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THEORETICAL PREDICTION OF INTERFERENCE LOADING ON AIRCRAFT STORES

PART III – PROGRAMMER'S MANUAL

BY

F. DAN FERNANDES

PREPARED FOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA 23365
UNDER
CONTRACT NUMBER NAS1-10374

JUNE 1972

GENERAL DYNAMICS
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THEORETICAL
PREDICTION OF INTERFERENCE LOADING
ON AIRCRAFT STORES; PART III -
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SUMMARY

A FORTRAN program is described for predicting interference loading on aircraft stores. An analysis of the program is presented from a programmer's point of view, including program organization, subroutine explanations, and FORTRAN variable definitions. This information is intended for use in any program modification, extension, or trouble-shooting efforts. This manual is supplementary to the separately documented program theory and user information.

CONTENTS

LIST OF FIGURES AND TABLES

INTRODUCTION

The computer program described here is designed to predict aerodynamic interference loadings on aircraft stores. Actually, three related programs are involved. References 1 and 2 supply the user information and the technical information needed by the engineer to apply these programs. This manual presents the programming details of the method, intended to allow the programmer to make modifications to the computer coding. The reader need not be familiar with the technical and engineering aspects of the program as contained in References 1 and 2. It is assumed that the reader is familiar with basic FORTRAN programming techniques. Also, ANSI flowcharting standards have been used here (Reference 3).

Several possible programming modifications come to mind which may better adapt the program to the user's particular requirements. For example, adding a plotting routine would aid in more efficient output analysis. Also, output (interference coefficients) could be accumulatively added for stacked runs, and the total outputted at the end. This would allow efficient separation of the interference from the different components of the aircraft. Some intermediate values may be of special interest, such as velocity field data or store load distribution data per unit length; such data may be printed or punched out for use in other programs. Dimensions may be decreased to save space or increased to extend capability. Unused portions of the program may be removed to save space or time.

Additional error signal print-out may be helpful.

A word of caution on program modifications is required; any modification, however slight, is not to be taken lightly. A thorough check-out should be made for each change. This program is very interdependent. Many variable locations are used more than once to save space. This increases the possibility of error. The information contained in this manual should be reviewed thoroughly before any programming changes are attempted.

This FORTRAN program has been made to run on the Control Data Corporation 6400 digital computer, using extended FORTRAN, version 2.0. The compiler operates in conjunction with version 1.1 COMPASS assembly language processor under the control of the SCOPE operating system, version 3.3. The computer codes are available through COSMIC (computer software management and information center). Requests should be directed to "COSMIC, Universiry of Georgia, Athens, Georgia, 30601."

REFERENCES

1. Fernandes, F. D., "Theoretical Prediction of Interference Loading on Aircraft Stores; Part I - Subsonic Flow," NASA CR-112065-1, June 1972.

2. Fernandes, F. D., "Theoretical Prediction of Interference Loading on Aircraft Stores; Part II - Supersonic Flow," NASA CR-112065-2, June 1972.

