0.550850E 00
		0.651857E 00	0.759866E 00	0.873101E 00	0.989705E 00
		0.110776E 01	0.122533E 01	0.134049E 01	0.145134E 01
		0.155606E 01	0.165294E 01	0.174038E 01	0.181695E 01
		0.188138E 01	0.193263E 01	0.196985E 01	0.199243E 01
2	0.907981E 00	0.455579E 00	0.468245E 00	0.493371E 00	0.530542E 00
		0.579149E 00	0.638394E 00	0.707303E 00	0.784746E 00
		0.869451E 00	0.960026E 00	0.105499E 01	0.115277E 01
		0.125177E 01	0.135037E 01	0.144694E 01	0.153989E 01
		0.162772E 01	0.170896E 01	0.178228E 01	0.184649E 01
		0.190053E 01	0.194351E 01	0.197472E 01	0.199365E 01
3	0.141421E 01	0.708435E 00	0.719028E 00	0.740039E 00	0.771125E 00
		0.811774E 00	0.861319E 00	0.918947E 00	0.983710E 00
		0.105455E 01	0.113029E 01	0.120971E 01	0.129148E 01
		0.137427E 01	0.145673E 01	0.153749E 01	0.161522E 01
		0.168867E 01	0.175661E 01	0.181793E 01	0.187162E 01
		0.191681E 01	0.195276E 01	0.197886E 01	0.199469E 01
4	0.178201E 01	0.892146E 00	0.901232E 00	0.919255E 00	0.945919E 00
		0.980786E 00	0.102328E 01	0.107271E 01	0.112827E 01
		0.118903E 01	0.125400E 01	0.132212E 01	0.139226E 01
		0.146328E 01	0.153400E 01	0.160327E 01	0.166995E 01
		0.173295E 01	0.179123E 01	0.184383E 01	0.189988E 01
		0.192865E 01	0.195948E 01	0.198187E 01	0.199545E 01
5	0.197535E 01	0.988728E 00	0.997022E 00	0.101347E 01	0.103781E 01
		0.106964E 01	0.110043E 01	0.115356E 01	0.120426E 01
		0.125973E 01	0.131904E 01	0.136121E 01	0.144524E 01
		0.151007E 01	0.157463E 01	0.163786E 01	0.169873E 01
		0.175623E 01	0.180943E 01	0.185744E 01	0.189948E 01
		0.193467E 01	0.196301E 01	0.198345E 01	0.199584E 01

UNSTEADY AERO COLLOCATION STATION COORDINATES ON THE TAIL

S STA NO	YC	XC VALUES--	
1	0.	0.347621E 01	0.399774E 01
2	0.618034E 00	0.347621E 01	0.399774E 01
3	0.117557E 01	0.347621E 01	0.399774E 01
4	0.161803E 01	0.347621E 01	0.399774E 01
5	0.190211E 01	0.347621E 01	0.399774E 01

INTEGRATION STATION COORDINATES ON THE TAIL

S STA NO	YI	XI VALUES--			
1	0.312869E 00	0.300226E 01	0.302025E 01	0.305558E 01	0.310697E 01
		0.317257E 01	0.325000E 01	0.333647E 01	0.342884E 01
		0.352379E 01	0.361788E 01	0.370771E 01	0.379003E 01
		0.386187E 01	0.392063E 01	0.396418E 01	0.399096E 01
2	0.907981E 00	0.300226E 01	0.302025E 01	0.305558E 01	0.310697E 01
		0.317257E 01	0.325000E 01	0.333647E 01	0.342884E 01
		0.352379E 01	0.361788E 01	0.370771E 01	0.379003E 01
		0.386187E 01	0.392063E 01	0.396418E 01	0.399096E 01
3	0.141421E 01	0.300226E 01	0.302025E 01	0.305558E 01	0.310697E 01
		0.317257E 01	0.325000E 01	0.333647E 01	0.342884E 01
		0.352379E 01	0.361788E 01	0.370771E 01	0.379003E 01
		0.386187E 01	0.392063E 01	0.396418E 01	0.399096E 01
4	0.178201E 01	0.300226E 01	0.302025E 01	0.305558E 01	0.310697E 01
		0.317257E 01	0.325000E 01	0.333647E 01	0.342884E 01
		0.352379E 01	0.361788E 01	0.370771E 01	0.379003E 01
		0.386187E 01	0.392063E 01	0.396418E 01	0.399096E 01
5	0.197538E 01	0.300226E 01	0.302025E 01	0.305558E 01	0.310697E 01
		0.317257E 01	0.325000E 01	0.333647E 01	0.342884E 01
		0.352379E 01	0.361788E 01	0.370771E 01	0.379003E 01
		0.386187E 01	0.392063E 01	0.396418E 01	0.399096E 01

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT-D)

AIC COLLOCATION STATION COORDINATES ON THE WING

YAIC	XAIC VALUES--		
0.200000E 00	0.575000E 00	0.105000E 01	0.152500E 01
0.600000E 00	0.725000E 00	0.115000E 01	0.157500E 01
0.100000E 01	0.875000E 00	0.125000E 01	0.162500E 01
0.140000E 01	0.102500E 01	0.135000E 01	0.167500E 01
0.180000E 01	0.117500E 01	0.145000E 01	0.172500E 01

AIC COLLOCATION STATION COORDINATES ON THE TAIL

YAIC	XAIC VALUES--	
0.100000E 00	0.325000E 01	0.375000E 01
0.500000E 00	0.325000E 01	0.375000E 01
0.100000E 01	0.325000E 01	0.375000E 01
0.150000E 01	0.325000E 01	0.375000E 01
0.190000E 01	0.325000E 01	0.375000E 01

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT-D)

OSCILLATORY FREQUENCY (CPS) 8.88777E 00

REFERENCE CHORD 1.00000E 00

REDUCED FREQUENCY (REF. CHORD) 1.00000E-01

REDUCED VELOCITY (REF. CHORD) 1.00000E 01

FREE STREAM MACH NUMBER 5.00000E-01

FREE STREAM VELOCITY 5.58435E 02

DENSITY 1.00

DYNAMIC PRESSURE (1/2*RHO*VEL**2) 1.55925E 05

AERODYNAMIC INFLUENCE COEFFICIENTS

RL	IM	RL	IM	RL	IM	RL	IM	RL	IM
ROW = 1									
1.9737E 03	-6.8820E 01	-3.4937E 03	9.1008E 01	1.5227E 03	-4.3777E 01	-3.8526E 03	1.1895E 02	6.5728E 03	-1.4104E 02
-2.7240E 03	7.0267E 01	2.7537E 03	-8.3180E 01	-4.6233E 03	1.0553E 02	1.8718E 03	-5.5529E 01	-7.9280E 02	1.6388E 01
1.2650E 03	-8.0521E 00	-4.7241E 02	2.0849E 00	3.5502E 01	-2.1366E 00	-2.9983E 01	1.6790E 00	-5.5499E 00	-6.7155E-01
2.8760E 00	1.9945E-01	-2.8647E 00	-3.4308E-01	2.8840E 00	2.1449E-01	-2.8742E 00	-3.5866E-01	3.1920E 00	2.5799E-01
-3.1778E 00	-4.1736E-01	1.8022E 00	1.4465E-01	-1.7943E 00	-2.3458E-01	4.7383E-01	9.5344E-03	-4.7348E-01	-2.9053E-02
ROW = 2									
-8.2336E 02	2.5013E 00	1.6737E 03	5.5166E 01	-8.4930E 02	-5.8917E 01	1.5732E 03	5.9970E-01	-3.1097E 03	-1.0717E 02
1.5349E 03	1.0498E 02	-1.1665E 03	-3.4436E-01	2.3154E 03	6.9444E 01	-1.1480E 03	-6.8425E 01	3.2028E 02	6.8815E-01
-6.0623E 02	-1.6573E 01	2.8581E 02	1.4769E 01	-8.4283E 00	6.3100E-01	8.3887E 00	-2.0749E 00	7.6526E-03	1.6766E 00
4.7742E-01	-2.5529E-01	-4.9027E-01	2.3146E-01	5.5339E-01	-2.7463E-01	-5.6713E-01	2.4702E-01	7.6444E-01	-3.3871E-01
-7.8133E-01	3.0056E-01	5.3086E-01	-2.0854E-01	-5.4124E-01	1.8206E-01	1.5747E-01	-4.6454E-02	-1.5987E-01	3.8574E-02
ROW = 3									
-1.8133E 03	5.0187E 01	3.6031E 03	-5.5244E 00	-1.7894E 03	-4.3430E 01	3.5560E 03	-7.3264E 01	-6.8783E 03	-2.6852E 01
3.3164E 03	9.1841E 01	-2.6049E 03	4.9184E 01	5.0399E 03	1.5615E 01	-2.4305E 03	-5.8212E 01	7.4842E 02	-6.6297E 00
-1.3871E 03	-1.6990E 01	6.3851E 02	2.0048E 01	-3.5167E 01	3.9275E-01	4.4978E 01	-8.3796E-01	-9.8485E 00	1.1417E 00
-8.6234E-01	-3.8770E-01	8.4218E-01	4.3076E-01	-7.7805E-01	-4.1873E-01	7.5660E-01	4.5766E-01	-6.8341E-01	-5.2082E-01
6.5679E-01	5.5498E-01	-2.6895E-01	-3.2426E-01	2.5242E-01	3.3772E-01	-4.4849E-02	-6.9013E-02	4.1388E-02	7.1218E-02
ROW = 4									
1.6134E 03	-5.6083E 01	-2.8560E 03	7.3909E 01	1.2448E 03	-3.5471E 01	-3.2326E 03	9.9479E 01	5.5215E 03	-1.1766E 02
-2.2921E 03	5.3317E 01	2.3850E 03	-7.1690E 01	-3.9981E 03	9.0136E 01	1.6150E 03	-4.7412E 01	-6.7888E 02	1.3935E 01
1.0850E 03	-6.5647E 00	-4.0628E 02	1.4960E 00	2.7291E 01	-1.7509E 00	-1.8182E 01	1.1926E 00	-9.1375E 00	-4.4365E-01
2.5517E 00	9.3700E-02	-2.5461E 00	-2.1806E-01	2.6010E 00	9.7705E-02	-2.9952E 00	-2.2763E-01	2.9618E 00	1.1325E-01
-2.9549E 00	-2.6113E-01	1.7237E 00	5.2876E-02	-1.7204E 00	-1.3890E-01	4.6304E-01	-1.6972E-02	-4.6380E-01	-6.0227E-03
ROW = 5									
-6.7228E 02	2.1321E 00	1.3666E 03	4.4769E 01	-6.9350E 02	-4.7923E 01	1.3179E 03	3.5572E-01	-2.6054E 03	-8.9287E 01
1.2862E 03	8.7620E 01	-1.0127E 03	-4.2131E-01	2.0100E 03	6.0463E 01	-9.9653E 02	-5.9452E 01	2.7136E 02	5.4356E-01
-5.1250E 02	-1.3812E 01	2.4083E 02	1.2273E 01	-6.6843E 00	5.3706E-01	6.2414E 00	-1.7949E 00	4.1580E-01	1.4837E 00
4.3617E-01	-2.1397E-01	-4.4692E-01	1.9219E-01	5.0314E-01	-2.3093E-01	-5.1468E-01	2.0583E-01	6.9002E-01	-2.8571E-01
-7.0424E-01	2.5128E-01	4.7625E-01	-1.7567E-01	-4.8408E-01	1.5191E-01	1.4083E-01	-3.8611E-02	-1.4274E-01	3.1944E-02

ROW = 6

-1.4817E 03	4.1122E 01	2.9441E 03	-4.8952E 00	-1.4621E 03	-8.5217E 01	2.9799E 03	-6.3169E 01	-5.7613E 03	-2.2010E 01
2.7807E 03	7.6633E 01	-2.2600E 03	4.2167E 01	4.3683E 03	1.4695E 01	-2.1079E 03	-5.1118E 01	6.3798E 02	-5.5341E 00
-1.1796E 03	-1.4543E 01	5.4168E 02	1.6954E 01	-2.8495E 01	2.7189E-01	3.5201E 01	-4.0257E-01	-6.7375E 00	9.2915E-01
-6.6757E-01	-3.1363E-01	6.5130E-01	3.4696E-01	-6.0738E-01	-8.3954E-01	5.9002E-01	3.6994E-01	-5.4696E-01	-4.2277E-01
5.2533E-01	4.5012E-01	-2.2341E-01	-2.6196E-01	2.1002E-01	2.7314E-01	-3.8856E-02	-5.3879E-02	3.6152E-02	5.5789E-02

ROW = 7

1.0435E 03	-3.6103E 01	-1.8449E 03	4.7281E 01	8.0288E 02	-2.2694E 01	-2.1633E 03	6.6322E 01	3.7020E 03	-7.8281E 01
-1.5398E 03	3.8571E 01	1.6329E 03	-4.9004E 01	-2.7279E 03	6.1132E 01	1.0963E 03	-3.2316E 01	-4.1553E 02	8.2255E 00
6.6756E 02	-2.0410E 00	-2.5211E 02	3.0659E-02	1.3014E 01	-1.1166E 00	-4.3361E-01	7.3819E-01	-1.2682E 01	-3.2596E-01
2.0245E 00	-6.1078E-02	-2.0269E 00	-3.9965E-02	2.1125E 00	-6.6098E-02	-2.1152E 00	-3.9407E-02	2.5182E 00	-6.8515E-02
-2.5157E 00	-3.6908E-02	1.5345E 00	-7.1741E-02	-1.5375E 00	-4.8373E-03	4.2687E-01	-4.3219E-02	-4.2898E-01	2.1995E-02

ROW = 8

-4.3508E 02	1.4336E 00	8.8464E 02	2.8799E 01	-4.4903E 02	-3.0904E 01	8.7995E 02	1.2660E-01	-1.7398E 03	-5.9256E 01
8.5898E 02	5.8260E 01	-6.9736E 02	-4.3407E-01	1.3844E 03	4.1943E 01	-6.8649E 02	-4.1113E 01	1.6082E 02	2.3372E-01
-2.9818E 02	-7.7195E 00	1.3811E 02	6.7759E 00	-5.0035E 00	3.5630E-01	6.4900E 00	-1.1335E 00	-1.5082E 00	8.7383E-01
3.6329E-01	-1.4989E-01	-3.7080E-01	1.3176E-01	4.1520E-01	-1.6241E-01	-4.2329E-01	1.4170E-01	5.6266E-01	-2.0233E-01
-5.7271E-01	1.7425E-01	3.8535E-01	-1.2509E-01	-3.9155E-01	1.0586E-01	1.1392E-01	-2.7930E-02	-1.1530E-01	2.2232E-02

ROW = 9

-9.5941E 02	2.6685E 01	1.9063E 03	-3.3822E 00	-9.4673E 02	-2.2648E 01	1.9907E 03	-4.2275E 01	-3.8498E 03	-1.4327E 01
1.8586E 03	5.0937E 01	-1.5538E 03	2.8599E 01	3.0027E 03	1.1095E 01	-1.4486E 03	-3.5722E 01	3.8319E 02	-3.1044E 00
-7.0270E 02	-9.0221E 00	3.1946E 02	1.0096E 01	-1.7516E 01	1.8686E-01	2.2340E 01	-3.9989E-01	-4.8423E 00	5.6148E-01
-3.8270E-01	-2.0151E-01	3.7229E-01	2.2042E-01	-3.5058E-01	-2.1873E-01	3.3943E-01	2.3628E-01	-3.2598E-01	-2.7334E-01
3.1150E-01	2.8962E-01	-1.3998E-01	-1.6899E-01	1.3132E-01	1.7600E-01	-2.5397E-02	-3.3956E-02	2.3678E-02	3.5298E-02

ROW =10

-5.4317E 00	-6.1884E-02	2.4578E 01	4.7794E-02	-1.9146E 01	-6.3614E-01	-1.4059E 01	1.4373E-01	3.2395E 01	-2.3621E-01
-1.8354E 01	-8.9387E-02	2.7575E 01	-1.2123E 00	-2.5780E 01	1.6042E 00	-1.7651E 00	-1.4930E 00	7.7277E 01	-2.2835E 00
-1.1114E 02	2.3135E 00	3.3912E 01	-1.9410E 00	2.0369E 01	-5.9082E-01	-2.6004E 01	8.8378E-01	5.6503E 00	-6.9801E-01
1.2317E 00	-3.1352E-01	-1.2471E 00	2.5285E-01	1.3504E 00	-3.3899E-01	-1.3671E 00	2.7159E-01	1.7380E 00	-4.2359E-01
-1.7567E 00	3.3691E-01	1.1537E 00	-2.7455E-01	-1.1671E 00	2.1698E-01	3.4234E-01	-8.0869E-02	-3.4688E-01	6.3790E-02

ROW =11

-4.9440E 00	-1.5437E-01	1.1752E 01	8.4297E-01	-6.7921E 00	-7.6690E-01	1.6399E 00	-1.0508E-01	-2.2915E 00	1.5682E-01
6.5425E-01	-9.3742E-02	-2.2368E 01	-2.5883E-01	4.6977E 01	2.0811E 00	-2.4579E 01	-1.9059E 00	-4.4594E 01	-2.6287E-01
9.1852E 01	3.0211E 00	-4.7222E 01	-2.8444E 00	-1.6339E 01	-5.3075E-02	3.5733E 01	9.4995E-01	-1.9382E 01	-9.8072E-01
2.6602E-01	-4.2761E-02	-2.6810E-01	2.9483E-02	2.8889E-01	-4.6506E-02	-2.9114E-01	3.2087E-02	3.6482E-01	-5.9079E-02
-3.6719E-01	4.0893E-02	2.3722E-01	-3.8385E-02	-2.3908E-01	2.6543E-02	6.9658E-02	-1.1057E-02	-7.0192E-02	7.5797E-03

ROW =12

-6.6534E 00	-3.0121E-02	1.4069E 01	6.9090E-01	-7.3988E 00	-6.9651E-01	6.5487E 00	-2.4946E-01	-1.2206E 01	3.3249E-01
5.6623E 00	-1.2111E-01	-4.2377E 01	4.7897E-01	8.3673E 01	1.3473E 00	-4.1269E 01	-1.7846E 00	-8.9802E 01	1.1218E 00
1.7711E 02	1.6048E 00	-8.7280E 01	-2.6440E 00	-2.8789E 01	4.3049E-01	6.0330E 01	2.5318E-01	-3.1582E 01	-7.5888E-01
6.6187E-02	-1.1698E-02	-6.6762E-02	8.3946E-03	6.3270E-02	-1.2740E-02	-6.3899E-02	9.5838E-03	5.9381E-02	-1.6652E-02
-6.0207E-02	1.3690E-02	2.6435E-02	-1.0446E-02	-2.7000E-02	9.1219E-03	6.4941E-03	-2.7737E-03	-6.6476E-03	2.4482E-03

ROW =13

-4.4838E 03	1.5190E 02	8.0225E 03	-1.9702E 02	-3.5518E 03	8.9764E 01	9.3031E 03	-2.8745E 02	-1.5881E 04	3.3953E 02
6.5677E 03	-1.6882E 02	-6.6640E 03	1.9836E 02	1.1233E 04	-2.4676E 02	-4.5740E 03	1.2704E 02	1.9162E 03	-4.0759E 01
-3.0149E 03	2.1190E 01	1.1012E 03	-6.8726E 00	-4.3178E 00	3.0200E 00	-4.3865E 01	-8.2333E-01	4.8303E 01	-7.5014E-01
-1.1583E 00	-1.4415E 00	1.0849E 00	1.4994E 00	-8.9173E-01	-1.5546E 00	8.1351E-01	1.5994E 00	-5.3061E-01	-1.9154E 00
4.3356E-01	1.9421E 00	4.[illegible]737E-03	-1.[illegible]810E 00	-6.3852E-02	1.1808E 00	7.9348E-02	-2.5568E-01	-9.2085E-02	2.5144E-01

ROW =14

1.8156E 03	-7.5304E 00	-3.6787E 03	-1.1565E 02	1.5669E 03	1.2537E 02	-3.8133E 03	-1.3374E 00	7.5471E 03	2.5874E 02
-3.7299E 03	-2.8395E 02	2.7864E 03	4.3072E-01	-5.5187E 03	-1.6356E 02	2.7232E 03	1.6085E 02	-7.9772E 02	-1.7790E 00
1.5224E 03	4.1505E [illegible]	-7.2435E 02	-3.7357E 01	-2.9587E 01	-1.6381E 00	8.5778E 01	7.6872E 00	-5.6082E 01	-6.7798E 00
1.6006E-01	3.8421E-01	-1.4149E-01	-3.6220E-01	6.8000E-02	3.3377E-01	-4.8532E-02	-3.8722E-01	-1.2547E-01	4.7772E-01

1.4960E-01	-4.7150E-01	-1.9455E-01	2.8936E-01	2.0911E-01	-2.7969E-01	-6.6712E-02	5.0569E-02	6.9239E-02	-4.7189E-02
ROW =15									
4.0390E 03	-1.1460E 02	-8.0169E 03	1.9959E 01	3.9772E 03	9.0880E 01	-8.6044E 03	1.8186E 02	1.6645E 04	6.4711E 01
-8.0386E 03	-2.2230E 02	6.2533E 03	-1.1677E 02	-1.2065E 04	-3.8997E 01	5.8106E 03	1.3906E 02	-1.8426E 03	1.6617E 01
3.4283E 03	4.1152E 01	-1.5853E 03	-4.9407E 01	-1.2504E 01	5.5265E-01	8.8195E 01	2.3810E 00	-7.5581E 01	-4.6680E 00
1.9360E 00	7.2871E-01	-1.8933E 00	-8.2541E-01	1.7871E 00	7.9096E-01	-1.7468E 00	-8.8041E-01	1.6943E 00	9.9026E-01
-1.6437E 00	-1.0750E 00	7.8592E-01	6.1426E-01	-7.5455E-01	-4.5358E-01	1.6842E-01	1.1769E-01	-1.6248E-01	-1.2602E-01
ROW =16									
4.9351E 02	-4.1937E 01	-1.3211E 03	1.0776E 02	8.2945E 02	-5.0041E 01	-9.8750E 02	8.1179E 01	2.6350E 03	-2.8705E 02
-1.6506E 03	9.7957E 01	7.5936E 02	-6.8551E 01	-2.0303E 03	1.7752E 02	1.2731E 03	-8.9871E 01	-2.2279E 02	1.8329E 01
5.9091E 02	-4.6446E 01	-3.6859E 02	2.3411E 01	5.0370E 00	-3.1670E-01	-1.3328E 01	1.0358E 00	8.3041E 00	-6.2970E-01
2.6100E 02	3.4605E 00	-2.6131E 02	-1.6534E 01	-4.0131E 02	-6.1988E 00	4.0050E 02	2.6229E 01	2.8349E 02	3.6910E 00
-2.8296E 02	-1.7840E 01	-1.0703E 02	-1.8109E 00	1.0680E 02	7.1528E 00	2.2973E 01	2.5863E-01	-2.2981E 01	-1.4055E 00
ROW =17									
8.7398E-01	-1.7967E-01	-3.0549E 00	6.6494E-01	2.1961E 00	-4.2336E-01	8.7348E 00	-1.6910E 00	-2.3657E 01	4.5021E 00
1.4980E 01	-2.5504E 00	1.5277E 00	5.5941E-02	-4.7914E 00	2.0521E-02	3.2698E 00	-1.1251E-02	5.6196E 00	-9.7271E-01
-1.5573E 01	2.6889E 00	9.9815E 00	-1.5760E 00	-3.2647E 00	1.1465E-01	8.3732E 00	-2.0608E-01	-5.1096E 00	4.0835E-02
9.2299E-01	2.5303E 01	-2.8589E-01	-2.5350E 01	5.9940E 00	-4.0392E 01	-7.0050E 00	4.0094E 01	3.6944E 00	2.6850E 01
-3.0160E 00	-2.7035E 01	2.5286E 00	-1.0883E 01	-2.8006E 00	1.0757E 01	-6.7581E-01	2.3514E 00	7.3381E-01	-2.3177E 00
ROW =18									
6.2240E 02	-5.2976E 01	-1.6665E 03	1.3628E 02	1.0464E 03	-6.3378E 01	-1.2736E 03	1.0442E 02	3.3982E 03	-2.6627E 02
-2.1286E 03	1.2585E 02	1.0151E 03	-9.1960E 01	-2.7145E 03	2.3827E 02	1.7023E 03	-1.2076E 02	-2.9286E 02	2.3624E 01
7.7440E 02	-5.9664E 01	-4.8279E 02	2.9891E 01	6.7064E 00	-5.6873E-01	-1.8159E 01	1.8562E 00	1.1455E 01	-1.1372E 00
3.3216E 02	4.3487E 00	-3.3155E 02	-2.0928E 01	-5.2143E 02	-8.0973E 00	5.2037E 02	3.4123E 01	3.8768E 02	5.0179E 00
-3.8693E 02	-2.4386E 01	-1.4196E 02	-2.4361E 00	1.4165E 02	9.5215E 00	3.1284E 01	3.4523E-01	-3.1227E 01	-1.9067E 00
ROW =19									
4.9964E-01	-2.5702E-01	-2.3430E 00	9.5634E-01	1.8642E 00	-6.3571E-01	1.2085E 01	-2.2692E 00	-3.2741E 01	6.0430E 00
2.0734E 01	-3.4127E 00	2.9853E 00	-4.4185E-02	-8.9911E 00	3.3427E-01	6.0181E 00	-1.9679E-01	8.5961E 00	-1.4296E 00
-2.3795E 01	3.9476E 00	1.5240E 01	-2.3044E 00	-4.0579E 00	9.9879E-02	1.0309E 01	-1.2290E-01	-6.2514E 00	-3.7174E-02
1.0279E 00	3.2111E 01	-2.1013E-01	-3.2163E 01	8.1071E 00	-5.2558E 01	-9.4224E 00	5.2195E 01	5.7821E 00	3.6573E 01
-4.6342E 00	-3.6863E 01	3.8983E 00	-1.4541E 01	-4.2610E 00	1.4347E 01	-7.9375E-01	3.1770E 00	8.7160E-01	-3.1374E 00
ROW =20									
4.1981E 02	-3.6167E 01	-1.1249E 03	9.3407E 01	7.0669E 02	-4.3764E 01	-8.9241E 02	7.2711E 01	2.3807E 03	-1.8526E 02
-1.4910E 03	8.7337E 01	7.4506E 02	-6.8354E 01	-1.9935E 03	1.7749E 02	1.2506E 03	-9.0338E 01	-1.7782E 02	1.2982E 01
4.6881E 02	-3.2098E 01	-2.9131E 02	1.5450E 01	7.1522E 00	-1.2235E 00	-2.0713E 01	3.7760E 00	1.3608E 01	-2.3748E 00
2.2722E 02	2.8563E 00	-2.2681E 02	-1.4198E 01	-3.6916E 02	-5.8523E 00	3.6840E 02	2.4278E 01	2.9673E 02	3.7170E 00
-2.9621E 02	-1.9528E 01	-8.8517E 01	-1.6593E 00	8.8313E 01	6.0772E 00	2.3488E 01	2.3241E-01	-2.3449E 01	-1.4048E 00
ROW =21									
-1.4660E-01	-3.1495E-01	-5.2318E-01	1.0989E 00	6.9102E-01	-7.4583E-01	9.5759E 00	-1.7399E 00	-2.6002E 01	4.6454E 00
1.6487E 01	-2.6168E 00	4.1684E 00	-3.3627E-01	-1.2104E 01	1.1132E 00	7.9558E 00	-6.3592E-01	9.0481E 00	-1.3779E 00
-2.5007E 01	3.8045E 00	1.6004E 01	-2.2027E 00	-1.4079E 00	-1.4376E-01	3.1825E 00	5.1625E-01	-1.7693E 00	-3.8261E-01
7.9284E-01	2.1900E 01	-2.4273E-01	-2.1940E 01	6.4420E 00	-3.7364E 01	-7.3774E 00	3.7064E 01	6.1085E 00	2.7644E 01
-5.4050E 00	-2.7950E 01	4.4347E 00	-9.4680E 00	-4.6684E 00	9.2469E 00	-1.1879E-01	2.2890E 00	1.7548E-01	-2.2831E 00
ROW =22									
-1.1293E 02	7.8593E 00	2.9914E 02	-1.6859E 01	-1.8651E 02	6.3355E 00	2.6300E 02	-2.2614E 01	-7.0340E 02	5.8168E 01
4.4127E 02	-2.8050E 01	-1.7956E 02	1.3592E 01	4.7625E 02	-3.3906E 01	-2.9711E 02	1.5939E 01	1.0969E 02	-1.1816E 01
-2.9565E 02	3.1423E 01	1.8628E 02	-1.7138E 01	2.5128E 01	-3.9213E 00	-7.0134E 01	1.0922E 01	4.5102E 01	-6.4562E 00
-5.6761E 01	-1.1098E 00	5.6629E 01	3.9429E 00	1.1645E 02	1.3824E 00	-1.1624E 02	-7.1946E 00	-5.2904E 01	-1.1624E 00
5.2770E 01	3.9030E 00	5.8308E 01	5.9507E-01	-5.8215E 01	-3.5054E 00	7.6395E-01	-5.3144E-02	-7.6941E-01	1.9991E-02
ROW =23									
3.6088E 00	-7.8852E-01	-1.0203E 01	2.2320E 00	6.6306E 00	-1.4029E 00	-4.5778E-01	1.0948E-01	9.6679E-01	-2.3750E-01
-5.1040E-01	1.2603E-01	4.4058E 00	-9.4483E-01	-1.2381E 01	2.5427E 00	5.0068E 00	-1.5049E 00	3.5843E 00	-5.2173E-01
-1.0131E 01	1.4923E 00	6.5634E 00	-8.7469E-01	4.3144E 00	-5.4418E-01	-1.1917E 01	1.5135E 00	7.6165E 00	-8.7922E-01

2.4373E 00	-6.0885E 00	-2.5887E 00	5.9676E 00	1.5137E 00	1.5989E 01	-1.2362E 00	-1.1065E 01	3.6447E 00	-5.9642E 00
-3.7917E 00	5.7825E 00	2.8849E 00	5.0320E 00	-2.7547E 00	-5.1762E 00	1.2694E 00	-1.7159E-01	-1.2724E 00	1.2821E-01

ROW =24

-1.3083E 03	1.9189E 02	3.4917E 03	-2.5788E 02	-2.1879E 03	1.1464E 02	2.9303E 03	-2.4337E 02	-7.8241E 03	6.2213E 02
4.9030E 03	-2.9571E 02	-2.2286E 03	1.9412E 02	5.9487E 03	-4.9910E 02	-3.7261E 03	2.4931E 02	6.7609E 02	-5.9982E 01
-1.8006E 03	1.5469E 02	1.1201E 03	-6.0189E 01	2.1598E 01	-5.0119E 00	-6.2097E 01	1.3824E 01	4.0612E 01	-8.2945E 00
-6.9467E 02	-1.0211E 01	6.9329E 02	4.4884E 01	1.2487E 03	1.8046E 01	-1.2463E 03	-6.0374E 01	-8.1698E 02	-1.2010E 01
8.1539E 02	5.2787E 01	3.4581E 02	4.9497E 00	-3.4514E 02	-2.2210E 01	-5.7624E 01	-8.3824E-01	5.7584E 01	3.7144E 00

ROW =25

1.7523E 01	-2.9877E 00	-4.7036E 01	6.7689E 00	2.9015E 01	-3.6364E 00	-2.1443E 01	4.1273E 00	5.7222E 01	-1.0823E 01
-3.5914E 01	6.0922E 00	7.0994E 00	-2.5525E 00	-1.9117E 01	6.8158E 00	1.2088E 01	-4.0813E 00	-1.0996E 01	1.4339E 00
2.9320E 01	-3.7204E 00	-1.8360E 01	2.0495E 00	1.3309E 01	-1.1700E 00	-3.5520E 01	3.0679E 00	2.2288E 01	-1.6558E 00
8.9596E 00	-6.9510E 01	-1.0697E 01	6.9065E 01	-6.7407E 00	1.2315E 02	9.8341E 00	-1.2281E 02	-2.2663E-01	-7.9717E 01
-1.7855E 00	7.9731E 01	-1.8376E 00	3.3712E 01	2.6840E 00	-3.3621E 01	3.5945E 00	-6.3280E 00	-3.7477E 00	6.1486E 00

Sample Problem 2

A cropped trapezoidal wing is analyzed for $M = 0.5$ and $k_r = 0.10$. Since the subsonic AIC program requires a control surface, a dummy surface is added with a minimal number of chordwise collocation stations (2) to minimize computing time. The surfaces are isolated and the option LPUNCH is input as 1 to punch the AIC matrix for the wing only. The wing has 4 chordwise and 4 spanwise collocation stations. Planform geometry and AIC control station locations are shown in Figure 4.6. Summarized below are input parameters. A listing of the data input cards and computer output follows.

X(1) = 0.0' X(2) = 1.0' X(3) = 2.0' X(4) = 3.0' X(5) = 4.0'
Y(1) = 0.0' Y(2) = 1.0' Y(3) = 2.0'

SOUND = 1116.87 ft/sec

NMACH = 1	Number of Mach numbers
KF = 1	Input reduced frequency
NFREQ = 1	Number of reduced frequencies
LCOLL = 1	Print collocation station coordinates
LPUNCH = 1	Punch AIC matrix for wing
NWCX = 4	Number of chordwise AIC collocation stations on wing
NCCX = 2	Number of chordwise AIC collocation stations on control surface
NIONCX = 4	Factor for determining number of chordwise integration stations
NIY = 4	Number of spanwise AIC collocation stations
ISOLAT = 1	Isolate wing and control surface
FMACH (1) = 0.5	Mach number
FREQ(1) = 0.10	Reduced frequency

YAIC(1,W) = 0.2' YAIC(2,W) = 0.7' YAIC(3,W) = 1.3'
YAIC(4,W) = 1.8'

YAIC(1,CS) = 0.2' YAIC(2,CS) = 0.7' YAIC(3,CS) = 1.3'
YAIC(4,CS) = 1.8'

XAIC(1,1,W) = 0.10'	XAIC(1,2,W) = 0.70'	XAIC(1,3,W) = 1.30'
XAIC(1,4,W) = 1.90'		
XAIC(2,1,W) = 0.10'	XAIC(2,2,W) = 0.70'	XAIC(2,3,W) = 1.30'
XAIC(2,4,W) = 1.90'		
XAIC(3,1,W) = 0.38'	XAIC(3,2,W) = 0.90'	XAIC(3,3,W) = 1.405'
XAIC(3,4,W) = 1.915'		
XAIC(4,1,W) = 0.86'	XAIC(4,2,W) = 1.22'	XAIC(4,3,W) = 1.58'
XAIC(4,4,W) = 1.94'		

XAIC(1,1,CS) = 3.25'	XAIC(1,2,CS) = 3.75'
XAIC(2,1,CS) = 3.25'	XAIC(2,2,CS) = 3.75'
XAIC(3,1,CS) = 3.25'	XAIC(3,2,CS) = 3.75'
XAIC(4,1,CS) = 3.25'	XAIC(4,2,CS) = 3.75'

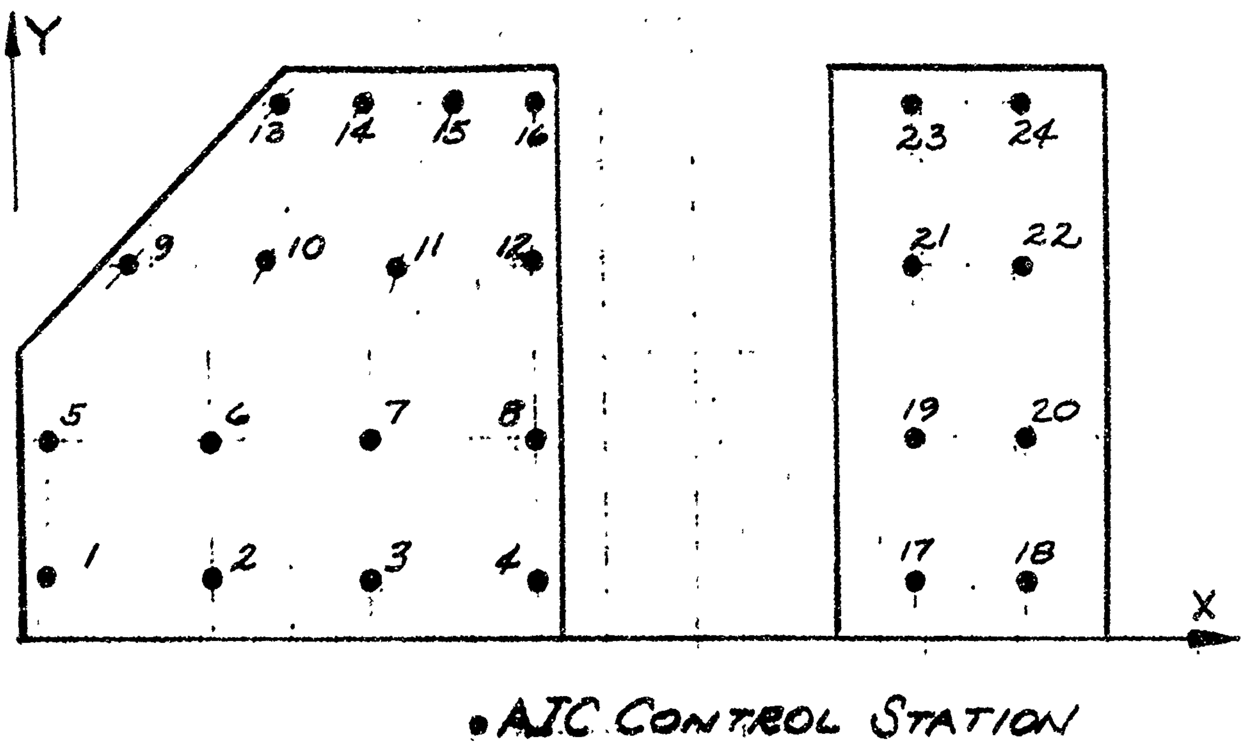


FIGURE 4.6
SUBSONIC SAMPLE PROBLEM #2

```
                                 DATA CARD COLUMN NUMBER
*********************************************************************************
         111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
*********************************************************************************


0.0         1.0         2.0         3.0         4.0
0.0         1.0         2.0         1116.87
          1           1           1           1           1
          4           2           4           4           1
0.5                                                                   MACH NO.
0.1                                                                   RED FREQ
0.200       0.700       1.300       1.800                             Y-WING
0.200       0.700       1.300       1.800                             Y-TAIL
0.100       0.700       1.300       1.900       0.100       0.700     X-WING
1.300       1.900       0.380       0.900       1.405       1.915     X-WING
0.860       1.220       1.580       1.940                             X-WING
3.250       3.750       3.250       3.750       3.250       3.750     X-TAIL
3.250       3.750                                                     X-TAIL


*********************************************************************************
         111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
*********************************************************************************
                                 DATA CARD COLUMN NUMBER
```

FIGURE 4.7 - LISTING OF INPUT DATA CARDS FOR SUBSONIC SAMPLE PROBLEM 2.

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM

FLIGHT CONDITIONS AND GEOMETRY

MACH NUMBER = 0.50000 SPEED OF SOUND = 1116.870 L/T RHO=0.10000000E 01

	WING	TAIL
L.E. STATION (L)	0.	3.000
ROOT CHORD (L)	2.000	1.000
L.E. SPAN (L)	1.000	2.000
T.E. SPAN (L)	2.000	2.000
TIP CHORD (L)	1.000	1.000
TOTAL AREA (L*L)	7.000	4.000
SPAN COLL. STA.	4	4
CHORD COLL. STA.	4	2
CHORD INTG. STA.	16	8
SPAN PRES MODES	4	4
CHORD PRES MODES	4	2

UNSTEADY AERO COLLOCATION STATION COORDINATES ON THE WING

S STA NO	YC	XC VALUES--			
1	0.	0.276266E 00	0.952418E 00	0.165486E 01	0.199547E 01
2	0.765367E 00	0.276266E 00	0.952418E 00	0.165486E 01	0.199547E 01
3	0.141421E 01	0.633263E 00	0.116938E 01	0.172634E 01	0.199641E 01
4	0.184776E 01	0.100692E 01	0.139647E 01	0.180116E 01	0.199739E 01

INTEGRATION STATION COORDINATES ON THE WING

S STA NO	YI	XI VALUES--			
1	0.390181E 00	0.452807E-02	0.405070E-01	0.111165E 00	0.213947E 00
		0.345139E 00	0.500000E 00	0.672932E 00	0.857685E 00
		0.104758E 01	0.123576E 01	0.141541E 01	0.158006E 01
		0.172373E 01	0.184125E 01	0.192837E 01	0.198193E 01
2	0.111114E 01	0.115417E 00	0.149396E 00	0.216128E 00	0.313198E 00
		0.437100E 00	0.583355E 00	0.746677E 00	0.921164E 00
		0.110051E 01	0.127823E 01	0.144790E 01	0.160339E 01
		0.173909E 01	0.185008E 01	0.193235E 01	0.198293E 01
3	0.166294E 01	0.665966E 00	0.690019E 00	0.737256E 00	0.805969E 00
		0.893675E 00	0.997204E 00	0.111281E 01	0.123633E 01
		0.136328E 01	0.148908E 01	0.160919E 01	0.171926E 01
		0.181531E 01	0.189387E 01	0.195211E 01	0.198792E 01
4	0.196157E 01	0.963922E 00	0.982602E 00	0.101929E 01	0.107265E 01
		0.114077E 01	0.122118E 01	0.131097E 01	0.140689E 01
		0.150549E 01	0.160319E 01	0.169647E 01	0.178196E 01
		0.185656E 01	0.191758E 01	0.196281E 01	0.199062E 01

UNSTEADY AERO COLLOCATION STATION COORDINATES ON THE TAIL

S STA NO	YC	XC VALUES--	
1	0.	0.345387E 01	0.399149E 01
2	.765367E 00	0.345387E 01	0.399149E 01
3	0.141421E 01	0.345387E 01	0.399149E 01
4	0.184776E 01	0.345387E 01	0.399149E 01

INTEGRATION STATION COORDINATES ON THE TAIL

S STA NO	YI	XI VALUES--			
1	0.390181E 00	0.300851E 01	0.307489E 01	0.319868E 01	0.336317E 01
		0.354613E 01	0.372287E 01	0.386950E 01	0.396624E 01
2	0.111114E 01	0.300851E 01	0.307489E 01	0.319868E 01	0.336317E 01
		0.354613E 01	0.372287E 01	0.386950E 01	0.396624E 01
3	0.166294E 01	0.300851E 01	0.307489E 01	0.319868E 01	0.336317E 01
		0.354613E 01	0.372287E 01	0.386950E 01	0.396624E 01
4	.196157E 01	0.300851E 01	0.307489E 01	0.319868E 01	0.336317E 01
		0.354613E 01	0.372287E 01	0.386950E 01	0.396624E 01

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT-D)

AIC COLLOCATION STATION COORDINATES ON THE WING

YAIC	XAIC VALUES--			
0.260000E 00	0.100000E 00	0.700000E 00	0.130000E 01	0.190000E 01
0.700000E 00	0.100000E 00	0.700000E 00	0.130000E 01	0.190000E 01
0.130000E 01	0.380000E 00	0.900000E 00	0.140500E 01	0.191500E 01
0.180000E 01	0.860000E 00	0.122000E 01	0.158000E 01	0.194000E 01

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT-D)

AIC COLLOCATION STATION COORDINATES ON THE TAIL

YAIC	XAIC VALUES--	
0.200000E 00	0.325000E 01	0.375000E 01
0.700000E 00	0.325000E 01	0.375000E 01
0.130000E 01	0.325000E 01	0.375000E 01
0.180000E 01	0.325000E 01	0.375000E 01

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT-D)

OSCILLATORY FREQUENCY (CPS) 8.88777E 00

REFERENCE CHORD 1.00000E 00

REDUCED FREQUENCY (REF. CHORD) 1.00000E-01

REDUCED VELOCITY (REF. CHORD) 1.00000E 01

FREE STREAM MACH NUMBER 5.00000E-01

FREE STREAM VELOCITY 5.58435E 02

DENSITY 1.00

DYNAMIC PRESSURE (1/2*RHO*VEL**2) 1.55925E 05

AERODYNAMIC INFLUENCE COEFFICIENTS

	RL	IM	RL	IM	RL	IM	RL	IM	RL	IM
ROW = 1										
	3.[illegible]277E 02	-6.6667E 00	-6.2017E 02	-1.1730E 01	4.9906E 02	2.2950E 01	-1.8156E 02	-1.4536E 01	-3.5214E 02	7.7012E 00
	7.7999E 02	1.3377E 01	-6.4773E 02	-3.3088E 01	2.1963E 02	2.0672E 01	2.1610E 02	-4.3830E 00	-4.5127E 02	-6.6972E 00
	3.6769E 02	1.3491E 01	-1.3248E 02	-8.5362E 00	-1.0106E 02	1.2299E 00	1.6562E 02	2.2269E 00	-9.1648E 01	-4.4175E 00
	2.7054E 01	2.5499E 00	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.		
ROW = 2										
	8.9541E 01	-2.0789E 00	-3.6262E 02	2.5103E 00	5.0217E 02	1.1902E 01	-2.2870E 02	-1.5052E 01	-1.0511E 02	2.6101E 00
	4.[illegible]242E 02	-2.9028E 00	-5.8406E 02	-1.4747E 01	2.5633E 02	1.7098E 01	6.4340E 01	-1.3046E 00	-2.7653E 02	1.8492E 00
	3.9[illegible]52E 02	7.4396E 00	-1.7812E 02	-9.7019E 00	-3.3853E 01	6.3348E-01	1.0687E 02	9.9410E-02	-1.2512E 02	-2.8557E 00
	5.[illegible]72E 01	2.5888E 00	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.		
ROW = 3										
	-1.7729E 02	7.5105E 00	3.2225E 02	6.6806E 00	-1.4545E 02	-1.4634E 01	9.4712E-01	2.4717E 00	2.1005E 02	-8.5703E 00
	-4.[illegible]374E 02	-6.3219E 00	2.5506E 02	1.7689E 01	-4.1797E 01	-5.1216E 00	-1.2602E 02	4.6707E 00	2.3020E 02	4.2672E 00
	-9.[illegible]456E 01	-9.3216E 00	-6.4790E 00	1.3600E 00	6.0737E 01	-1.1565E 00	-8.5944E 01	-1.4354E 00	1.7455E 01	1.4350E 00
	7.[illegible]188E 00	1.5492E-01	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.		
ROW = 4										
	-1.9852E 02	8.5586E 00	5.3919E 02	-1.3007E 00	-5.2016E 02	-1.3441E 01	1.7980E 02	8.4671E 00	2.3606E 02	-9.9570E 00
	-6.8[illegible]85E 02	3.1092E 00	6.9193E 02	1.5837E 01	-2.4744E 02	-1.1339E 01	-1.4162E 02	5.2873E 00	4.0095E 02	-9.3467E-01
	-3.9420E 02	-8.5774E 00	1.3504E 02	5.3909E 00	7.2062E 01	-1.5670E 00	-1.5869E 02	-3.9219E-01	1.2770E 02	2.1940E 00
	-4.[illegible]095E 01	-1.1911E 00	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	[illegible]	0.	0.	0.	0.	0.		
ROW = 5										
	2.2[illegible]14E 02	-4.9078E 00	-4.5335E 02	-8.2165E 00	3.7130E 02	1.5819E 01	-1.3804E 02	-1.0203E 01	-2.5620E 02	5.6712E 00
	5.8394E 02	9.3838E 00	-4.9522E 02	-2.4941E 01	1.6729E 02	1.5652E 01	2.1195E 02	-4.3845E 00	-4.4682E 02	-6.4478E 00
	3.6973E 02	1.3361E 01	-1.3483E 02	-8.5730E 00	-9.8198E 01	1.1979E 00	1.5691E 02	2.8483E 00	-8.1314E 01	-4.1119E 00
	2.2574E 01	2.3012E 00	0.	0.	0.	0.	0.	0.	0.	0.

```
ROW = 6
  6.4679E 01 -1.4648E 00 -2.6468E 02  1.9922E 00  3.7066E 02  8.2695E 00 -1.7038E 02 -1.0905E 01 -7.5857E 01  1.8906E 00
  3.7675E 02 -2.2438E 00 -4.2802E 02 -1.0628E 01  1.8684E 02  1.2297E 01  6.2281E 01 -1.2306E 00 -2.7545E 02  1.9763E 00
  3.9519E 02  7.3449E 00 -1.8188E 02 -9.8388E 00 -3.3263E 01  6.6362E-01  1.0153E 02  1.7567E-01 -1.1483E 02 -2.7928E 00
  4.6547E 01  2.3699E 00  0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.

ROW = 7
 -1.7819E 02  5.5285E 00  2.3393E 02  4.8690E 00 -1.0440E 02 -1.0908E 01 -9.9578E-01  1.8222E 00  1.5333E 02 -6.3050E 00
 -3.7576E 02 -4.1516E 00  2.0786E 02  1.3047E 01 -4.0722E 01 -4.2135E 00 -1.2315E 02  4.6603E 00  2.2623E 02  4.2515E 00
 -9.6670E 01 -9.5611E 00 -9.1653E 00  1.3951E 00  5.9340E 01 -1.0576E 00 -8.1925E 01 -1.3560E 00  1.5280E 01  1.0896E 00
  7.2765E 00  2.6230E-01  0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.

ROW = 8
 -1.4318E 02  6.2412E 00  3.9137E 02 -1.0005E 00 -3.7849E 02 -9.8672E 00  1.3054E 02  6.1771E 00  1.7172E 02 -7.2891E 00
 -5.7712E 02  2.7788E 00  5.2523E 02  1.1437E 01 -1.9005E 02 -8.5277E 00 -1.3746E 02  5.1976E 00  3.9474E 02 -9.6239E-01
 -3.9150E 02 -8.7469E 00  1.3338E 02  5.4807E 00  7.0677E 01 -1.4915E 00 -1.5213E 02 -4.3782E-01  1.1960E 02  1.9948E 00
 -3.8172E 01 -1.0529E 00  0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.

ROW = 9
  4.6979E 01 -1.1843E 00 -1.0236E 02 -1.2399E 00  9.3337E 01  1.5185E 00 -4.0002E 01 -1.2296E 00 -5.6749E 01  1.2945E 00
  1.4682E 02  1.8743E 00 -1.3196E 02 -7.0504E 00  4.1825E 01  4.3984E 00  1.1167E 02 -2.4032E 00 -2.3048E 02 -3.2353E 00
  1.9391E 02  6.0459E 00 -7.5104E 01 -4.0479E 00 -1.8902E 01  1.7013E-01  1.3828E 01  7.4985E-01  1.6267E 01 -6.1641E-01
 -1.1207E 01  1.5619E-01  0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.

ROW =10
  1.3925E 01 -2.7235E-01 -5.9586E 01  6.8621E-01  8.8990E 01  1.1332E 00 -4.3271E 01 -2.2388E 00 -1.6181E 01  4.0905E-01
  7.2155E 01 -5.9037E-01 -9.6177E 01 -2.3731E 00  4.0247E 01  2.5894E 00  3.2291E 01 -6.0941E-01 -1.4788E 02  1.1821E 00
  2.1892E 02  3.8027E 00 -1.0317E 02 -5.4764E 00 -8.3388E 00  2.6658E-01  9.6817E 00  3.5495E-01  5.9130E 00 -6.0830E-01
 -7.2432E 00 -2.1548E-02  0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.

ROW =11
 -2.7412E 01  1.3036E 00  5.0047E 01  1.0829E 00 -1.9762E 01 -2.5424E 00 -2.7807E 00  2.8189E-01  3.4722E 01 -1.4636E 00
 -8.5232E 01 -4.6331E-01  7.0856E 01  3.2160E 00 -2.0395E 01 -1.5715E 00 -6.4063E 01  2.5212E 00  1.1232E 02  2.4260E 00
 -3.5871E 01 -5.0829E 00 -1.2233E 01  4.1498E-01  1.2479E 01  1.1393E-02 -9.3474E 00 -1.8208E-01 -4.0810E 00 -6.4229E-01
  9.6150E-01  2.8642E-01  0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.

ROW =12
 -3.3261E 01  1.4017E 00  8.4463E 01 -2.8477E-01 -8.2248E 01 -2.1376E 00  2.8106E 01  1.2449E 00  3.8287E 01 -1.6621E 00
 -1.2568E 02  1.1429E 00  1.4010E 02  2.5728E 00 -5.2752E 01 -2.2764E 00 -7.0847E 01  2.7464E 00  2.0235E 02 -3.9995E-01
 -1.9802E 02 -4.6879E 00  6.6604E 01  2.7877E 00  1.6746E 01 -1.9716E-01 -2.0533E 01 -3.3236E-01  3.1910E 00 -1.4875E-03
  5.9792E-01  8.6263E-02  0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.

ROW =13
 -4.3238E 02  9.1045E 00  9.0371E 02  1.7560E 01 -7.1672E 02 -3.7351E 01  2.4511E 02  2.3084E 01  7.3188E 02 -1.6371E 01
 -1.6378E 03 -2.6432E 01  1.3925E 03  6.5947E 01 -4.8621E 02 -4.1930E 01 -4.1622E 02  8.2079E 00  8.8129E 02  1.3887E 01
 -6.9764E 02 -3.1538E 01  2.3176E 02  1.9440E 01  2.6766E 02 -3.5799E 00 -4.5456E 02 -6.5103E 00  2.8251E 02  8.9503E 00
 -9.6574E 01 -5.2103E 00  0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.

ROW  14
 -1.3151E 02  3.3710E 00  5.1639E 02 -2.8059E 00 -6.8630E 02 -1.8196E 01  3.0095E 02  2.0501E 01  2.1543E 02 -5.1456E 00
 -9.5857E 02  6.9704E 00  1.2483E 03  2.9452E 01 -5.5610E 02 -3.6036E 01 -1.2577E 02  2.8289E 00  5.3123E 02 -2.7508E 00
 -7.2457E 02 -1.6163E 01  3.1676E 02  1.8436E 01  8.7939E 01 -1.5304E 00 -2.9530E 02  4.0006E-01  3.6949E 02  6.3263E 00
```

```
 0.         0.         0.         0.         0.         0.         0.         0.

ROW =15
 2.5733E 02 -1.0030E 01 -4.8466E 02 -8.8707E 00  2.5609E 02  2.0049E 01 -2.9884E 01 -4.8168E 00 -4.3398E 02  1.8357E 01
 8.8297E 02  1.2974E 01 -5.2959E 02 -3.7692E 01  8.1570E 01  1.0432E 01  2.4709E 02 -8.4484E 00 -4.6408E 02 -7.5156E 00
 2.7713E 02  1.6972E 01 -1.051 E 01 -3.4595E 00 -1.5822E 02  3.2897E 00  2.2951E 02  3.8219E 00 -4.4802E 01 -4.6171E 00
-2.6379E 01 -3.1114E-01  0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.

ROW =16
 2.9189E 02 -1.1961E 01 -7.9972E 02  2.1928E 00  7.8367E 02  1.8864E 01 -2.7622E 02 -1.2744E 01 -4.8470E 02  2.0924E 01
 1.4152E 03 -7.0528E 00 -1.4475E 03 -3.3044E 01  5.1765E 02  2.3544E 01  2.7927E 02 -9.9155E 00 -7.9722E 02  2.0247E 00
 7.9315E 02  1.6515E 01 -2.7546E 02 -1.1058E 01 -1.8613E 02  4.1966E 00  4.2539E 02  7.3774E-01 -3.5381E 02 -5.9360E 00
 1.1463E 02  3.2194E 00  0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.

ROW =17
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         1.4874E 02  8.5825E-02 -1.4858E 02 -7.5105E 00 -1.3241E 02 -3.1614E 00  1.3207E 02  9.7704E 00
 1.1124E 02 -2.2422E-01 -1.0115E 02 -4.8296E 00 -1.9256E 01 -8.1550E-01  1.9186E 01  1.7767E 00

ROW =18
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         7.8454E 00  1.2079E 01 -7.5390E 00 -1.2471E 01  5.3214E 00 -1.3812E 01 -5.6680E 00  1.3546E 01
 4.7754E 00  8.2047E 00 -4.5004E 00 -8.4395E 00  1.8605E 00 -2.2848E 00 -1.9181E 00  2.1919E 00

ROW =19
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         1.1409E 02 -6.7884E-01 -1.1401E 02 -5.0161E 00 -8.9860E 01 -2.6648E 00  8.9601E 01  7.1500E 00
 1.0613E 02 -3.9511E-01 -1.0605E 02 -4.9027E 00 -1.6178E 01 -8.5592E-01  1.6108E 01  1.6634E 00

ROW =20
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         7.8169E 00  8.7152E 00 -7.5971E 00 -9.1053E 00  5.8465E 00 -9.9190E 00 -6.0945E 00  9.6270E 00
 6.2826E 00  8.3237E 00 -6.0730E 00 -8.6373E 00  2.4078E 00 -2.1138E 00 -2.4606E 00  1.9935E 00

ROW =21
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         3.4365E 01 -1.3484E 00 -3.4409E 01 -3.6701E-01 -1.0400E 01 -1.1977E 00  1.0314E 01  1.7167E 00
 6.7 12E 01 -6.0923E-01 -6.6982E 01 -2.7360E 00  6.5885E 00 -4.1669E-01 -6.6089E 00  8.7728E-02

ROW =22
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         4.9007E 00  1.8190E 00 -4.8571E 00 -2.0636E 00  4.2096E 00 -2.0316E 00 -4.2593E 00  1.8214E 00
 6.515E 00   4.7852E 00 -5.9296E 00 -5.0873E 00  2.4128E 00  4.8592E-02 -2.4101E 00 -1.6905E-01

ROW =23
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
```

```
 0.            0.           -1.6762E 02 -3.3919E 00  1.6724E 02  1.1759E 01  3.0324E 02  4.1393E 00 -3.0267E 02 -1.9276E 01
-1.5643E 02 -3.1144E 00  1.5607E 02  1.0923E 01  6.9669E 01  8.1585E-01 -6.9944E 01 -4.2933E 00

ROW =24
 0.            0.            0.            0.            0.            0.            0.            0.            0.            0.
 0.            0.            0.            0.            0.            0.            0.            0.            0.            0.
 0.            0.            0.            0.            0.            0.            0.            0.            0.            0.
 0.            0.           4.2380E 00 -1.6859E 01 -4.6607E 00  1.6647E 01 -1.6720E 00  2.8860E 01  2.3963E 00 -2.8776E 01
 4.0806E 00 -1.5706E 01 -4.4734E 00  1.5502E 01 -3.8450E-01  6.5085E 00  5.4729E-01 -6.4892E 00
```

Sample Problem 3

A 45° delta wing-control surface combination is analyzed for M = 0.5 and f = 5.0 cps. There are 4 spanwise and 4 chordwise AIC control stations for both the wing and control surface. The planform geometry and AIC control station locations are shown in Figure 4.8. The input parameters are summarized below and a listing of the data input cards and computer output follows.

X(1) = 0.0' X(2) = 2.0' X(3) = 2.0' X(4) = 3.0' X(5) = 4.0'
Y(1) = 0.0' Y(2) = 0.0' Y(3) = 2.0'

SOUND = 1116.87 ft/sec

NMACH = 1	Number of Mach numbers
KF = 0	Input frequencies
NFREQ = 1	Number of frequencies
LCOLL = 1	Print collocation station coordinates
LPUNCH = 4	Punch cards for total AIC matrix
NWCX = 4	Number of chordwise AIC collocation stations on wing
NCCX = 4	Number of chordwise AIC collocation stations on control surface
NIONCX = 4	Factor for determining number of chordwise integration stations
NIY = 4	Number of spanwise AIC collocation stations
ISOLAT = 0	Surfaces are not isolated
FMACH(1) = 0.5	Mach number
FREQ(1) = 5.0	Frequency

YAIC(1,W) = 0.2' YAIC(2,W) = 0.6' YAIC(3,W) = 1.0'
YAIC(4,W) = 1.4'

YAIC(1,CS) = 0.25' YAIC(2,CS) = 0.75' YAIC(3,CS) = 1.25'
YAIC(4,CS) = 1.75'

XAIC(1,1,W) = 0.56'   XAIC(1,2,W) = 0.92'   XAIC(1,3,W) = 1.28'
XAIC(1,4,W) = 1.64'

XAIC(2,1,W) = 0.88'   XAIC(2,2,W) = 1.16'   XAIC(2,3,W) = 1.44'
XAIC(2,4,W) = 1.72'

XAIC(3,1,W) = 1.20'   XAIC(3,2,W) = 1.40'   XAIC(3,3,W) = 1.60'
XAIC(3,4,W) = 1.80'

XAIC(4,1,W) = 1.52'   XAIC(4,2,W) = 1.64'   XAIC(4,3,W) = 1.76'
XAIC(4,4,W) = 1.88'

XAIC(1,1,CS) = 3.125'   XAIC(1,2,CS) = 3.375'   XAIC(1,3,CS) = 3.625'
XAIC(1,4,CS) = 3.875'

XAIC(2,1,CS) = 3.125'   XAIC(2,2,CS) = 3.375'   XAIC(2,3,CS) = 3.625'
XAIC(2,4,CS) = 3.875'

XAIC(3,1,CS) = 3.125'   XAIC(3,2,CS) = 3.375'   XAIC(3,3,CS) = 3.625'
XAIC(3,4,CS) = 3.875'

XAIC(4,1,CS) = 3.125'   XAIC(4,2,CS) = 3.375'   XAIC(4,3,CS) = 3.625'
XAIC(4,4,CS) = 3.875'

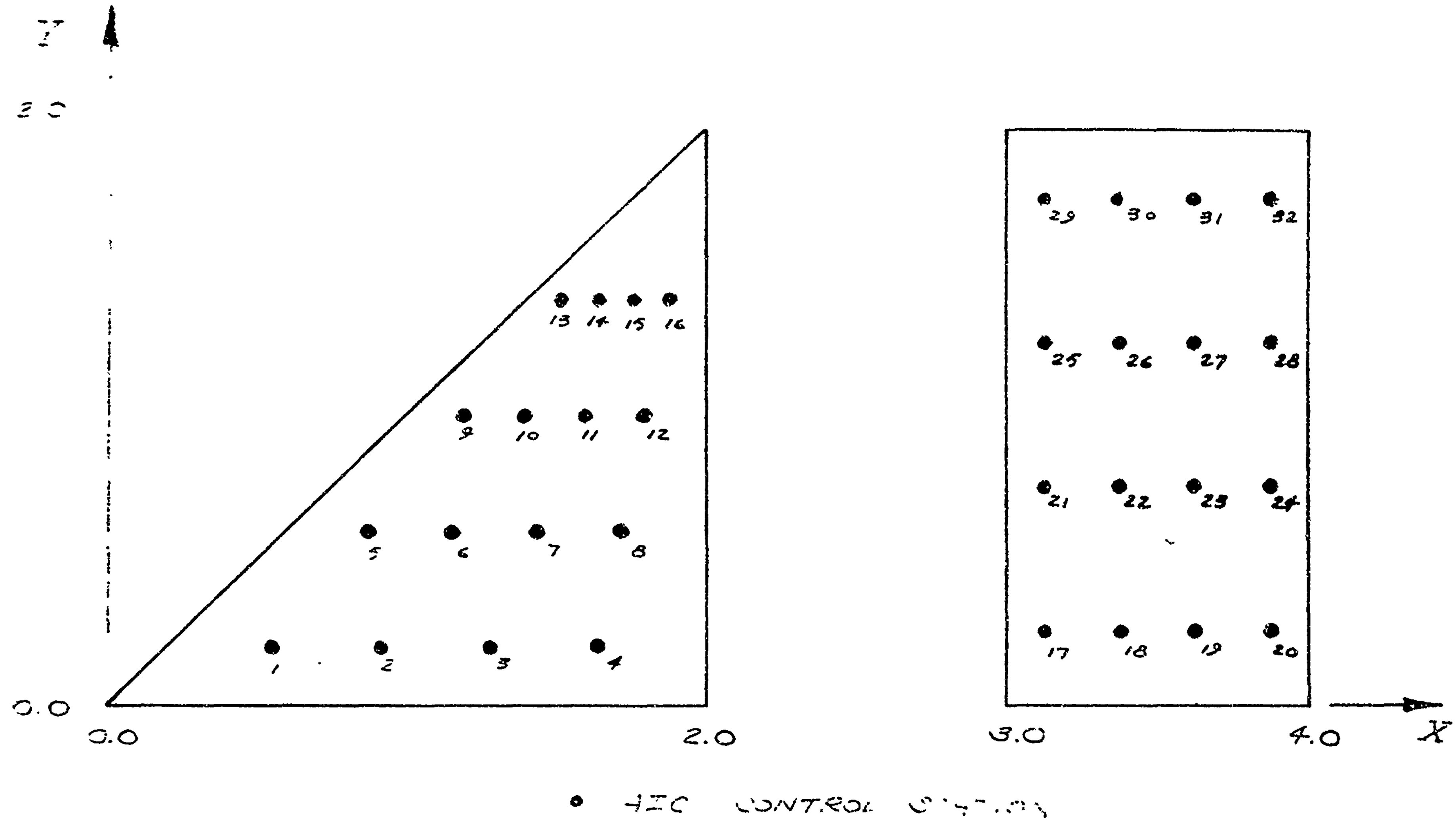


FIGURE 4.8 - SUBSONIC SAMPLE PROBLEM 2

```
                            DATA CARD COLUMN NUMBER
********************************************************************************
         11111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************



0.0       2.0       2.0       3.0       4.0
0.3       0.0       2.0       1116.87
         1         0         1         1         4
         4         4         4         4         0
0.5                                                                  MACH NO.
5.0                                                                  FREQ.
0.200     0.600     1.000     1.400                                  Y-WING
0.250     0.750     1.250     1.750                                  Y-TAIL
0.560     0.920     1.280     1.640     0.880     1.160              X-WING
1.440     1.720     1.200     1.400     1.600     1.800              X-WING
1.520     1.640     1.760     1.880                                  X-WING
3.125     3.375     3.625     3.875     3.125     3.375              X-TAIL
3.625     3.875     3.125     3.375     3.625     3.875              X-TAIL
3.125     3.375     3.625     3.875                                  X-TAIL



********************************************************************************
         11111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
                            DATA CARD COLUMN NUMBER
```

FIGURE 4.9 - LISTING OF INPUT DATA CARDS FOR SUBSONIC SAMPLE PROBLEM 3.

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM

FLIGHT CONDITIONS AND GEOMETRY

MACH NUMBER = 0.50000   SPEED OF SOUND = 1116.870 L/T   RHO=0.10000000E 01

	WING	TAIL
L.E. STATION (L)	0.	3.000
ROOT CHORD (L)	2.000	1.000
L.E. SPAN (L)	0.	2.000
T.E. SPAN (L)	2.000	2.000
TIP CHORD (L)	0.	1.000
TOTAL AREA (L*L)	4.000	4.000
SPAN COLL. STA.	4	4
CHORD COLL. STA.	4	4
CHORD INTG. STA.	16	16
SPAN PRES MODES	4	4
CHORD PRES MODES	4	4

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT-D)

UNSTEADY AERO COLLOCATION STATION COORDINATES ON THE WING

S STA NO	YC	XC VALUES--				
1	0.	0.276266E 00	0.952418E 00	0.165486E 01	0.199547E 01
2	0.765367E 00	0.935910E 00	0.135331E 01	0.178694E 01	0.199720E 01
3	0.141421E 01	0.149513E 01	0.169317E 01	0.189891E 01	0.199847E 01
4	0.184776E 01	0.186879E 01	0.192026E 01	0.197373E 01	0.199966E 01

INTEGRATION STATION COORDINATES ON THE WING

S STA NO	YI	XI VALUES--			
1	0.390181E 00	0.393825E 00	0.422785E 00	0.479658E 00	0.562389E 00
		0.667987E 00	0.792635E 00	0.931830E 00	0.108054E 01
		0.123339E 01	0.138485E 01	0.152946E 01	0.166198E 01
		0.177763E 01	0.187222E 01	0.194234E 01	0.198545E 01
2	0.111114E 01	0.111315E 01	0.112914E 01	0.116055E 01	0.120672E 01
		0.126453E 01	0.133336E 01	0.141021E 01	0.149232E 01
		0.157672E 01	0.166035E 01	0.174019E 01	0.181336E 01
		0.187722E 01	0.192945E 01	0.196816E 01	0.199197E 01
3	0.166294E 01	0.166370E 01	0.166977E 01	0.168167E 01	0.169960E 01
		0.172111E 01	0.174720E 01	0.177635E 01	0.180749E 01
		0.183949E 01	0.187120E 01	0.190148E 01	0.192923E 01
		0.195344E 01	0.197325E 01	0.198793E 01	0.199695E 01
4	0.196157E 01	0.196166E 01	0.196235E 01	0.196371E 01	0.196568E 01
		0.196820E 01	0.197118E 01	0.197450E 01	0.197805E 01
		0.198170E 01	0.198532E 01	0.198877E 01	0.199193E 01
		0.199469E 01	0.199695E 01	0.199862E 01	0.199965E 01

UNSTEADY AERO COLLOCATION STATION COORDINATES ON THE TAIL

S STA NO	YC	XC VALUES--			
1	0.	0.313813E 01	0.347621E 01	0.382743E 01	0.399774E 01
2	0.765367E 00	0.313813E 01	0.347621E 01	0.382743E 01	0.399774E 01
3	0.141421E 01	0.313813E 01	0.347621E 01	0.382743E 01	0.399774E 01
4	0.184776E 01	0.313813E 01	0.347621E 01	0.382743E 01	0.399774E 01

INTEGRATION STATION COORDINATES ON THE TAIL

S STA NO	YI	XI VALUES--			
1	0.390181E 00	0.300226E 01	0.302025E 01	0.305558E 01	0.310697E 01
		0.317257E 01	0.325000E 01	0.333647E 01	0.342884E 01
		0.352379E 01	0.361788E 01	0.370771E 01	0.379003E 01
		0.386187E 01	0.392063E 01	0.396418E 01	0.399096E 01
2	0.111114E 01	0.300226E 01	0.302025E 01	0.305558E 01	0.310697E 01
		0.317257E 01	0.325000E 01	0.333647E 01	0.342884E 01
		0.352379E 01	0.361788E 01	0.370771E 01	0.379003E 01
		0.386187E 01	0.392063E 01	0.396418E 01	0.399096E 01
3	0.166294E 01	0.300226E 01	0.302025E 01	0.305558E 01	0.310697E 01
		0.317257E 01	0.325000E 01	0.333647E 01	0.342884E 01
		0.352379E 01	0.361788E 01	0.370771E 01	0.379003E 01
		0.386187E 01	0.392063E 01	0.396418E 01	0.399096E 01
4	0.196157E 01	0.300226E 01	0.302025E 01	0.305558E 01	0.310697E 01
		0.317257E 01	0.325000E 01	0.333647E 01	0.342884E 01
		0.352379E 01	0.361788E 01	0.370771E 01	0.379003E 01
		0.386187E 01	0.392063E 01	0.396418E 01	0.399096E 01

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT-D)

AIC COLLOCATION STATION COORDINATES ON THE WING

YAIC	XAIC VALUES--			
0.200000E 00	0.560000E 00	0.920000E 00	0.128000E 01	0.164000E 01
0.600000E 00	0.880000E 00	0.116000E 01	0.144000E 01	0.172000E 01
0.100000E 01	0.120000E 01	0.140000E 01	0.160000E 01	0.180000E 01
0.140000E 01	0.152000E 01	0.164000E 01	0.176000E 01	0.188000E 01

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT-D)

AIC COLLOCATION STATION COORDINATES ON THE TAIL

YAIC	XAIC VALUES--			
0.250000E 00	0.312500E 01	0.337500E 01	0.362500E 01	0.387500E 01
0.750000E 00	0.312500E 01	0.337500E 01	0.362500E 01	0.387500E 01
0.125000E 01	0.312500E 01	0.337500E 01	0.362500E 01	0.387500E 01
0.175000E 01	0.312500E 01	0.337500E 01	0.362500E 01	0.387500E 01

HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT-D)

OSCILIATORY FREQUENCY (CPS) 5.00000E 00

REFERENCE CHORD 1.00000E 00

REDUCED FREQUENCY (REF. CHORD) 5.62571E-02

REDUCED VELOCITY (REF. CHORD) 1.77756E 01

FREE STREAM MACH NUMBER 5.00000E-01

FREE STREAM VELOCITY 5.58435E 02

DENSITY 1.00

DYNAMIC PRESSURE (1/2*RHO*VEL**2) 1.55925E 05

AERODYNAMIC INFLUENCE COEFFICIENTS

RL	IM	RL	IM	RL	IM	RL	IM	RL	IM
ROW = 1									
2.5673E 03	-2.9785E 01	-7.7904E 03	-4.5876E 01	8.4193E 03	2.0440E 02	-3.1958E 03	-1.3970E 02	-4.9141E 03	5.0985E 01
1.2869E 04	4.3412E 01	-1.2358E 04	-2.2343E 02	4.4032E 03	1.5052E 02	3.3245E 03	-2.6726E 01	-8.9088E 03	-2.6779E 00
9.2355E 03	7.3226E 01	-3.6510E 03	-5.9477E 01	-8.1422E 02	1.0365E 01	2.6406E 03	-2.8112E 01	-3.4314E 03	3.6715E 01
1.6751E 03	-1.4966E 01	4.4291E 00	-2.0916E-01	-1.0595E 01	8.5137E-01	2.0391E 01	-2.0327E 00	-1.4236E 01	1.2149E 00
7.2694E-01	-2.3879E-02	-2.0411E 00	1.7339E-01	4.3454E 00	-4.7356E-01	-3.0321E 00	2.8997E-01	2.5813E 00	-1.1019E-01
-6.7138E 00	5.5841E-01	1.3635E 01	-1.4009E 00	-9.5079E 00	8.4097E-01	7.6408E-01	-2.7008E-02	-2.3851E 00	1.9735E-01
5.2725E 00	-5.3522E-01	-3.6541E 00	3.2560E-01						
ROW = 2									
-3.[illegible]768E-02	7.5376E 00	-9.6302E 02	-5.0438E 00	2.0128E 03	2.0049E 01	-1.0495E 03	-2.4288E 01	-4.6365E 01	-6.6186E 00
1.[illegible]106E 03	5.5177E 00	-3.1298E 03	-2.9621E 01	1.5653E 03	3.1467E 01	6.4005E 01	3.7660E 00	-1.1280E 03	-2.9843E 00
2.[illegible]89E 03	1.1[illegible]18E 01	-1.0448E 03	-1.2304E 01	1.3121E 01	-4.6586E-01	1.4578E 02	2.2442E 00	-2.3786E 02	-4.0268E 00
7.[illegible]959E 01	1.6202E 00	1.2082E 00	-2.2042E-01	-4.2680E 00	9.2242E-01	9.8038E 00	-2.1423E 00	-6.7560E 00	1.3716E 00
5.[illegible]165E-01	-4.9175E-02	-1.2879E 00	2.0630E-01	2.4655E 00	-4.9277E-01	-1.6907E 00	3.1573E-01	1.1702E 00	-1.5044E-01
-3.[illegible]93E 00	6.4[illegible]67E-01	7.2114E 00	-1.5131E 00	-4.9709E 00	9.6830E-01	5.5073E-01	-5.9023E-02	-1.5362E 00	2.7458E-01
3.[illegible]593E 00	-6.5627E-01	-2.1776E 00	4.1625E-01						
ROW = 3									
-6.[illegible]413E 0[illegible]	2.2031E 01	1.4974E 03	-7.7901E 00	-9.1550E 02	-2.7591E 01	9.2526E 01	1.2217E 01	1.3025E 03	-2.8957E 01
-2.[illegible]514E 03	1.1957E 01	1.2856E 03	2.3651E 01	-5.6936E 01	-8.7148E 00	-8.5753E 02	1.3013E 01	1.6842E 03	-7.8314E 00
-9.[illegible]16E 0[illegible]	-6.8127E [illegible]	1.4363E 02	3.5957E 00	2.3793E 02	-1.4094E 00	-6.3986E 02	6.4704E 00	7.5844E 02	-9.8509E 00
-3.[illegible]52E 0[illegible]	3.4903E 0[illegible]	1.464[illegible]E 00	-2.0096E-01	-4.4114E 00	8.9416E-01	9.4105E 00	-2.1318E 00	-6.4762E 00	1.3685E 00
4.[illegible]125E-0[illegible]	-5.[illegible]321E-02	-1.1241E 00	2.1284E-01	2.2900E 00	-5.0107E-01	-1.5805E 00	3.2049E-01	1.1459E 00	-1.4560E-01
-3.[illegible]725E 0[illegible]	6.4241E-0[illegible]	6.8259E 00	-1.5306E 00	-4.7090E 00	9.8139E-01	5.2842E-01	-6.1521E-02	-1.4632E 00	2.8859E-01
2.[illegible]879E 0[illegible]	-6.8366E-0[illegible]	-2.0572E 00	4.3342E-01						
ROW = 4									
-1.[illegible]45E 03	[illegible]	5.[illegible]E 03	-5.3853E 01	-6.3603E 03	-6.8825E 01	2.3073E 03	5.5107E 01	3.4227E 03	-6.7138E 01
-9.[illegible]626E [illegible]3	[illegible]	[illegible]550E 03	7.5354E 01	-3.5564E 03	-5.9912E 01	-2.3198E 03	2.7931E 01	6.6552E 03	-2.3235E 01
-6.[illegible]16E 03	-2.4148E 0[illegible]	2.4663E 03	2.4525E 01	5.7895E 02	-1.1506E 00	-2.0137E 03	7.0142E 00	2.5907E 03	-8.2366E 00
-1.[illegible]	3.4[illegible]E-0[illegible]	[illegible]	-[illegible]582E-0[illegible]	-9.7291E [illegible]	8.7732E-01	1.5671E 01	-2.3302E 00	-1.1572E 01	1.3473E 00
3.[illegible]92E-0[illegible]	-4.4624E-02	-2.2978E 00	2.3468E-01	3.3703E [illegible]	-5.6300E-01	-2.3938E 00	3.4867E-01	2.2181E 00	-1.2075E-01
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.5498E-01	-5.8284E-02	-2.[illegible]191E 00	3.2242E-01

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  4.3971E 00 -7.8007E-01 -3.0374E 00  4.8182E-01

ROW = 5
  1.7828E 03 -2.0541E 01 -5.4233E 03 -3.0736E 01  5.9027E 03  1.3874E 02 -2.2619E 03 -9.8660E 01 -3.5440E 03  3.6887E 01
  9.2708E 03  2.8965E 01 -8.8956E 03 -1.5604E 02  3.1685E 03  1.0572E 02  2.9053E 03 -2.3204E 01 -7.6201E 03  1.9278E-01
  7.7771E 03  5.4610E 01 -3.0622E 03 -4.5656E 01 -7.3925E 02  8.4810E 00  2.2252E 03 -2.1771E 01 -2.7315E 03  2.8037E 01
  1.2456E 03 -1.1380E 01  5.2399E 00 -4.1110E-01 -1.3203E 01  1.6814E 00  2.6057E 01 -3.9697E 00 -1.8117E 01  2.4832E 00
  9.9515E-01 -7.6419E-02 -2.7562E 00  3.7215E-01  5.7702E 00 -9.2799E-01 -4.0118E 00  5.8688E-01  3.2677E 00 -2.5902E-01
 -8.7190E 00  1.1579E 00  1.7826E 01 -2.7946E 00 -1.2389E 01  1.7525E 00  1.0872E 00 -9.0476E-02 -3.2999E 00  4.6801E-01
  7.1522E 00 -1.1618E 00 -4.9460E 00  7.3066E-01

ROW = 6
  1.1520E 00  5.2419E 00 -6.6942E 02 -3.5382E 00  1.3979E 03  1.3829E 01 -7.2939E 02 -1.6790E 01 -3.4796E 01 -4.6350E 00
  1.1546E 03  4.0155E 00 -2.2355E 03 -2.1204E 01  1.1155E 03  2.2304E 01  5.4774E 01  2.7050E 00 -9.6806E 02 -2.6757E 00
  1.8022E 03  1.0513E 01 -8.8881E 02 -1.0883E 01  8.0612E 00 -3.0581E-02  1.2056E 02  1.6942E 00 -1.7268E 02 -3.5353E 00
  4.4074E 01  1.2465E 00  1.2011E 00 -1.8274E-01 -3.9101E 00  7.7147E-01  8.7121E 00 -1.8030E 00 -6.0132E 00  1.1511E 00
  4.4798E-01 -4.1164E-02 -1.1245E 00  1.7462E-01  2.1634E 00 -4.1820E-01 -1.4882E 00  2.6714E-01  1.0785E 00 -1.2545E-01
 -3.0537E 00  5.3861E-01  6.3631E 00 -1.2776E 00 -4.3951E 00  8.1539E-01  4.9377E-01 -4.9558E-02 -1.3533E 00  2.3129E-01
  2.7670E 00 -5.5415E-01 -1.9106E 00  3.5074E-01

ROW = 7
 -4.6615E 02  1.5235E 01  1.0358E 03 -5.5881E 00 -6.3568E 02 -1.8617E 01  6.6249E 01  8.2244E 00  9.3998E 02 -2.0515E 01
 -1.8313E 03  8.7439E 00  9.4260E 02  1.6269E 01 -5.1488E 01 -6.1016E 00 -7.5069E 02  1.0521E 01  1.4336E 03 -6.7567E 00
 -7.0213E 02 -3.5886E 00  9.9278E 01  1.7148E 00  2.1941E 02 -7.3018E-01 -5.6047E 02  4.7851E 00  6.4418E 02 -7.9819E 00
 -3.0312E 02  2.7021E 00  1.1282E 00 -1.3456E-01 -3.3320E 00  4.1258E-01  7.0628E 00 -1.4712E 00 -4.8680E 00  9.3988E-01
  3.2742E-01 -3.4203E-02 -8.6264E-01  1.4720E-01  1.7275E 00 -3.4848E-01 -1.1947E 00  2.2155E-01  9.0053E-01 -9.8367E-02
 -2.4932E 00  4.4155E-01  5.1361E 00 -1.0591E 00 -3.5502E 00  6.7572E-01  4.2134E-01 -4.2014E-02 -1.1208E 00  1.9884E-01
  2.2496E 00 -4.7310E-01 -1.5531E 00  2.9838E-01

ROW = 8
 -1.1832E 03  3.2339E 01  3.9887E 03 -2.3755E 01 -4.4091E 03 -4.6522E 01  1.6038E 03  3.7574E 01  2.4736E 03 -4.7571E 01
 -7.1189E 03  3.2783E 01  7.0706E 03  5.3717E 01 -2.4256E 03 -4.2937E 01 -2.0283E 03  2.3045E 01  5.6873E 03 -1.8528E 01
 -5.7140E 03 -1.9501E 01  2.0450E 03  1.9646E 01  5.4536E 02 -4.2312E-01 -1.7709E 03  4.2176E 00  2.1854E 03 -5.0728E 00
 -9.5988E 02 -6.0947E-01  3.0485E 00 -5.5704E-02 -6.3085E 00  4.3121E-01  1.0665E 01 -1.2178E 00 -7.4149E 00  7.4072E-01
  2.2574E-01 -2.0621E-02 -8.5297E-01  1.2304E-01  2.1633E 00 -3.0088E-01 -1.5425E 00  1.8187E-01  1.5071E 00 -5.1382E-02
 -3.6336E 00  3.4209E-01  7.0578E 00 -9.0191E-01 -4.9387E 00  5.5030E-01  5.4053E-01 -2.8091E-02 -1.4101E 00  1.7095E-01
  2.8269E 00 -4.1985E-01 -1.9596E 00  2.5407E-01

ROW = 9
  9.5645E 02 -1.1028E 01 -2.9560E 03 -1.4255E 01  3.2888E 03  6.9578E 01 -1.2891E 03 -4.9282E 01 -2.1012E 03  2.2125E 01
  5.4931E 03  1.4455E 01 -5.2529E 03 -8.7349E 01  1.8608E 03  5.9753E 01  2.1345E 03 -1.7277E 01 -5.4401E 03  3.8145E 00
  5.4405E 03  2.9088E 01 -2.1349E 03 -2.6469E 01 -2.0178E 02  4.3493E 00  6.4102E 02 -1.4115E 01 -8.5429E 02  2.0488E 01
  4.1509E 02 -9.5236E 00  5.9732E 00 -6.3946E-01 -1.5818E 01  2.6068E 00  3.1964E 01 -6.1158E 00 -2.2157E 01  3.8917E 00
  1.3079E 00 -1.3681E-01 -3.5606E 00  5.9535E-01  7.3288E 00 -1.4356E 00 -5.0846E 00  9.1894E-01  4.0121E 00 -4.2966E-01
 -1.0879E 01  1.8255E 00  2.2328E 01 -4.3375E 00 -1.5487E 01  2.7643E 00  1.4943E 00 -1.6494E-01 -4.3606E 00  7.6845E-01
  9.2413E 00 -1.8516E 00 -6.3858E 00  1.1777E 00

ROW =10
  1.7910E 00  2.7901E 00 -3.5619E 02 -1.7543E 00  7.4250E 02  6.8169E 00 -3.8800E 02 -8.5675E 00 -2.1692E 01 -2.5870E 00
  6.7372E 02  2.3095E 00 -1.2950E 03 -1.2112E 01  6.4283E 02  1.2585E 01  4.0095E 01  1.3762E 00 -6.8695E 02 -1.8096E 00
  1.2605E 03  8.0553E 00 -6.1365E 02 -7.6991E 00  1.0768E 01  4.6670E-01 -[illegible].1110E 01  8.5319E-01  1.4761E 02 -1.6493E 00
 -1.2725E 02 -3.2990E-01  1.0361E 00 -1.3484E-01 -3.1486E 00  5.7346E-01  6.8186E 00 -1.3491E 00 -4.7136E 00  8.5945E-01
  3.5474E-01 -3.1021E-02 -8.7702E-01  1.3222E-01  1.6831E 00 -3.1710E-01 -1.1619E 00  2.0201E-01  8.8880E-01 -9.3704E-02
 -2.4216E 00  4.0367E-01  4.9647E 00 -9.6149E-01 -3.4373E 00  6.1232E-01  4.0330E-01 -3.7577E-02 -1.0679E 00  1.7409E-01
  2.1520E 00 -4.1776E-01 -1.4898E 00  2.6401E-01

ROW =11
 -2.4824E 02  8.0778E 00  5.6376E 02 -3.2049E 00 -3.6576E 02 -9.6402E 00  5.0335E 01  4.4285E 00  5.5918E 02 -1.1765E 01
 -1.1013E 03  5.2493E 00  5.9033E 02  9.1900E 00 -4.8320E 01 -3.7070E 00 -5.5475E 02  4.8748E 00  1.0296E 03 -4.9056E 00
 -5.4277E 02 -3.9764E-01  6.7987E 01  9.3260E-02  8.2712E 01  7.2416E-01 -2.7071E 02  2.3278E 00  4.3459E 02 -5.4068E 00
 -2.4658E 02  1.4012E 00  5.8338E-01 -4.9287E-02 -1.6947E 00  2.4845E-01  3.5830E 00 -6.1294E-01 -2.4753E 00  3.8642E-01
  1.9610E-01 -1.3689E-02 -4.7295E-01  6.2117E-02  9.0159E-01 -1.4914E-01 -6.2563E-01  9.3031E-02  5.1069E-01 -3.7831E-02
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-1.?244E 00	1.8244E-01	2.6478E 00	-4.4768E-01	-1.8369E 00	2.8151E-01	2.5584E-01	-1.7010E-02	-6.1630E-01	8.4056E-02
1.?757E 00	-2.0277E-01	-8.1636E-01	1.2572E-01						

ROW =12

-6.??5E 02	1.7122E 01	2.1526E 03	-1.3304E 01	-2.4085E 03	-2.3440E 01	8.8816E 02	1.9622E 01	1.4750E 03	-2.7301E 01
-4.?492E 03	1.8771E 01	4.2308E 03	3.1599E 01	-1.4567E 03	-2.5555E 01	-1.4992E 03	1.5608E 01	4.0841E 03	-1.2223E 01
-4. 23E 03	-1.2208E 01	1.4274E 03	1.2668E 01	1.9472E 02	2.2165E 00	-6.9105E 02	-2.1085E-01	9.8534E 02	-2.5979E 00
-4.?898E 02	-6.7221E-01	1.0851E 00	6.9468E-02	-1.8820E 00	-1.5160E-01	2.6831E 00	2.2597E-01	-1.8864E 00	-1.7463E-01
5.?494E-02	1.0856E-02	-1.7922E-01	-2.0789E-02	4.9763E-01	4.0246E-02	-3.7156E-01	-3.4775E-02	5.2367E-01	4.0166E-02
-1.?153E 00	-8.4554E-02	1.7189E 00	1.3494E-01	-1.2277E 00	-1.0841E-01	2.1811E-01	1.1577E-02	-4.1485E-01	-2.2825E-02
6.?417E-01	4.3815E-02	-4.7705E-01	-3.6794E-02						

ROW =13

-4.?228E 03	5.6887E 01	1.3184E 04	6.4762E 01	-1.4183E 04	-3.4484E 02	5.2211E 03	2.3301E 02	1.0798E 04	-1.2236E 02
-2.8314E 04	-6.0205E 01	2.7306E 04	4.3190E 02	-9.7894E 03	-2.9774E 02	-8.2285E 03	7.4447E 01	2.1478E 04	-3.3629E 01
-2.?672E 04	-1.0100E 02	8.422?E 03	9.6452E 01	4.9774E 03	-4.1204E 01	-1.4292E 04	9.6451E 01	1.6877E 04	-1.2647E 02
-7.?621E 03	4.9455E 01	1.4143E 01	-1.9295E 00	-3.9119E 01	8.1451E 00	8.0080E 01	-1.9278E 01	-5.5228E 01	1.2439E 01
3.?792E 00	-4.8493E-01	-9.4176E 00	2.0005E 00	1.9255E 01	-4.6676E 00	-1.3351E 01	2.9981E 00	1.0294E 01	-1.4057E 00
-2.?153E 01	5.9176E 00	5.7702E 01	-1.3987E 01	-3.9935E 01	9.0199E 00	4.5863E 00	-6.1016E-01	-1.2399E 01	2.6735E 00
2.5133E 01	-6.2423E 00	-1.7358E 01	3.9805E 00						