3. Chapmin, N., "Flowcharting with the ANSI Standard: A Tutorial," Computing Surveys, Vol. 2, No. 2, June 1970.

PROGRAM ORGANIZATION

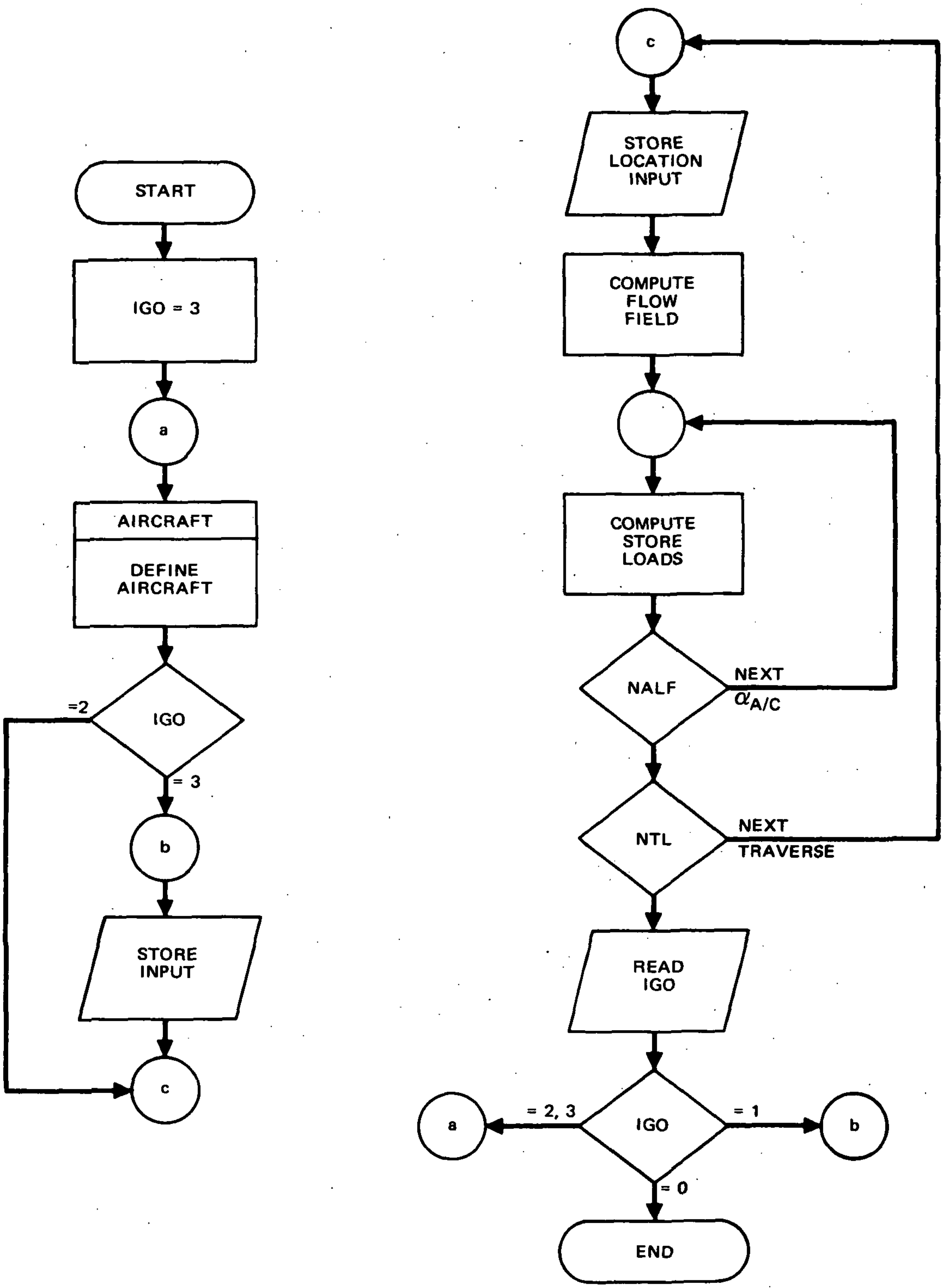
The prediction method consists of two separate main programs, called STORLD and SHOCK. Program SHOCK is a supplementary program, used to calculate inputs sometimes required for application of program STORLD to supersonic flow. The organization of program STORLD will be presented here; program SHOCK is discussed separately in APPENDIX A.

There exist two versions of program STORLD (store load), one for subsonic flow and one for supersonic flow. These two programs are composed of three groups of subroutines. The first group, referred to here as the "dual group", is applicable to both subsonic flow and supersonic flow and is duplicated in the two programs. The second group is applicable to subsonic flow only, and the third group is applicable to supersonic flow only. The following discussion is, therefore, organized by subroutine group rather than by program."

The overall logical flow of program STORLD is presented in Figure 1. This is a flowchart of the main program itself, which is very short and serves only to organize the procedure. This procedure permits run stacking for store location, store geometry, and aircraft geometry as shown.

The network of communication between program STORLD and its subroutines is shown in Figure 2 and in the continuation networks

FIGURE 1
PROGRAM STORLD LOGICAL FLOW



of Figures 3, 4, 5, and 6. Figure 2 shows subroutines AIRCFT and PARTS with continuation symbols A and B. These two subroutines serve as an interface between the dual group of subroutines and the other two groups. Network continuations A and B are shown in Figures 3 and 4 for the "subsonic" group of subroutines. Network continuations A and B are shown in Figures 5 and 6 for the "supersonic" group of subroutines. The purpose of each of the subroutines is presented in the next section.