ROW =14

7.?93?E 00	-1.1196E 01	1.5007E 03	4.4376E 00	-3.1304E 03	-2.4133E 01	1.6215E 03	3.3013E 01	1.1475E 02	1.2142E 01
-3.??78E 03	-1.0137E 01	6.8081E 03	5.9956E 01	-3.4045E 03	-6.3787E 01	-1.8567E 02	-3.7168E 00	2.6479E 03	3.5437E 00
-4.?867E 03	-2.2053E 01	2.3245E 03	2.2764E 01	6.5204E 01	1.2568E 00	-1.4605E 03	-4.2915E 00	2.6784E 03	1.0091E 01
-1.?632E 03	-6.7399E 00	1.8057E 00	1.0618E-01	-2.5961E 00	-3.5520E-01	2.8661E 00	6.9959E-01	-2.0732E 00	-4.9424E-01
-1.?117E-01	2.4670E-02	9.9616E-02	-6.8280E-02	2.1133E-01	1.4632E-01	-1.9282E-01	-1.0385E-01	4.8233E-01	7.3410E-02
-7.?679E-01	-2.3396E-01	1.2712E 00	4.8585E-01	-9.5484E-01	-3.4126E-01	-8.4124E-03	2.8200E-02	-3.5497E-02	-1.0290E-01
1.?492E-01	2.2848E-01	-1.4958E-01	-1.5518E-01						

ROW =15

1.?363E 03	-3.5887E 01	-2.737?E 03	1.1241E 01	1.9651E 03	5.5479E 01	-3.6473E 02	-2.8835E 01	-2.8511E 03	6.0016E 01
5.?647E 03	-2.6845E 01	-2.8733E 03	-4.6932E 01	1.6016E 02	1.8463E 01	2.1346E 03	-2.4961E 01	-4.1721E 03	1.7917E 01
2.?721E 03	7.6722E 00	-4.3473E 02	-6.6150E 00	-1.2718E 03	7.4944E 00	2.7094E 03	-1.8993E 01	-2.1497E 03	2.4858E 01
7.?211E 02	-9.6715E 00	-7.4020E-01	3.2179E-01	3.3049E 00	-1.3240E 00	-7.9245E 00	3.0722E 00	5.3794E 00	-2.0202E 00
-4.?35E-01	8.3988E-02	1.1?19E 00	-3.2535E-01	2.1730E 00	7.4214E-01	1.4860E 00	-4.8382E-01	-9.3099E-01	2.3910E-01
2.??11E 00	-9.6785E-01	-6.2?35E 00	2.2454E 00	4.2394E 00	-1.4718E 00	-5.9007E-01	1.0470E-01	1.5351E 00	-4.4896E-01
-2.?816E 00	1.0357E 00	2.0429E 00	-6.6775E-01						

ROW =16

2.?767E 03	-7.7500E 01	-1.0093E 04	5.7141E 01	1.1441E 04	1.2549E 02	-4.2243E 03	-1.0281E 02	-7.5185E 03	1.4046E 02
2.?623E 04	-9.8371E 01	-2.1475E 04	-1.5772E 02	7.3722E 03	1.2804E 02	5.8412E 03	-5.7742E 01	-1.6278E 04	4.7005E 01
1.?297E 04	5.2158E 01	-5.8612E 03	-5.5666E 01	-3.3464E 03	1.3469E 01	9.9252E 03	-2.8318E 01	-1.0927E 04	2.1124E 01
4.?478E 03	1.2531E 00	-6.5?79E 00	5.0583E-01	1.4692E 01	-2.2959E 00	-2.6248E 01	5.6489E 00	1.8106E 01	-3.6279E 00
-3.?246E-01	1.3552E-01	2.0194E 00	-6.0403E-01	-5.5478E 00	1.4008E 00	3.9310E 00	-8.9352E-01	-3.2039E 00	3.8498E-01
8.?926E 00	-1.7371E 00	-1.7861E 01	4.1747E 00	1.2404E 01	-2.6800E 00	-1.3418E 00	1.7793E-01	3.7144E 00	-8.2538E-01
-7.?471E 00	1.9269E 00	5.1861E 00	-1.2231E 00						

ROW =17

-2.?766E 02	1.7164E 01	?.3656E 03	-1.3206E 02	-5.0104E 03	2.7296E 02	2.9241E 03	-1.3558E 02	4.4566E 02	-2.3438E 01
-3.?519E 03	1.9876E 02	?.3621E 03	-4.1074E 02	-4.8576E 03	2.0716E 02	-3.4383E 02	2.1404E 01	2.8840E 03	-1.6737E 02
-6.?827E 03	3.4867E 02	3.5436E 03	-1.8757E 02	6.9926E 01	7.8264E-01	-7.8320E 02	1.8608E 01	1.6728E 03	-4.1729E 01
-9.?96?E 02	2.0205E 01	3.4853E 03	-2.1451E 01	-7.6048E 03	-2.7020E 01	6.3626E 03	7.3998E 01	-2.2430E 03	-4.8154E 01
-4.?92?E 03	2.9916E ?1	1.0663E 04	4.4581E 01	-8.6131E 03	-1.2430E 02	2.8423E 03	7.7423E 01	2.9092E 03	-1.7963E 01
-6.?625E 0?	-2.3233E 01	5.2?5 E 03	4.4505E 0?	-1.8217E 03	-4.1280E 01	-7.0289E 02	4.2435E 00	1.5375E 03	7.5715E 00
-3.?154E ?3	-2.2154E ??	3.5?74E 02	?.2842E 01						

ROW =18

-4.7286E 01	3.1764E 00	3.9558E 02	-2.3552E 01	-8.3832E 02	4.8799E 01	4.9024E 02	-2.4605E 01	6.8332E 01	-3.6674E 00
-6.?897E 02	3.?992E 01	?.2896E 03	-6.4077E 01	-7.4920E 02	3.2399E 01	-5.5649E 01	3.6730E 00	4.6073E 02	-2.8043E 01
-9.?249E 02	5.8563E 01	5.6758E 02	-3.1741E 01	4.1626E 00	9.5094E-01	-8.3263E 01	-1.6746E 00	1.8166E 02	2.7768E 00

NOT REPRODUCIBLE

-9.[illegible]496E 02	5.4501E 0[illegible]	4.1637E 03	-5.2199E-01	-5.8196E 03	-4.8602E 01	2.5906E 03	4.7850E 01	5.4909E 02	-2.8334E 00
-2.[illegible]907E 03	8.0441E-0[illegible]	3.5495E 03	2.7249E 01	-1.6078E 03	-2.8248E 01	-1.3413E 02	8.5698E-01	5.9941E 02	1.8293E-01
-6.[illegible]741E 02	-7.8756E 0[illegible]	3.6209E 02	7.2713E 00						
ROW =19									
4.[illegible]E 0[illegible]	-2.1810E 0[illegible]	-3.7455E 02	1.8540E 01	7.9232E 02	-3.8099E 01	-4.6042E 02	1.8291E 01	-8.2628E 01	4.3365E 00
7.[illegible]33E 02	-3.7[illegible]61E 0[illegible]	-1.5371E 03	7.6580E 01	8.9276E 02	-3.8656E 01	5.5182E 01	-3.1123E 00	-4.7595E 02	2.5782E 01
1.[illegible]24E 03	-5.3437E 0[illegible]	-5.8174E 02	2.8339E 01	-2.2849E 01	1.3424E 00	1.9401E 02	-1.1212E 01	-4.0757E 02	2.3381E 01
2.[illegible]45E 02	-1.2917E 0[illegible]	-1.3205E 03	1.6849E 01	2.1047E 03	5.6222E 00	-4.7444E 02	-1.9436E 01	-3.0953E 02	1.5817E-01
1.[illegible]325E 03	-2.2201E 01	-3.0822E 03	-9.0241E 00	8.9286E 02	2.8745E 01	3.0661E 02	-2.8146E 00	-1.1080E 03	1.3695E 01
1.[illegible]869E 03	5.3765E 0[illegible]	-4.4703E 02	-1.6805E 01	-2.3168E 02	8.1385E-01	2.7411E 02	-3.0786E 00	-4.5736E 02	-1.4536E 00
1.[illegible]986E 02	4.3495E 0[illegible]	3.3350E 01	-6.2692E-01						
ROW =20									
8.[illegible]E 0[illegible]	-4.7162E 0[illegible]	-7.2823E 02	3.8361E 01	1.5413E 03	-7.9052E 01	-8.9719E 02	3.8612E 01	-1.5077E 02	8.0150E 00
1.7312E 03	-6.8373E 0[illegible]	-7.8148E 03	1.4134E 02	1.6349E 03	-7.1461E 01	1.0435E 02	-6.1964E 00	-8.9125E 02	5.0190E 01
1.[illegible]781E 03	-1.0425E 02	-1.0915E 03	5.5666E 01	-3.2648E 01	1.3179E 00	3.0245E 02	-1.4259E 01	-6.3873E 02	3.0093E 01
3.6897E 02	-1.6262E 01	-2.6063E 03	3.1754E 01	6.8721E 03	-1.0718E 01	-6.3885E 03	-4.1347E 01	2.1229E 03	2.6833E 01
3.[illegible]452E 03	-4.3689E 0[illegible]	-9.9321E 03	1.3163E 01	9.3094E 03	6.2797E 01	-3.1228E 03	-4.1858E 01	-2.1920E 03	2.6246E 01
5.[illegible]74E 03	-8.3538E 0[illegible]	-5.4247E 03	-3.6060E 01	1.8095E 03	2.3601E 01	5.4268E 02	-6.1483E 00	-1.4529E 03	1.3706E 00
1.[illegible]729E 03	1.0263E 01	-4.6267E 02	-6.8235E 00						
ROW =21									
-1.[illegible]463E 02	1.1055E 0[illegible]	1.3866E 03	-8.1074E 01	-2.9355E 03	1.6735E 02	1.7146E 03	-8.4055E 01	2.7759E 02	-1.4588E 01
-2.[illegible]735E 03	1.2247E 02	5.2313E 03	-2.5227E 02	-3.0365E 03	1.2681E 02	-2.7208E 02	1.6705E 01	2.3107E 03	-1.3253E 02
-4.[illegible]331E 03	2.7563E 02	2.8453E 03	-1.4868E 02	2.9266E 01	3.6733E 00	-5.0763E 02	-1.4170E 00	1.0999E 03	1.2809E-01
-6.[illegible]53E 02	-3.5480E 00	2.0386E 03	-1.2580E 01	-4.4601E 03	-1.4292E 01	3.7757E 03	3.9014E 01	-1.3541E 03	-2.5801E 01
-2.[illegible]379E 03	1.7897E 01	6.4[illegible]77E 03	2.7009E 01	-5.1578E 03	-7.5374E 01	1.6879E 03	4.6730E 01	2.2048E 03	-1.3700E 01
-4.[illegible]92E 03	-1.7185E 0[illegible]	4.0207E 03	4.7641E 01	-1.4062E 03	-3.0775E 01	-5.3285E 02	3.2073E 00	1.1658E 03	5.9644E 00
-9.[illegible]85[illegible]E 02	-1.6742E 01	2.7553E 02	1.0039E 01						
ROW =22									
-2.[illegible]646E 01	2.1446E 0[illegible]	2.3579E 02	-1.5065E 01	-4.9956E 02	3.1196E 01	2.9260E 02	-1.5971E 01	4.1775E 01	-2.2550E 00
-3.[illegible]574E 02	1.8841E 0[illegible]	7.9554E 02	-3.8820E 01	-4.6174E 02	1.9568E 01	-4.3297E 01	2.8412E 00	3.6453E 02	-2.2008E 01
-7.[illegible]131E 02	4.6[illegible]64E 0[illegible]	4.5022E 02	-2.4962E 01	-4.1075E 00	1.4876E 00	-2.6701E 01	-5.4707E 00	6.3762E 01	1.0735E 01
-3.[illegible]226[illegible] 0[illegible]	-6.7386E 0[illegible]	3.8332E 02	-1.7022E 00	-1.7471E 03	8.0924E-01	2.5222E 03	1.7823E 01	-1.1583E 03	-1.9430E 01
-5.[illegible]565E 02	3.3985E 0[illegible]	2.5001E 03	-3.1857E-01	-3.4744E 03	-2.9156E 01	1.5398E 03	2.8482E 01	4.1184E 02	-2.0035E 00
[illegible].[illegible]892E 03	6.3365E-01	2.7154E 03	2.0591E 01	-1.2379E 03	-2.1647E 01	-1.0260E 02	7.1216E-01	4.5302E 02	1.5586E-01
-6.[illegible]598E 02	-6.0598E 0[illegible]	2.6653E 02	5.4552E 00						
ROW 23									
2.[illegible]306E 01	-1.2[illegible]49E 00	-2.1566E 02	1.0332E 01	4.5582E 02	-2.1143E 01	-2.6458E 02	1.0055E 01	-5.3377E 01	2.7796E 00
4.[illegible]874E 02	-2.3568E 01	-9.8981E 02	4.8588E 01	5.7465E 02	-2.4456E 01	4.4891E 01	-2.4805E 00	-3.8740E 02	2.0742E 01
3.[illegible]6[illegible]E 02	-4.3[illegible]45E 01	-4.7422E 02	2.2799E 01	-2.1084E 01	1.1375E 00	1.8246E 02	-9.8811E 00	-3.8421E 02	2.0638E 01
2.[illegible]286E 02	-1.1338E 01	-7.6773E 02	9.8946E 00	1.2205E 03	3.2072E 00	-2.6389E 02	-1.1276E 01	-1.8876E 02	-4.8823E-02
1.[illegible]719E 03	-1.3145E 01	-1.8634E 03	-5.5085E 00	5.6233E 02	1.7345E 01	1.6900E 02	-1.9500E 00	-8.3767E 02	1.0588E 01
[illegible].[illegible]795E 03	3.7546E 00	-3.0841E 02	-1.2658E 01	-1.9333E 02	3.2097E-01	2.0916E 02	-2.2580E 00	-3.5316E 02	-1.1529E 00
1.[illegible]556E 02	3.3662E 00	1.8444E 01	-6.1242E-01						
ROW =24									
4.[illegible]	-2.8246E 0[illegible]	-4.2460E 02	2.2433E 01	8.9805E 02	-4.6108E 01	-5.2262E 02	2.2544E 01	-9.6253E 01	5.0930E 00
8.4996E 02	-4.3[illegible]64E 01	-[illegible].7959E 03	6.8837E 01	1.0426E 03	-4.4790E 01	8.3759E 01	-4.8898E 00	-7.1872E 02	4.0040E 01
1.[illegible]164E 03	-8.3294E 0[illegible]	-8.5[illegible]7[illegible]E 02	4.4431E 01	-2.6491E 01	7.9830E-01	2.6097E 02	-1.0729E 01	-5.5326E 02	2.2757E 01
3.[illegible]861E 02	-1.2079E 01	-1.5192E 03	1.8573E 01	4.0048E 03	-6.4647E 00	-3.7209E 03	-2.3556E 01	1.2354E 03	1.5232E 01
2.[illegible]592E 03	-2.61[illegible]3E 0[illegible]	-5.9967E 03	7.7657E 00	5.6298E 03	3.7915E 01	-1.8924E 03	-2.5406E 01	-1.6496E 03	2.0032E 01
4.[illegible]549E 03	-6.47[illegible]8E 0[illegible]	-4.0671E 03	-2.7107E 01	1.3519E 03	1.7575E 01	4.1525E 02	-4.6122E 00	-1.1143E 03	9.5621E-01
1.[illegible]568E 03	7.9754E 0[illegible]	-3.5774E 02	-5.3590E 00						
ROW =25									
-4.[illegible]335E 01	4.2571E 0[illegible]	5.734[illegible]E 02	-2.6615E 01	-7.8906E 02	5.4662E 01	4.6234E 02	-2.8633E 01	7.6665E 01	-3.3461E 00
-7.[illegible]348E 02	3.2508E 01	1.5301E 03	-6.6090E 01	-8.8384E 02	3.2491E 01	-8.3597E 01	5.0706E 00	7.9930E 02	-4.4123E 01

7.[illegible]40E 02	-8.1676E 01	5.7182E 02	-3.6491E 00	-1.2681E 03	-1.6459E 00	1.1338E 03	4.4608E 00	-4.3757E 02	-3.5693E 00
-9.[illegible]407E 02	5.4868E 00	1.9970E 03	8.8250E 00	-1.5819E 03	-2.4717E 01	4.9897E 02	1.5050E 01	1.1474E 03	-7.2727E 00
-2.5[illegible]69E 03	-8.[illegible]815E 00	2.1301E 03	2.2380E 01	-7.7055E 02	-1.4880E 01	-8.7949E 01	4.3377E-01	1.9429E 02	1.7087E 00
-1.[illegible]277E 02	-4.8718E 00	6.4181E 00	2.5612E 00						

ROW =26

-8.[illegible]38E 0[illegible]	9.6[illegible]16E-[illegible]1	6.8351E 01	-5.7602E 00	-1.4468E 02	1.1907E 01	8.5319E 01	-6.4041E 00	1.0211E 01	-5.4684E-01
-1.[illegible]89E 02	4.5689E 00	2.1410E 02	-9.2599E 00	-1.2347E 02	4.5518E 00	-1.2296E 01	8.8346E-01	1.1833E 02	-7.3361E 00
-2.5396E 02	1.5566E 01	1.4797E 02	-8.5044E 00	-2.8065E 01	2.8261E 00	1.6006E 02	-1.6169E 01	-3.2922E 02	3.3230E 01
1.[illegible]728E 02	-1.9257E 01	1.1013E 02	-4.1617E-01	-4.9705E 02	6.6486E-01	7.2970E 02	3.5009E 00	-3.4275E 02	-4.6771E 00
-1.[illegible]38E 02	1.2096E 00	7.7671E 02	-8.6070E-02	-1.0559E 03	-9.1239E 00	4.5957E 02	8.6143E 00	2.0930E 02	-8.5629E-01
-9.[illegible]65E 02	4.1279E-01	1.4486E 03	1.0478E 01	-6.7114E 02	-1.1485E 01	-2.1769E 01	3.1282E-01	7.0896E 01	9.7942E-02
-6.[illegible]766E 0[illegible]	-1.2210E 00	1.6641E 01	6.3969E-01						

ROW =27

5.[illegible]52E 0[illegible]	-2.1918E-01	-5.4193E 01	2.0154E 00	1.1411E 02	-4.0063E 00	-6.5774E 01	1.7402E 00	-1.8434E 01	9.0384E-01
1.[illegible]286E 02	-7.7033E 00	-3.4337E 02	1.5781E 01	1.9899E 02	-7.8344E 00	1.7471E 01	-8.3420E-01	-1.5870E 02	7.6904E 00
3.[illegible]555E 02	-1.5983E 01	-1.9436E 02	8.3331E 00	-3.6292E 00	-8.2933E-03	4.3525E 01	-9.8609E-01	-9.2307E 01	2.0473E 00
5.[illegible]412E 01	-9.4397E-01	-2.0907E 02	2.8245E 00	3.2839E 02	7.8340E-01	-5.6259E 01	-3.0239E 00	-6.3022E 01	-2.0751E-01
3.[illegible]437E 02	-3.8694E 00	-5.9496E 02	-1.8343E 00	2.0596E 02	5.5222E 00	3.4592E 01	-9.3292E-01	-4.3254E 02	5.7845E 00
6.[illegible]695E 02	1.8078E 0[illegible]	-1.2002E 02	-6.4395E 00	-1.2431E 02	-2.5392E-01	3.7939E 01	-9.8994E-02	-7.8973E 01	-3.3088E-01
6.[illegible]930E 01	7.1402E-01	-2.0890E 01	-5.3439E-01						

ROW =28

1.2989E 01	-8.1266E-01	-1.1312E 02	5.9237E 00	2.3863E 02	-1.2027E 01	-1.3856E 02	5.8772E 00	-3.1400E 01	1.5813E 00
2.8255E 02	-1.3431E 01	-5.9641E 02	2.7484E 01	3.4537E 02	-1.3659E 01	3.0844E 01	-1.6448E 00	-2.8252E 02	1.4677E 01
5.9908E 02	-3.0667E 01	-3.4749E 02	1.6207E 01	8.0918E 00	-1.3603E 00	-1.3505E 01	6.2712E 00	2.3732E 01	-1.2846E 01
-1.[illegible]347E 01	7.7929E 00	-4.1899E 02	5.2152E 00	1.1039E 03	-2.1141E 00	-1.0231E 03	-5.6867E 00	3.3829E 02	3.6045E 00
7.[illegible]466E 02	-7.9693E 00	-1.9032E 03	2.2354E 00	1.7971E 03	1.2104E 01	-6.0866E 02	-8.2671E 00	-8.4332E 02	1.0611E 01
2.[illegible]253E 03	-3.6016E 00	-2.0608E 03	-1.3696E 01	6.7895E 02	8.6617E 00	8.3177E 01	-5.7338E-01	-2.2995E 02	-9.3523E-02
2.[illegible]45E 02	1.7899E 0[illegible]	-8.3667E 01	-1.4052E 00						

ROW =29

3.[illegible]46E 02	-1.7125E 01	-3.2874E 03	1.4814E 02	6.9453E 03	-3.0215E 02	-4.0301E 03	1.4116E 02	-8.3892E 02	4.3098E 01
7.[illegible]482E 03	-3.6337E 02	-1.5516E 04	7.4868E 02	9.0099E 03	-3.7590E 02	6.7782E 02	-3.6124E 01	-5.8145E 03	3.0102E 02
1.[illegible]244E 04	-6.2325E 02	-7.1388E 03	3.2858E 02	-3.7303E 02	2.2725E 01	3.1078E 03	-1.8109E 02	-6.5337E 03	3.7705E 02
3.[illegible]996E 03	-2.0898E 02	-4.8347E 03	2.9131E 01	1.0538E 04	4.5923E 01	-8.4763E 03	-1.2740E 02	2.7729E 03	7.9139E 01
8.[illegible]919E 03	-5.5986E 01	-1.9617E 04	-7.9469E 01	1.5923E 04	2.2150E 02	-5.2981E 03	-1.3850E 02	-5.3059E 03	3.2351E 01
1.[illegible]575E 04	4.9659E 01	-9.3370E 03	-1.3859E 02	3.0670E 03	8.6167E 01	1.8045E 03	-1.1185E 01	-3.9625E 03	-1.5767E 01
3.[illegible]558E 03	4.4208E 01	-1.0976E 03	-2.7722E 01						

ROW =30

5.[illegible]677E 01	-2.4910E 0[illegible]	-4.9859E 02	2.2077E 01	1.0533E 03	-4.4995E 01	-6.1080E 02	2.0883E 01	-1.2893E 02	6.6586E 00
1.[illegible]283E 03	-5.6254E 01	-2.3822E 03	1.1594E 02	1.3833E 03	-5.8284E 01	1.0168E 02	-5.3931E 00	-8.7417E 02	4.5254E 01
1.[illegible]3E 03	-9.3649E 0[illegible]	-1.0681E 03	4.9323E 01	-5.8890E 01	3.7917E 00	4.8262E 02	-2.9371E 01	-1.0135E 03	6.1059E 01
5.[illegible]984E 02	-3.3962E 01	-9.2999E 02	5.4953E 00	4.1147E 03	-2.8464E-01	-5.7229E 03	-4.8551E 01	2.5379E 03	4.7325E 01
1.[illegible]1E 0[illegible]	-9.8874E 00	-7.6616E 03	1.3821E 00	1.0730E 04	8.7834E 01	-4.7880E 03	-8.7301E 01	-1.0109E 03	5.9478E 00
4.[illegible]228E 03	-4.0801E-01	-6.3203E 03	-5.3595E 01	2.8142E 03	5.2462E 01	3.3754E 02	-1.8534E 00	-1.5508E 03	1.6672E-01
2.[illegible]46E 03	1.834[illegible]E 01	-9.9129E 02	-1.8280E 01						

ROW =31

-7.[illegible]98E 0[illegible]	3.6160E [illegible]	5.3146E 02	-3.0285E 01	-1.3345E 03	6.1938E 01	7.7506E 02	-2.9465E 01	1.5455E 02	-8.1112E 00
-[illegible]582E 03	6.8518E [illegible]	2.8687E 03	-1.4125E 02	-1.6657E 03	7.1152E 01	-1.2133E 02	6.6841E 00	1.0436E 03	-5.5557E 01
-2.[illegible]287E 03	1.1517E 02	1.2767E 03	-6.0947E 01	5.4776E 01	-3.0210E 00	-4.7829E 02	2.6067E 01	1.0076E 03	-5.4422E 01
5.[illegible]42[illegible] 02	2.9923E 01	[illegible].6625E 03	-2.1650E 01	-3.0617E 03	-9.2571E 00	9.1385E 02	2.9029E 01	2.8509E 02	-3.4468E 00
-3.[illegible]927E 03	4.3932E [illegible]	5.5459E 03	1.6383E 01	-1.[illegible]137E 03	-5.2496E 01	-5.7908E 02	4.7577E 00	2.0452E 03	-2.4012E 01
-3.[illegible]15E 03	-1.0[illegible]95E [illegible]	9.7231E 02	3.2027E 01	3.3399E 02	-3.5150E 00	-6.9350E 02	8.3838E 00	1.1299E 03	3.4134E 00
-3.[illegible]25E 02	-1.3753E [illegible]	-1.3219E 02	7.1500E-01						

ROW =32

-1.2962E 02	6.4139E 00	1.1452E 03	-5.4467E 01	-2.4199E 03	1.1136E 02	1.4050E 03	-5.2818E 01	2.8230E 02	-1.4873E 01
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

-3.[illegible]25E 0[illegible]	2.0709E 02	2.2945E 03	-1.0953E 02	1.0152E 02	-5.8813E 00	-8.7547E 02	4.9387E 01	1.8428E 03	-1.0297E 02
-[illegible].[illegible]59[illegible]E 0[illegible]	5.6790E 01	3.7169E 03	-4.2925E 01	-9.8610E 03	1.2447E 01	9.2502E 03	6.3215E 01	-3.1063E 03	-4.2293E 01
-6.[illegible]73[illegible]E 0[illegible]	8.0350E [illegible]	[illegible].8224E 04	-2.4602E 01	-1.7077E 04	-1.1418E 02	5.7265E 03	7.5999E 01	4.0589E 03	-4.7270E 01
-[illegible].[illegible]84E [illegible]4	1.3519E [illegible]	1.0117E 04	7.0204E 01	-3.3922E 03	-4.6667E 01	-1.3615E 03	1.6095E 01	3.6355E 03	-4.2501E 00
-3.[illegible]58E 0[illegible]	-2.4606E 0[illegible]	1.1419E 03	1.5990E 01						

PART IV - SECTION B4.0

LISTING OF SUBSONIC AIC COMPUTER PROGRAM

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CMAIN      MAIN
      COMPLEX A,AA,ANM,CZERO,WASH,AIC
      DIMENSION TEMP(40,40),AIC(40,80),WASH(40),FM(40,40)
      COMMON/C1/A(80),AA(40,80),ANM(40,40),CZERO
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WI(90),
     2          XE(5),YE(3),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA( 1)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(10,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C4/CLEN,NGSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6          NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,QWCX,CXMN,IMOD,IROW,
     8          EM,FK,B2,NWIX,NCIX,CRON,NWCY,IFR,E1,E2,QWY,QWWX,
     9          SN,WBO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      COMMON/C5/LPUNCH,KF
      EQUIVALENCE (AA,AIC),(A,WASH),(FM,T)
C ***
C ***
      WRITE(6,66)
   66 FORMAT(1H1)
    1 CALL KEDA
      FW = 2*NWIX + 1
      FC = 2*NCIX + 1
      QWWX = 2.0*PI/FW
      QWCX = 2.0*PI/FC
      QWY = PI/FLOAT(2*NIY)
      CALL GEOM
      CALL TRAMP(NIY,NWCX,NCCX,NXWING,NYWING,NXCS,NYCS,2,WBO,SN)
      NRS=NIY*(NWCX+NCCX)
      NCS=NXWING*NYWING+NXCS*NYCS
      DO 200 NIT=1,NRS
      DO 200 MIT=1,NCS
  200 TEMP(NIT,MIT)=TR(NIT,MIT)
      CALL TRAMP(NIY,NWCX,NCCX,NXWING,NYWING,NXCS,NYCS,1,WBO,SN)
      DO 201 NIT=1,NRS
      DO 201 MIT=1,NCS
  201 TR(NIT,MIT)=TEMP(NIT,MIT)
      DO 100 MACH=1,NMACH
      MACH = MACH
      EM = FMACH(MACH)
      U = EM*SOUND
      ROU = WBO/U
      B2 = 1.0 - EM*EM
      CALL KOUT(1)
      IF (LCOLL .NE. 0) CALL KOUT(2)
      DO 100 IFR=1,NFREQ
      IFR = IFR
      IF (KF .EQ. 1) FREQ(IFR)=FREQ(IFR)*U/(WBO*2.0*PI)
      FK=2.0*PI*FREQ(IFR)*WBO/U
C     NSURF = 1 (WING) OR 2 (CONTROL SURFACE)
      NCX = NWCX
      MOMIT = 1
      NMODES = NXWING*NYWING + NXCS*NYCS
      MAUG = NCOLS + NMODES
      DO 4 J=1,NCOLS
      TI(J) = 0
      DO 4 K=1,MAUG
    4 AA(J,K) = CZERO
      IROW = 1
      DO 15 NSURF=1,2
```

```
      NSURF = NSURF
      DO 14 IY=1,NIY
      IIY = IY
      IF(NOMIT-MOMIT.LT.0)  GO TO 7
      IF(IY-NOM(MOMIT).EQ.0)  GO TO 13
 7      YCOLL = SN*Y(IY)
      DO 12 IX=1,NCX
      IIX = IX
      XCOLL= XS(1,NSURF,IX,IY)
      CALL CORD
      DO 50 M=1,NMODES
      SR = TR(IROW,M)
      SI = TI(IROW,M)*FK/WBO
      MNC = NCOLS + M
 50   WASH(MNC) = CMPLX(SR,SI)
      DO 60 N=1,NCOLS
 60   CALL CGRED(A,N,N)
      IROW = IROW + 1
 12   CONTINUE
        GO TO 14
 13     MOMIT = MOMIT +1
 14   CONTINUE
      NCX = NCCX
 15   CONTINUE
      CALL XLSQ
      CALL AICS
      CALL KOUT(6)
      IF (LPUNCH .NE. 0) CALL KOUT(7)
100   CONTINUE
      GO TO 1
      END
```

```
CKFDA          KFDA
      SUBROUTINE KFDA
      COMPLEX A,AA,ANM,CZERO,WASH,AIC
      DIMENSION AIC(40,80),WASH(40)
      COMMON/C1/A(80),AA(40,80),ANM(40,40),CZERO
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(3),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(10,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C4/CLEN,NOSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6          NMODES,LCOLL,LPRWSH,IPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,QWCX,CXMN,IMOD,IROW,
     8          EM,EK,B2,NWIX,NCIX,CRON,NWCY,IFR,E1,F2,QNY,QWWX,
     9          SN,WBO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      COMMON/C5/LPUNCH,KF
      EQUIVALENCE (AA,AIC),(A,WASH)
   11 FORMAT(6F12.8)
   12 FORMAT(6I12)
      READ(5,11)(XE(I),I=1,5)
      READ(5,11) (YE(I),I=1,3),SOUND
      RHO=1.0
      READ (5,12) NMACH,KF,NFREQ,LCOLL,LPUNCH
      READ (5,12) NWCX,NCCX,NIONCX,NIY,ISOLAT
      INWTS=0
      NWPX=NWCX
      NXWING=NWCX
      NCPX=NCCX
      NXCS=NCCX
      NWCY=NIY
      NPY=NIY
      NYWING=NIY
      NYCS=NIY
      NCOLS=NPY*(NWPX+NCPX)
      NCIX=NCCX*NIONCX
      NWIX=NWCX*NIONCX
      NWTS = NWCY*NWCX +NIY*NCCX
      DO 40 I=1,NWTS
   40 WT(I) = 1.0
      IF(INWTS.NE.0)  READ(5,11) (WT(I),I=1,NWTS)
      NCOLS = NPY * (NWPX + NCPX)
      NCIX =   NCCX*NIONCX
      NWIX=   NWCX*NIONCX
      NOMIT = 0
      DO 4 I=1,5
    4 NOM(I) = 0
      IF(NWCY.GE.NIY)  GO TO 5
      NOMIT = NIY-NWCY
      READ(5,12) (NOM(I),I=1,NOMIT)
    5 READ(5,11) (FMACH(I),I=1,NMACH)
      DO 7 I=1,NMACH
      IF(FMACH(I).LE.0.99)  GO TO 7
      WRITE(6,13)
   13 FORMAT(/1H     A MACH NUMBER GREATER THAN 0.99 HAS BEEN READ IN----
     1CASE TERMINATED)
      CALL EXIT
    7 CONTINUE
      READ (5,11) (FREQ(I),I=1,NFREQ)
      READ(5,11) (YAIC(I,1),I=1,NYWING)
      READ(5,11) (YAIC(I,2),I=1,NYCS)
```

```
      READ(5,11) ((XAIC(I,J,1),I=1,NXWING),J=1,NYWING)
      READ(5,11) ((XAIC(I,J,2),I=1,NXCS),J=1,NYCS)
      IF(NCIX.GT.40.OR.NWIX.GT.40)  GO TO 86
      IF(NWCX*NWCY+NCCX*NIY.GT.90)  GO TO 86
      IF(NPY*(NWPX+NCPX).GT.50)  GO TO 86
      IF(NWPX.GT.10.OR.NCPX.GT.10.OR.NPY.GT.10)  GO TO 86
      RETURN
   86 FM = FMACH(1)
      CALL KOUT(1)
      CALL KOUT(5)
      RETURN
      END
```

```
CKOUT        KOUT
      SUBROUTINE KOUT(IND)
      COMPLEX A,AA,ANM,CZERO,WASH,AIC
      DIMENSION SURF(2,2),XPR(50),AIC(40,80),WASH(40)
      COMMON/C1/A(80),AA(40,80),ANM(40,40),CZERO
      COMMON/C2/HKFR(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(3),UX(10),UY(10),WXINN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C4/CLFN,NGSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6          NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,QWCX,CXMN,IMOD,IROW,
     8          EM,FK,B2,NWIX,NCIX,CBON,NWCY,IFR,E1,E2,QWY,QWWX,
     9          SN,WBO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      COMMON/C5/LPUNCH,KF
      EQUIVALENCE (AA,AIC),(A,WASH),(XPR,IL)
      DATA (SURF(1,I),I=1,2)/8HWING    ,8HTAIL    /
      GO TO (10,20,30,40,50,60,70), IND
C     ******************************************************************
   10 XV=XE(5)-XE(4)
      XX=XE(3)-XE(2)
      AW=2.0*(XE(3)*YE(3)-0.5*XE(2)*(YE(3)-YE(2)))
      AT=2.0*XV*YE(3)
      WRITE(6,11)EM,SOUND,RHO,XE(1),XE(4),XE(3),XV,YE(2),YE(3),YE(3),
     1YE(3),XX,XV,AW,AT,NWCY,NIY,NWCX,NCCX,NWIX,NCIX,NPY,NPY,NWPX,NCPX
   11 FORMAT(1H1///// 32X,41HHUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM
     1 ///37X,30HFLIGHT CONDITIONS AND GEOMETRY/1H0//15X, 13HMACH NUMBER
     2 =,F8.5,4X,16HSPEED OF SOUND =F10.3,4H L/T,4X,4HRHO=,E14.8//1H0/
     354X,4HWING,18X,
     3 4HTAIL///22X,16HL.E. STATION (L),2F22.3//22X,16HROOT CHORD    (L),
     4 2F22.3// 22X,16HL.E. SPAN     (L),2F22.3//22X,16HT.E. SPAN     (L),
     5 2F22.3// 22X,16HTIP CHORD     (L),2F22.3//22X,16HTOTAL AREA (L*L)
     6 2F22.3//22X,16HSPAN  COLL. STA.,I19,I22,//22X,16HCHORD COLL. STA.
     7 I19,I22//22X,16HCHORD INTG. STA.,I19,I22//22X,16HSPAN  PRES MODES
     8,I19,I22//22X,16HCHORD PRES MODES,I19,I22)
      IF(FMACH(MACH).LE.0.95)  GO TO 15
      WRITE(6,14)
   14 FORMAT(92H   A MACH NUMBER GREATER THAN 0.95 HAS BEEN USED--------
     1USE CAUTION IN APPLYING CASE RESULTS)
   15 IF(NOMIT.EQ.0) RETURN
      WRITE(6,12)(NOM(I),I=1,NOMIT)
   12 FORMAT(1H0,15X,51HTHE SPANWISE COLLOCATION STATION(S) OMITTED ON W
     1ING,9I5)
      RETURN
C     ******************************************************************
   20 NCX=NWCX
      NIX=NWIX
      DO 150 NS=1,2
      WRITE(6,22)(SURF(I,NS),I=1,2)
   22 FORMAT(1H1,////30X,50HHUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CO
     1NT-D)      //////
     220X,53HUNSTEADY AERO COLLOCATION STATION COORDINATES ON THE 2A6/1H
     30,12H    S STA NO,7X,2HYC,8X,/X,11HXC VALUES--)
      DO 123 IY=1,NIY
      YC=WBO*SN*Y(IY)
      DO 120 IX=1,NCX
  120 XPR(IX)=WBO*XS(1,NS,IX,IY)
  123 WRITE(6,124) IY,YC,(XPR(IX),IX=1,NCX)
```

```
124 FORMAT(1H0,I12,5E17.6/(1H ,29X,4E17.6))
    WRITE(6,105) (SURF(I,NS),I=1,2)
105 FORMAT(1H0,24X,39HINTEGRATION STATION COORDINATES ON THE 2A6/1H0,
   112H    S STA NO,7X,2HYI,8X,7X,11HXI VALUES--)
    DO 106 IY=1,NIY
    YI=WBO*SN*ETA(IY)
    DO 126 IX=1,NIX
126 XPR(IX)=WBO*XS(2,NS,IX,IY)
106 WRITE(6,124) IY,YI,(XPR(IX),IX=1,NIX)
    NCX=NCCX
    NIX=NCIX
150 CONTINUE
    NXS=NXWING
    NYS=NYWING
    DO 200 NS=1,2
    WRITE (6,201) (SURF(I,NS),I=1,2)
201 FORMAT(1H1,////30X,50HHUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CO
   1NT-D)    //////
   228X,43HAIC COLLOCATION STATION COORDINATES ON THE 2A6/1H0,
   319X, 4HYAIC,13X,13HXAIC VALUES--)
    DO 202 IY=1,NYS
    YC=YAIC(IY,NS)
202 WRITE(6,203) YC,(XAIC(IX,IY,NS),IX=1,NXS)
    NYS=NYCS
200 NXS=NXCS
203 FORMAT(1H0,12X,5E17.6/(1H ,29X,4E17.6))
    RETURN
C   ****************************************************************
 30 DO 34 NS = 1,2
    WRITE(6,21)FREQ(IFR),NMODES,EK,EM
 21 FORMAT(1H1,31X,42HMISSILE SUBSONIC AIRLOADS PROGRAM (CONT-D)//1H /
   1 9X,27HOSCILLATORY FREQUENCY (CPS),F12.5,14X,I2,15H COLL. STATIONS
   2  /1H0,8X,30HREDUCED FREQUENCY (SEMI-CHORD),F9.5,14X,23HFREE STREA
   3M MACH NUMBER,F9.3/1H )
    WRITE(6,31) IMOD
 31 FORMAT(31X,40HPRESSURE COEFFICIENTS FOR COLL. STA. NO.I3//19X,1HI1
   21X,10HR COEFF(I)12X,10HI COEFF(I) 9X,9HSPAN MODE 3X,10HCHORD MODE)
    WRITE(6,32)(SURF(KI,NS),KI=1,2)
 32 FORMAT(1H0,9X,2A6//)
    GO TO(2,3),NS
  2 NL = NWPX
    ML = NPY
    IK = 1
    GO TO 4
  3 NL = NCPX
    ML = NPY
    IK = NWPX*NPY+1
  4 DO 6 IMM=1,ML
    DO 6 INN=1,NL
    WRITE(6,33)IK,ANM(IK,IMOD),IMM,INN
 33 FORMAT(1H0,I19,1P2E22.5,2I13)
  6 IK = IK + 1
 34 CONTINUE
    RETURN
C   ****************************************************************
 40 WRITE(6,41)
 41 FORMAT(1H0,20X,38HERROR IN INPUT DATA (NO TAIL) REQUIRES//,21X,19H
   1TERMINATION OF CASE)
    CALL EXIT
C   ****************************************************************
 50 WRITE(6,51)
```

```
   51 FORMAT(1H0,20X,63HNUMBER OF COLLOCATION OR INTEGRATION STATIONS OR
     1 PRESSURE TERMS///1X,25HEXCEEDS ALLOWABLE MAXIMUM///35X,18HCASE IS
     2 TERMINATED)
      CALL EXIT
C     ******************************************************************
   60 VEL=FM*SOUND
      Q=0.5*RHO*VEL**2
      EK1=1.0/EK
      REFC=(XE(3)-XE(1))/2.0
      WRITE (6,220) FREQ(IFR),REFC,EK,EK1,EM,U,RHO,Q
  220 FORMAT (1H1,31X,50H HUGHES AIRCRAFT CO. SUBSONIC AIC PROGRAM (CONT
     1-D)////9X,28H OSCILLATORY FREQUENCY (CPS),4X,1PE12.5,/1H0,9X,15HRE
     2FERENCE CHORD,4X,1PE12.5,/1H0,9X,30HREDUCED FREQUENCY (REF. CHORD)
     3,4X,1PE12.5,/1H0,9X,29HREDUCED VELOCITY (REF. CHORD),4X,1PE12.5,
     4/1H0,9X,23HFREE STREAM MACH NUMBER,4X,1PE12.5,/1H0,9X,20HFREE STRE
     5AM VELOCITY,4X,1PE12.5,/1H0,9X,7HDENSITY,4X,0PF5.2,/1H0,9X,33HDYNA
     6MIC PRESSURE (1/2*RHO*VEL**2),4X,1PE12.5,////)
      WRITE(6,221)
  221 FORMAT(///35X,34HAERODYNAMIC INFLUENCE COEFFICIENTS,//4X,2HRL,10X,
     12HIM,10X,2HRL,10X,2HIM,10X,2HRL,10X,2HIM,10X,2HRL,10X,2HIM,10X,2HR
     2L,10X,2HIM,/)
      NROWS=NYWING*NXWING+NXCS*NYCS
      DO 222 NROW=1,NROWS
      WRITE(6,223)NROW
      WRITE(6,224) (AIC(NROW,NCOL),NCOL=1,NROWS)
  223 FORMAT(/ 5HROW =  I2)
  224 FORMAT(1P10E12.4)
  222 CONTINUE
      RETURN
C     ******************************************************************
   70 NW=NXWING*NYWING
      NC=NXCS*NYCS
      NT=NW+NC
      NW1=NW+1
      GO TO (81,82,83,84),LPUNCH
   81 CONTINUE
      DO 301 I=1,NW
      PUNCH 85, (AIC(I,J),J=1,NW)
  301 CONTINUE
   85 FORMAT (1P6E12.5)
      RETURN
   82 CONTINUE
      DO 302 I=NW1,NT
      PUNCH 85, (AIC(I,J),J=NW1,NT)
  302 CONTINUE
      RETURN
   83 CONTINUE
      DO 303 I=1,NW
      PUNCH 85, (AIC(I,J),J=1,NW)
  303 CONTINUE
      DO 304 I=NW1,NT
      PUNCH 85, (AIC(I,J),J=NW1,NT)
  304 CONTINUE
      RETURN
   84 CONTINUE
      DO 305 I=1,NT
      PUNCH 85, (AIC(I,J),J=1,NT)
  305 CONTINUE
 1000 RETURN
      END
```

CAICS

```
      SUBROUTINE AICS
      COMPLEX A,AA,ANM,CZERO,WASH,AIC
      DIMENSION AIC(40,80),WASH(40),FM(40,40)
      COMMON/C1/A(80),AA(40,80),ANM(40,40),CZERO
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(5),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C4/CLEN,NOSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NTOWCX,RHO,
     6          NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,QWCX,CXMN,IMOD,IROW,
     8          EM,EK,B2,NWIX,NCIX,CHON,NWCY,IFR,E1,E2,QWY,QWWX,
     9          SN,WRO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      EQUIVALENCE (AA,AIC),(A,WASH),(FM,T)
      NCOLS=NPY*(NWPX+NCPX)
      NROWS=NXWING*NYWING+NYCS*NXCS
      CALL FORCE
      DO 200 I=1,NROWS
      DO 200 J=1,NCOLS
      SR=FM(I,J)
      SI=0.0
  200 AA(I,J)=CMPLX(SR,SI)
      DO 300 I=1,NROWS
      DO  50 J=1,NROWS
      A(J)=(0.0,0.0)
      DO 250 K=1,NCOLS
  250 A(J)=A(J)-AA(I,K)*ANM(K,J)
      DO 225 L=1,NROWS
  225 AIC(I,L)=(YE(3)-YE(1))*A(L)/(2.0*EK**2)
  300 CONTINUE
      RETURN
      END
```

```
CCGRED      CGRED
      SUBROUTINE CGRED(V,IR,IC)
      COMPLEX ANM,CZERO,AIC,WASH
      DIMENSION AIC(40,80),WASH(40),V(2,1)
      COMMON/C1/A(2,80),AA(2,40,80),ANM(40,40),CZERO
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(3),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C4/CLFN,NGSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6          NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,OWCX,CXMN,IMOD,IROW,
     8          FM,FK,B2,NWIX,NCIX,CRON,NWCY,IFR,E1,E2,OWY,OWWX,
     9          SN,WRO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      EQUIVALENCE (AA,AIC),(A,WASH)
      RMN = SQRT(AA(1,IR,IC)**2 + AA(2,IR,IC)**2)
      IF(AA(2,IR,IC).LE.E2)  GO TO 30
      CR = AA(1,IR,IC)/RMN
      CI = AA(2,IR,IC)/RMN
      DO 20 N=IC,MAUG
      TI = CR*AA(1,IR,N) + CI*AA(2,IR,N)
      AA(2,IR,N) = CR*AA(2,IR,N) - CI*AA(1,IR,N)
   20 AA(1,IR,N) = TI
   30 RAN = SQRT(V(1,IC)**2 + V(2,IC)**2)
      IF(RAN.LE.E2)  GO TO 60
      RAN = SQRT(RAN**2 + RMN**2)
      CR = V(1,IC)/RAN
      CI = V(2,IC)/RAN
      RMN = RMN/RAN
      DO 50 N=IC,MAUG
      AIR = RMN*AA(1,IR,N) + CR*V(1,N) + CI*V(2,N)
      AII = RMN*AA(2,IR,N) + CR*V(2,N) - CI*V(1,N)
      VR = RMN*V(1,N) - CR*AA(1,IR,N) + CI*AA(2,IR,N)
      VI = RMN*V(2,N) - CR*AA(2,IR,N) - CI*AA(1,IR,N)
      AA(1,IR,N) = AIR
      AA(2,IR,N) = AII
      V(1,N) = VR
   50 V(2,N) = VI
   60 RETURN
      END
```

```
CFORCE
      SUBROUTINE FORCE
      DIMENSION FM(40,40)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(10,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(3),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      COMMON/C4/CLEN,NGSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6          NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,OWCX,CXMN,IMOD,IROW,
     8          EM,EK,B2,NWIX,NCIX,CRON,NWCY,IFR,E1,E2,OWY,OWWX,
     9          SN,WBO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      EQUIVALENCE (FM,T)
      MROWS=NIY*(NWCX+NCCX)
      MCOLS=NPY*(NWPX+NCPX)
      DO 100 I=1,MROWS
      DO 100 J=1,MCOLS
  100 FM(I,J)=0.0
C *** BEGIN TO ASSEMBLE FM(IROW,ICOL) MATRIX STARTING WITH WING
      IROW=1
      DO 300 I=1,NIY
      IF (I .EQ. 1) GO TO 105
      IF (I .EQ. NIY) GO TO 110
      SNL=(0.5*(YAIC(I-1,1)+YAIC(I,1))-YE(1))/(YE(3)-YE(1))
      SNU=(0.5*(YAIC(I,1)+YAIC(I+1,1))-YE(1))/(YE(3)-YE(1))
      GO TO 115
  105 SNL=0.0
      SNU=(0.5*(YAIC(1,1)+YAIC(2,1))-YE(1))/(YE(3)-YE(1))
      GO TO 115
  110 SNL=(0.5*(YAIC(NIY-1,1)+YAIC(NIY,1))-YE(1))/(YE(3)-YE(1))
      SNU=1.0
  115 CONTINUE
      DO 300 J=1,NWCX
      IF (J .EQ. 1) GO TO 120
      IF (J .EQ. NWCX) GO TO 125
      CNL=(0.5*(XAIC(J,I,1)+XAIC(J-1,I,1))-XE(1)-0.5*(XE(3)-XE(1)))/
     1(0.5*(XE(3)-XE(1)))
      CNU=(0.5*(XAIC(J+1,I,1)+XAIC(J,I,1))-XE(1)-0.5*(XE(3)-XE(1)))/
     1(0.5*(XE(3)-XE(1)))
      GO TO 130
  120 CNL=-1.0
      CNU=(0.5*(XAIC(1,I,1)+XAIC(2,I,1))-XE(1)-0.5*(XE(3)-XE(1)))/
     1(0.5*(XE(3)-XE(1)))
      GO TO 130
  125 CNL=(0.5*(XAIC(NWCX-1,I,1)+XAIC(NWCX,I,1))-XE(1)-.5*(XE(3)-XE(1)))
     1/(0.5*(XE(3)-XE(1)))
      CNU=+1.0
  130 CONTINUE
      ICOL=1
      DO 200 K=1,NPY
      CALL MINTS(K,SNL,SNU,FS)
      DO 200 L=1,NWPX
      CALL MINTC(L,CNL,CNU,FC)
      FM(IROW,ICOL)=FS*FC
  200 ICOL=ICOL+1
  300 IROW=IROW+1
C *** ASSEMBLE CONTROL SURFACE CONTRIBUTION
      DO 600 I=1,NIY
      IF (I .EQ. 1) GO TO 505
```

```
      IF (I .EQ. NIY) GO TO 510
      SNL=(0.5*(YAIC(I-1,2)+YAIC(I,2))-YE(1))/(YE(3)-YE(1))
      SNU=(0.5*(YAIC(I,2)+YAIC(I+1,2))-YE(1))/(YE(3)-YE(1))
      GO TO 515
505   SNL=0.0
      SNU=(0.5*(YAIC(1,2)+YAIC(2,2))-YE(1))/(YE(3)-YE(1))
      GO TO 515
510   SNL=(0.5*(YAIC(NIY-1,2)+YAIC(NIY,2))-YE(1))/(YE(3)-YE(1))
      SNU=1.0
515   CONTINUE
      DO 600 J=1,NCCX
      IF (J .EQ. 1) GO TO 720
      IF (J .EQ. NCCX) GO TO 725
      CNL=(0.5*(XAIC(J,1,2)+XAIC(J-1,1,2))-XE(4)-0.5*(XE(5)-XE(4)))/
     1(0.5*(XE(5)-XE(4)))
      CNU=(0.5*(XAIC(J+1,1,2)+XAIC(J,1,2))-XE(4)-0.5*(XE(5)-XE(4)))/
     1(0.5*(XE(5)-XE(4)))
      GO TO 730
720   CNL=-1.0
      CNU=(0.5*(XAIC(1,1,2)+XAIC(2,1,2))-XE(4)-0.5*(XE(5)-XE(4)))/
     1(0.5*(XE(5)-XE(4)))
      GO TO 730
725   CNL=(0.5*(XAIC(NCCX-1,1,2)+XAIC(NCCX,1,2))-XE(4)-0.5*(XE(5)-XE(4))
     1)/(0.5*(XE(5)-XE(4)))
      CNU=1.0
730   CONTINUE
      ICOL=NPY*NWPX+1
      DO 800 K=1,NPY
      CALL MINTS(K,SNL,SNU,FS)
      DO 800 L=1,NCPX
      CALL MINTC(L,CNL,CNU,FC)
      FM(IROW,ICOL)=FS*FC
800   ICOL=ICOL+1
600   IROW=IROW+1
      RETURN
      END
```

```
CCORD        CORD
      SUBROUTINE CORD
      COMPLEX A,AA,ANM,CZERO,WASH,AIC,AK,H2,TRM,D1,CRNL
      DIMENSION AIC(40,80),WASH(40)
      COMMON/C1/A(80),AA(40,80),ANM(40,40),CZERO
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(3),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C4/CLEN,NGSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6          NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,QWCX,CXMN,IMOD,IROW,
     8          EM,EK,B2,NWIX,NCIX,CRON,NWCY,IFR,E1,E2,QWY,QWWX,
     9          SN,WRO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      EQUIVALENCE (AA,AIC),(A,WASH)
C     THIS SUBROUTINE CONSTRUCTS A ROW OF THE DOWNWASH MATRIX
C     THE PRESSURE SERIES IS A PRODUCT OF CHEBYSHEV POLYNOMIALS IN THE
C       NEGATIVE OF PERCENT SEMI-CHORD FROM THE MID-CHORD AND PERCENT
C       SEMI-SPAN FROM THE ROOT.
      DO 6 JC=1,NCOLS
    6 A(JC) = CZERO
      IC1 = 0
      NIX = NWIX
      QWX = -QWWX*SN**2/(8.0*PI)
      NPX = NWPX
C     THE DO 14 LOOP COMPUTES THE NON-SINGULAR PORTION OF D(N,M)
C     DUE TO BOTH SURFACES
      DO 14 MSURF=1,2
      IF(MSURF.NE.NSURF.AND.ISOLAT.NE.0) GO TO 13
      DO 12 IY=1,NIY
      ETAI = SN*ETA(IY)
      ET2 = ETA(IY)**2
      IF(NPY.GT.1) CALL CHEB(NPY-1,ETA(IY),UY(2))
      UY(1) = 1.0 -ET2
      DO 3 K=2,NPY
    3 UY(K) = ET2*UY(1)*UY(K)
        DO 10 IX=1,NIX
          XI = XS(2,MSURF,IX,IY)
          XID = XCOLL -XI
      AK = CRNL(EK,XID,YCOLL-ETAI,EM,B2) + CRNL(EK,XID,YCOLL+ETAI,EM,B2)
          IC = IC1 +1
      H2 = AK*QWX*QWY
      IF(NPX.GT.1) CALL CHEB(NPX-1,-SIX(IX,MSURF),UX(2))
      UX(1) = 1.0 -SIX(IX,MSURF)
      DO 4 K=2,NPX
    4 UX(K) = (1.0 +SIX(IX,MSURF))*UX(1)*UX(K)
C     ** ADD AN INCREMENT TO EACH ELEMENT OF THE ROW FOR (XI,ETAI) **
          DO 10 NY=1,NPY
      TRM = H2 * UY(NY)
      DO 10 NX=1,NPX
      A(IC) = A(IC) +TRM*UX(NX)
   10 IC = IC+1
C     ** IC EQUALS NPY*NWPX+1 AT THE END OF THE FIRST PASS **
   12 CONTINUE
   13   NIX = NCIX
      QWX = -QWCX*SN**2/(8.0*PI)
        NPX = NCPX
   14   IC1 = NPY*NWPX
      IC1 = 0
```

```
      NPX = NWPX
      XCOLS = XS(1,NSURF,IIX,IIY)
      Y2 = Y(IIY)**2
      CALL CHEB(NPY-1,Y(IIY),UY(2))
      UY(1) = -2.0
      DO 15 K=2,NPY
   15 UY(K) = -2.0*Y2*UY(K)
      DO 40 MSURF=1,NSURF
C     ** THIS LOOP ADDS THE CONTRIBUTION OF THE SINGULAR INTEGRAL
C        ALONG THE LINE FROM THE WING L.E. TO THE COLLOCATION POINT
      IF(MSURF.NE.NSURF.AND.ISOLAT.NE.0) GO TO 23
      IF(NSURF.LE.MSURF)  GO TO 16
      UPLIM = PI
      GO TO 18
   16 XT = SCX(IIX,NSURF)
      UPLIM = -ATAN(SQRT(1.0-XT**2)/XT)
      IF(UPLIM.LT.0.0)  UPLIM=UPLIM+PI
   18 QWSNG = FLOAT(2*NIY)*UPLIM/8.0
      DO 22 N=1,6
      IC = IC1+1
C       ** THIS LOOP CONSTRUCTS D(0,M) ,M=0,1,....NPX-1
        VINT = UPLIM*ZCOR(N)
        C = COS(VINT)
      CALL CHEB(NPX-1, C,UX(2))
      UX(1) = 1.0 +C
      DO 19 K=2,NPX
   19 UX(K) = (1.0 -C)*UX(1)*UX(K)
      ARG = EK*(XCOLS -WXCMN(IIY) +C*WRCN(IIY))
      IF(MSURF.EQ.2) ARG=EK*(XCOLS-CXMN+C*CBON)
        C1 = COS(ARG)
        S1 = SQRT(1.0 -C1**2)
      D1 = CMPLX(C1,-S1)*HCOR(N)
      DO 22 NY=1,NPY
      TRM = QWSNG*UY(NY)*D1
      DO 22 NX=1,NPX
      A(IC) = A(IC) +TRM*UX(NX)
   22 IC = IC+1
   23 IC1 = NPY*NWPX
   40 NPX = NCPX
      RETURN
      END
```

```
CCRNL          CRNL
      COMPLEX FUNCTION CRNL(CK,X,Y,CM,R2)
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCHN(11),WBCN(11),WBIN(11),WT(90),
     2          XF(5),YF(5),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          FTA(11)
      COMMON/C4/CLFN,NGSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIU,CX,RHO,
     6          NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,OWCX,CXMN,IMOD,IROW,
     8          EM,EK,R2,NWIX,NCIX,CROH,NWCY,IFR,F1,F2,OWY,OWWX,
     9          SN,WRO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      R=ABS(Y)
      R2=R*R
      CK1 = CK*R
      G1 = 0.0
      G3 = 0.0
      G4 = 0.0
    5 S2 = X*X + R2*R2
      S = SQRT(S2)
      U1 = (CM*S-X)/(R2*R)
      UK = CK1*U1
      DO 10 I = 1,NGSKRN
      UZ = U1*ZKER(I)
      UZ2 = UZ**2
      G=UK*ZKER(I)
      F = HKER(I)/SQRT(1.0+UZ2)*UZ*U1
      G3=G3+F*COS(G)
      G4=G4+F*SIN(G)
      V = 1.0 - ZKER(I)**
      F = HKER(I)*  . *V* EXP(-CK1*V)/ SQRT(1.0+V)
   10 G1=G1+F
      G2 = G1 + G3
      XS = X/S
      IF(CK.NE.0.0) GO TO 22
      F14 = 1.0
      GO TO 23
   22 F14 = CK1*BESL(CK1)
   23 G1=CK1*G4-F14-XS*COS(UK)
      G2=CK1*G2+XS*SIN(UK)
      XK = CK*X
      CO = COS(XK)
      SI = SIN(XK)
      CRNL = CMPLX((CO*G1+SI*G2)/R2,(CO*G2-SI*G1)/R2)
      RETURN
      END
```

```
CBESL         BESL
      FUNCTION BESL(X)
      IF(X.GT.2.0)  GO TO 50
      T=X/3.75
      T=T*T
      BSI1=0.5+T*(0.87890594+T*(0.51498869+T*(0.15084934+T*(0.02658733+T
     1*(0.00301532+T*(0.00032411))))))
      BSI1=BSI1*X
      Y=X/2.0
      BSK1=X*ALOG(Y)*BSI1+1.0
      Y=Y*Y
      BSK1=BSK1+Y*(0.15443144+Y*(-0.67278579+Y*(-0.18156897+Y*
     1(-0.01919402+Y*(-0.00110404+Y*(-0.00004686))))))
      BESL =BSK1/X
      GO TO 60
 50   Y=2.0/X
      BSK1=1.25331414+Y*(0.23498619+Y*(-0.03655620+Y*(0.01504268+Y*
     1(-0.00780353+Y*(0.00325614+Y*(-0.00068245))))))
      BESL =BSK1/(SQRT(X)*EXP(X))
   60 RETURN
      END
```

```
CCHEB        CHEB
      SUBROUTINE CHEB(N1,X,UX)
      DIMENSION UX(1)
      DO 10 I=1,N1
   10 UX(I) = 0.0
      UX(1) = 1.0
      UX(2) = 2.0*X
      IF(N1.LT.3)  RETURN
      DO 20 I=3,N1
   20 UX(I) = 2.0*X*UX(I-1) -UX(I-2)
      RETURN
      END
```

```
CCONS1        CONS1
      BLOCK DATA
      COMPLEX A,AA,ANM,CZERO,WASH,AIC
      DIMENSION AIC(40,80),WASH(40)
      COMMON/C1/A(80),AA(40,80),ANM(40,40),CZERO
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(3),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      COMMON/C4/CLEN,NGSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6          NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,QWCX,CXMN,IMOD,IROW,
     8          EM,EK,B2,NWIX,NCIX,CRON,NWCY,IFR,E1,E2,QWY,QWWX,
     9          SN,WRO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      EQUIVALENCE (AA,AIC),(A,WASH)
      DATA PI/3.1415926?/
      DATA HCOR/0.08566225,0.18038079,0.2339569/,0.23395697,0.18038079,
     10.08566225/
      DATA ZCOR/0.03376524,0.1693953?,0.38069041,0.61930959,0.83060469,
     10.96623476/
C     ****************************************************************
C     NGSKRN SHOULD BE COMPATIBLE WITH HKER AND ZKER LISTS
      DATA NGSKRN/8/
      DATA (HKER(I),I=1,8)/0.05061427,0.11119052,0.15685332,0.18134189
     X,0.18134189,0.15685332,0.11119052,0.05061427/
      DATA (ZKER(I),I=1,8)/0.01985507,0.10166676,0.23723380,0.40828266
     X,0.59171732,0.76276620,0.89833324,0.98014493/
C     ****************************************************************
      DATA E1/0.0000001/,E2/0.0000001/,CZERO/(0.0,0.0)/
      END
```

```
CXS          XS
      FUNCTION XS(L,NS,I3,J3)
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(3),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      COMMON/C4/CLEN,NGSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6          NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,QWCX,CXMN,IMOD,IROW,
     8          EM,EK,B2,NWIX,NCIX,CRON,NWCY,IFR,E1,E2,QWY,QWWX,
     9          SN,WBO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      GO TO (10,40),L
   10 GO TO (20,30),NS
   20 XS = WXCMN(J3) + WBCN(J3) * SCX(I3,1)
      RETURN
   30 XS = CXMN + CRON * SCX(I3,2)
      RETURN
   40 GO TO (50,60),NS
   50 XS = WXIMN(J3) + WBIN(J3) * SIX(I3,1)
      RETURN
   60 XS = CXMN + CRON * SIX(I3,2)
      RETURN
      END
```

```
C          XINT
      FUNCTION XINT (IY,IX,NIY,NS,WBO,SN)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(3),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      IF (NS .EQ. 1) GO TO 200
      XINT=WBO*XS(1,2,IX,1)
      RETURN
  200 IF (YAIC(IY,1) .GT. YE(2)) GO TO 300
      XINT=WBO*XS(1,1,IX,1)
      RETURN
  300 SLOPE=(WBO*SN*Y(NIY)-YE(2))/(WBO*XS(1,1,IX,NIY)-WBO*XS(1,1,IX,1))
      XINT=WBO*XS(1,1,IX,1)+(YAIC(IY,1)-YE(2))/SLOPE
      RETURN
      END
```

```
CARCCOS
      FUNCTION ARCCOS(X)
C *** DEFINE F(X)=A(0)+A(1)*X+A(2)*X**2+...+A(8)*X**8
C *** THEN ARCCOS(X)=F(X)*(1-X)**0.5  IF X.LT.1 AND .GT.0
C *** AND ARCCOS(X)=PI-(1-ABS(X))**0.5*F(ABS(X)) IF X.LT.0 AND .GT.-1
C *** ARCCOS(X) IN RADIANS ***  VALID FOR  0 TO PI  RADIANS
C *** ACCURATE TO AT LEAST 6 SIGNIFICANT FIGURES UNLESS X APPROACHES 1.0
      A0=1.57079633
      A1=-.21460184
      A2=0.08904567
      A3=-.05072733
      A4=0.03313246
      A5=-.02199838
      A6=0.01261235
      A7=-.00499706
      A8=0.00095128
      IF (X .GE. 0.0) GO TO 100
      Z=ABS(X)
      ARCCOS=3.1415927-(1.0-Z)**0.5*(A0+A1*Z+A2*Z**2+A3*Z**3+A4*Z**4
     1+A5*Z**5+A6*Z**6+A7*Z**7+A8*Z**8)
      RETURN
  100 ARCCOS=(1.0-X)**0.5*(A0+A1*X+A2*X**2+A3*X**3+A4*X**4+A5*X**5
     1+A6*X**6+A7*X**7+A8*X**8)
      RETURN
      END
```

```
CMINTC
      SUBROUTINE MINTC(IS,CNL,CNU,FC)
C *** CHORDWISE PRESSURE INTEGRATION
C *** CNL=LOWER INTEGRATION LIMIT
C *** CNU=UPPER INTEGRATION LIMIT
      CL=ARCCOS(CNL)
      CU=ARCCOS(CNU)
      SI=FLOAT(IS-1)
      IF (IS .EQ. 1) GO TO 10
      IF (IS .EQ. 2) GO TO 20
      FC=(SIN((SI+1.0)*CU))/(2.0*(SI+1.0))-(SIN((SI-1.0)*CU))/(2.0*(SI-
     1   1.0))-
     2   (SIN((SI+1.0)*CL))/(2.0*(SI+1.0))+(SIN((SI-1.0)*CL))/(2.0*(SI-
     1   1.0))
      GO TO 100
   10 FC=SIN(CU)-CU-SIN(CL)+CL
      GO TO 100
   20 FC=(SIN(2.0*CU))/4.0-CU/2.0-(SIN(2.0*CL))/4.0+CL/2.0
  100 CONTINUE
      RETURN
      END
```

```
CMINTS
      SUBROUTINE MINTS(IS,SNL,SNU,FS)
C *** SPANWISE PRESSURE INTEGRATION
C *** SNL=LOWER INTEGRATION LIMIT
C *** SNU=UPPER INTEGRATION LIMIT
      SL=ARCCOS(SNL)
      SU=ARCCOS(SNU)
      IF (IS .EQ. 1) GO TO 10
      IF (IS .EQ. 2) GO TO 20
      IF (IS .EQ. 4) GO TO 40
      SI=FLOAT(IS-1)
      FS=(1.0/8.0)*((1.0/(SI-1.0))*(SIN((SI-1.0)*SU)-SIN((SI-1.0)*SL))
     1            -(1.0/(SI+1.0))*(SIN((SI+1.0)*SU)-SIN((SI+1.0)*SL))
     2            +(1.0/(SI-3.0))*(SIN((SI-3.0)*SU)-SIN((SI-3.0)*SL))
     3            -(1.0/(SI+3.0))*(SIN((SI+3.0)*SU)-SIN((SI+3.0)*SL)))
      GO TO 100
   10 FS=0.5*(SU-SL-SNU*(1.0-SNU**2)**0.5+SNL*(1.0-SNL**2)**0.5)
      GO TO 100
   20 FS=0.25*(SNU*(1.0-SNU**2)**1.5-SNL*(1.0-SNL**2)**1.5+
     1   0.5*(SU-SL-SNU*(1.0-SNU**2)**0.5+SNL*(1.0-SNL**2)**0.5))
      GO TO 100
   40 FS=(1.0/8.0)*(SU-SL)+0.25*(SIN(SU)*COS(SU)-SIN(SL)*COS(SL))
     1  +(11.0/12.0)*(COS(SU)*(SIN(SU)**3)-COS(SL)*(SIN(SL)**3))
     2  -(2.0/3.0)*(COS(SU)*(SIN(SU)**5)-COS(SL)*(SIN(SL)**5))
  100 CONTINUE
      RETURN
      END
```

```
CXLSQ          XLSQ
      SUBROUTINE XLSQ
      COMPLEX A,AA,ANM,CZERO,WASH,AIC
      DIMENSION AIC(40,80),WASH(40)
      COMMON/C1/A(80),AA(40,80),ANM(40,40),CZERO
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1           HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2           XE(5),YE(5),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3           ETA(11)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1           C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C4/CLEN,NOSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6           NMODES,LCOLL,LPRWSH,LPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7           NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,OWCX,CXMN,IMOD,IROW,
     8           FM,FK,B2,NWIX,NCIX,CRON,NWCY,IFR,E1,E2,OWY,OWWX,
     9           SN,WBO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      EQUIVALENCE (AA,AIC),(A,WASH)
      I1 = 1
      DO 136 I=1,NCOLS
      RII = CABS(AA(I1,I))
      IF(RII.LE.E2) GO TO 135
      IL(I) = I1
      I1 = I1 + 1
      GO TO 136
  135 IL(I) = -1
      II2 = NCOLS - 1 - (I-I1)
      DO 1135 II=I1,II2
 1135 CALL CGRED(AA(II+1,1),II,I+1)
  136 CONTINUE
C     SOLVE FOR THE COEFFICIENTS BY BACK SUBSTITUTION
  140 II = NCOLS
      DO 150 I = 1,NCOLS
      DO 150 L=1,NMODES
  150 ANM(I,L) = CZERO
      DO 210 J=1,NCOLS
      IF(IL(II).LE.0) GO TO 210
      JI = IL(II)
      DO 200 L=1,NMODES
      ML = NCOLS + L
      IF(II-NCOLS) 170,190,220
  170 IK = II + 1
      DO 180 K=IK,NCOLS
  180 ANM(II,L) = ANM(II,L) - AA(JI,K)*ANM(K,L)
  190 ANM(II,L) = (ANM(II,L) + AA(JI,ML))/AA(JI,II)
  200 CONTINUE
  210 II = II - 1
  220 RETURN
      END
```

```
CGEOM        GEOM
      SUBROUTINE GEOM
      COMPLEX A,AA,ANM,CZERO,WASH,AIC
      DIMENSION AIC(40,30),WASH(40)
      COMMON/C1/A(80),AA(40,80),ANM(40,40),CZERO
      COMMON/C2/HKER(20),ZKER(20),FMACH(6),FREQ(10),NOM(5),IL(50),
     1          HCOR(6),ZCOR(6),WXCMN(11),WBCN(11),WBIN(11),WT(90),
     2          XE(5),YE(3),UX(10),UY(10),WXIMN(11),SIX(40,2),SCX(10,2),
     3          ETA(11)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      COMMON/C4/CLEN,NGSKRN,NPY,SOUND,NMACH,NFREQ,MAUG,NIONCX,RHO,
     6          NMODES,LCOLL,LPRWSH,IPRCO,IIY,IIX,NSURF,ISOLAT,FW,FC,
     7          NCOLS,NOMIT,MACH,XCOLL,YCOLL,PI,U,OWCX,CXMN,IMOD,IROW,
     8          EM,EK,B2,NWIX,NCIX,CBON,NWCY,IFR,E1,F2,OWY OWWX,
     9          SN,WBO,NIY,NWCX,NCCX,NWPX,NCPX,NXWING,NYWING,NXCS,NYCS
      EQUIVALENCE (AA,AIC),(A,WASH)
C     WBO = WING ROOT SEMI-CHORD
C     S = SEMI-SPAN
C     WTCN = WING TIP CHORD - NORMALIZED ON WBO
C     WTLEN = WING TIP L.E. - NORMALIZED
C     SN = SEMI-SPAN - NORMALIZED
C     CBO = CONTROL SEMI-CHORD
C     FW = 2*NWIX+1
C     FC = 2*NCIX+1
      WBO = XE(3)/2.0
      CLEN = XE(4)/WBO
      S = YE(3)
      WTCN = (XE(3)-XE(2))/WBO
      WTLEN = XE(2)/WBO
      SN = S/WBO
      CBO = (XE(5)-XE(4))/2.0
      F1=FW
      F2 = F1*PI/2.
      J = NWIX
C    COMPUTE CHORDWISE INTEGRATION AND COLLOCATION STATIONS
C    FIRST ON THE WING SURFACE
      DO 5 I=1,NWIX
      F2 = F2 -2.*PI
      SIX(J,1) = SIN(F2/F1)
      I1 = FLOAT(I)/FLOAT(NIONCX) + 0.99
      SCX(I1,1) = -SIX(J,1)
    5 J=J-1
      F1=FC
      F2 = F1*PI/2.
      J = NCIX
C     THEN ON THE CONTROL SURFACE
      DO 6 I=1,NCIX
      F2 = F2 -2.*PI
      SIX(J,2) = SIN(F2/F1)
      I1 = FLOAT(I)/FLOAT(NIONCX) + 0.99
      SCX(I1,2) = -SIX(J,2)
    6 J=J-1
      F1 = 4*NIY
      F2=0.0
C    COMPUTE SPANWISE INTEGRATION AND COLLOCATION STATIONS
      DO 8 I=1,NIY
      Y(I) = SIN(F2/F1)
      F2 = F2 +PI
      ETA(I) = SIN(F2/F1)
    8 F2 = F2 +PI
```

```
C      COMPUTE WING SEMI-CHORDS AND MID-CHORD LOCATIONS AT THE
C      SPANWISE COLLOCATION AND INTEGRATION STATIONS
       PIB = YE(2)/YE(3)
       POB =1.0-PIB
       CBON = (XE(5)-XE(1))/(2.0*WBO)
       CXMN = CBON +XE(4)/WBO
       DO 16 I=1,NIY
       IF(ETA(I).LE.PIB)  GO TO 12
       F1 = WTLEN*(ETA(I)-PIB)/POB
       IF(Y(I).LE.PIB)   GO TO 13
       F2 = WTLEN*(Y(I)-PIB)/POB
       GO TO 14
    12 F1 = 0.0
    13 F2 = 0.0
    14 WBIN(I) = 0.5*(2.0-F1)
       WXIMN(I) = WBIN(I) +F1
       WBCN(I) = 0.5*(2.0-F2)
    16 WXCMN(I) = WBCN(I) +F2
    56 RETURN
       END
```

```
CTRAMP
      SUBROUTINE TRAMP(NIY,NWCX,NCCX,NXWING,NYWING,NXCS,NYCS,NIF,WBO,SN)
C *** TRANSFORMATION MATRIX PROGRAM
C *** TRANSFORMS AIC COLLOCATION STATIONS TO UNSTEADY AERO STATIONS
      COMMON/C3/Y(10),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(10,40),TM(40,40),TR(40,40),TI(40,40)
C *** ZERO  (TM)  MATRIX FOR CHORDWISE TRANSFORMATION
      KROWS=NXWING*NYWING+NXCS*NYCS
      KCOLS=KROWS
      DO 50 I=1,KROWS
      DO 50 J=1,KCOLS
   50 TM(I,J)=0.0
C *** CHORDWISE TRANSFORMATION (WING)
      IF (NXWING .EQ. 0) GO TO 1999
      DO 1000 I=1,NYWING
      CALL BMAT(NXWING,NRSB,NCSB)
      CALL TMAT(NXWING,1,MSIZE,1,I,WBO,SN)
      DO 1001 MR=1,MSIZE
      DO 1001 MC=1,NCSB
      TR(MR,MC)=0.0
      DO 1001 MRC=1,MSIZE
 1001 TR(MR,MC)=TR(MR,MC)+T(MR,MRC)*B(MRC,MC)
      CALL CMAT(NWCX,NIY,NXWING,NYWING,NIF,1,I,NRSC,NCSC,WBO,SN)
      DO 1002 MR=1,NRSC
      DO 1002 MC=1,NCSB
      T(MR,MC)=0.0
      DO 1002 MRC=1,NCSC
 1002 T(MR,MC)=T(MR,MC)+C(MR,MRC)*TR(MRC,MC)
      KROW=(I-1)*NXWING
      DO 1080 LR=1,NXWING
      LROW=KROW+LR
      KCOL=(I-1)*NXWING
      DO 1080 LC=1,NXWING
      LCOL=KCOL+LC
 1080 TM(LROW,LCOL)=T(LR,LC)
 1000 CONTINUE
 1999 CONTINUE
C *** CHORDWISE TRANSFORMATION (CONTROL SURFACE)
      IF (NXCS .EQ. 0) GO TO 2999
      DO 2000 I=1,NYCS
      CALL BMAT(NXCS,NRSB,NCSB)
      CALL TMAT(NXCS,1,MSIZE,2,I,WBO,SN)
      DO 2001 MR=1,MSIZE
      DO 2001 MC=1,NCSB
      TR(MR,MC)=0.0
      DO 2001 MRC=1,MSIZE
 2001 TR(MR,MC)=TR(MR,MC)+T(MR,MRC)*B(MRC,MC)
      CALL CMAT(NCCX,NIY,NXCS,NYCS,NIF,2,I,NRSC,NCSC,WBO,SN)
      DO 2002 MR=1,NRSC
      DO 2002 MC=1,NCSB
      T(MR,MC)=0.0
      DO 2002 MRC=1,NCSC
 2002 T(MR,MC)=T(MR,MC)+C(MR,MRC)*TR(MRC,MC)
      KROW=NXWING*NYWING+(I-1)*NXCS
      DO 2080 LR=1,NXCS
      LROW=KROW+LR
      KCOL=NXWING*NYWING+(I-1)*NXCS
      DO 2080 LC=1,NXCS
      LCOL=KCOL+LC
 2080 TM(LROW,LCOL)=T(LR,LC)
 2000 CONTINUE
```

```
 2999 CONTINUE
C *** REARRANGE ROWS AND COLUMNS FOR SPANWISE TRANSFORMATION
      CALL RMAT(NXWING,NYWING,NXCS,NYCS,MSIZE)
      DO 2050 MR=1,MSIZE
      DO 2050 MC=1,MSIZE
      TI(MR,MC)=0.0
      DO 2050 MRC=1,MSIZE
 2050 TI(MR,MC)=TI(MR,MC)+R(MR,MRC)*TM(MRC,MC)
C *** ZERO (TM) MATRIX FOR SPANWISE TRANSFORMATION
      KROWS=NIY*(NWCX+NCCX)
      KCOLS=NXWING*NYWING+NXCS*NYCS
      DO 60 I=1,KROWS
      DO 60 J=1,KCOLS
   60 TM(I,J)=0.0
C *** SPANWISE TRANSFORMATION (WING)
      IF (NYWING .EQ. 0) GO TO 3999
      DO 3000 I=1,NWCX
      CALL BMAT(NYWING,NRSB,NCSB)
      CALL TMAT(NYWING,2,MSIZE,1,1,WBO,SN)
      DO 3001 MR=1,MSIZE
      DO 3001 MC=1,NCSB
      TR(MR,MC)=0.0
      DO 3001 MRC=1,MSIZE
 3001 TR(MR,MC)=TR(MR,MC)+T(MR,MRC)*B(MRC,MC)
      CALL SMAT(NIY,NYWING,1,NRSS,NCSS,WBO,SN)
      DO 3002 MR=1,NRSS
      DO 3002 MC=1,NCSB
      T(MR,MC)=0.0
      DO 3002 MRC=1,NCSS
 3002 T(MR,MC)=T(MR,MC)+C(MR,MRC)*TR(MRC,MC)
      KROW=(I-1)*NIY
      DO 3080 LR=1,NIY
      LROW=KROW+LR
      NITR=NXWING-1
      DO 3070 J=1,NITR
      IF (WBO*XS(1,1,I,1) .LT. .5*(XAIC(J,1,1)+XAIC(J+1,1,1)))GO TO 3050
 3070 CONTINUE
      KCOL=NYWING*(NXWING-1)
      GO TO 3090
 3050 KCOL=NYWING*(J-1)
 3090 DO 3080 LC=1,NYWING
      LCOL=KCOL+LC
 3080 TM(LROW,LCOL)=T(LR,LC)
 3000 CONTINUE
 3999 CONTINUE
C *** SPANWISE TRANSFORMATION (CONTROL SURFACE)
      IF (NYCS .EQ. 0) GO TO 4999
      DO 4000 I=1,NCCX
      CALL BMAT(NYCS,NRSB,NCSB)
      CALL TMAT(NYCS,2,MSIZE,2,1,WBO,SN)
      DO 4001 MR=1,MSIZE
      DO 4001 MC=1,NCSB
      TR(MR,MC)=0.0
      DO 4001 MRC=1,MSIZE
 4001 TR(MR,MC)=TR(MR,MC)+T(MR,MRC)*B(MRC,MC)
      CALL SMAT(NIY,NYCS,2,NRSS,NCSS,WBO,SN)
      DO 4002 MR=1,NRSS
      DO 4002 MC=1,NCSB
      T(MR,MC)=0.0
      DO 4002 MRC=1,NCSS
 4002 T(MR,MC)=T(MR,MC)+C(MR,MRC)*TR(MRC,MC)
```

```
      KROW=(I-1)*NIY+NWCX*NIY
      DO 4080 LR=1,NIY
      LROW=KROW+LR
      NITR=NXCS-1
      DO 4070 J=1,NITR
      IF (WBO*XS(1,2,I,1) .LT. .5*(XAIC(J,1,2)+XAIC(J+1,1,2)))GO TO 405
 4070 CONTINUE
      KCOL=NYWING*NXWING+NYCS*(NXCS-1)
      GO TO 4090
 4050 KCOL=NYWING*NXWING+NYCS*(J-1)
 4090 DO 4080 LC=1,NYCS
      LCOL=KCOL+LC
 4080 TM(LROW,LCOL)=T(LR,LC)
 4060 CONTINUE
 4999 CONTINUE
C *** REARRANGE ROWS AND COLUMNS SO STATIONS ARE STACKED ROWWISE
      CALL RMAT(NIY,NWCX,NIY,NCCX,NSIZE)
      DO 5001 MR=1,NSIZE
      DO 5001 MC=1,KCOLS
      TR(MR,MC)=0.0
      DO 5001 MRC=1,NSIZE
 5001 TR(MR,MC)=TR(MR,MC)+R(MR,MRC)*TM(MRC,MC)
      DO 5002 MR=1,KROWS
      DO 5002 MC=1,KCOLS
      TM(MR,MC)=0.0
      DO 5002 MRC=1,KCOLS
 5002 TM(MR,MC)=TM(MR,MC)+TR(MR,MRC)*TI(MRC,MC)
      DO 5050 I=1,KROWS
      DO 5050 J=1,KCOLS
      TR(I,J)=TM(I,J)
 5050 TI(I,J)=TM(I,J)
      RETURN
      END
```

```
CTMAT  TMAT
      SUBROUTINE TMAT(NPTS,ND,MSIZE,NS,IY,WBO,SN)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
C *** GENERATES (T)**(-1) MATRIX
C *** NPTS = NUMBER OF AIC POINTS ALONG STRIP IN ND DIRECTION
C *** MSIZE = ORDER OF  T  MATRIX
C *** NS = SURFACE  (1=WING AND 2=CONTROL SURFACE)
C *** ND = INTERPOLATION DIRECTION  (1=CHORDWISE AND 2=SPANWISE)
      IF (NPTS .LT. 4) MSIZE=NPTS
      IF (NPTS .GT. 3) MSIZE=3*NPTS-6
      DO 1 J=1,MSIZE
      DO 1 K=1,MSIZE
    1 T(J,K)=0.0
      IF (NPTS .GT. 4) GO TO 5000
      GO TO (2000,2000,3000,4000), NPTS
C *** NPTS=2  (TWO POINTS ALONG STRIP)
 2000 T(1,1)=1.0
      T(2,1)=1.0
      IF (ND .EQ. 1) T(1,2)=XAIC(1,IY,NS)
      IF (ND .EQ. 1) T(2,2)=XAIC(2,IY,NS)
      IF (ND .EQ. 2) T(1,2)=YAIC(1,NS)
      IF (ND .EQ. 2) T(2,2)=YAIC(2,NS)
      GO TO 6000
C *** NPTS=3  (THREE POINTS ALONG STRIP)
 3000 T(1,1)=1.0
      T(2,1)=1.0
      T(3,1)=1.0
      IF (ND .EQ. 2) GO TO 3010
C *** NPTS=3  CHORDWISE DIRECTION
      T(1,2)=XAIC(1,IY,NS)
      T(1,3)=T(1,2)**2
      T(2,2)=XAIC(2,IY,NS)
      T(2,3)=T(2,2)**2
      T(3,2)=XAIC(3,IY,NS)
      T(3,3)=T(3,2)**2
      GO TO 6000
C *** NPTS=3  SPANWISE DIRECTION
 3010 T(1,2)=YAIC(1,NS)
      T(1,3)=T(1,2)**2
      T(2,2)=YAIC(2,NS)
      T(2,3)=T(2,2)**2
      T(3,2)=YAIC(3,NS)
      T(3,3)=T(3,2)**2
      GO TO 6000
C *** NPTS=4  (FOUR POINTS ALONG STRIP)
 4000 T(1,1)=1.0
      T(2,1)=1.0
      T(3,1)=1.0
      T(4,2)=1.0
      T(5,4)=1.0
      T(6,4)=1.0
      T(3,4)=-1.0
      T(4,5)=-1.0
      IF (ND .EQ. 2) GO TO 4010
C *** NPTS=4  CHORDWISE DIRECTION
      T(1,2)=XAIC(1,IY,NS)
      T(1,3)=T(1,2)**2
      T(2,2)=XAIC(2,IY,NS)
      T(2,3)=T(2,2)**2
      T(3,2)=0.5*(XAIC(2,IY,NS)+XAIC(3,IY,NS))
```

```
      T(3,3)=T(3,2)**2
      T(3,5)=-T(3,2)
      T(3,6)=-T(3,3)
      T(4,3)=2.0*T(3,2)
      T(4,6)=-T(4,3)
      T(5,5)=XAIC(3,IY,NS)
      T(5,6)=T(5,5)**2
      T(6,5)=XAIC(4,IY,NS)
      T(6,6)=T(6,5)**2
      GO TO 6000
C *** NPTS=4  SPANWISE DIRECTION
 4010 T(1,2)=YAIC(1,NS)
      T(1,3)=T(1,2)**2
      T(2,2)=YAIC(2,NS)
      T(2,3)=T(2,2)**2
      T(3,2)=0.5*(YAIC(2,NS)+YAIC(3,NS))
      T(3,3)=T(3,2)**2
      T(3,5)=-T(3,2)
      T(3,6)=-T(3,3)
      T(4,3)=2.0*T(3,2)
      T(4,6)=-T(4,3)
      T(5,5)=YAIC(3,NS)
      T(5,6)=T(5,5)**2
      T(6,5)=YAIC(4,NS)
      T(6,6)=T(6,5)**2
      GO TO 6000
C *** NPTS .GT. 4
 5000 IF (ND .EQ. 2) GO TO 5500
C *** NPTS .GT. 4  (CHORDWISE DIRECTION)
      T(1,1)=1.0
      T(1,2)=XAIC(1,IY,NS)
      T(1,3)=T(1,2)**2
      T(2,1)=1.0
      T(2,2)=XAIC(2,IY,NS)
      T(2,3)=T(2,2)**2
      T(MSIZE,MSIZE-2)=1.0
      T(MSIZE,MSIZE-1)=XAIC(NPTS,IY,NS)
      T(MSIZE,MSIZE)=T(MSIZE,MSIZE-1)**2
      T(MSIZE-1,MSIZE-2)=1.0
      T(MSIZE-1,MSIZE-1)=XAIC(NPTS-1,IY,NS)
      T(MSIZE-1,MSIZE)=T(MSIZE-1,MSIZE-1)**2
      NT=NPTS-4
      DO 5010 N=1,NT
      NR=2+3*N
      NC=3*N+1
      NP=N+2
      T(NR,NC)=1.0
      T(NR,NC+1)=XAIC(NP,IY,NS)
 5010 T(NR,NC+2)=T(NR,NC+1)**2
      NT=NPTS-3
      DO 5020 N=1,NT
      NR=3*N
      NC=3*N-2
      T(NR,NC)=1.0
      T(NR+1,NC+1)=1.0
      T(NR,NC+3)=-1.0
      T(NR+1,NC+4)=-1.0
      T(NR,NC+1)=0.5*(XAIC(N+1,IY,NS)+XAIC(N+2,IY,NS))
      T(NR,NC+2)=T(NR,NC+1)**2
      T(NR,NC+4)=-T(NR,NC+1)
      T(NR,NC+5)=-T(NR,NC+2)
```

```
      T(NR+1,NC+2)=2.0*T(NR,NC+1)
 5420 T(NR+1,NC+5)=-T(NR+1,NC+2)
      GO TO 6000
C *** NPTS .GT. 4  (SPANWISE DIRECTION)
 5500 T(1,1)=1.0
      T(1,2)=YAIC(1,NS)
      T(1,3)=T(1,2)**2
      T(2,1)=1.0
      T(2,2)=YAIC(2,NS)
      T(2,3)=T(2,2)**2
      T(MSIZE,MSIZE-2)=1.0
      T(MSIZE,MSIZE-1)=YAIC(NPTS,NS)
      T(MSIZE,MSIZE)=T(MSIZE,MSIZE-1)**2
      T(MSIZE-1,MSIZE-2)=1.0
      T(MSIZE-1,MSIZE-1)=YAIC(NPTS-1,NS)
      T(MSIZE-1,MSIZE)=T(MSIZE-1,MSIZE-1)**2
      NT=NPTS-4
      DO 5510 N=1,NT
      NR=2+3*N
      NC=3*N+1
      NP=N+2
      T(NR,NC)=1.0
      T(NR,NC+1)=YAIC(NP,NS)
 5510 T(NR,NC+2)=T(NR,NC+1)**2
      NT=NPTS-3
      DO 5520 N=1,NT
      NR=3*N
      NC=3*N-2
      T(NR,NC)=1.0
      T(NR+1,NC+1)=1.0
      T(NR,NC+3)=-1.0
      T(NR+1,NC+4)=-1.0
      T(NR,NC+1)=0.5*(YAIC(N+1,NS)+YAIC(N+2,NS))
      T(NR,NC+2)=T(NR,NC+1)**2
      T(NR,NC+4)=-T(NR,NC+1)
      T(NR,NC+5)=-T(NR,NC+2)
      T(NR+1,NC+2)=2.0*T(NR,NC+1)
 5520 T(NR+1,NC+5)=-T(NR+1,NC+2)
C *** INVERT  T  MATRIX
 6000 CONTINUE
      CALL MINV (MSIZE,T,C)
      RETURN
      END
```

```
CCMAT     CMAT
      SUBROUTINE CMAT(NPTS,NIY,NAICPX,NAICPY,NIF,NS,IY,NRS,NCS,WBO,SN)
C *** FOR CHORDWISE TRANSFORMATIONS
C *** NPTS = NUMBER OF CHORDWISE UNSTEADY AERO COLLOCATION STATIONS
C *** NIY = NUMBER OF SPANWISE UNSTEADY AERO COLLOCATION STATIONS
C *** NAICPX = NUMBER OF CHORDWISE AIC COLLOCATION STATIONS
C *** NAICPY = NUMBER OF SPANWISE AIC COLLOCATION STATIONS
C *** IY = SPAN NUMBER OF AIC STRIP BEING TRANSFORMED
C *** NIF = CODE FOR DIFFERENTIATION  (1=NO DERIVATIVE AND 2=D( )/DX )
C *** MATRIX SIZE IS (NRS,NCS)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(10,40),
     1          C(10,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      IF (NAICPX .GT. 3) GO TO 5
      NRS=NAICPX
      NCS=NAICPX
      DO 1 I=1,NRS
      DO 1 J=1,NCS
    1 C(I,J)=0.0
      GO TO 100
    5 NRS=NAICPX
      NCS=3*(NAICPX-2)
      DO 4 I=1,NRS
      DO 4 J=1,NCS
    4 C(I,J)=0.0
  100 IF (NCS .GT. 6) GO TO 500
      IF (NCS .EQ. 6) GO TO 400
      GO TO (200,200,300),NCS
C *** TWO POINTS
  200 DO  210 I=1,NAICPX
      C(I,1)=1.0
      C(I,2)=XINT(IY,I,NIY,NS,WBO,SN)
      IF (NIF .EQ. 2) C(I,1)=0.0
      IF (NIF .EQ. 2) C(I,2)=1.0
  210 CONTINUE
      RETURN
C *** THREE POINTS
  300 DO  310 I=1,NAICPX
      C(I,1)=1.0
      IF (NIF .EQ. 2) C(I,1)=0.0
      C(I,2)=XINT(IY,I,NIY,NS,WBO,SN)
      IF (NIF .EQ. 2) C(I,2)=1.0
      C(I,3)=C(I,2)**2
      IF (NIF .EQ. 2) C(I,3)=2.0*XINT(IY,I,NIY,NS,WBO,SN)
  310 CONTINUE
      RETURN
C *** FOUR POINTS
  400 DO  410 I=1,NAICPX
      NX=NPTS-1
      DO 406 J=1,NX
      IF (0.5*(XAIC(J,IY,NS)+XAIC(J+1,IY,NS)).GT.XINT(IY,I,NIY,NS,WBO,SN
     1)) GO TO 407
  406 CONTINUE
      NX=NPTS
      GO TO 408
  407 NX=J
  408 KC=1
      IF (NX .GT. 2) KC=4
      C(I,KC)=1.0
      C(I,KC+1)=XINT(IY,I,NIY,NS,WBO,SN)
      C(I,KC+2)=C(I,KC+1)**2
      IF (NIF .EQ. 2) C(I,KC)=0.0
```

```
      IF (NIF .EQ. 1) C(I,KC+1)=1.0
      IF (NIF .EQ. 1) C(I,KC+2)=2.0*XINT(IY,I,NIY,NS,WBO,SN)
  410 CONTINUE
      RETURN
C *** .GT. FOUR POINTS
  500 DO 510 I=1,NAICPX
      NX=NPTS-1
      DO 506 J=1,NX
      IF (0.5*(XAIC(J,IY,NS)+XAIC(J+1,IY,NS)).GT.XINT(IY,I,NIY,NS,WBO,SN
     1)) GO TO 507
  506 CONTINUE
      NX=NPTS
      GO TO 508
  507 NX=J
  508 IF (NX .LT. 3) GO TO 550
      IF (NX .GT. NAICPX-2) GO TO 580
      KC=(NX-2)*3+1
      C(I,KC)=1.0
      C(I,KC+1)=XINT(IY,I,NIY,NS,WBO,SN)
      C(I,KC+2)=C(I,KC+1)**2
      IF (NIF .EQ. 1) C(I,KC+1)=1.0
      IF (NIF .EQ. 1) C(I,KC)=0.0
      IF (NIF .EQ. 1) C(I,KC+2)=2.0*XINT(IY,I,NIY,NS,WBO,SN)
      GO TO 510
  550 C(I,1)=1.0
      C(I,2)=XINT(IY,I,NIY,NS,WBO,SN)
      C(I,3)=C(I,2)**2
      IF (NIF .EQ. 1) C(I,1)=0.0
      IF (NIF .EQ. 1) C(I,2)=1.0
      IF (NIF .EQ. 1) C(I,3)=2.0*XINT(IY,I,NIY,NS,WBO,SN)
      GO TO 510
  580 C(I,NCS-2)=1.0
      C(I,NCS-1)=XINT(IY,I,NIY,NS,WBO,SN)
      C(I,NCS)=C(I,NCS-1)**2
      IF (NIF .EQ. 1) C(I,NCS-2)=0.0
      IF (NIF .EQ. 1) C(I,NCS-1)=1.0
      IF (NIF .EQ. 1) C(I,NCS)=2.0*XINT(IY,I,NIY,NS,WBO,SN)
  510 CONTINUE
      RETURN
      END
```

```
CSMAT  SMAT
      SUBROUTINE SMAT(NIY,NAICPY,NS,NRS,NCS,WBO,SN)
C *** SPANWISE TRANSFORMATION
C *** NIY = NUMBER OF SPANWISE UNSTEADY AERO COLLOCATION STATIONS
C *** NAICPY = NUMBER OF SPANWISE AIC COLLOCATION STATIONS
C *** NS = SURFACE  (1=WING AND 2=CONTROL SURFACE)
C *** MATRIX SIZE IS NRS BY NCS
      COMMON/C3/Y(11),XAIC(10,11,2),YAIC(10,2),B(40,40),R(40,40),
     1            C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      IF (NAICPY .GT. 3) GO TO 8
      NRS=NIY
      NCS=NAICPY
      DO 6 I=1,NRS
      DO 6 J=1,NCS
    6 C(I,J)=0.0
      GO TO 100
    8 NRS=NIY
      NCS=3*(NAICPY-2)
      DO 9 I=1,NRS
      DO 9 J=1,NCS
    9 C(I,J)=0.0
  100 IF (NCS .GT. 4) GO TO 500
      IF (NCS .EQ. 4) GO TO 400
      GO TO (200,200,300),NCS
C *** TWO POINTS
  200 DO 260 I=1,NIY
      C(I,1)=1.0
      C(I,2)=WBO*SN*Y(I)
  260 CONTINUE
      RETURN
C *** THREE POINTS
  300 DO 360 I=1,NIY
      C(I,1)=1.0
      C(I,2)=WBO*SN*Y(I)
      C(I,3)=C(I,2)**2
  360 CONTINUE
      RETURN
C *** FOUR POINTS
  400 DO 490 I=1,NIY
      IC=4
      IF (WBO*SN*Y(I) .LT. 0.5*(YAIC(2,NS)+YAIC(3,NS))) IC=1
      C(I,IC)=1.0
      C(I,IC+1)=WBO*SN*Y(I)
      C(I,IC+2)=C(I,IC+1)**2
  490 CONTINUE
      RETURN
C *** .GT. FOUR POINTS
  500 DO 526 I=1,NIY
      NI=NAICPY-2
      DO 525 J=1,NI
      IF (0.5*(YAIC(J,NS)+YAIC(J+1,NS)) .GT. WBO*SN*Y(I)) GO TO 523
  525 CONTINUE
      IC=3*NAICPY-8
      GO TO 524
  523 IC=(J-2)*3+4
      IF (J .LT. 3) IC=1
  524 C(I,IC)=1.0
      C(I,IC+1)=WBO*SN*Y(I)
      C(I,IC+2)=C(I,IC+1)**2
  526 CONTINUE
      RETURN
      END
```

```
CRMAT        RMAT
      SUBROUTINE RMAT (NXWING,NYWING,NXCS,NYCS,MSIZE)
C *** REARRANGES AIC STATIONS INTO PROPER SEQUENCE FOR SPANWISE
C *** INTERPOLATION
C *** MATRIX SIZE IS MSIZE=NXWING*NYWING+NXCS*NYCS (SQUARE)
      COMMON/C3/Y([illegible]),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
      CZERO=0.0
      MSIZE=NXWING*NYWING+NXCS*NYCS
      DO 100 I=1,MSIZE
      DO 100 J=1,MSIZE
  100 R(I,J)=CZERO
      IF (NXWING .EQ. 0) GO TO 250
      K=1
      KK=1
      II=NYWING*NXWING
      DO 200 I=1,II
      R(I,K)=1.0
      K=K+NXWING
      IF (K .GT. II) KK=KK+1
      IF (K .GT. II) K=KK
  200 CONTINUE
  250 CONTINUE
      IF (NXCS .EQ. 0) GO TO 350
      II=NXCS*NYCS
      K=NYWING*NYWING+1
      KK=NXWING*NYWING+1
      DO 300 I=1,II
      IK=I+NXWING*NYWING
      R(IK,K)=1.0
      K=K+NXCS
      IF (K .GT. MSIZE) KK=KK+1
      IF (K .GT. MSIZE) K=KK
  300 CONTINUE
  350 CONTINUE
      RETURN
      END
```

```
CBMAT       BMAT
      SUBROUTINE BMAT(NPTS,IRS,ICS)
      COMMON/C3/Y(11),XAIC(10,10,2),YAIC(10,2),B(40,40),R(40,40),
     1          C(40,40),T(40,40),TM(40,40),TR(40,40),TI(40,40)
C *** B - B(IRS,ICS) MATRIX
C *** NPTS = NUMBER OF AIC STATION ALONG STRIP (EITHER CHORDWISE OR
C ***           SPANWISE)
      ICS=NPTS
      IF (NPTS .GT. 3) GO TO 200
      IRS=NPTS
      DO 10 I=1,IRS
      DO 10 J=1,ICS
      B(I,J)=0.0
      IF (I .EQ. J) B(I,J)=1.0
   10 CONTINUE
      RETURN
  200 IRS=6+(NPTS-4)*3
      DO 300 I=1,IRS
      DO 300 J=1,ICS
  300 B(I,J)=0.0
      B(1,1)=1.0
      B(2,2)=1.0
      B(IRS,ICS)=1.0
      B(IRS-1,ICS-1)=1.0
      IF (NPTS .EQ. 4) GO TO 400
      K=NPTS-4
      DO 350 I=1,K
      NR=2+3*I
      NC=2+I
  350 B(NR,NC)=1.0
  400 RETURN
      END
```

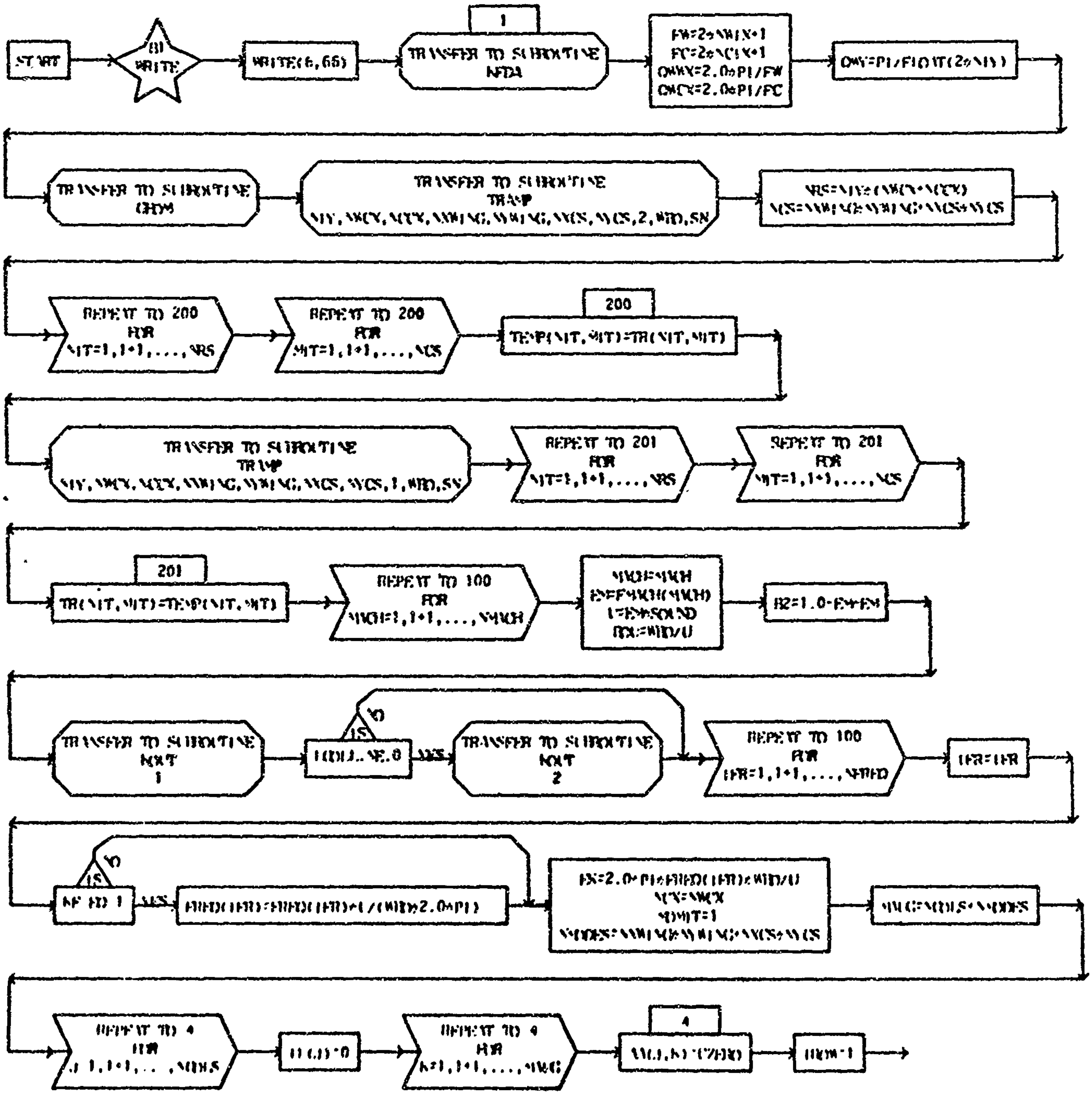
```
CMINV     MINV
      SUBROUTINE MINV (NM,A,U)
      DIMENSION A(40,40),U(40,40)
      DO 9001 I=1,NM
      DO 9001 J=1,NM
      U(I,J)=0.0
      IF (I.EQ.J) U(I,J)=1.0
 9001 CONTINUE
      EPS=0.00000001
      DO 9015 I=1,NM
      K=I
      IF (I-NM) 9021,9017,9021
 9021 IF (A(I,I)-EPS) 9005,9006,9007
 9005 IF (-A(I,I)-EPS) 9006,9006,9007
 9006 K=K+1
      DO 9023 J=1,NM
      U(I,J)=U(I,J)+U(K,J)
 9023 A(I,J)=A(I,J)+A(K,J)
      GO TO 9021
 9017 DIV=A(I,I)
      DO 9019 J=1,NM
      U(I,J)=U(I,J)/DIV
 9019 A(I,J)=A(I,J)/DIV
      DO 9015 MM=1,NM
      DELT=A(MM,I)
      IF (ABS(DELT)-EPS) 9015,9015,9016
 9016 IF (MM-I) 9010,9015,9010
 9010 DO 9011 J=1,NM
      U(MM,J)=U(MM,J)-U(I,J)*DELT
 9011 A(MM,J)=A(MM,J)-A(I,J)*DELT
 9015 CONTINUE
      DO 9033 I=1,NM
      DO 9033 J=1,NM
 9033 A(I,J)=U(I,J)
      RETURN
      END
```

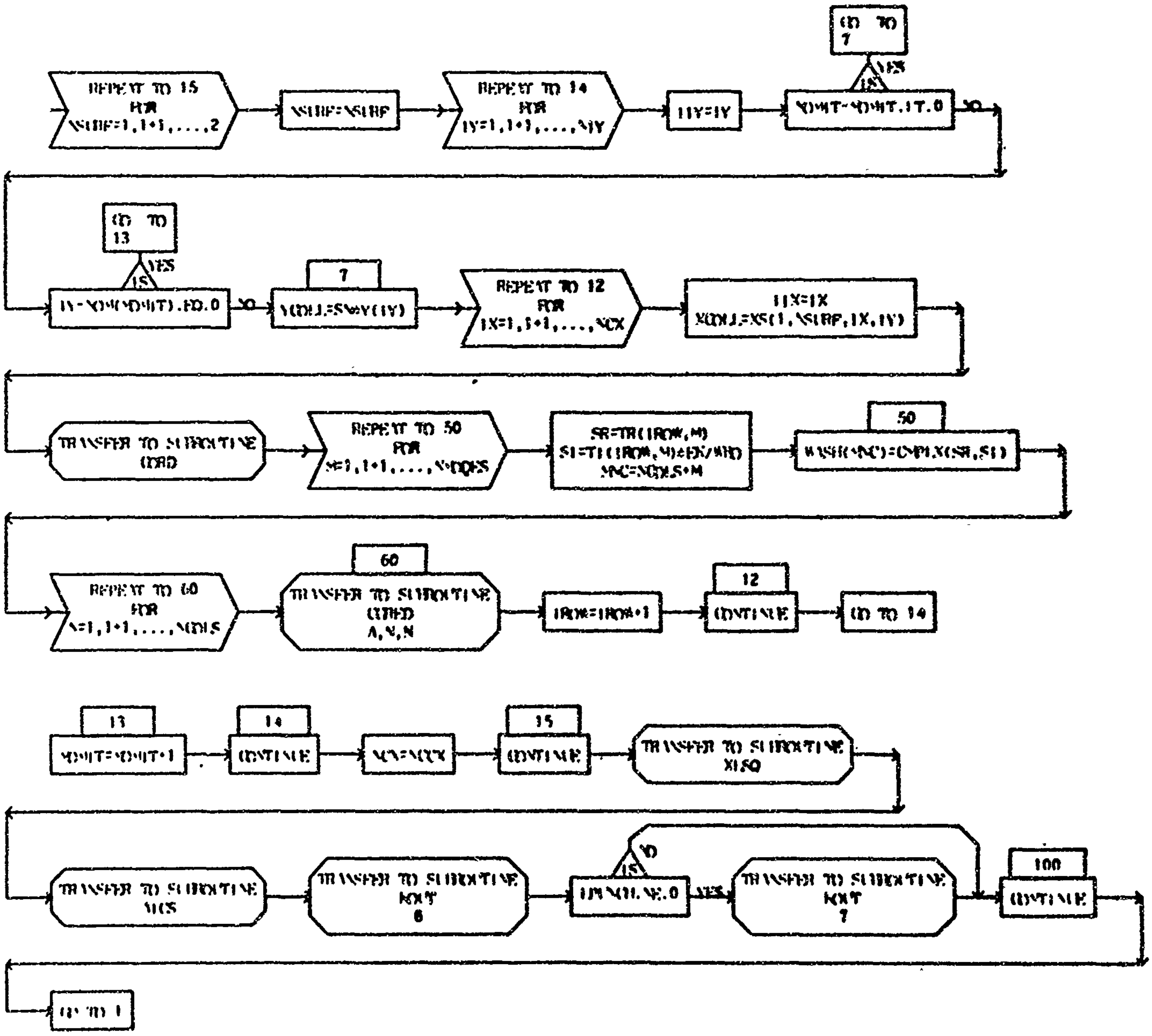
PART IV - SECTION B5.0

FLOW CHARTS FOR SUBSONIC
AIC COMPUTER PROGRAM

DIMENSIONED VARIABLES

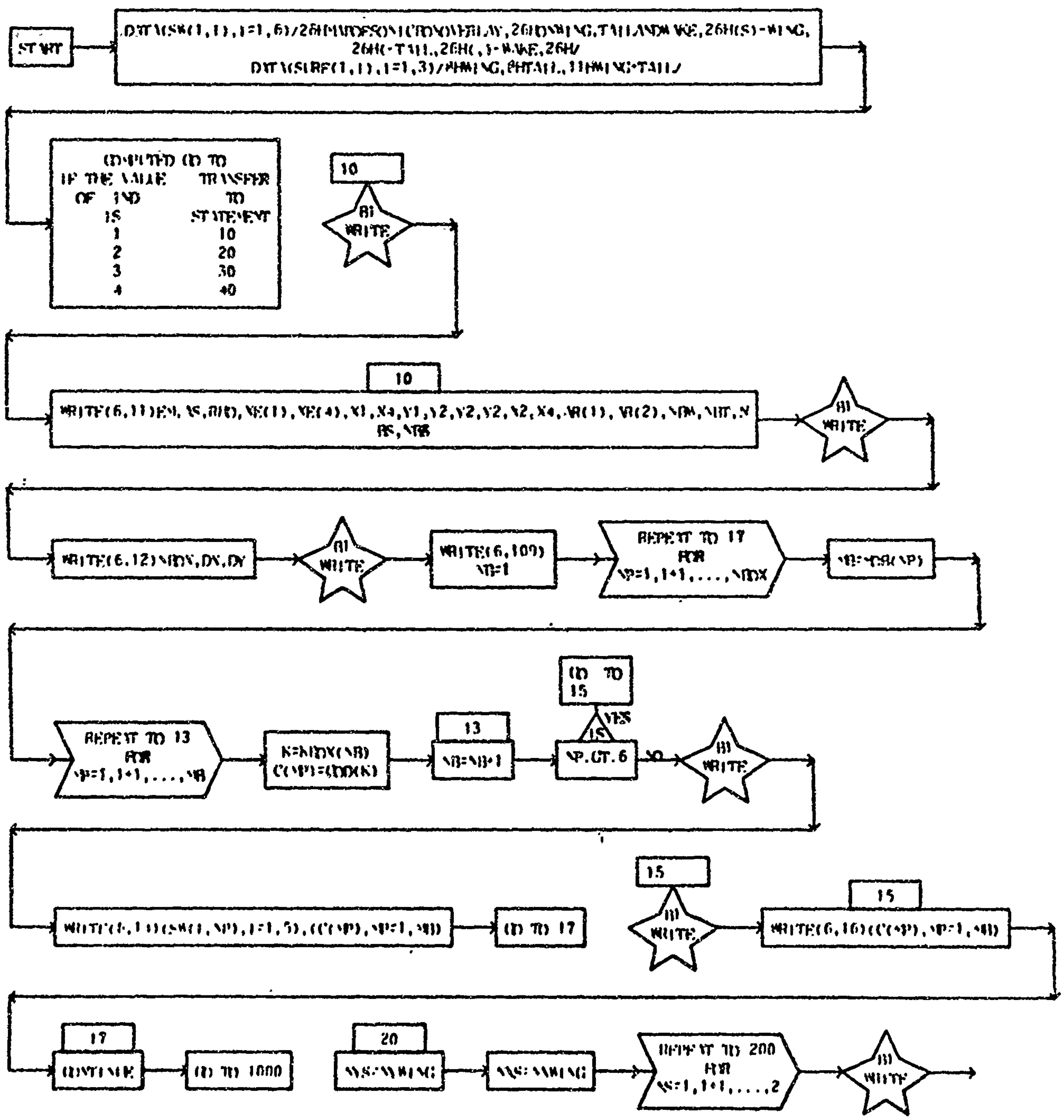
SYMBOL	STOR WDS	SYMBOL	STOR WDS	SYMBOL	STOR WDS	SYMBOL	STOR WDS	SYMBOL	STOR WDS
TEMP	40, 40	UC	40, 40	WASH	40	EM	40, 40		

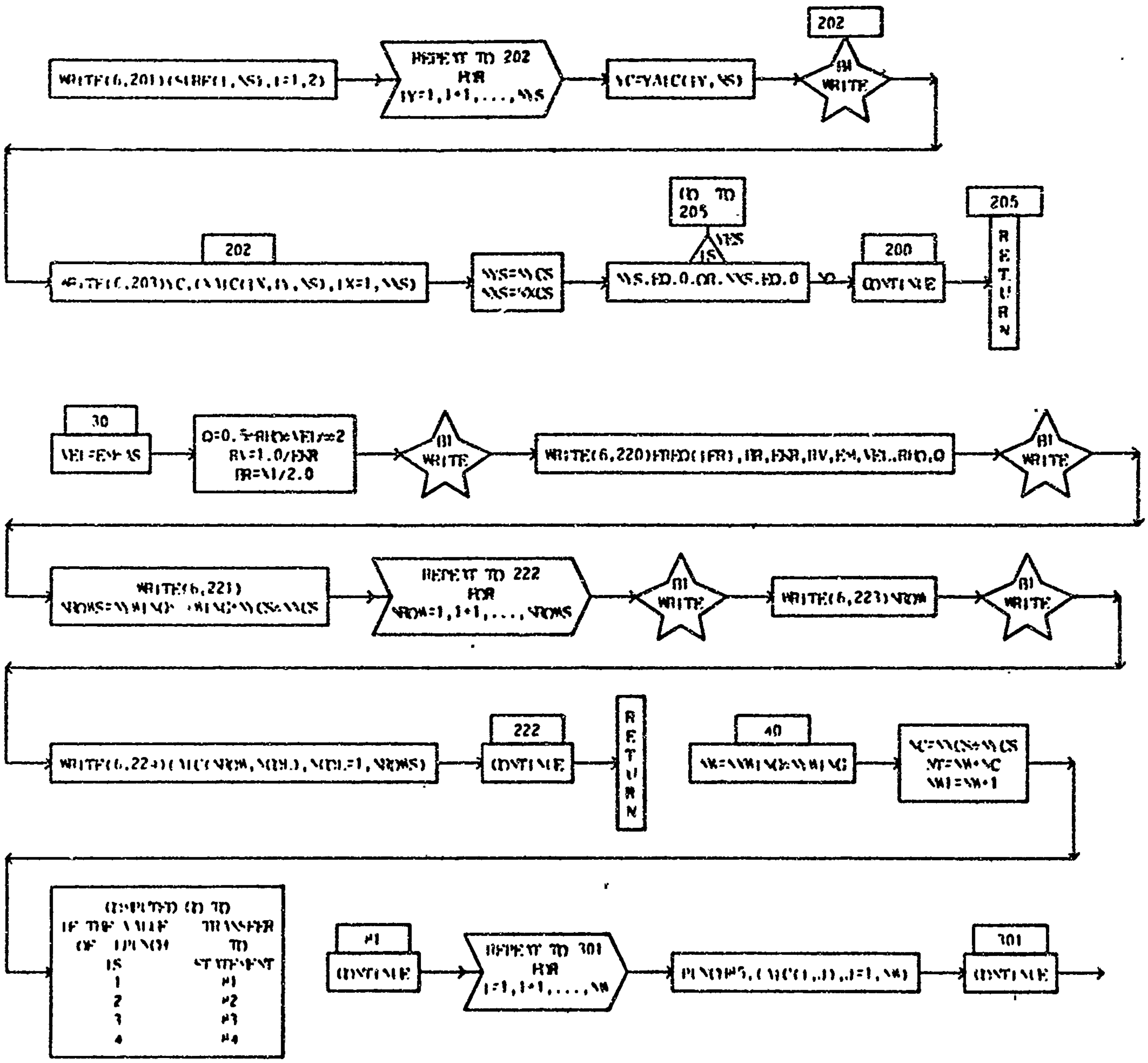

START
81 WRITE
WRITE(6,66)
1
TRANSFER TO SUBROUTINE
200
201
REPEAT TO 200
FOR
REPEAT TO 201
REPEAT TO 100
TRANSFER TO SUBROUTINE
4
REPEAT TO 4

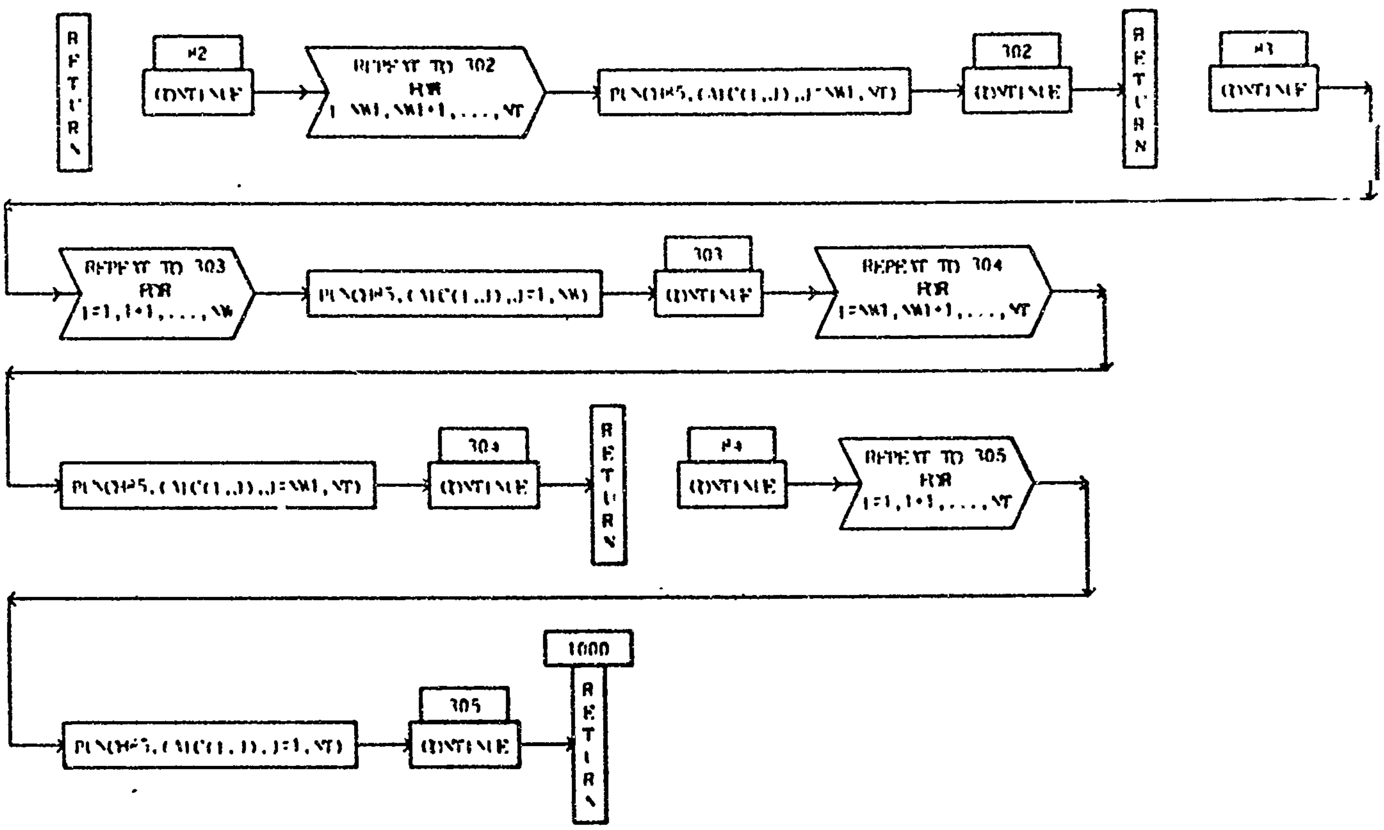

GO TO 7
YES
IS
NO
REPEAT TO 15
FOR
REPEAT TO 14
FOR
GO TO 13
7
REPEAT TO 12
FOR
TRANSFER TO SUBROUTINE
REPEAT TO 50
FOR
50
REPEAT TO 60
FOR
60
TRANSFER TO SUBROUTINE
12
CONTINUE
GO TO 14
13
14
CONTINUE
15
CONTINUE
TRANSFER TO SUBROUTINE
TRANSFER TO SUBROUTINE
TRANSFER TO SUBROUTINE
6
TRANSFER TO SUBROUTINE
7
100
CONTINUE

D I M E N S I O N E D   V A R I A B L E S

SYMBOL	STOR NOS	SYMBOL	STOR NOS	SYMBOL	STOR NOS	SYMBOL	STOR NOS	SYMBOL	STOR NOS
[illegible]	5,6	SURF	2,3	COD	7	C	50		


START
10
BI WRITE
15
13
17
20


202
REPEAT TO 202
FOR
WRITE
202
GO TO
205
YES
IS
200
CONTINUE
205
RETURN
30
Q=0.5*RHO*VEL**2
RV=1.0/ENR
WRITE
WRITE(6,220)
WRITE
WRITE(6,221)
REPEAT TO 222
FOR
WRITE
WRITE(6,223)
WRITE
222
CONTINUE
RETURN
40
COMPUTED GO TO
IF THE VALUE
TRANSFER
TO
IS
STATEMENT
1
2
3
4
CONTINUE
REPEAT TO 301
FOR
301
CONTINUE

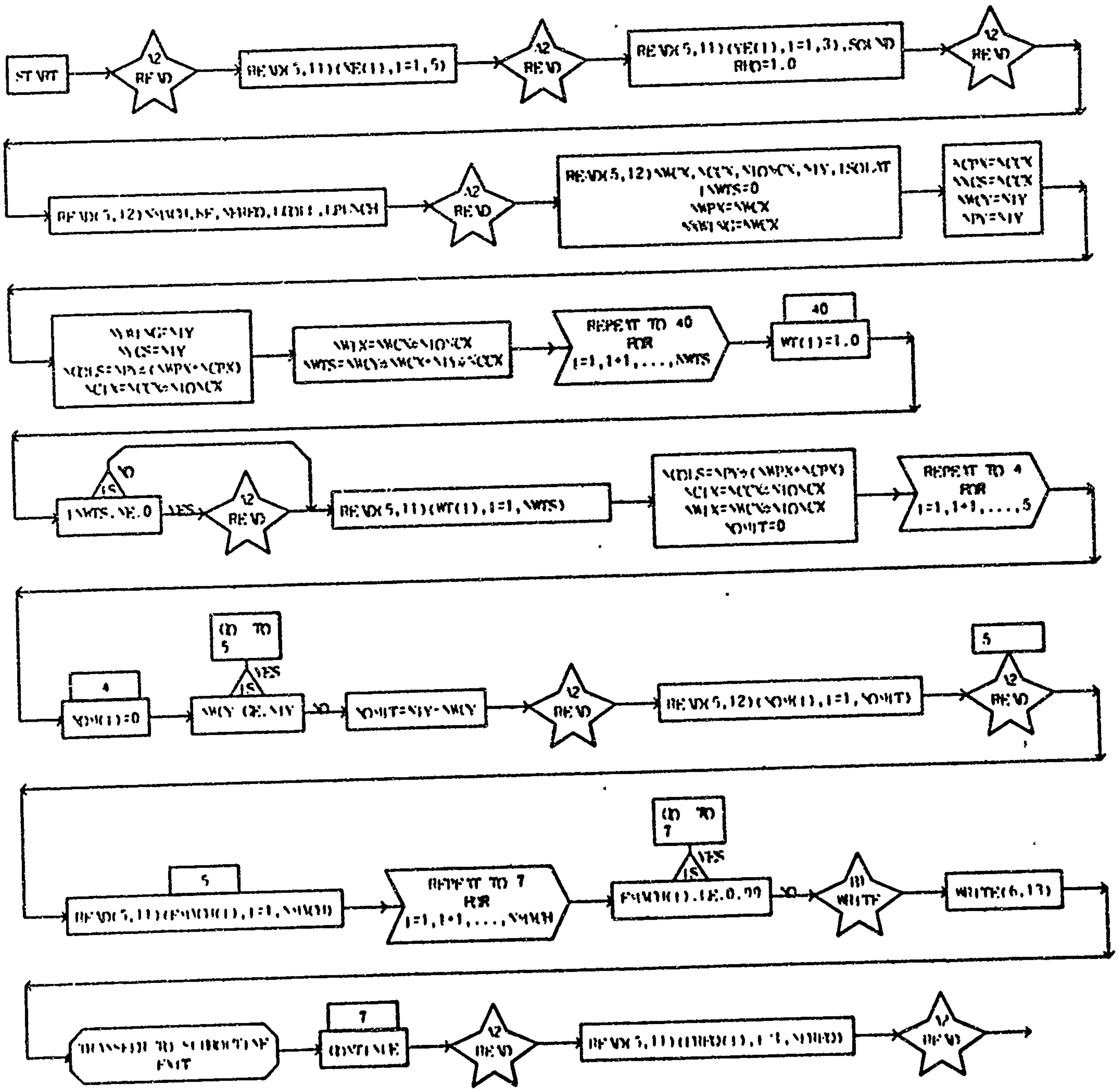

RETURN
#2
CONTINUE
REPEAT TO 302
302
CONTINUE
RETURN
#3
CONTINUE
REPEAT TO 303
FOR
303
CONTINUE
REPEAT TO 304
FOR
304
CONTINUE
RETURN
#4
CONTINUE
REPEAT TO 305
FOR
305
CONTINUE
1000
RETURN

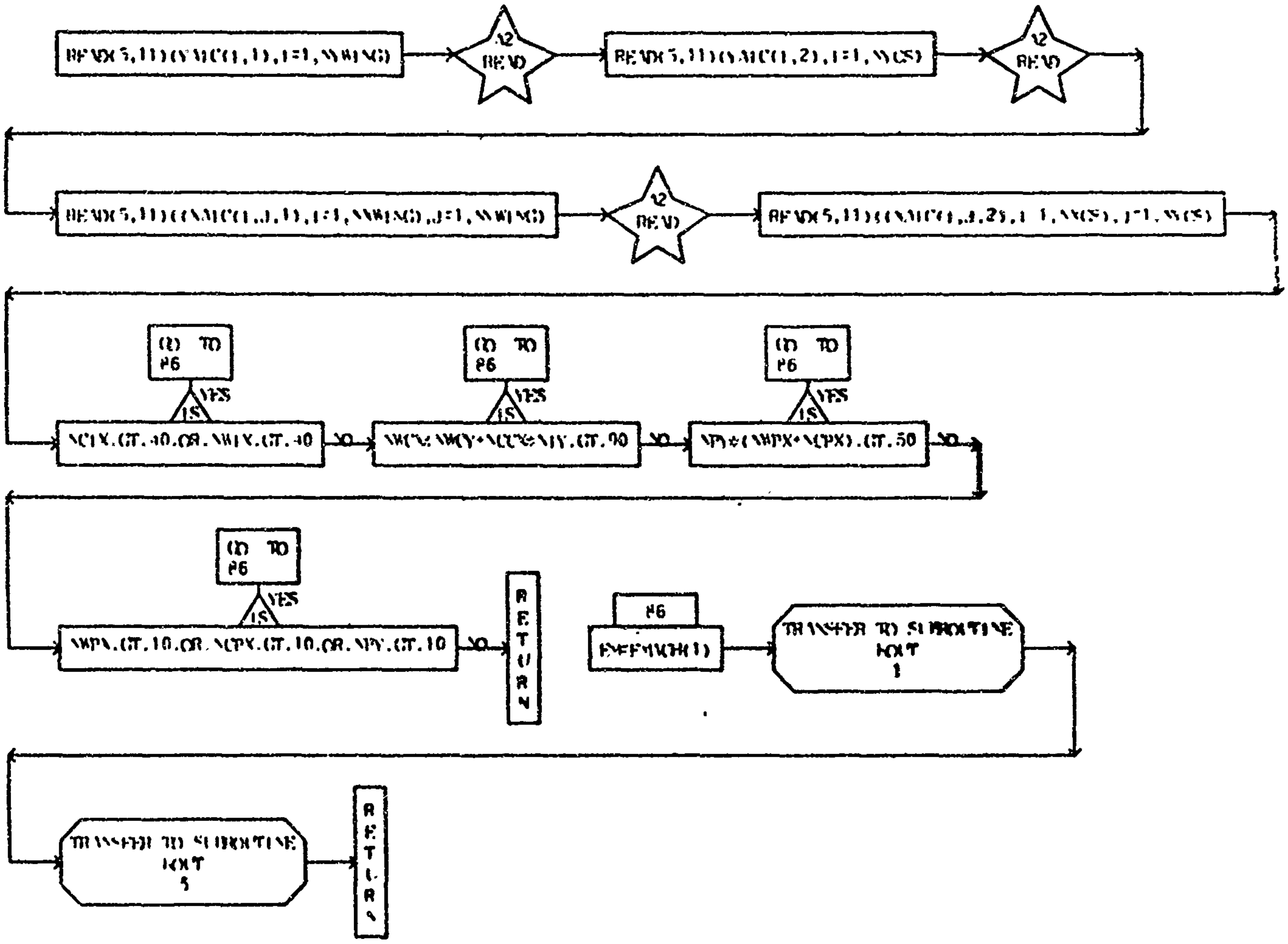
NFD1 NFD1

D I M E N S I O N E D   V A R I A B L E S

SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES
MC	40,40	WASH	40						

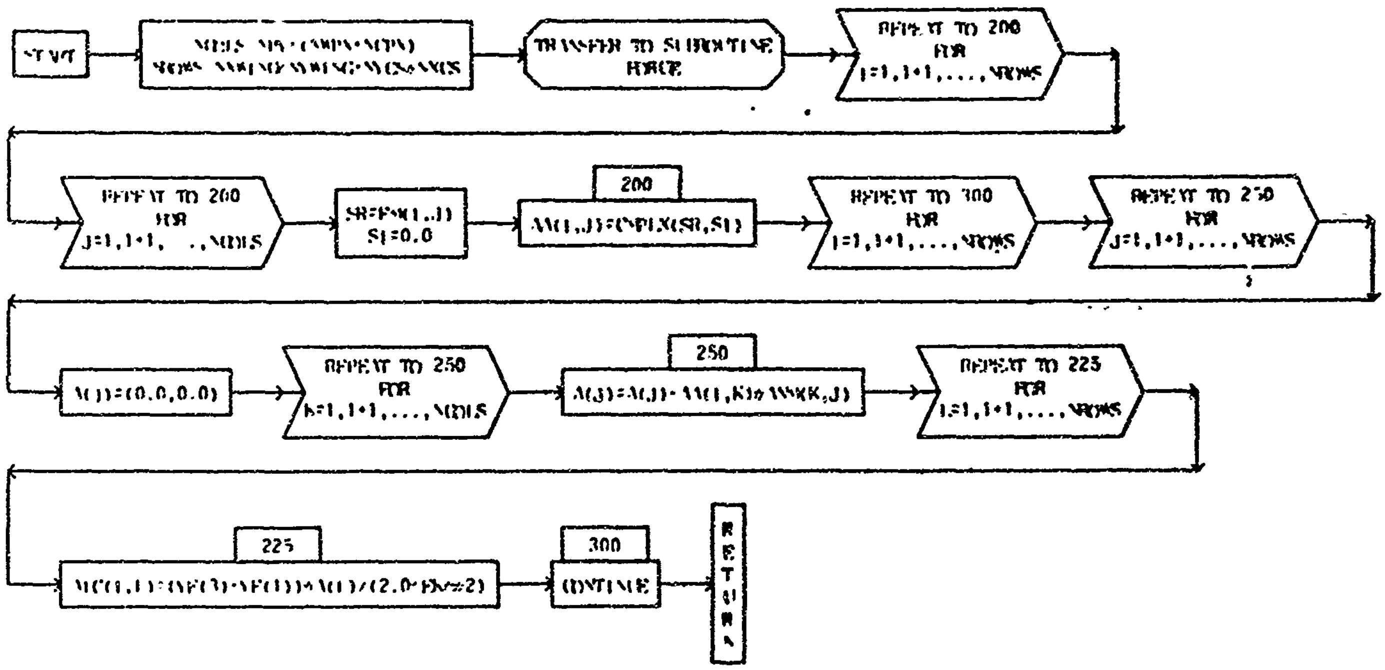
SUBROUTINE NFD1




READ
YES
IS
NO
RETURN
TRANSFER TO SUBROUTINE

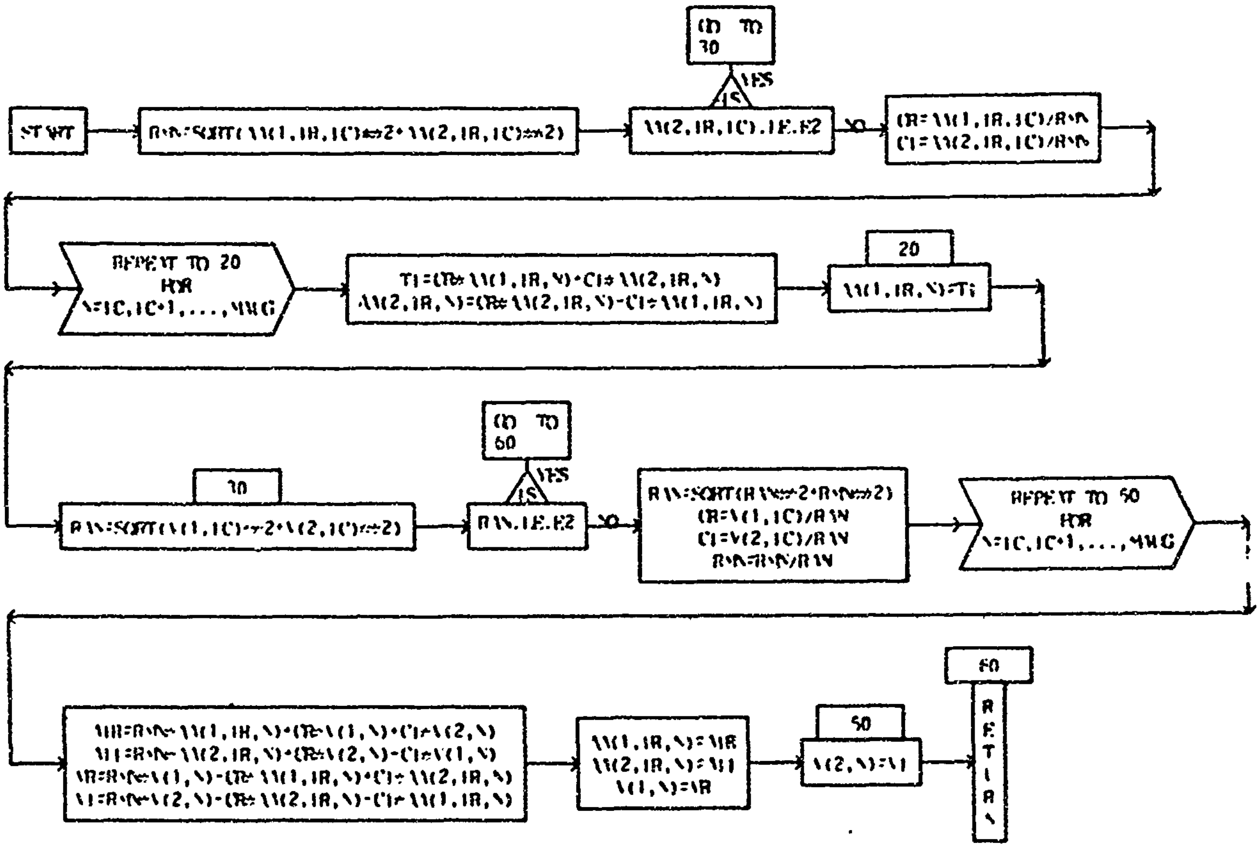
D I M E N S I O N E D   V A R I A B L E S

SYMBOL	STORAGE	SYMBOL	STORAGE	SYMBOL	STORAGE	SYMBOL	STORAGE	SYMBOL	STORAGE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				


START
TRANSFER TO SUBROUTINE FORCE
REPEAT TO 200
FOR
I=1,1+1,...,NROWS
REPEAT TO 200
FOR
J=1,1+1, ..,NCOLS
SI=0.0
200
REPEAT TO 300
FOR
I=1,1+1,...,NROWS
REPEAT TO 250
FOR
J=1,1+1,...,NROWS
A(J)=(0.0,0.0)
REPEAT TO 250
FOR
K=1,1+1,...,NCOLS
250
REPEAT TO 225
FOR
I=1,1+1,...,NROWS
225
300
CONTINUE
RETURN

D I M E N S I O N E D   V A R I A B L E S

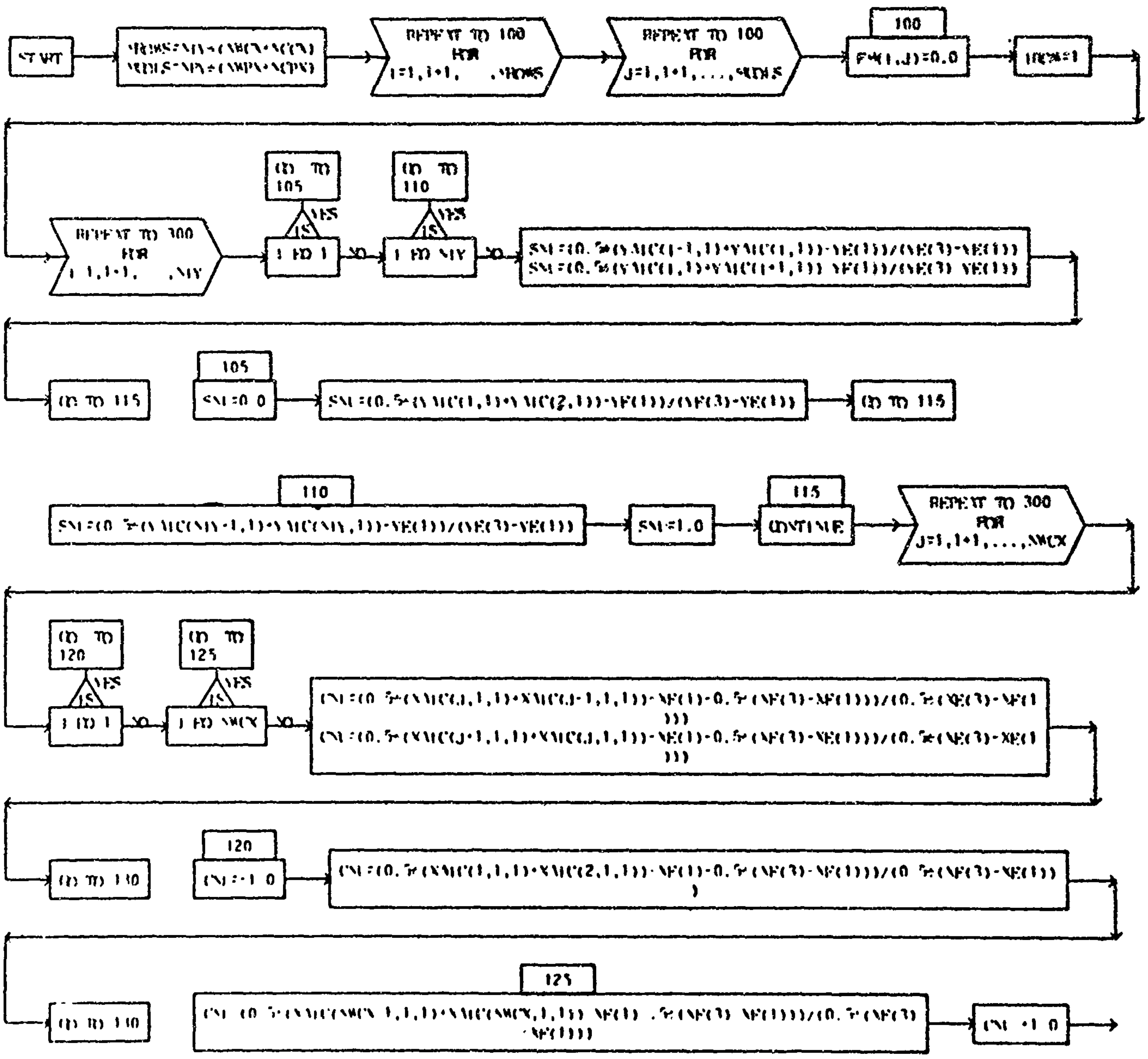
SYMBOL	STORAGE	SYMBOL	STORAGE	SYMBOL	STORAGE	SYMBOL	STORAGE	SYMBOL	STORAGE
MC	10,80	WASH	40	V	2,1				

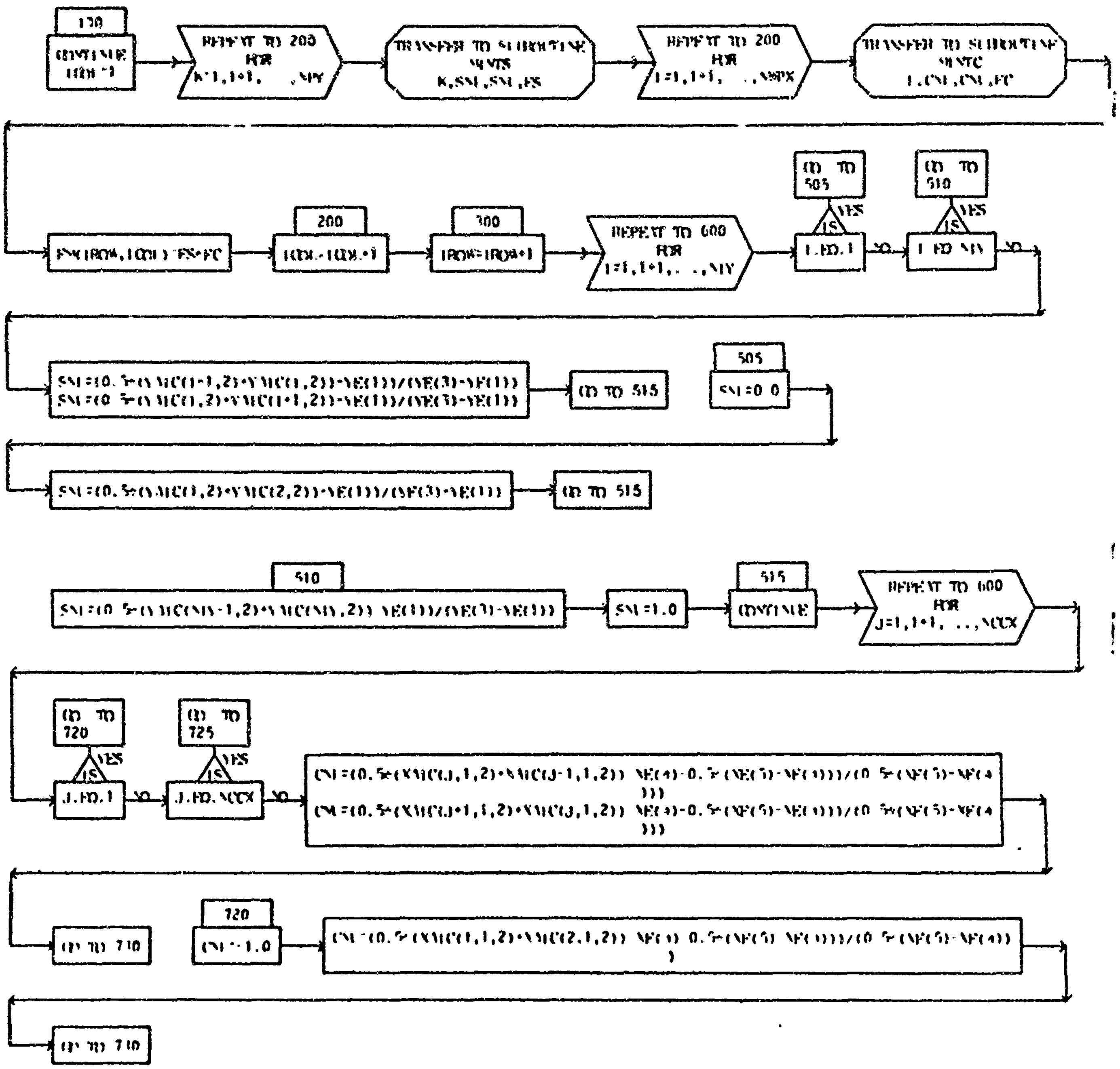

START
YES
NO
REPEAT TO 20
20
10
REPEAT TO 50
50
60

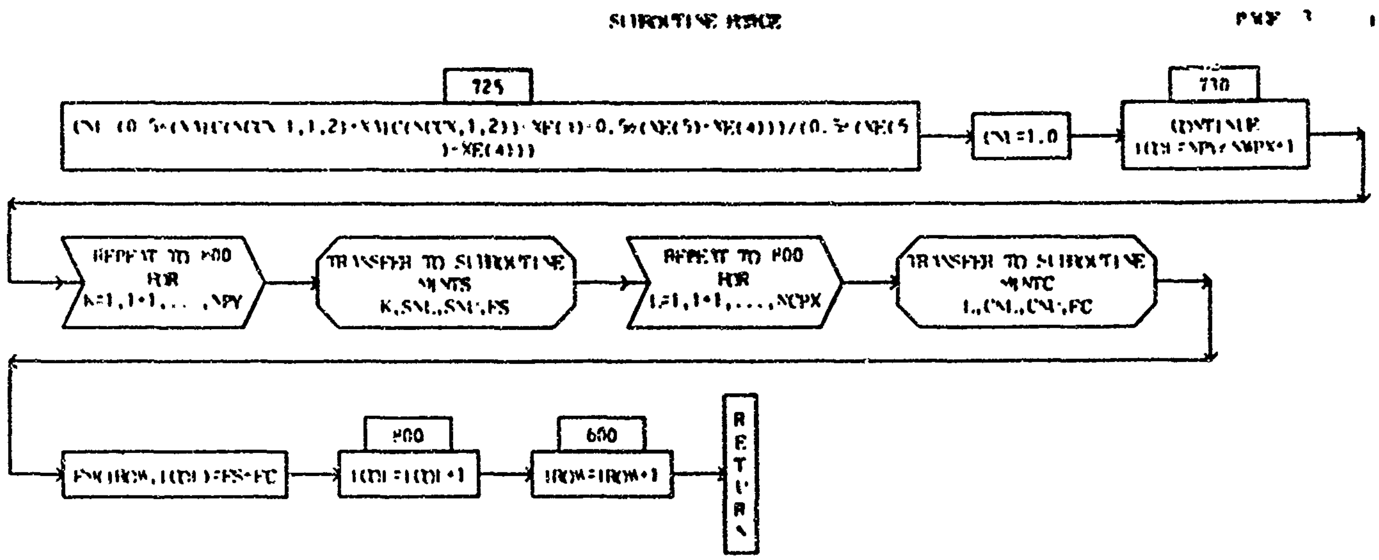
D I M E N S I O N E D   V A R I A B L E S

SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES
FM	10,10								

SUBROUTINE FORCE PAGE 1

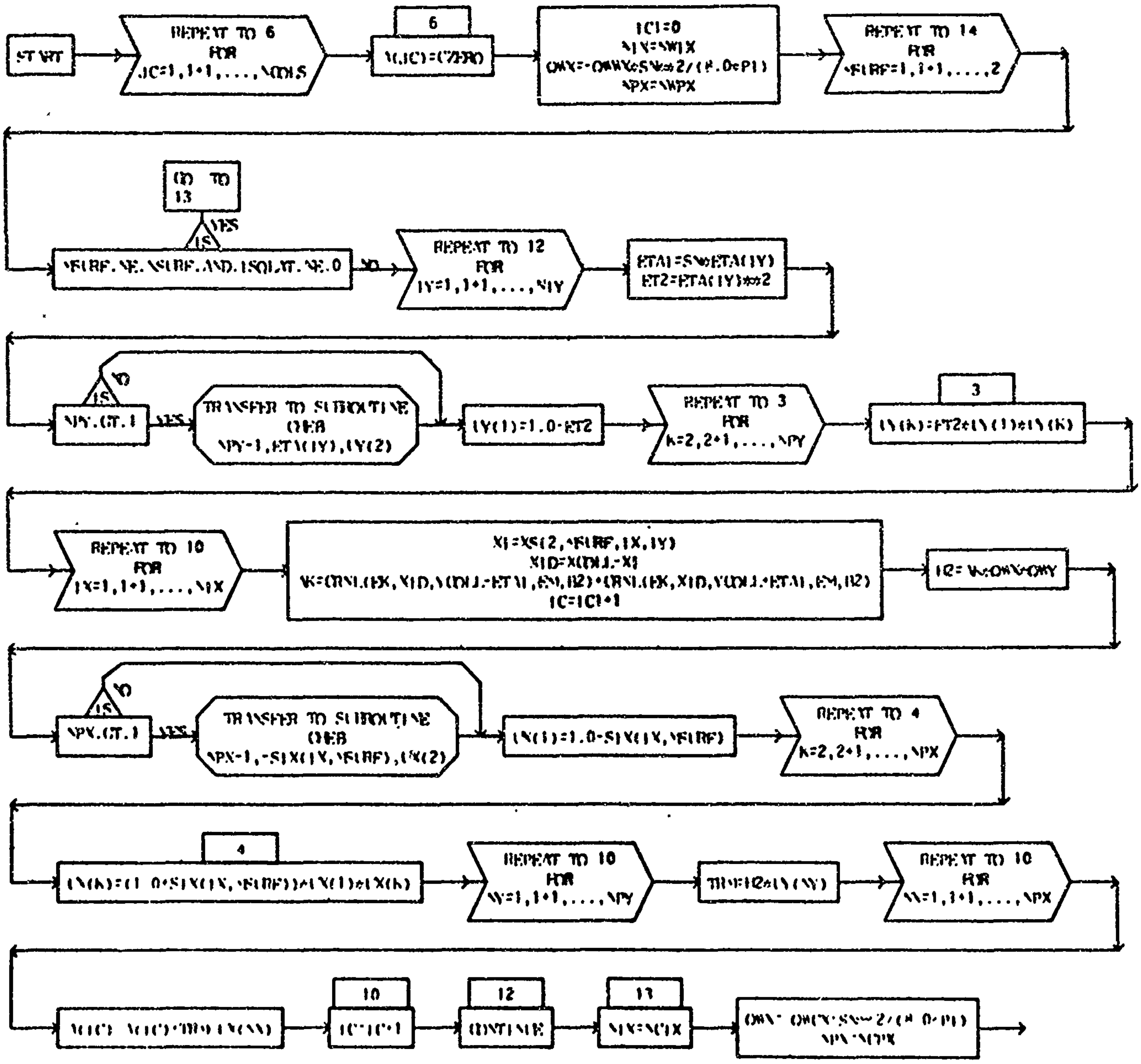


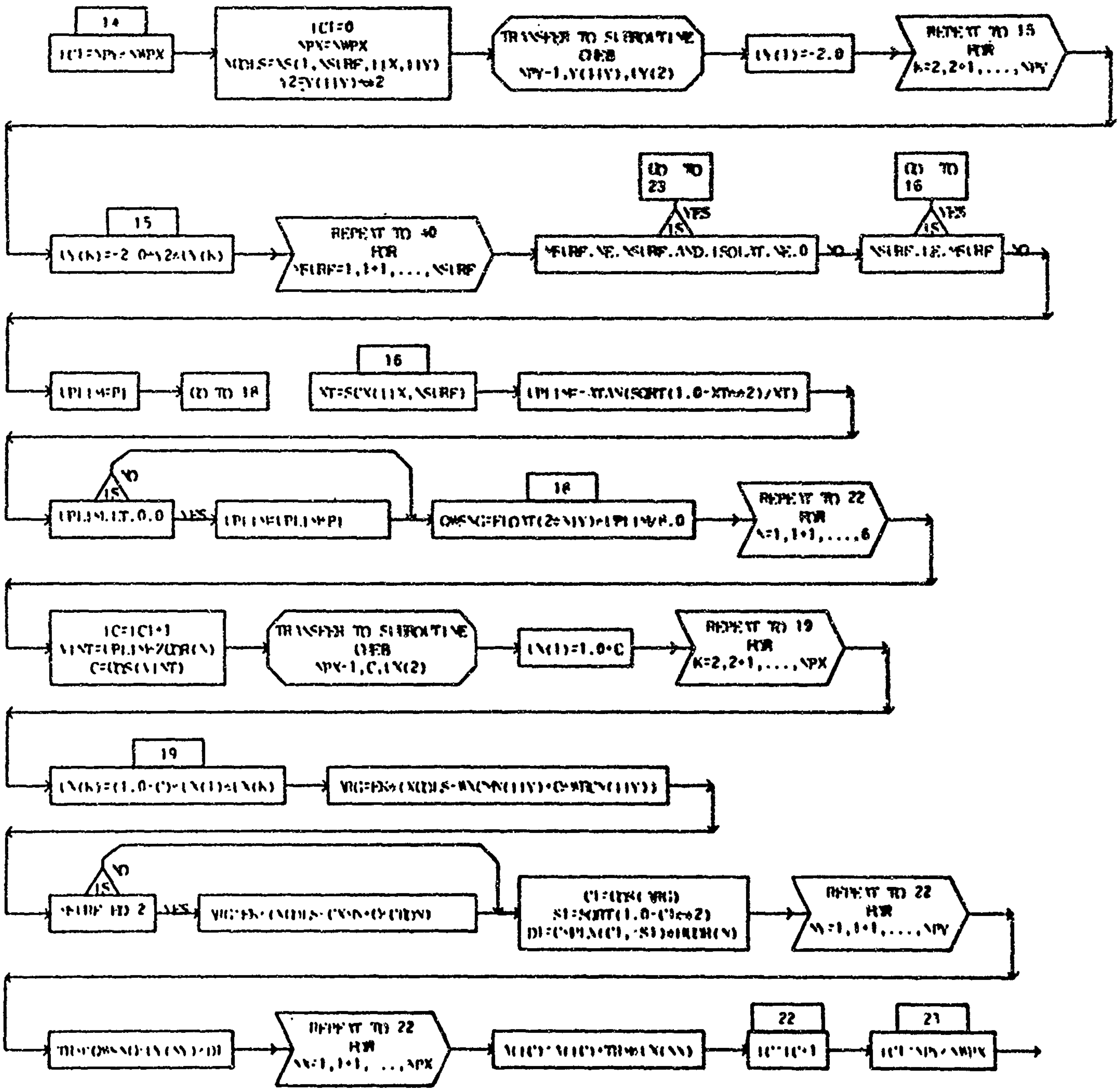

REPEAT TO 200
FOR
TRANSFER TO SUBROUTINE
REPEAT TO 200
FOR
TRANSFER TO SUBROUTINE
200
300
REPEAT TO 600
FOR
GO TO
505
GO TO
510
YES
IS
NO
GO TO 515
505
GO TO 515
510
SNI=1.0
515
CONTINUE
REPEAT TO 600
FOR
GO TO
720
GO TO
725
YES
IS
J.EQ.1
NO
720

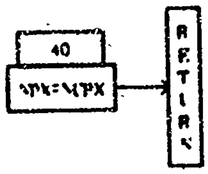

725
CNL=1.0
730
REPEAT TO 800
FOR
TRANSFER TO SUBROUTINE
K,SNL,SNU,FS
REPEAT TO 800
FOR
TRANSFER TO SUBROUTINE
800
600
IROW=IROW+1
R
E
T
R

DIMENSIONED VARIABLES

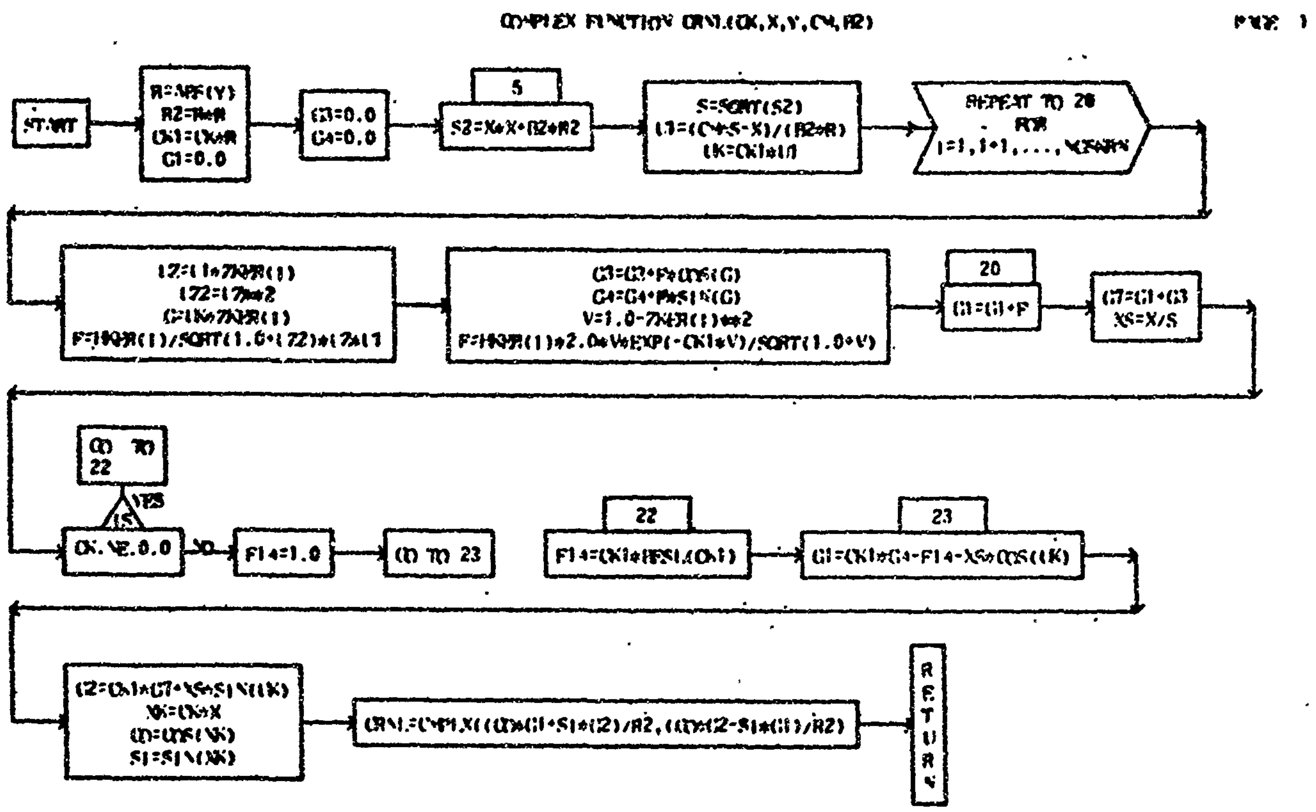
SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES
MC	40,80	WASH	40						

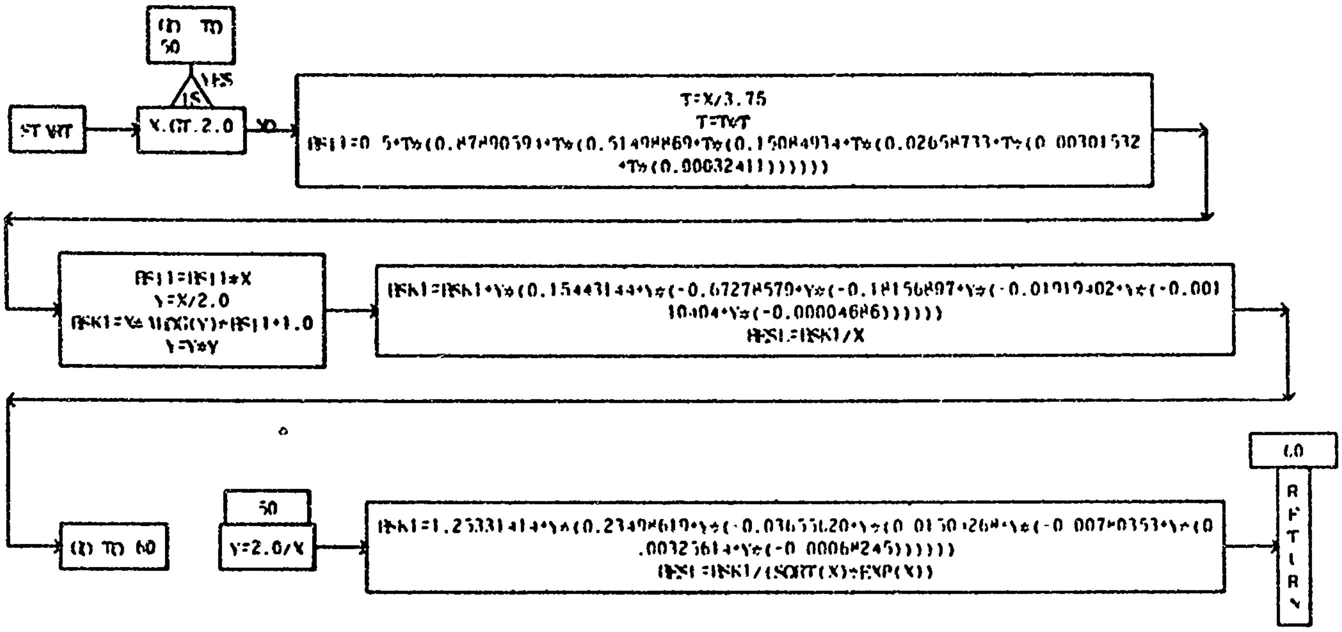

START
REPEAT TO 6
FOR
6
REPEAT TO 14
FOR
GO TO
13
YES
IS
NO
REPEAT TO 12
FOR
TRANSFER TO SUBROUTINE
REPEAT TO 3
3
REPEAT TO 10
IC=IC+1
REPEAT TO 4
4
10
12
13
CONTINUE


14
15
16
19
22
REPEAT TO 15
REPEAT TO 22
REPEAT TO 19
YES
NO
IS


40
RETURN

ORNL. ORNL.

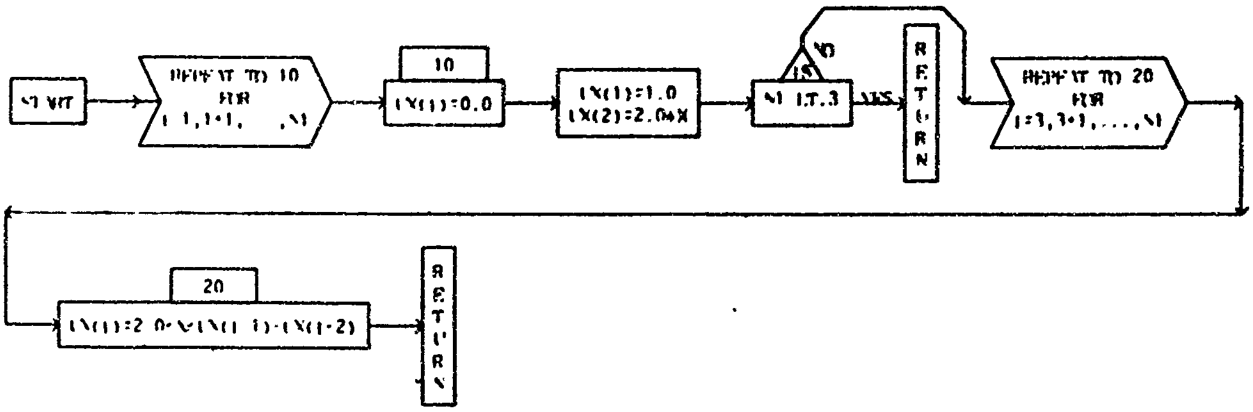

START
C1=0.0
C3=0.0
C4=0.0
5
S=SQRT(S2)
REPEAT TO 20
FOR
20
XS=X/S
GO TO
22
YES
NO
F14=1.0
GO TO 23
22
23
RETURN


GO TO 50
YES
NO
START
X.GT.2.0
T=X/3.75
T=T*T
BESI1=0.5+T*(0.87890594+T*(0.51498869+T*(0.15084934+T*(0.02658733+T*(0.00301532
+T*(0.00032411))))))
BESI1=BESI1*X
Y=X/2.0
BESK1=X*ALOG(Y)*BESI1+1.0
Y=Y*Y
BESK1=BESK1+Y*(0.15443144+Y*(-0.67278579+Y*(-0.18156897+Y*(-0.01919402+Y*(-0.001
10404+Y*(-0.00004686))))))
BESK1=BESK1/X
GO TO 60
50
Y=2.0/X
BESK1=1.25331414+Y*(0.23498619+Y*(-0.03655620+Y*(0.01504268+Y*(-0.00780353+Y*(0
.00325614+Y*(-0.00068245))))))
BESK1=BESK1/(SQRT(X)*EXP(X))
60
RETURN

D I M E N S I O N E D   V A R I A B L E S

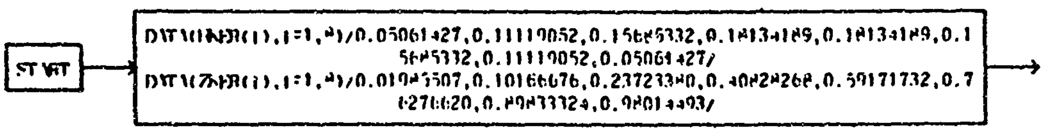
SYMBOL	STORAGE	SYMBOL	STORAGE	SYMBOL	STORAGE	SYMBOL	STORAGE	SYMBOL	STORAGE
IX	1								

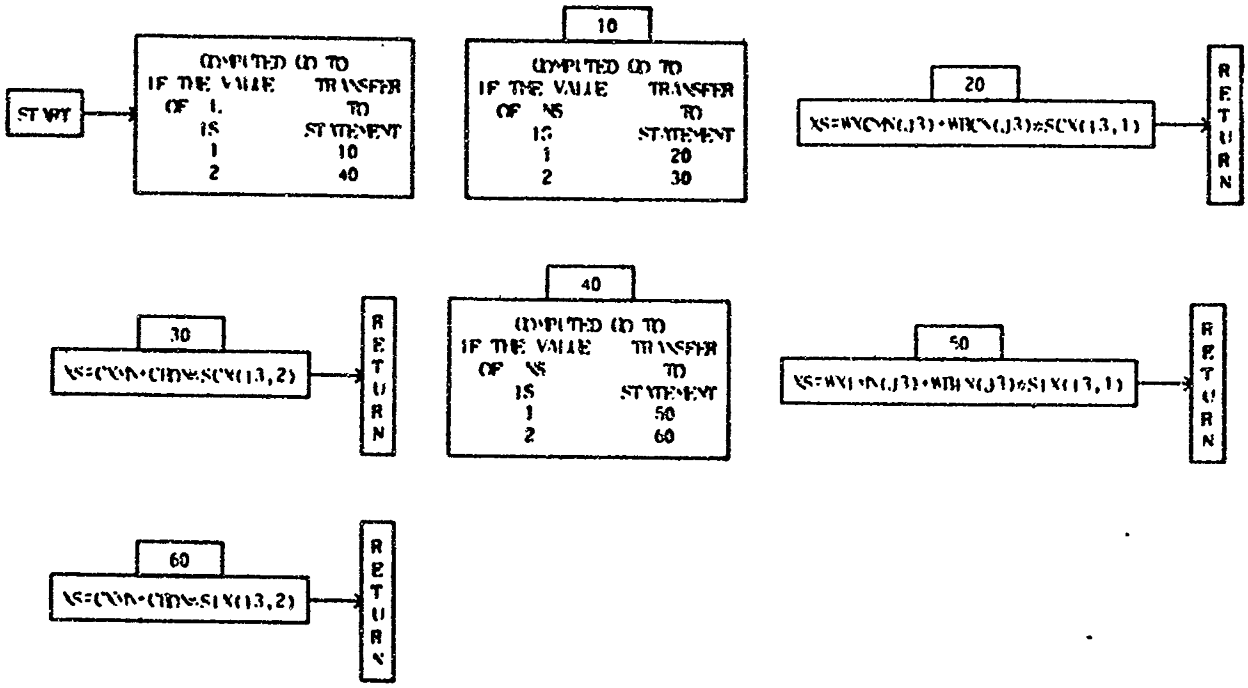
SUBROUTINE CHEB(NI,X,TX) PAGE 1



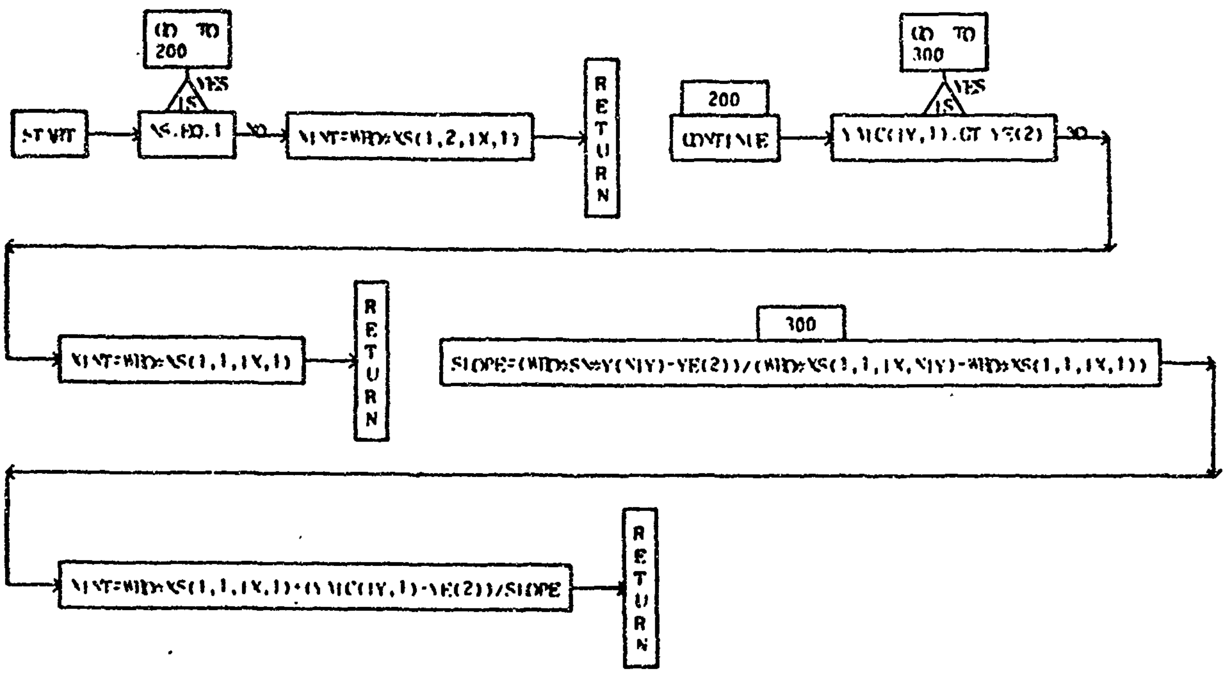
D I M E N S I O N E D   V A R I A B L E S

SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES
MC	40,80	WASH	40						

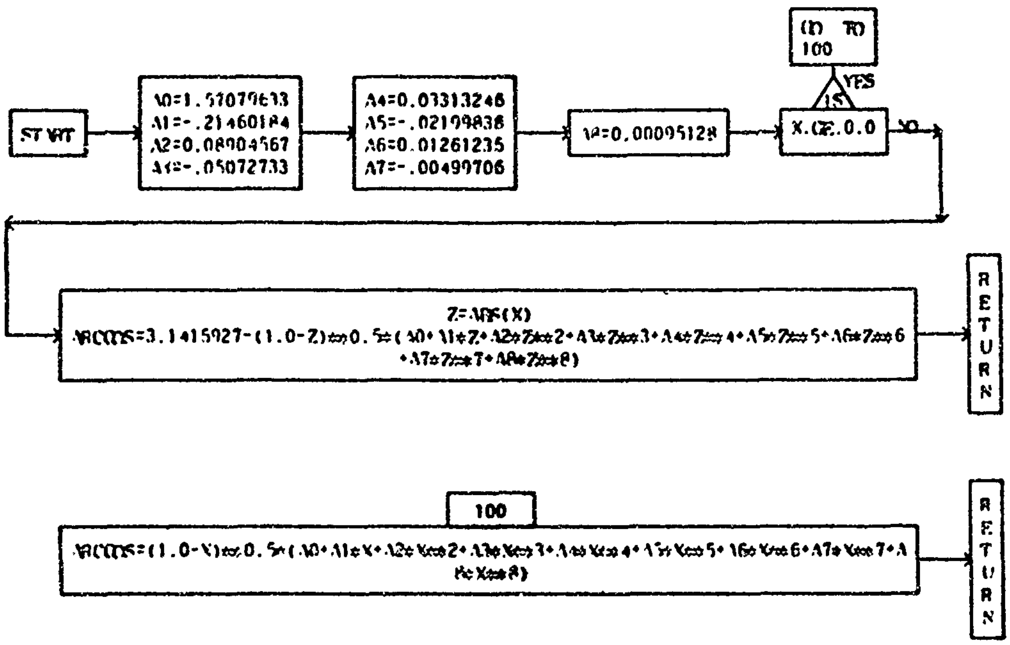

START
DATA(WNER(I),I=1,8)/0.05061427,0.11119052,0.15685332,0.18134189,0.18134189,0.1
5685332,0.11119052,0.05061427/
DATA(ZNER(I),I=1,8)/0.01985507,0.10166676,0.23723380,0.40828268,0.59171732,0.7
6276620,0.89833324,0.98014493/

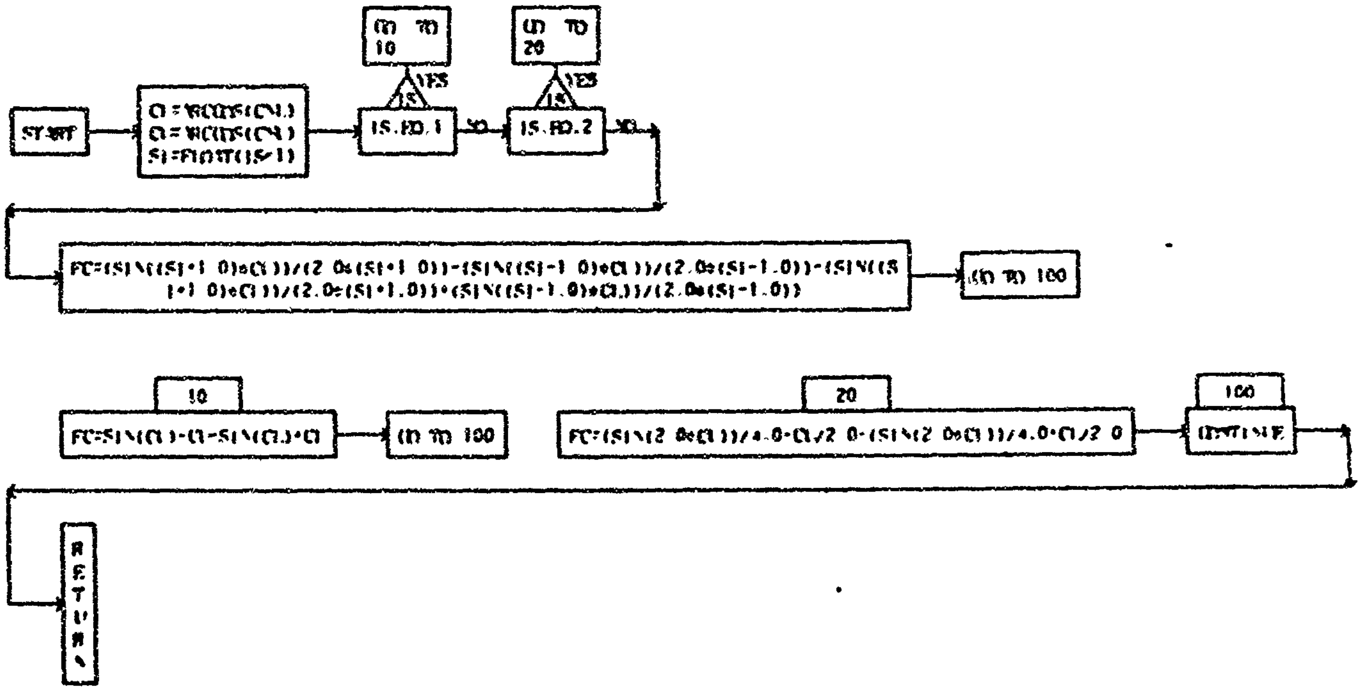

START
COMPUTED GO TO
IF THE VALUE OF L IS 1 TRANSFER TO STATEMENT 10
2 40
10
COMPUTED GO TO
IF THE VALUE OF NS IS 1 TRANSFER TO STATEMENT 20
2 30
20
XS=WXCON(J3)+WBCN(J3)*SCN(I3,1)
RETURN
30
XS=CXON+CBDN*SCN(I3,2)
RETURN
40
COMPUTED GO TO
IF THE VALUE OF NS IS 1 TRANSFER TO STATEMENT 50
2 60
50
XS=WXION(J3)+WBIN(J3)*SIN(I3,1)
RETURN
60
XS=CXON+CBDN*SIN(I3,2)
RETURN

FUNCTION XINT (IY,IX,NIY,NS,WBD,SN) PAGE 1

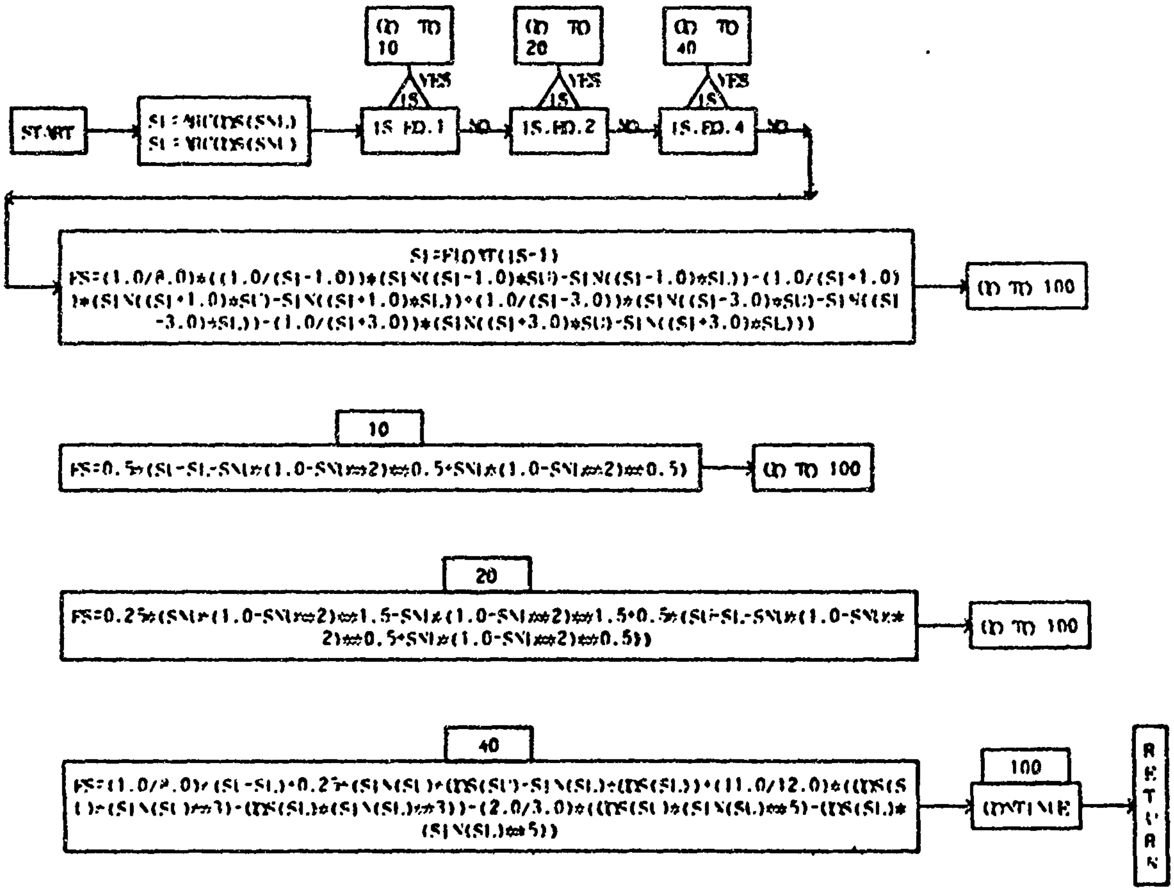


NOTES


START
A0=1.57079633
A1=-.21460184
A2=0.08904567
A3=-.05072733
A4=0.03313246
A5=-.02199836
A6=0.01261235
A7=-.00499706
A8=0.00095128
X.GE.0.0
IS
YES
GO TO 100
NO
Z=ABS(X)
ARCCOS=3.1415927-(1.0-Z)**0.5*(A0+A1*Z+A2*Z**2+A3*Z**3+A4*Z**4+A5*Z**5+A6*Z**6+A7*Z**7+A8*Z**8)
RETURN
100
ARCCOS=(1.0-X)**0.5*(A0+A1*X+A2*X**2+A3*X**3+A4*X**4+A5*X**5+A6*X**6+A7*X**7+A8*X**8)
RETURN



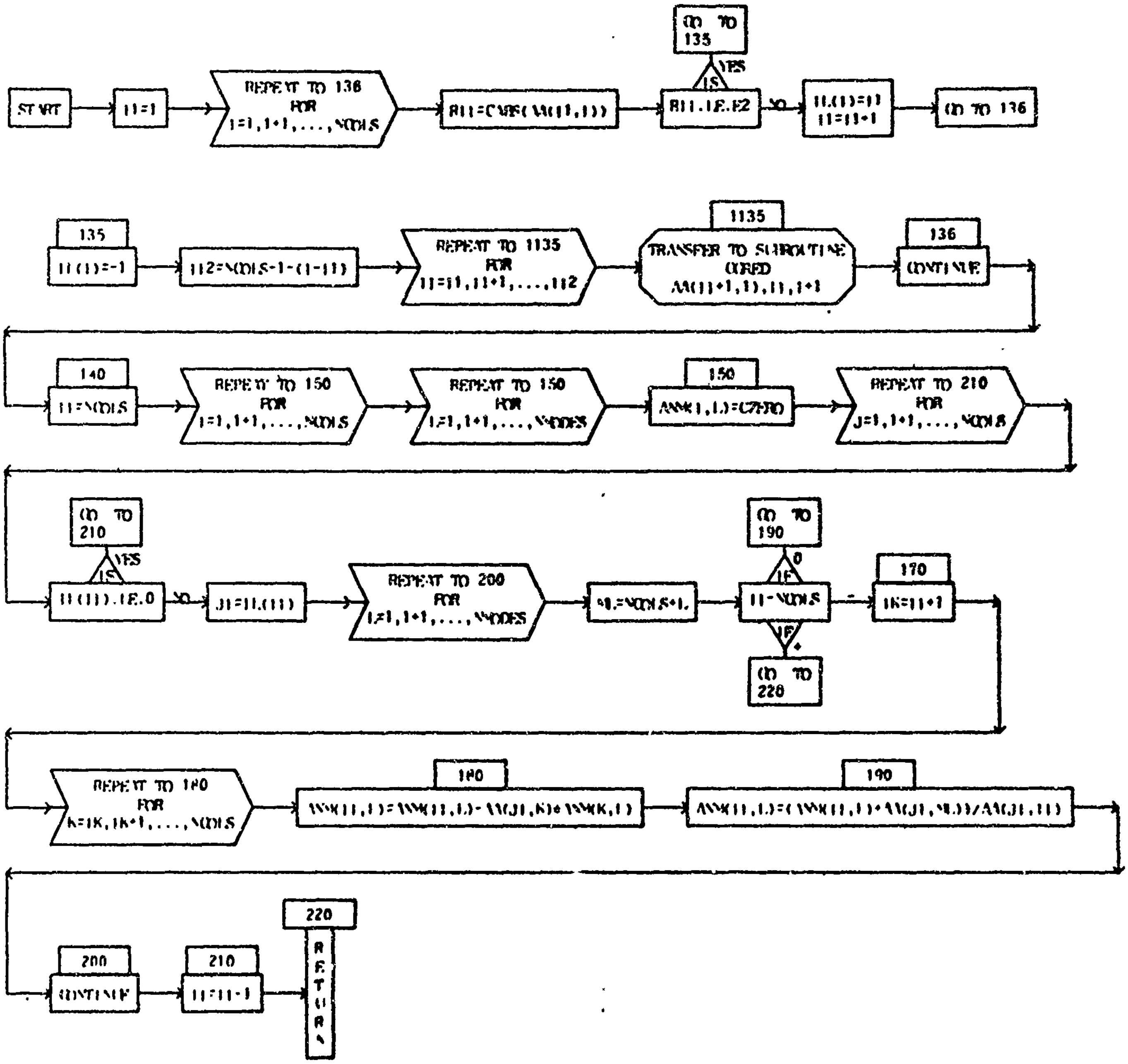
START
GO TO 10
GO TO 20
YES
IS.EQ.1
NO
IS.EQ.2
GO TO 100
10
20
100
CONTINUE
R E T U R N


START
SU=ARCOS(SNU)
SL=ARCOS(SNL)
IS.EQ.1
IS.EQ.2
IS.EQ.4
IS
YES
NO
GO TO 10
GO TO 20
GO TO 40
SI=FLOAT(IS-1)
FS=(1.0/8.0)*((1.0/(SI-1.0))*(SIN((SI-1.0)*SU)-SIN((SI-1.0)*SL))-(1.0/(SI+1.0))*(SIN((SI+1.0)*SU)-SIN((SI+1.0)*SL))+(1.0/(SI-3.0))*(SIN((SI-3.0)*SU)-SIN((SI-3.0)*SL))-(1.0/(SI+3.0))*(SIN((SI+3.0)*SU)-SIN((SI+3.0)*SL)))
GO TO 100
10
FS=0.5*(SU-SL-SNU*(1.0-SNU**2)**0.5+SNL*(1.0-SNL**2)**0.5)
GO TO 100
20
FS=0.25*(SNU*(1.0-SNU**2)**1.5-SNL*(1.0-SNL**2)**1.5+0.5*(SU-SL-SNU*(1.0-SNU**2)**0.5+SNL*(1.0-SNL**2)**0.5))
GO TO 100
40
FS=(1.0/8.0)*(SU-SL)+0.25*(SIN(SU)*COS(SU)-SIN(SL)*COS(SL))+(11.0/12.0)*((COS(SU)*(SIN(SU)**3)-COS(SL)*(SIN(SL)**3))-(2.0/3.0)*((COS(SU)*(SIN(SL)**5)-COS(SL)*(SIN(SL)**5))
100
CONTINUE
RETURN

D I M E N S I O N E D   V A R I A B L E S

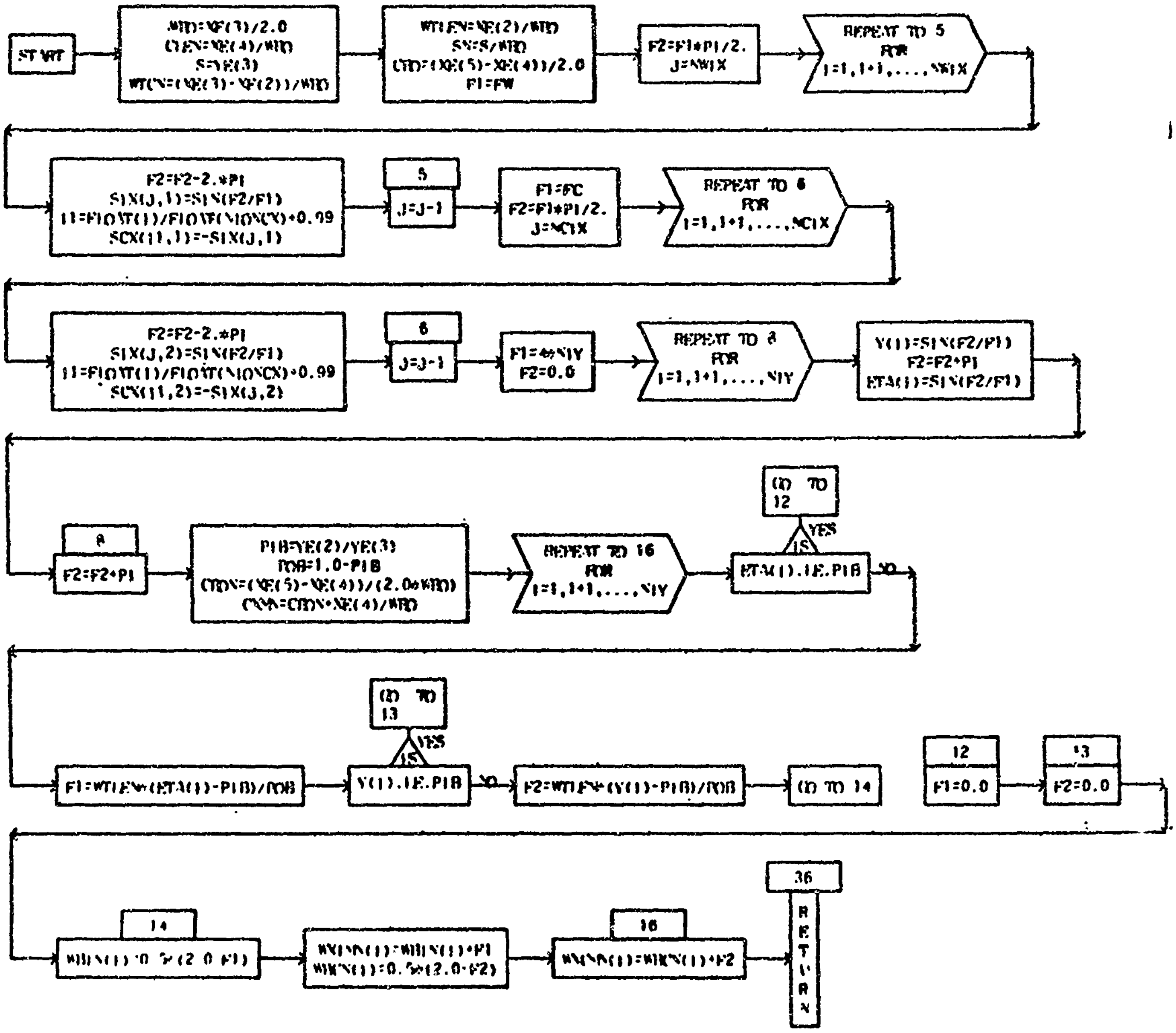
SYMBOL	STOR XES	SYMBOL	STOR XES	SYMBOL	STOR XES	SYMBOL	STOR XES	SYMBOL	STOR XES
NC	10,80	WASH	40						

SUBROUTINE XLRO PAGE 1



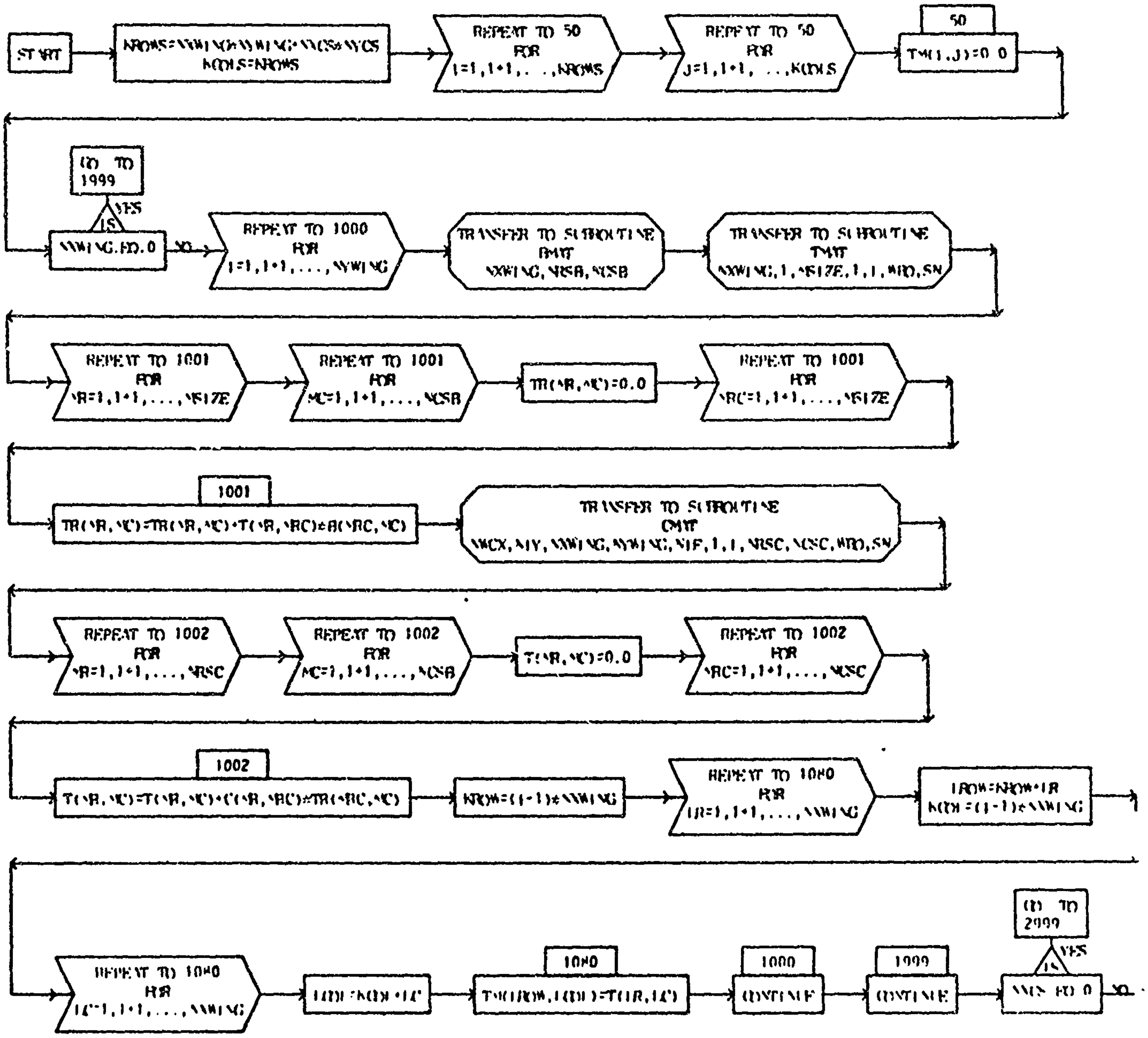
DIMENSIONED VARIABLES

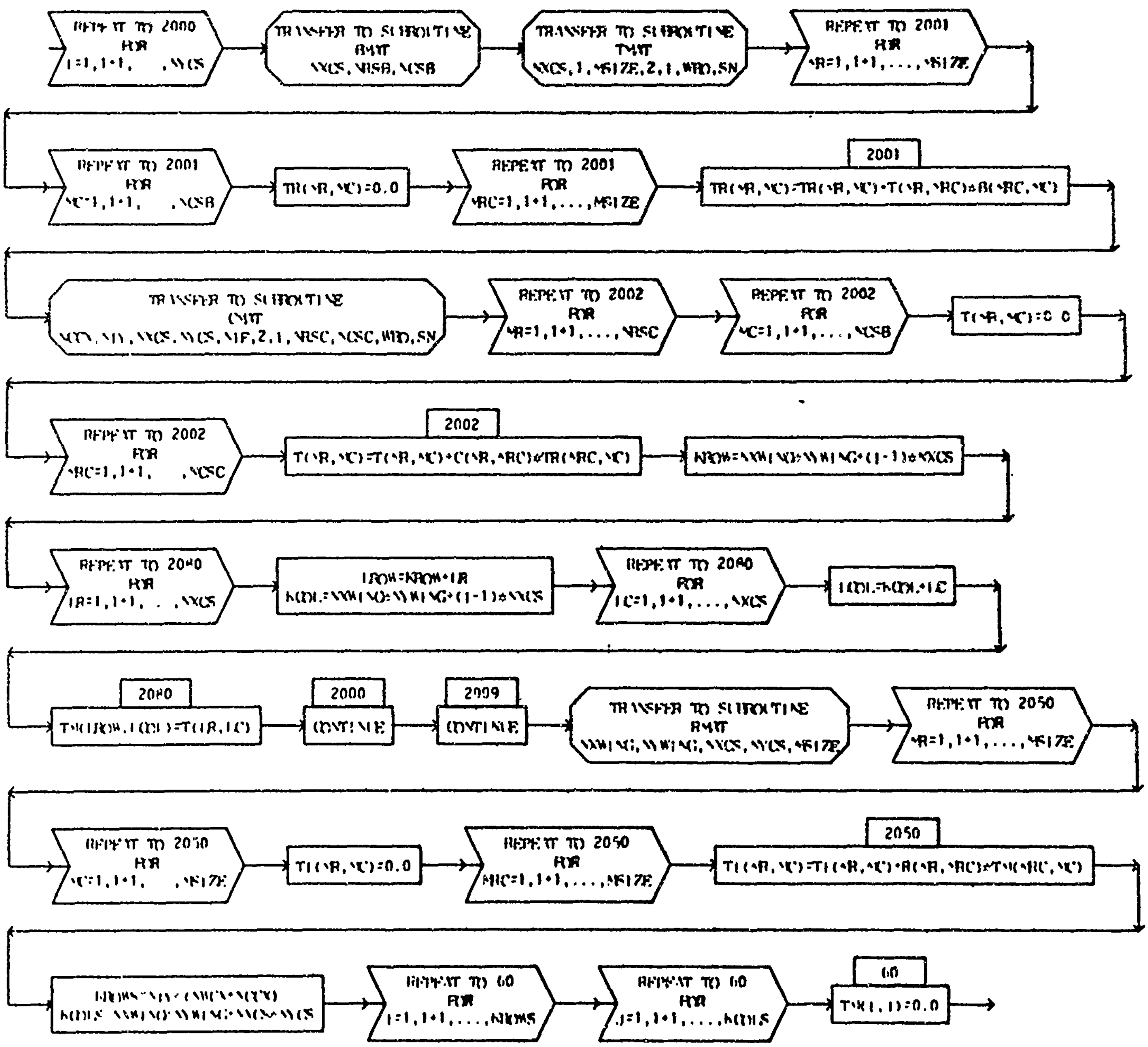
SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES
MC	40,80	WASH	40						

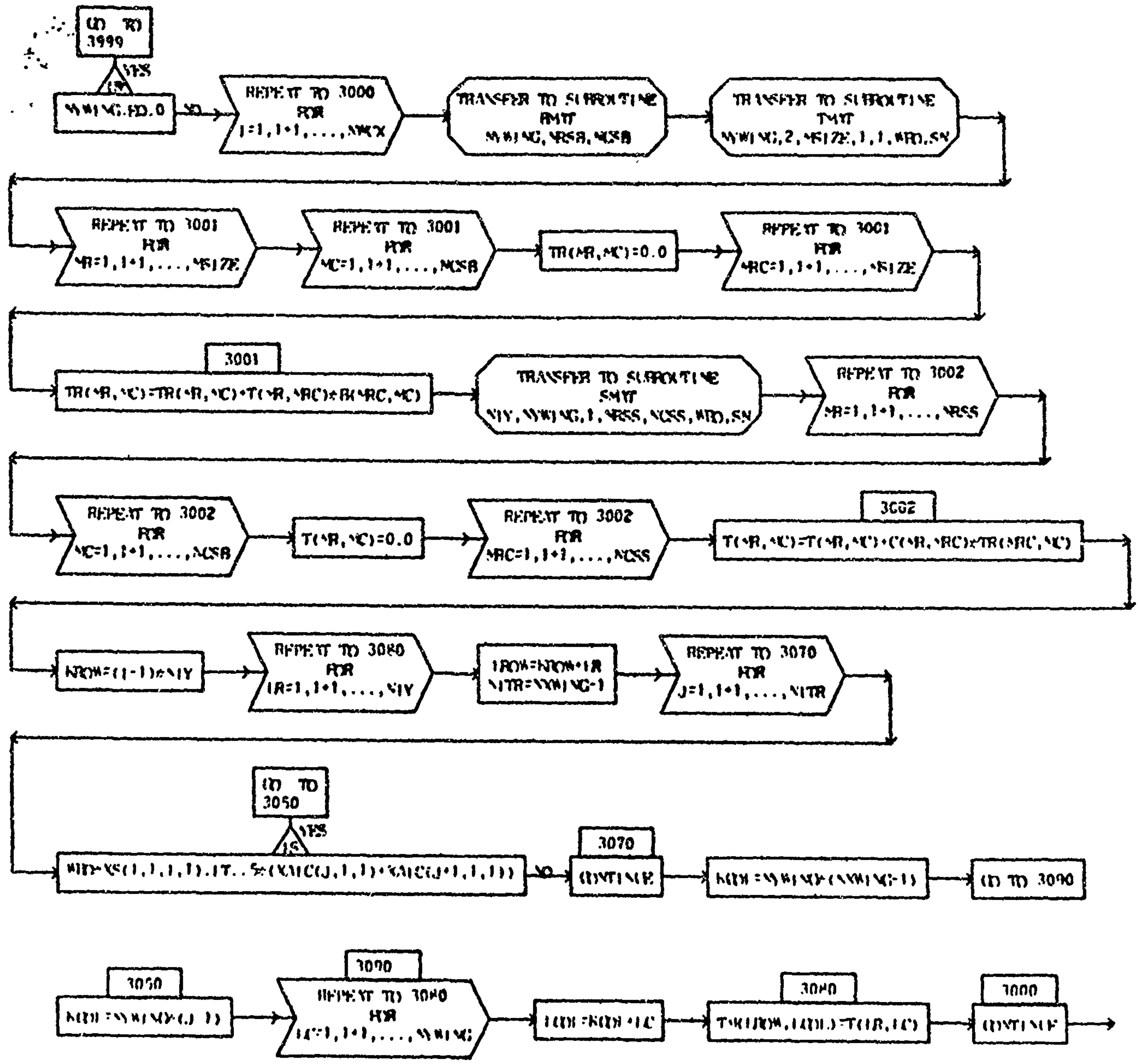

START
WTD=XE(3)/2.0
CLEN=XE(4)/WTD
S=YE(3)
WTCN=(XE(3)-XE(2))/WTD
WTLEN=XE(2)/WTD
SN=S/WTD
CTD=(XE(5)-XE(4))/2.0
F1=FW
F2=F1*PI/2.
J=NWIX
REPEAT TO 5 FOR I=1,I+1,...,NWIX
F2=F2-2.*PI
SIX(J,1)=SIN(F2/F1)
I1=FLOAT(I)/FLOAT(NIONCX)+0.99
SCX(I1,1)=-SIX(J,1)
5
J=J-1
F1=FC
F2=F1*PI/2.
J=NCIX
REPEAT TO 6 FOR I=1,I+1,...,NCIX
F2=F2-2.*PI
SIX(J,2)=SIN(F2/F1)
I1=FLOAT(I)/FLOAT(NIONCX)+0.99
SCX(I1,2)=-SIX(J,2)
6
J=J-1
F1=4*NIY
F2=0.0
REPEAT TO 8 FOR I=1,I+1,...,NIY
Y(I)=SIN(F2/F1)
F2=F2+PI
ETA(I)=SIN(F2/F1)
8
F2=F2+PI
PIB=YE(2)/YE(3)
POB=1.0-PIB
CTDN=(XE(5)-XE(4))/(2.0*WTD)
CNMN=CTDN+XE(4)/WTD
REPEAT TO 16 FOR I=1,I+1,...,NIY
GO TO 12
YES
IS
ETA(I).LE.PIB
NO
GO TO 13
YES
IS
F1=WTLEN*(ETA(I)-PIB)/POB
Y(I).LE.PIB
NO
F2=WTLEN*(Y(I)-PIB)/POB
GO TO 14
12
F1=0.0
13
F2=0.0
14
WBN(I)=0.5*(2.0-F1)
WNSN(I)=WBN(I)+F1
WBCN(I)=0.5*(2.0-F2)
16
WNSN(I)=WBCN(I)+F2
36
RETURN

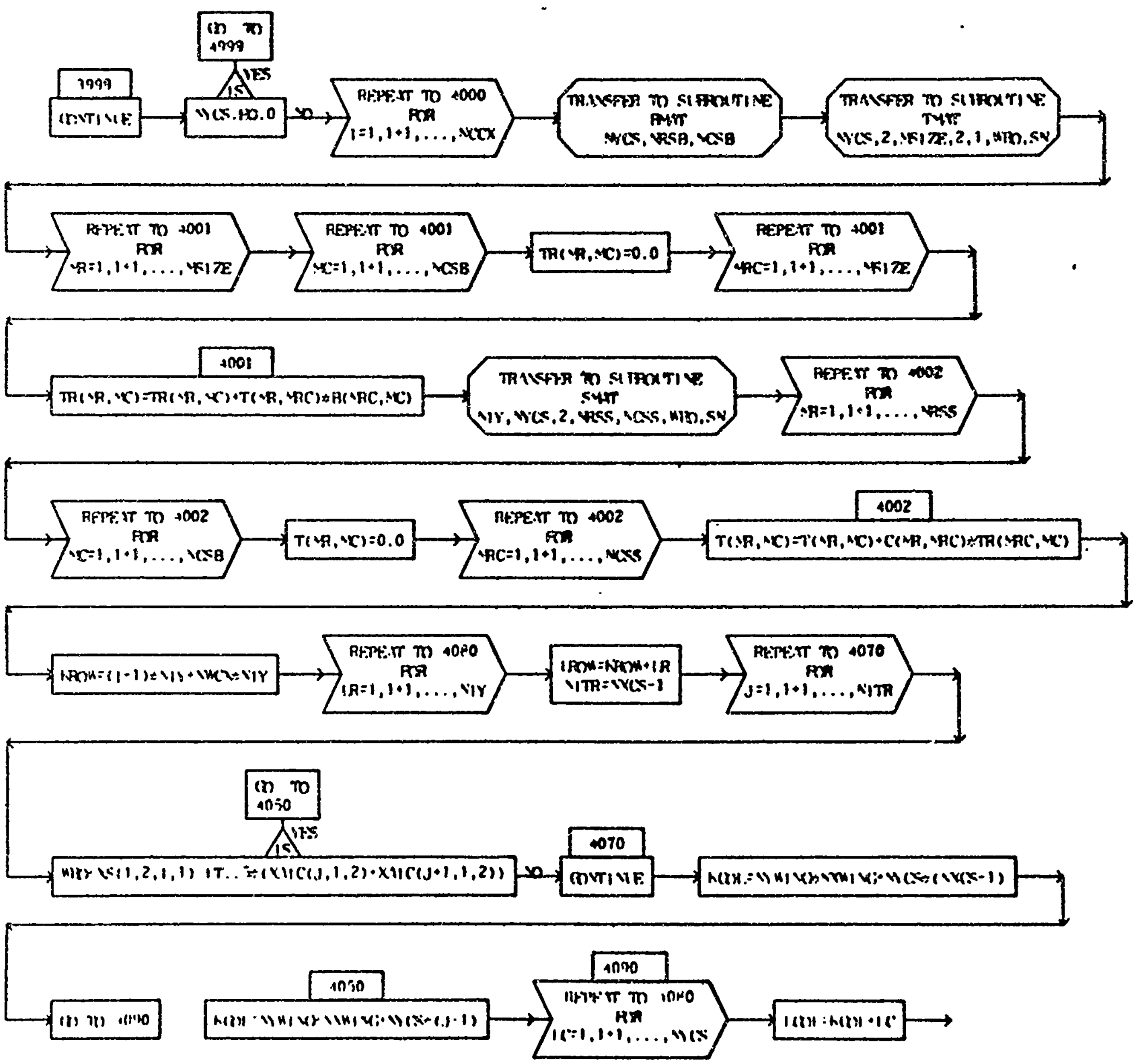
NOT REPRODUCIBLE

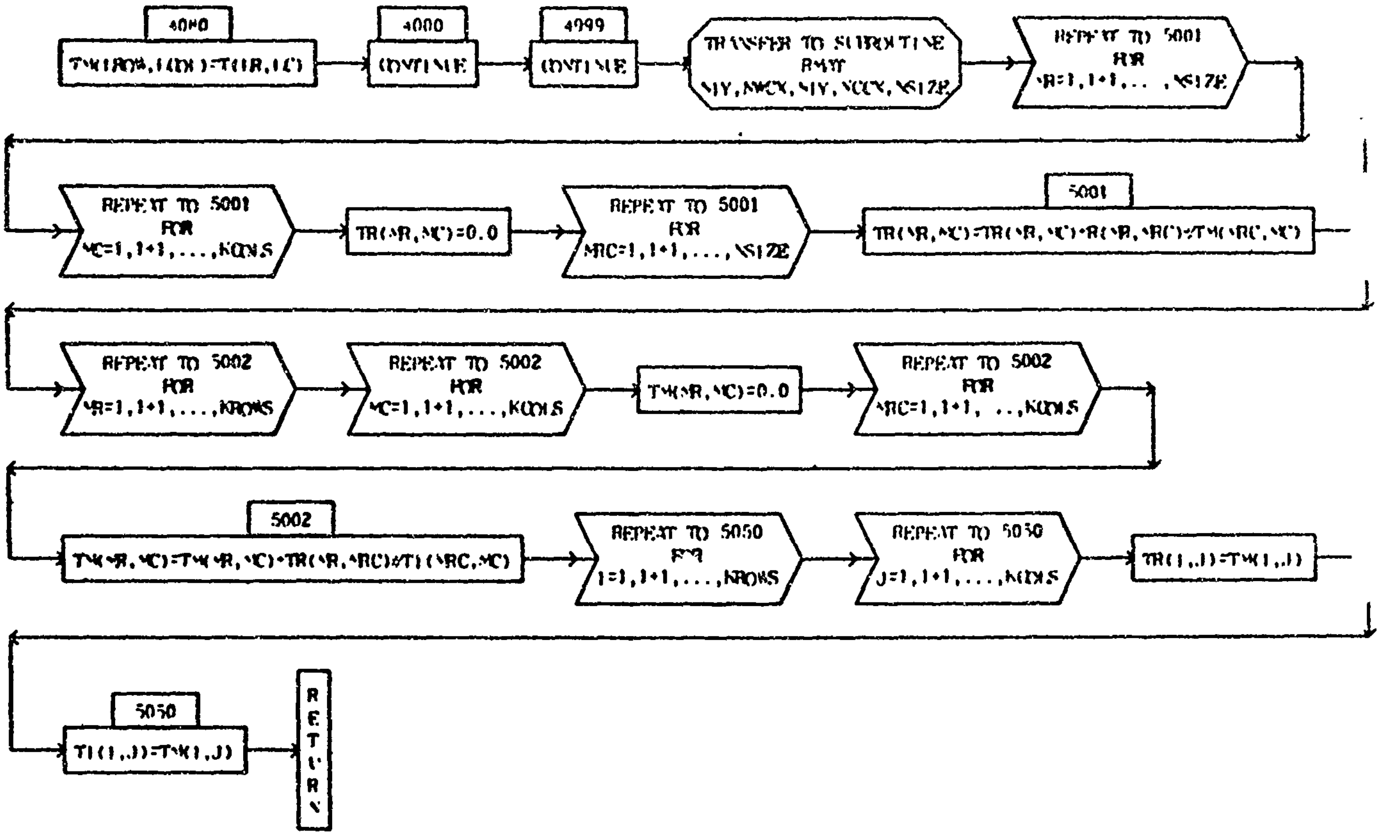
SUBROUTINE TRAMP(NIY,NMCX,NCCX,NXWING,NYWING,NXCS,NYCS,NIF,WRD,SN) PAGE 1

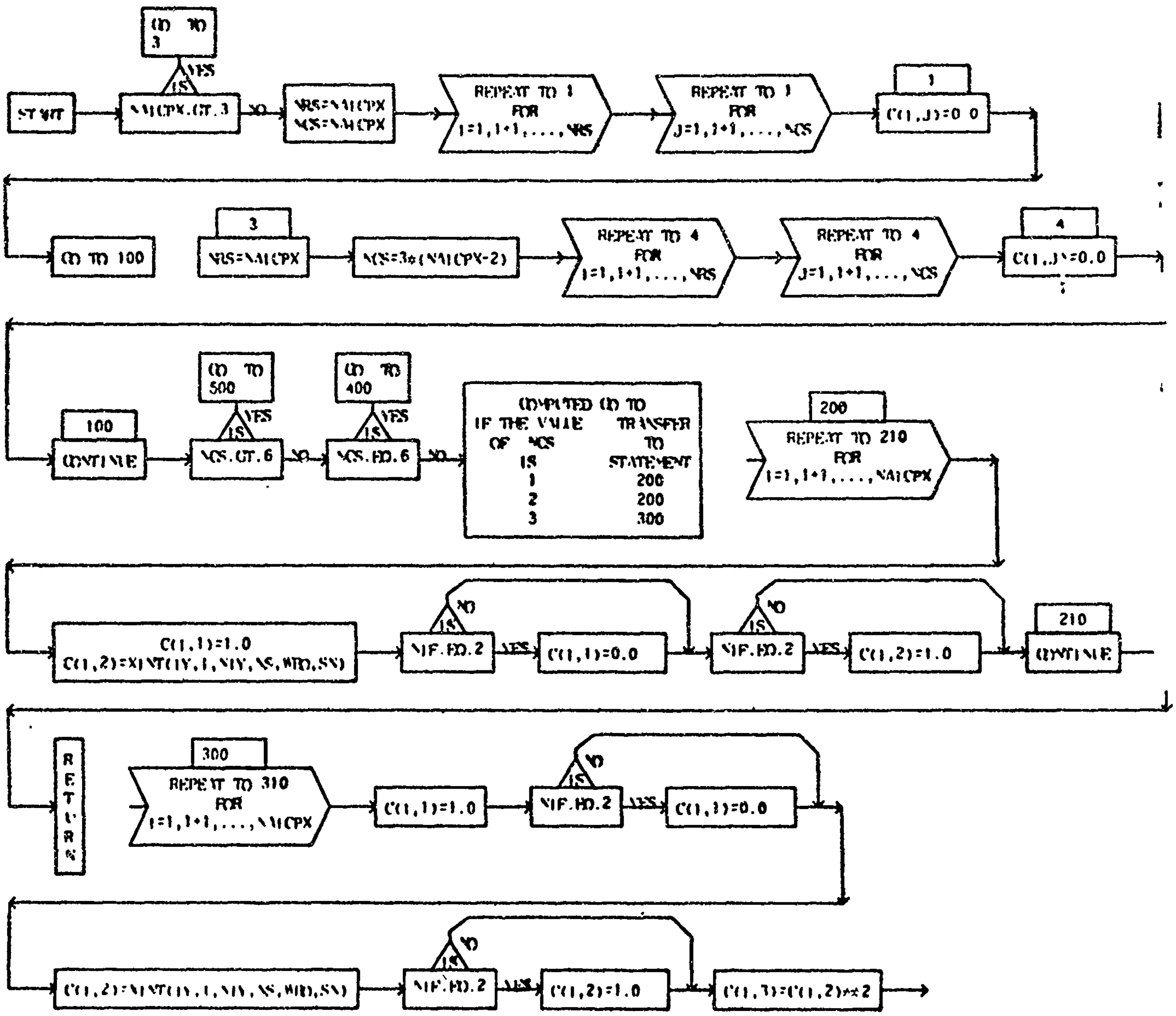


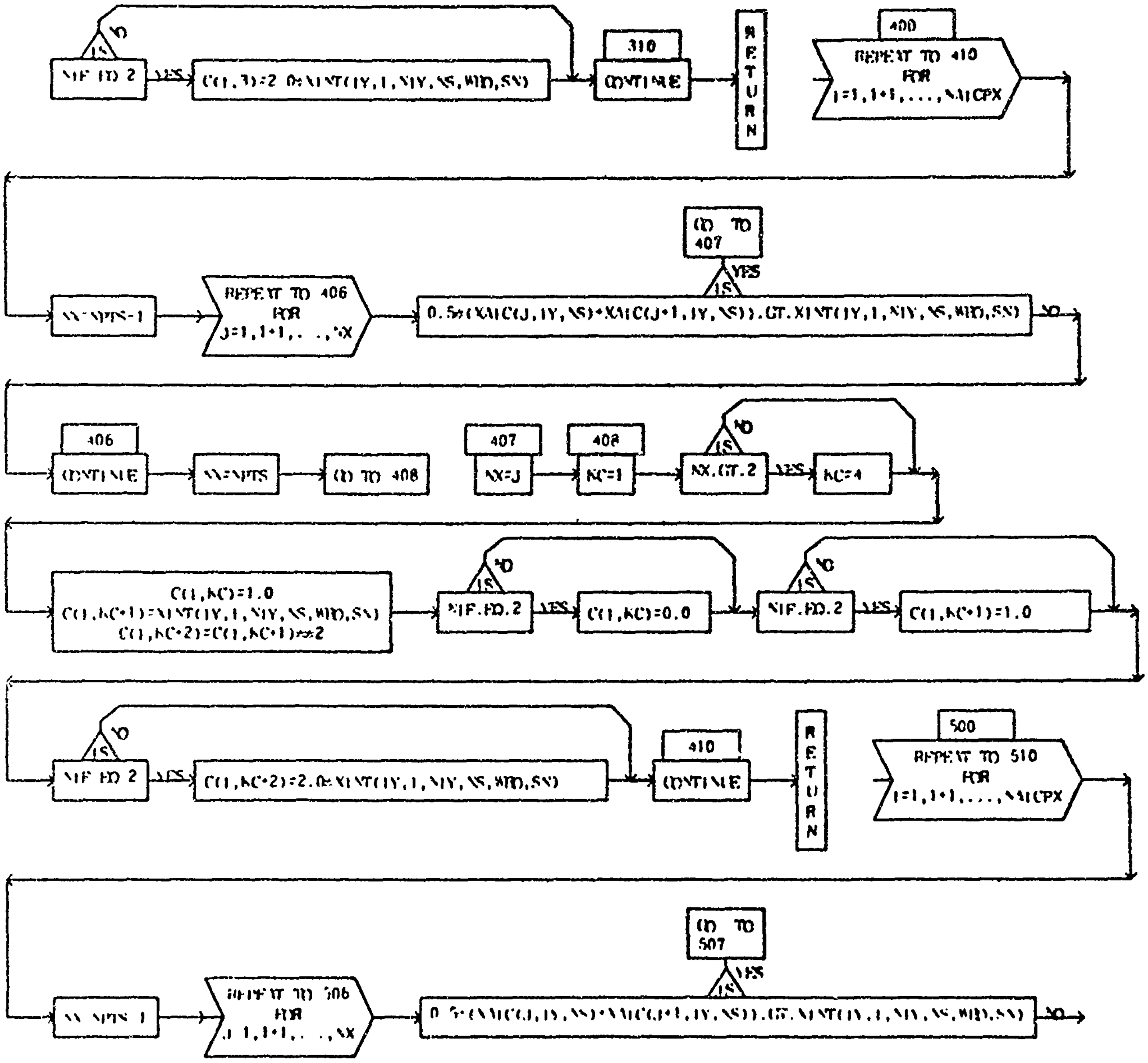

REPEAT TO 2000 FOR I=1,I+1, ,NYCS
TRANSFER TO SUBROUTINE BMAT NXCS,NBSB,NCSB
TRANSFER TO SUBROUTINE TMAT NXCS,1,MSIZE,2,1,WRD,SN
REPEAT TO 2001 FOR MR=1,1+1,...,MSIZE
REPEAT TO 2001 FOR MC=1,1+1, ,NCSB
TR(MR,MC)=0.0
REPEAT TO 2001 FOR MRC=1,1+1,...,MSIZE
2001
TR(MR,MC)=TR(MR,MC)+T(MR,MRC)*B(MRC,MC)
TRANSFER TO SUBROUTINE CMAT
REPEAT TO 2002 FOR MR=1,1+1,...,NRSC
REPEAT TO 2002 FOR MC=1,1+1,...,NCSB
T(MR,MC)=0.0
REPEAT TO 2002 FOR MRC=1,1+1, ,NCSC
2002
T(MR,MC)=T(MR,MC)+C(MR,MRC)*TR(MRC,MC)
REPEAT TO 2080 FOR IR=1,1+1, . ,NXCS
REPEAT TO 2080 FOR IC=1,1+1,...,NXCS
2080
2000
CONTINUE
2099
CONTINUE
TRANSFER TO SUBROUTINE RMAT
REPEAT TO 2050 FOR MR=1,1+1,...,MSIZE
REPEAT TO 2050 FOR MC=1,1+1, ,MSIZE
TI(MR,MC)=0.0
REPEAT TO 2050 FOR MRC=1,1+1,...,MSIZE
2050
REPEAT TO 60 FOR I=1,1+1,...,KROWS
REPEAT TO 60 FOR J=1,1+1,...,KCOLS
60
T(I,J)=0.0

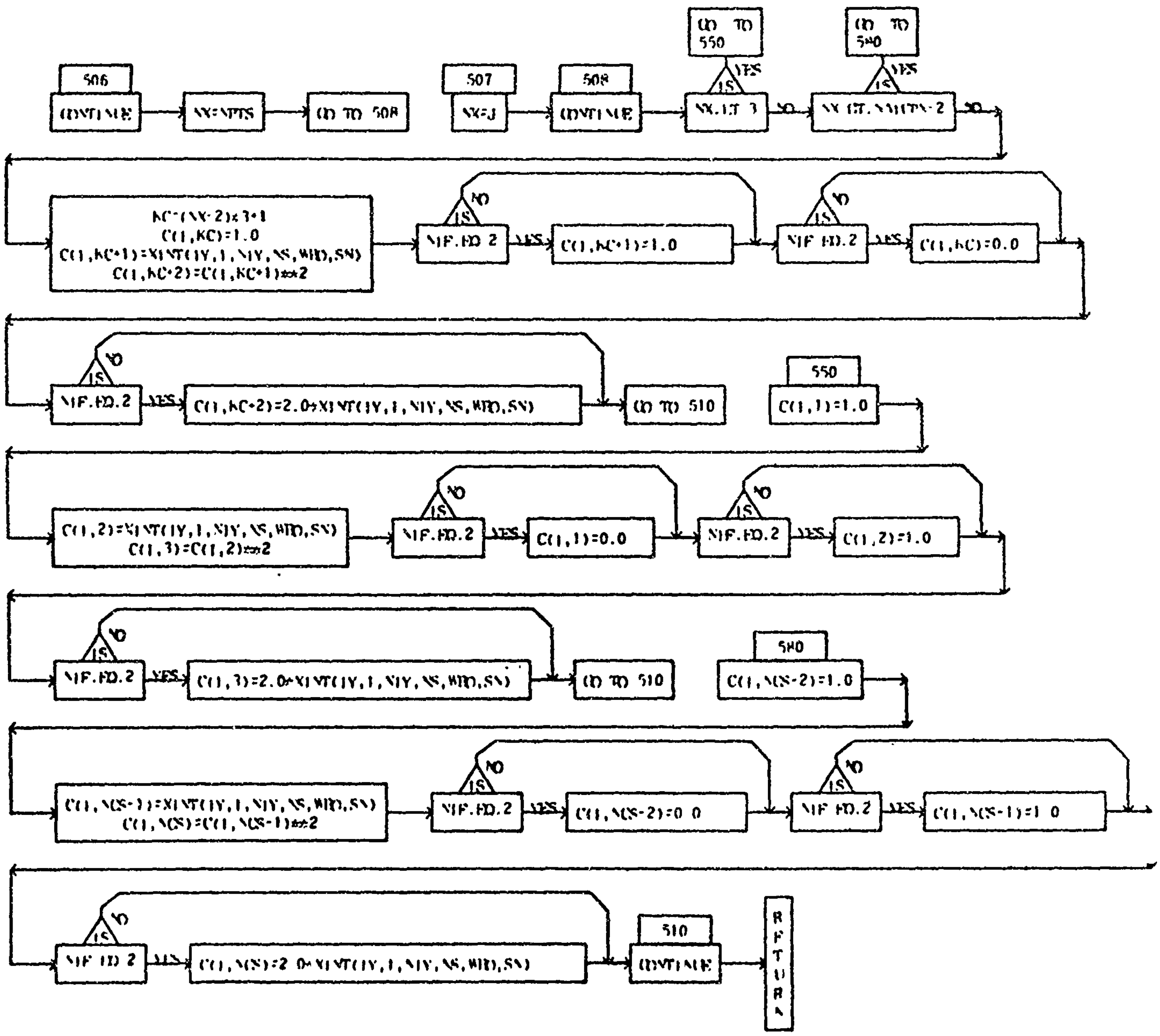

GO TO 3999
YES
IS
NO
REPEAT TO 3000 FOR
TRANSFER TO SUBROUTINE
REPEAT TO 3001 FOR
TR(MR,MC)=0.0
3001
REPEAT TO 3002 FOR
T(MR,MC)=0.0
3002
REPEAT TO 3080 FOR
REPEAT TO 3070 FOR
GO TO 3050
3070
CONTINUE
GO TO 3090
3050
3090
3080
3000

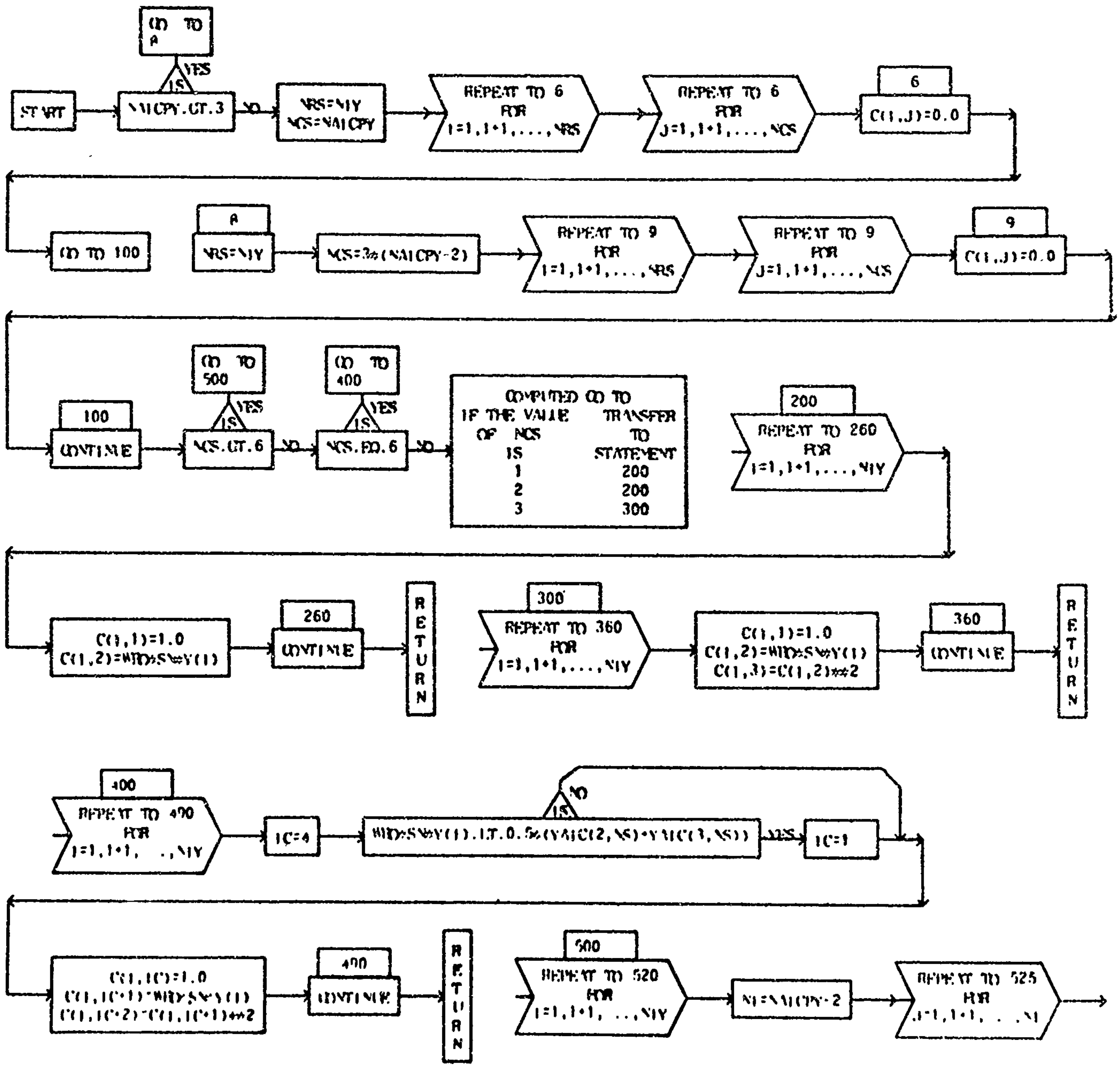

1999
CONTINUE
GO TO 4999
YES
IS
NYCS.EQ.0
NO
REPEAT TO 4000 FOR I=1,I+1,...,NCCX
TRANSFER TO SUBROUTINE RMAT NYCS,NRSB,NCSB
TRANSFER TO SUBROUTINE TMAT NYCS,2,NSIZE,2,1,WRD,SN
REPEAT TO 4001 FOR NR=1,1+1,...,NSIZE
REPEAT TO 4001 FOR NC=1,1+1,...,NCSB
TR(NR,NC)=0.0
REPEAT TO 4001 FOR NRC=1,1+1,...,NSIZE
4001
TR(NR,NC)=TR(NR,NC)+T(NR,NRC)*B(NRC,NC)
TRANSFER TO SUBROUTINE SMAT NIY,NYCS,2,NRSS,NCSS,WRD,SN
REPEAT TO 4002 FOR NR=1,1+1,...,NRSS
REPEAT TO 4002 FOR NC=1,1+1,...,NCSB
T(NR,NC)=0.0
REPEAT TO 4002 FOR NRC=1,1+1,...,NCSS
4002
T(NR,NC)=T(NR,NC)+C(NR,NRC)*TR(NRC,NC)
REPEAT TO 4080 FOR IR=1,1+1,...,NIY
REPEAT TO 4070 FOR J=1,1+1,...,NITR
GO TO 4050
4070
CONTINUE
4050
REPEAT TO 4080 FOR IC=1,1+1,...,NYCS

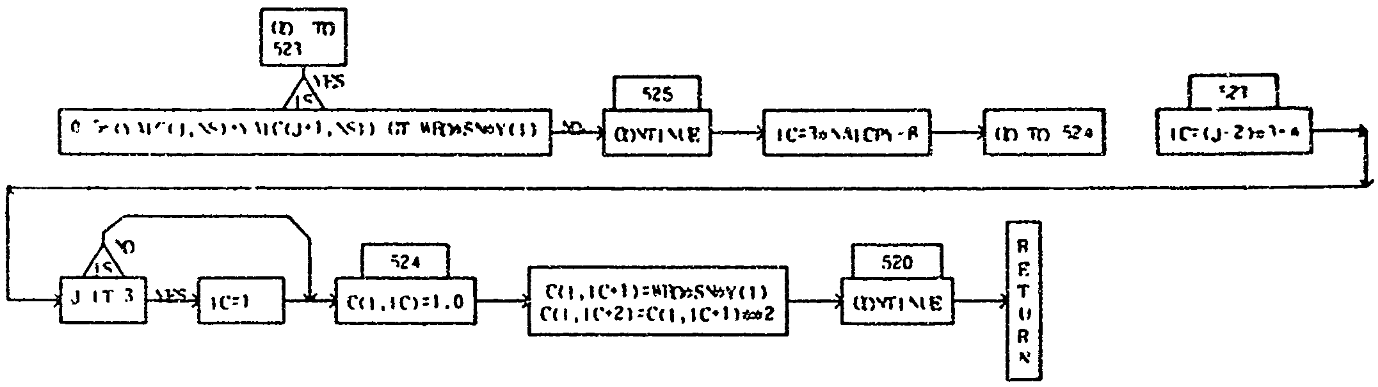

4000
CONTINUE
4999
CONTINUE
TRANSFER TO SUBROUTINE
REPEAT TO 5001
FOR
REPEAT TO 5001
FOR
TR(NR,NC)=0.0
REPEAT TO 5001
FOR
5001
REPEAT TO 5002
FOR
REPEAT TO 5002
FOR
TM(NR,NC)=0.0
REPEAT TO 5002
FOR
5002
REPEAT TO 5050
REPEAT TO 5050
FOR
5050
RETURN


START
IS NAICPX.GT.3
YES
GO TO 3
NO
NRS=NAICPX
NCS=NAICPX
REPEAT TO 1 FOR I=1,I+1,...,NRS
REPEAT TO 1 FOR J=1,J+1,...,NCS
1
C(I,J)=0.0
GO TO 100
3
NRS=NAICPX
NCS=3*(NAICPX-2)
REPEAT TO 4 FOR I=1,I+1,...,NRS
REPEAT TO 4 FOR J=1,J+1,...,NCS
4
C(I,J)=0.0
100
CONTINUE
IS NCS.GT.6
GO TO 500
IS NCS.EQ.6
GO TO 400
COMPUTED GO TO
IF THE VALUE OF NCS IS 1 2 3
TRANSFER TO STATEMENT 200 200 300
200
REPEAT TO 210 FOR I=1,I+1,...,NAICPX
C(I,1)=1.0
C(I,2)=XINT(IY,I,NIY,NS,WID,SN)
IS NIF.EQ.2
C(I,1)=0.0
C(I,2)=1.0
210
CONTINUE
RETURN
300
REPEAT TO 310 FOR I=1,I+1,...,NAICPX
C(I,1)=1.0
C(I,1)=0.0
C(I,2)=XINT(IY,I,NIY,NS,WID,SN)
C(I,2)=1.0
C(I,3)=C(I,2)**2

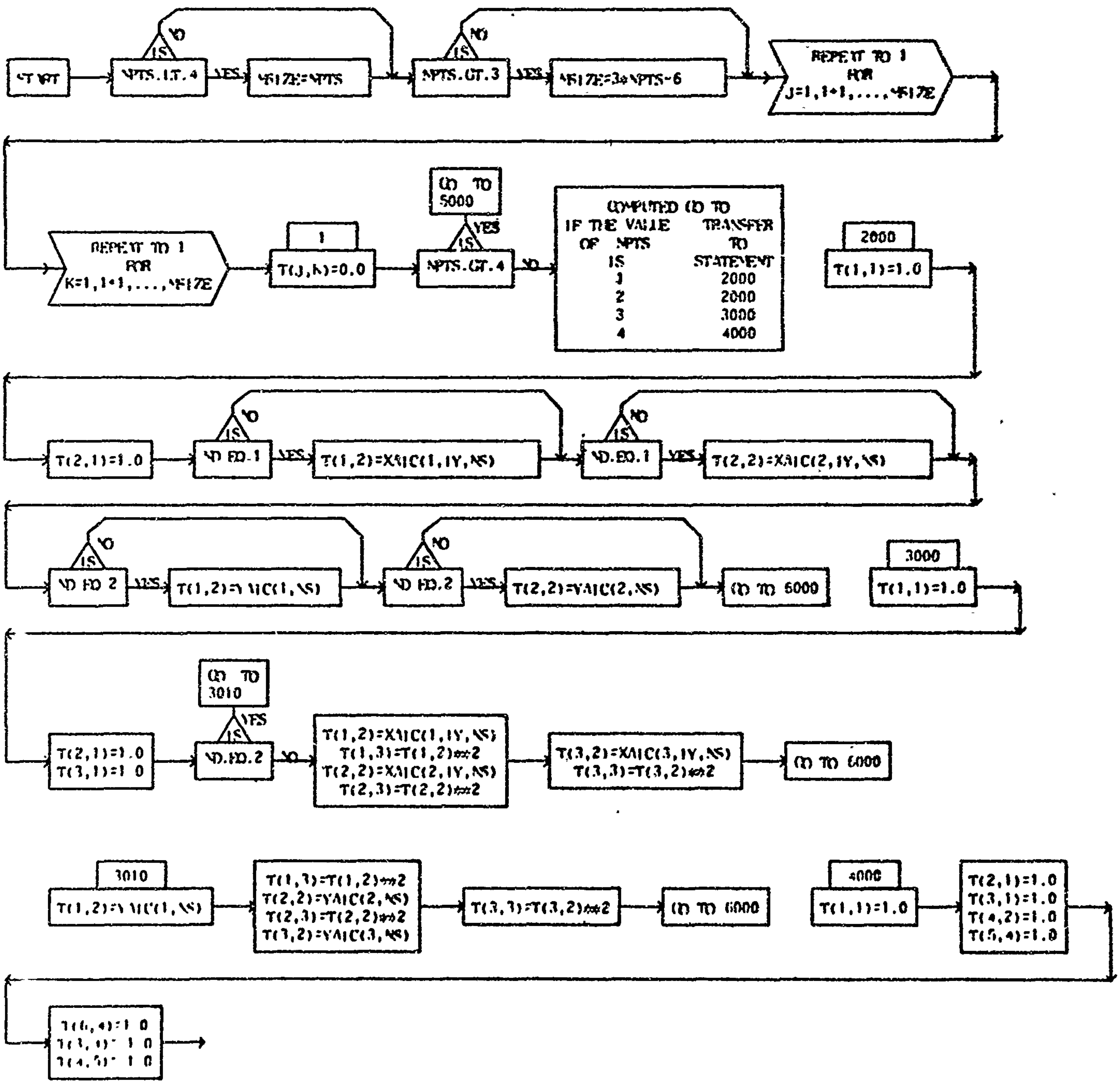

IS
NO
NIF.EQ.2
YES
C(I,3)=2.0*XINT(IY,1,NIY,NS,WID,SN)
310
CONTINUE
RETURN
400
REPEAT TO 410
FOR
I=1,1+1,....,NXICPX
NX=NPTS-1
REPEAT TO 406
FOR
J=1,1+1,...,NX
GO TO
407
0.5*(XXICU(J,IY,NS)+XXICU(J+1,IY,NS)).GT.XINT(IY,1,NIY,NS,WID,SN)
406
CONTINUE
NX=NPTS
GO TO 408
407
NX=J
408
KC=1
NX.GT.2
KC=4
C(I,KC)=1.0
C(I,KC+1)=XINT(IY,1,NIY,NS,WID,SN)
C(I,KC+2)=C(I,KC+1)**2
NIF.EQ.2
C(I,KC)=0.0
C(I,KC+1)=1.0
C(I,KC+2)=2.0*XINT(IY,1,NIY,NS,WID,SN)
410
500
REPEAT TO 510
506
507

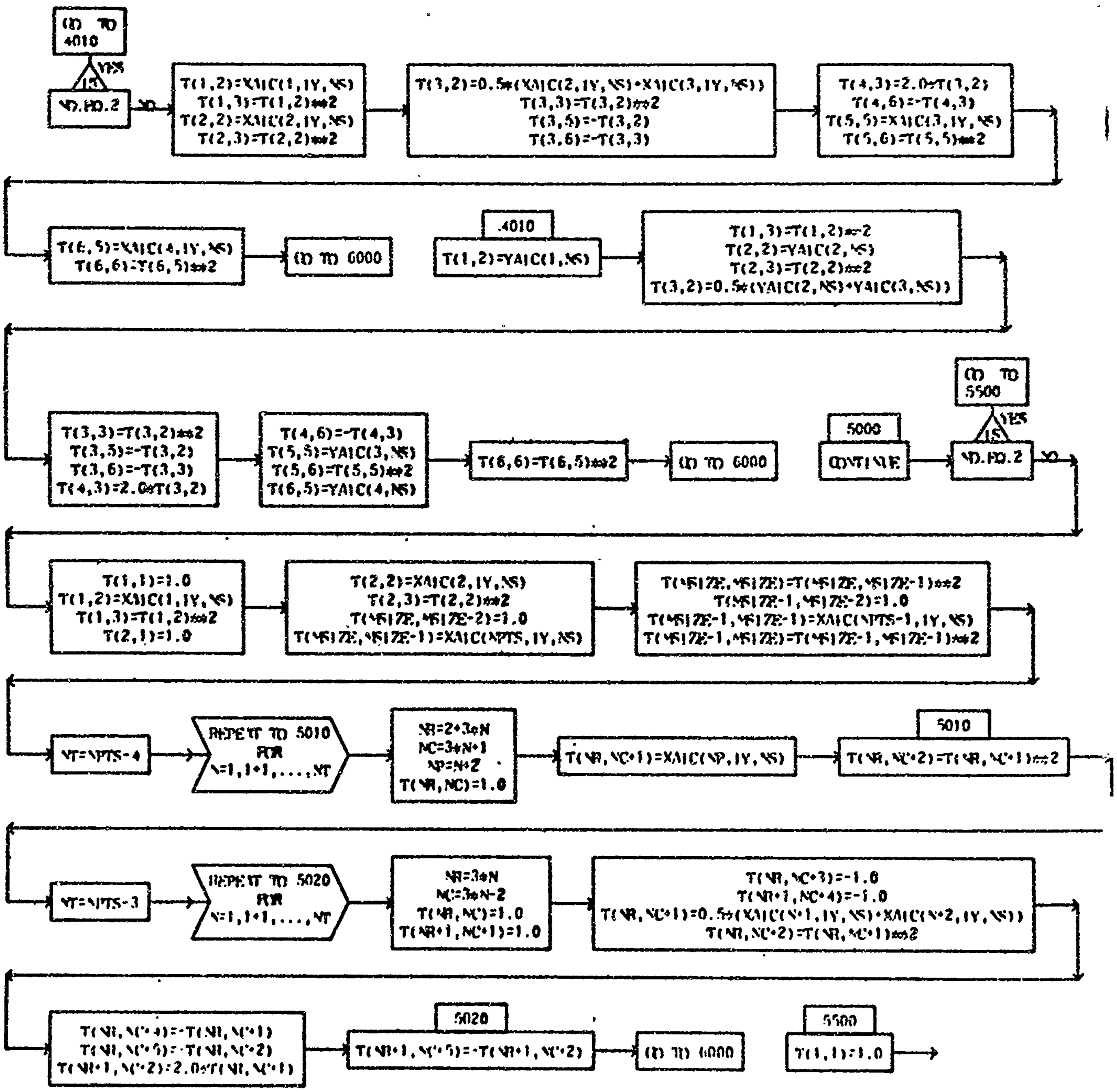

506
CONTINUE
507
508
CONTINUE
YES
NO
IS
550
C(1,1)=1.0
C(1,1)=0.0
C(1,2)=1.0
510
CONTINUE
RETURN

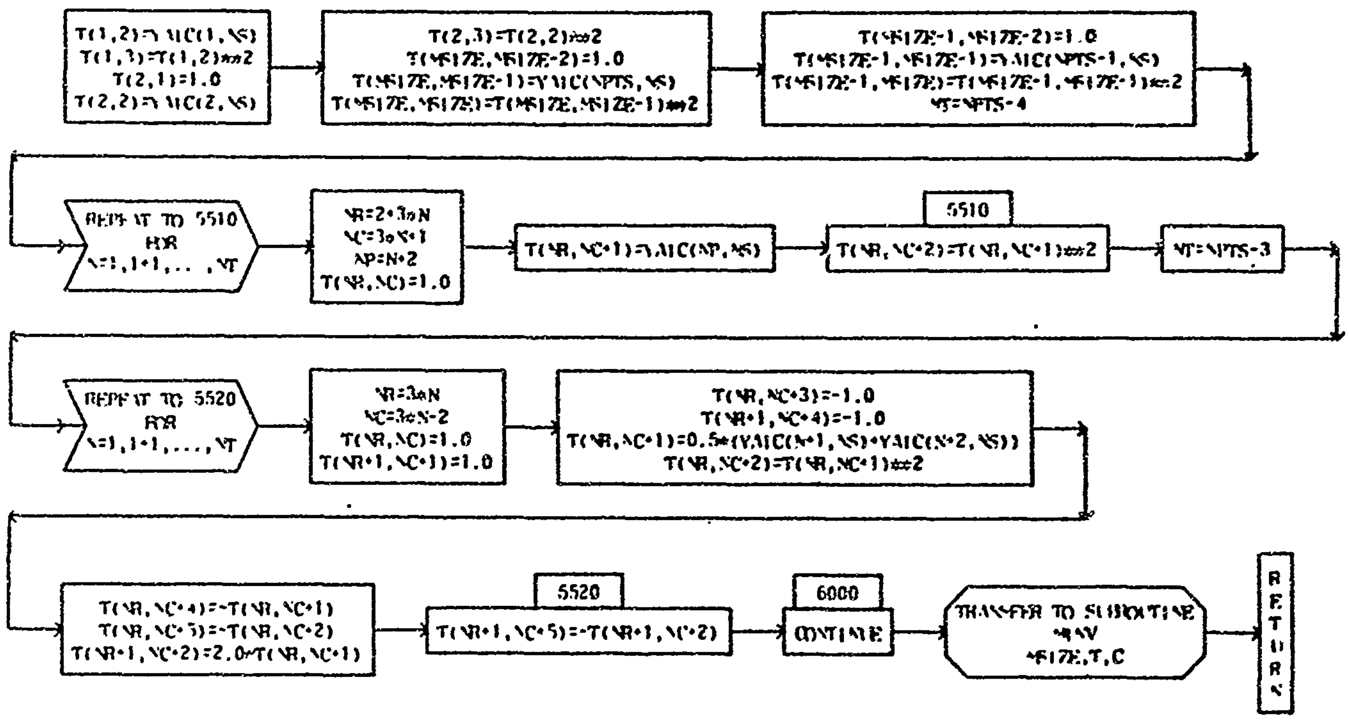

START
NALCPY.GT.3
IS
YES
NO
GO TO 8
NRS=NIY
NCS=NALCPY
REPEAT TO 6 FOR I=1,I+1,...,NRS
REPEAT TO 6 FOR J=1,J+1,...,NCS
6
C(I,J)=0.0
GO TO 100
8
NRS=NIY
NCS=3*(NALCPY-2)
REPEAT TO 9 FOR I=1,I+1,...,NRS
REPEAT TO 9 FOR J=1,J+1,...,NCS
9
C(I,J)=0.0
100
CONTINUE
NCS.GT.6
GO TO 500
NCS.EQ.6
GO TO 400
COMPUTED GO TO
IF THE VALUE OF NCS IS 1 2 3
TRANSFER TO STATEMENT 200 200 300
200
REPEAT TO 260 FOR I=1,I+1,...,NIY
C(I,1)=1.0
C(I,2)=WID*SN*Y(I)
260
CONTINUE
RETURN
300
REPEAT TO 360 FOR I=1,I+1,...,NIY
C(I,1)=1.0
C(I,2)=WID*SN*Y(I)
C(I,3)=C(I,2)**2
360
CONTINUE
RETURN
400
REPEAT TO 490 FOR I=1,I+1,...,NIY
IC=4
WID*SN*Y(I).LT.0.5*(YALC(2,NS)+YALC(3,NS))
IC=1
C(I,IC)=1.0
C(I,IC+1)=WID*SN*Y(I)
C(I,IC+2)=C(I,IC+1)**2
490
CONTINUE
RETURN
500
REPEAT TO 520 FOR I=1,I+1,...,NIY
NI=NALCPY-2
REPEAT TO 525 FOR J=1,J+1,...,NI


GO TO 523
YES
IS
NO
525
CONTINUE
IC=3*NSICPY-8
GO TO 524
523
IC=(J-2)*3+4
NO
IS
J LT 3
YES
IC=1
524
C(I,IC)=1.0
C(I,IC+1)=WRD*SN*Y(I)
C(I,IC+2)=C(I,IC+1)**2
520
CONTINUE
RETURN

[illegible]


START
IS NPTS.LT.4
NO
YES
NSIZE=NPTS
IS NPTS.GT.3
NO
YES
NSIZE=3*NPTS-6
REPEAT TO 1 FOR J=1,1+1,...,NSIZE
REPEAT TO 1 FOR K=1,1+1,...,NSIZE
1
T(J,K)=0.0
GO TO 5000
IS NPTS.GT.4
YES
NO
COMPUTED GO TO
IF THE VALUE OF NPTS IS
TRANSFER TO STATEMENT
1 2000
2 2000
3 3000
4 4000
2000
T(1,1)=1.0
T(2,1)=1.0
IS ND.EQ.1
NO
YES
T(1,2)=XAIC(1,IY,NS)
IS ND.EQ.1
NO
YES
T(2,2)=XAIC(2,IY,NS)
IS ND.EQ.2
NO
YES
T(1,2)=YAIC(1,NS)
IS ND.EQ.2
NO
YES
T(2,2)=YAIC(2,NS)
GO TO 6000
3000
T(1,1)=1.0
T(2,1)=1.0
T(3,1)=1.0
GO TO 3010
IS ND.EQ.2
YES
NO
T(1,2)=XAIC(1,IY,NS)
T(1,3)=T(1,2)**2
T(2,2)=XAIC(2,IY,NS)
T(2,3)=T(2,2)**2
T(3,2)=XAIC(3,IY,NS)
T(3,3)=T(3,2)**2
GO TO 6000
3010
T(1,2)=YAIC(1,NS)
T(1,3)=T(1,2)**2
T(2,2)=YAIC(2,NS)
T(2,3)=T(2,2)**2
T(3,2)=YAIC(3,NS)
T(3,3)=T(3,2)**2
GO TO 6000
4000
T(1,1)=1.0
T(2,1)=1.0
T(3,1)=1.0
T(4,2)=1.0
T(5,4)=1.0
T(6,4)=1.0
T(3,1)=1.0
T(4,5)=1.0


GO TO 4010
YES
IS
ND.EQ.2
NO
T(1,2)=XAIC(1,IY,NS)
T(1,3)=T(1,2)**2
T(2,2)=XAIC(2,IY,NS)
T(2,3)=T(2,2)**2
T(3,2)=0.5*(XAIC(2,IY,NS)+XAIC(3,IY,NS))
T(3,3)=T(3,2)**2
T(3,5)=-T(3,2)
T(3,6)=-T(3,3)
T(4,3)=2.0*T(3,2)
T(4,6)=-T(4,3)
T(5,5)=XAIC(3,IY,NS)
T(5,6)=T(5,5)**2
T(6,5)=XAIC(4,IY,NS)
T(6,6)=T(6,5)**2
GO TO 6000
4010
T(1,2)=YAIC(1,NS)
T(1,3)=T(1,2)**2
T(2,2)=YAIC(2,NS)
T(2,3)=T(2,2)**2
T(3,2)=0.5*(YAIC(2,NS)+YAIC(3,NS))
T(3,3)=T(3,2)**2
T(3,5)=-T(3,2)
T(3,6)=-T(3,3)
T(4,3)=2.0*T(3,2)
T(4,6)=-T(4,3)
T(5,5)=YAIC(3,NS)
T(5,6)=T(5,5)**2
T(6,5)=YAIC(4,NS)
T(6,6)=T(6,5)**2
GO TO 6000
5000
CONTINUE
GO TO 5500
YES
IS
ND.EQ.2
NO
T(1,1)=1.0
T(1,2)=XAIC(1,IY,NS)
T(1,3)=T(1,2)**2
T(2,1)=1.0
T(2,2)=XAIC(2,IY,NS)
T(2,3)=T(2,2)**2
T(MSIZE,MSIZE-2)=1.0
T(MSIZE,MSIZE-1)=XAIC(NPTS,IY,NS)
T(MSIZE,MSIZE)=T(MSIZE,MSIZE-1)**2
T(MSIZE-1,MSIZE-2)=1.0
T(MSIZE-1,MSIZE-1)=XAIC(NPTS-1,IY,NS)
T(MSIZE-1,MSIZE)=T(MSIZE-1,MSIZE-1)**2
NT=NPTS-4
REPEAT TO 5010
FOR
N=1,1+1,...,NT
NR=2+3*N
NC=3*N+1
NP=N+2
T(NR,NC)=1.0
T(NR,NC+1)=XAIC(NP,IY,NS)
5010
T(NR,NC+2)=T(NR,NC+1)**2
NT=NPTS-3
REPEAT TO 5020
FOR
N=1,1+1,...,NT
NR=3*N
NC=3*N-2
T(NR,NC)=1.0
T(NR+1,NC+1)=1.0
T(NR,NC+3)=-1.0
T(NR+1,NC+4)=-1.0
T(NR,NC+1)=0.5*(XAIC(N+1,IY,NS)+XAIC(N+2,IY,NS))
T(NR,NC+2)=T(NR,NC+1)**2
T(NR,NC+4)=-T(NR,NC+1)
T(NR,NC+5)=-T(NR,NC+2)
T(NR+1,NC+2)=2.0*T(NR,NC+1)
5020
T(NR+1,NC+5)=-T(NR+1,NC+2)
GO TO 6000
5500
T(1,1)=1.0


T(1,2)=YAIC(1,NS)
T(1,3)=T(1,2)**2
T(2,1)=1.0
T(2,2)=YAIC(2,NS)
T(2,3)=T(2,2)**2
T(MSIZE,MSIZE-2)=1.0
T(MSIZE,MSIZE-1)=YAIC(NPTS,NS)
T(MSIZE,MSIZE)=T(MSIZE,MSIZE-1)**2
T(MSIZE-1,MSIZE-2)=1.0
T(MSIZE-1,MSIZE-1)=YAIC(NPTS-1,NS)
T(MSIZE-1,MSIZE)=T(MSIZE-1,MSIZE-1)**2
NT=NPTS-4
REPEAT TO 5510 FOR N=1,1+1,...,NT
NR=2+3*N
NC=3*N+1
NP=N+2
T(NR,NC)=1.0
T(NR,NC+1)=YAIC(NP,NS)
5510
T(NR,NC+2)=T(NR,NC+1)**2
NT=NPTS-3
REPEAT TO 5520 FOR N=1,1+1,...,NT
NR=3*N
NC=3*N-2
T(NR,NC)=1.0
T(NR+1,NC+1)=1.0
T(NR,NC+3)=-1.0
T(NR+1,NC+4)=-1.0
T(NR,NC+1)=0.5*(YAIC(N+1,NS)+YAIC(N+2,NS))
T(NR,NC+2)=T(NR,NC+1)**2
T(NR,NC+4)=-T(NR,NC+1)
T(NR,NC+5)=-T(NR,NC+2)
T(NR+1,NC+2)=2.0*T(NR,NC+1)
5520
T(NR+1,NC+5)=-T(NR+1,NC+2)
6000
CONTINUE
TRANSFER TO SUBROUTINE
MSIZE,T,C
RETURN

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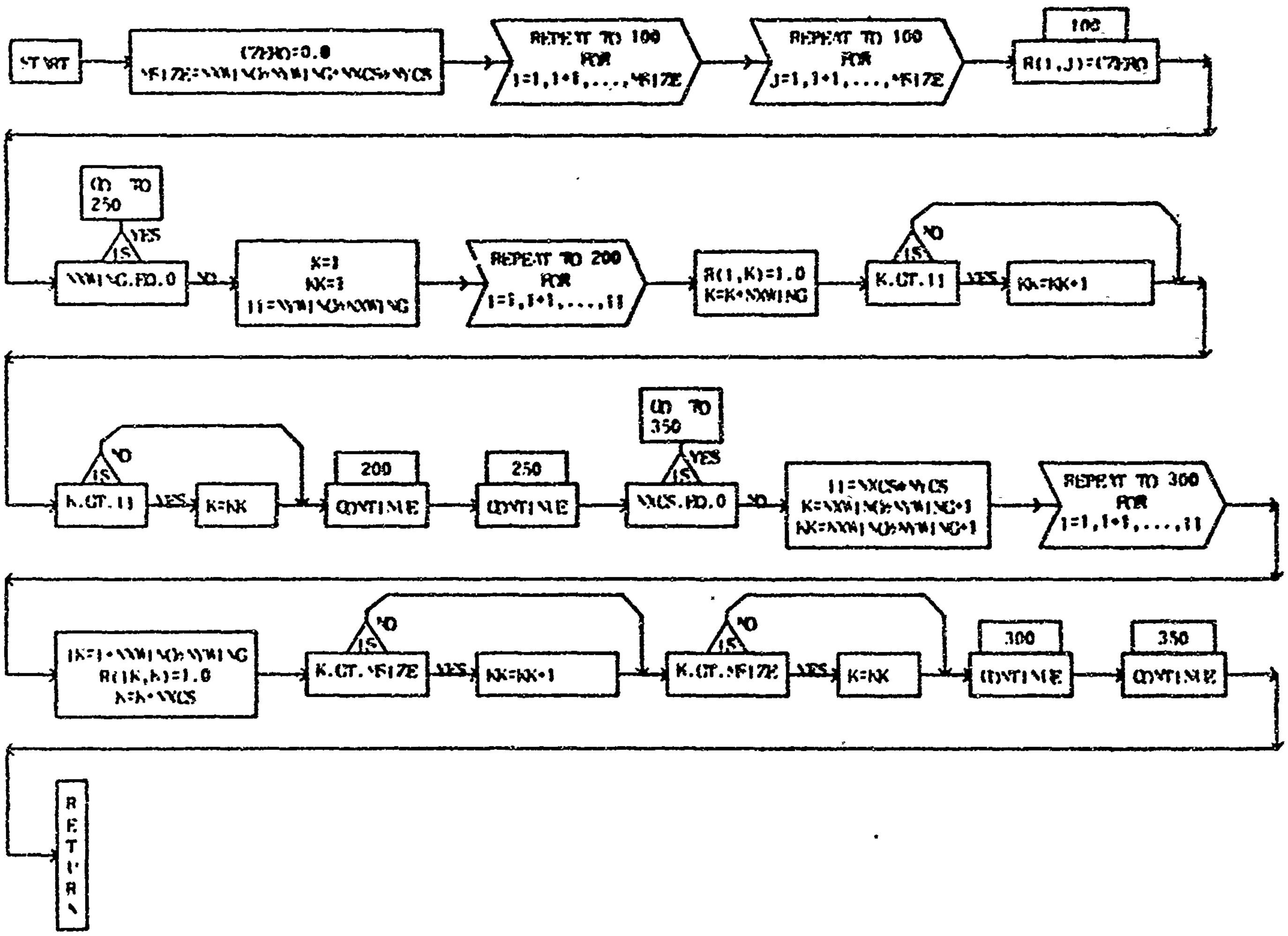
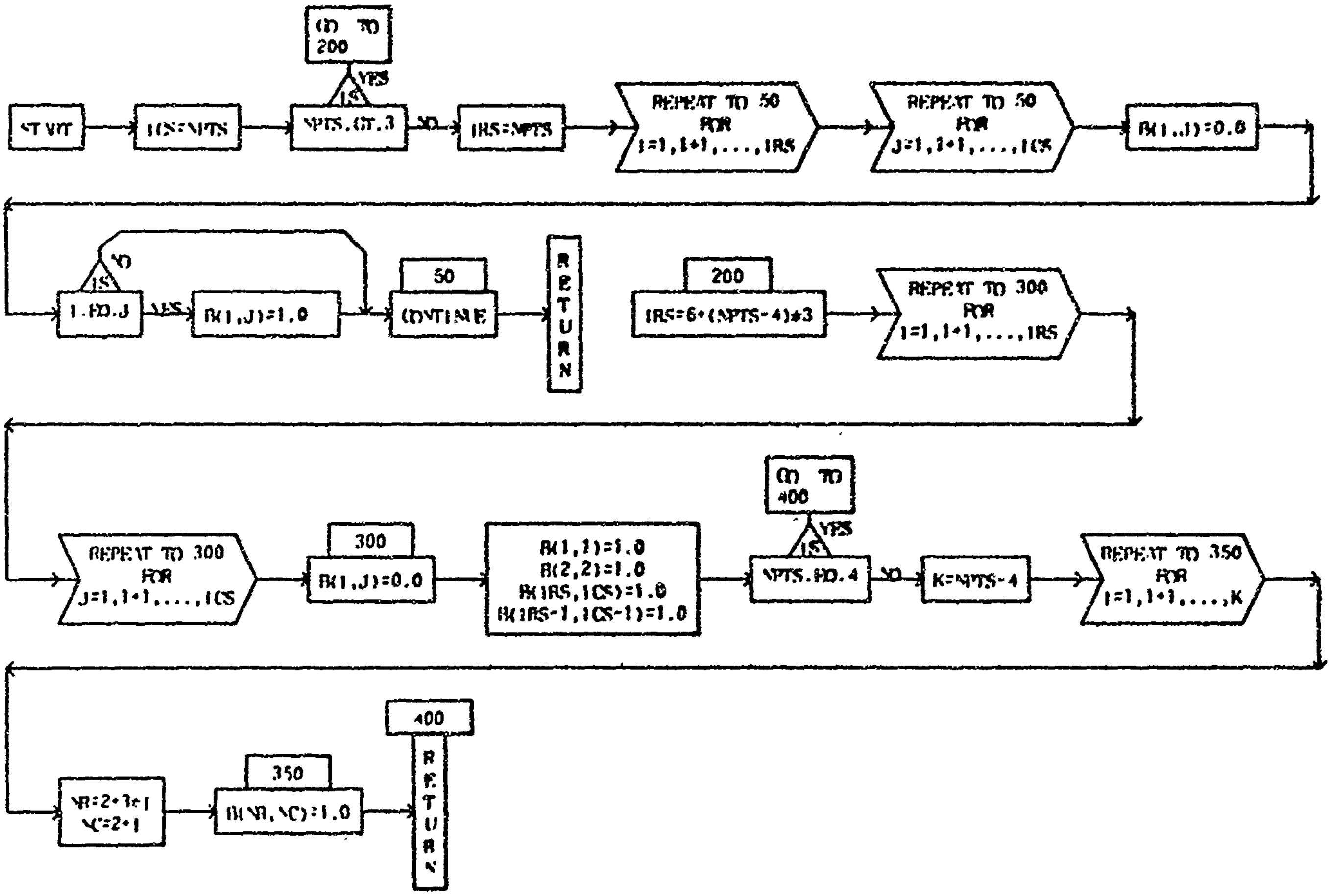
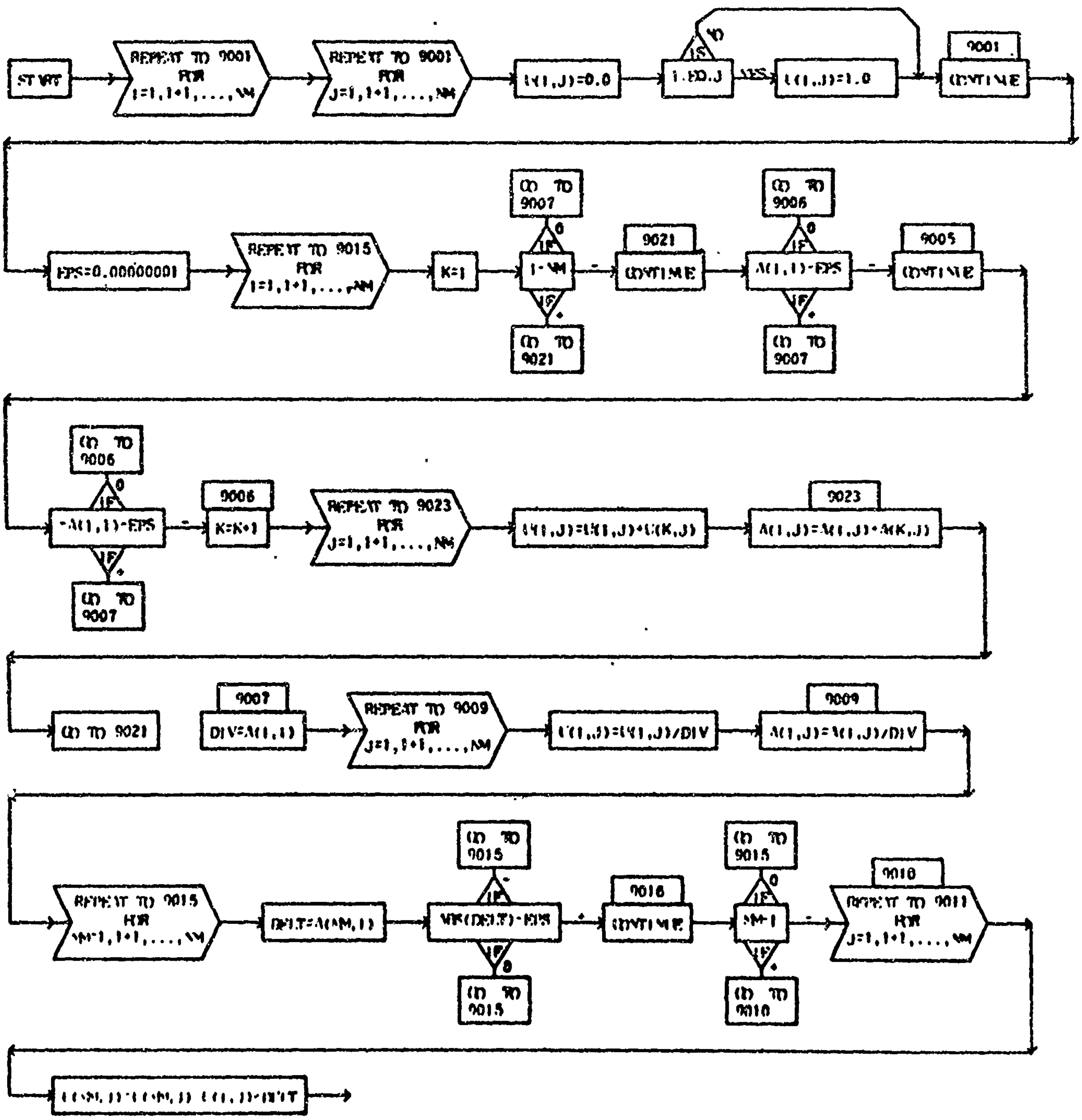
SUBROUTINE RMAT (NXWING,NYWING,NXCS,NYCS,MSIZE) PAGE 1

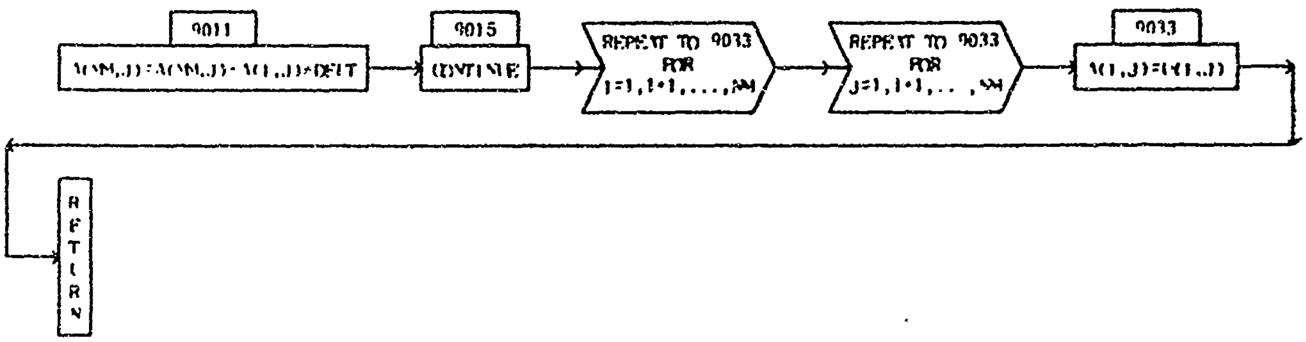



START
ICS=NPTS
NPTS.GT.3
GO TO 200
YES
IS
NO
IRS=NPTS
REPEAT TO 50 FOR I=1,I+1,...,IRS
REPEAT TO 50 FOR J=1,J+1,...,ICS
B(I,J)=0.0
I.EQ.J
B(I,J)=1.0
50
CONTINUE
RETURN
200
IRS=6+(NPTS-4)*3
REPEAT TO 300 FOR I=1,I+1,...,IRS
REPEAT TO 300 FOR J=1,J+1,...,ICS
300
B(I,J)=0.0
B(1,1)=1.0
B(2,2)=1.0
B(IRS,ICS)=1.0
B(IRS-1,ICS-1)=1.0
NPTS.EQ.4
GO TO 400
K=NPTS-4
REPEAT TO 350 FOR I=1,I+1,...,K
350
B(NR,NC)=1.0
400

DIMENSIONED VARIABLES

SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES	SYMBOL	STORAGES
[illegible]	40,40	[illegible]	40,40						


START
REPEAT TO 9001
FOR
9001
CONTINUE
YES
NO
EPS=0.00000001
REPEAT TO 9015
K=I
GO TO
9007
9021
CONTINUE
9006
9005
9023
K=K+1
9009
DIV=A(I,I)
9018
IF


9011
9015
CONTINUE
REPEAT TO 9033 FOR
REPEAT TO 9033 FOR
9033
RETURN

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

HUGHES AIRCRAFT COMPANY, MISSILE SYSTEMS DIVISION
FALLBROOK AND ROSCOE BLVDS.
CANOGA PARK, CALIFORNIA 91304

2a. REPORT SECURITY CLASSIFICATION

UNCLASSIFIED

2b. GROUP

3. REPORT TITLE

COLLOCATION FLUTTER ANALYSIS STUDY

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

FINAL REPORT (MARCH 1968 THROUGH MARCH 1969)

5. AUTHOR(S) (First name, middle initial, last name)

DYNAMICS AND ENVIRONMENT SECTION, DONALD R. ULBRICH

6. REPORT DATE

APRIL 4, 1969

7a. TOTAL NO. OF PAGES

7b. NO. OF REFS

8a. CONTRACT OR GRANT NO.

N00019-68-C-0247

b. PROJECT NO.

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

IN ADDITION TO SECURITY REQUIREMENTS WHICH APPLY TO THIS DOCUMENT AND MUST BE MET, EACH TRANSMITTAL OF THIS DOCUMENT OUTSIDE THE AGENCIES OF THE U.S. GOVERNMENT MUST HAVE PRIOR APPROVAL OF THE COMMANDER NASC

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY

NAVAL AIR SYSTEMS COMMANDS
DEPARTMENT OF THE NAVY
WASHINGTON, D.C.

13. ABSTRACT

THIS STUDY COVERS THE DEVELOPMENT OF A SET OF COMPUTER PROGRAM TO PERFORM FLUTTER ANALYSIS BY THE COLLOCATION METHOD. WHILE THIS METHOD HAS BEEN KNOWN FOR SOME TIME, ONLY RECENTLY HAVE ADVANCES IN COMPUTER TECHNOLOGY MADE THE METHOD TECHNICALLY AND FINANCIALLY FEASIBLE. THE INGREDIENTS OF A COLLOCATION FLUTTER ANALYSIS ARE 1) A FLEXIBILITY MATRIX, 2) AERODYNAMIC INFLUENCE COEFFICIENT MATRIX, AND 3) AN EIGENVALUE SOLUTION. THIS STUDY IS PRESENTED IN FOUR VOLUMES. VOLUME I CONTAINS A GENERAL PROGRAM DISCUSSION. VOLUME II CONTAINS THE PROGRAM FLUENC WHICH CALCULATES THE FLEXIBILITY MATRIX. VOLUME III CONTAINS A SET OF THREE PROGRAMS TO CALCULATE AERODYNAMIC INFLUENCE COEFFICIENTS FOR SUBSONIC, TRANSONIC, AND SUPERSONIC FLIGHT REGIMES. VOLUME IV CONTAINS THE PROGRAM COFA WHICH SETS UP AND SOLVES THE FLUTTER EIGENVALUE MATRIX.

DD FORM 1473

UNCLASSIFIED

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UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
FLUTTER						
VIBRATION						
AERODYNAMIC INFLUENCE COEFFICIENTS						

UNCLASSIFIED
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