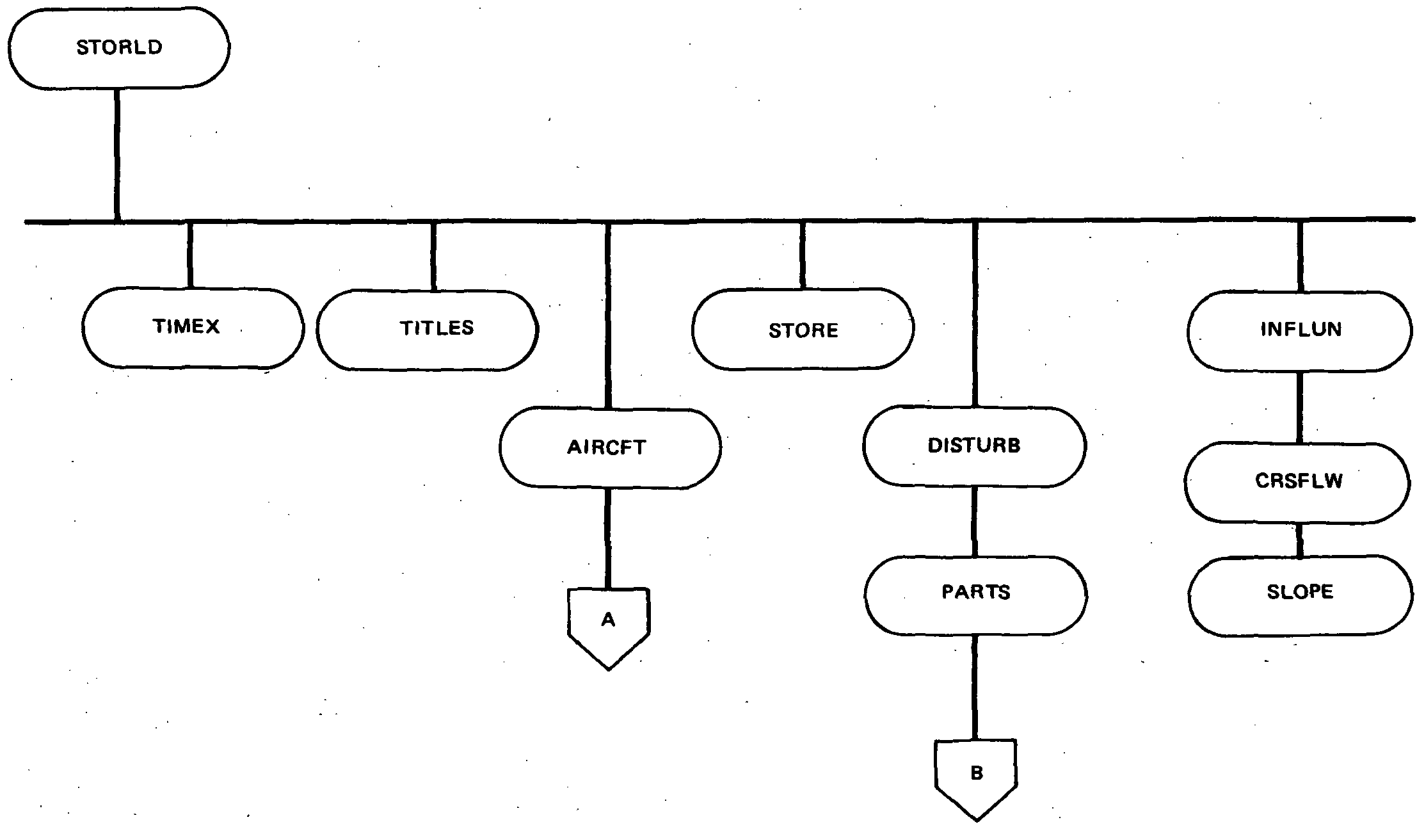


FIGURE 2
PROGRAM STORLD COMMUNICATION NETWORK, SUBSONIC AND SUPERSONIC FLOW

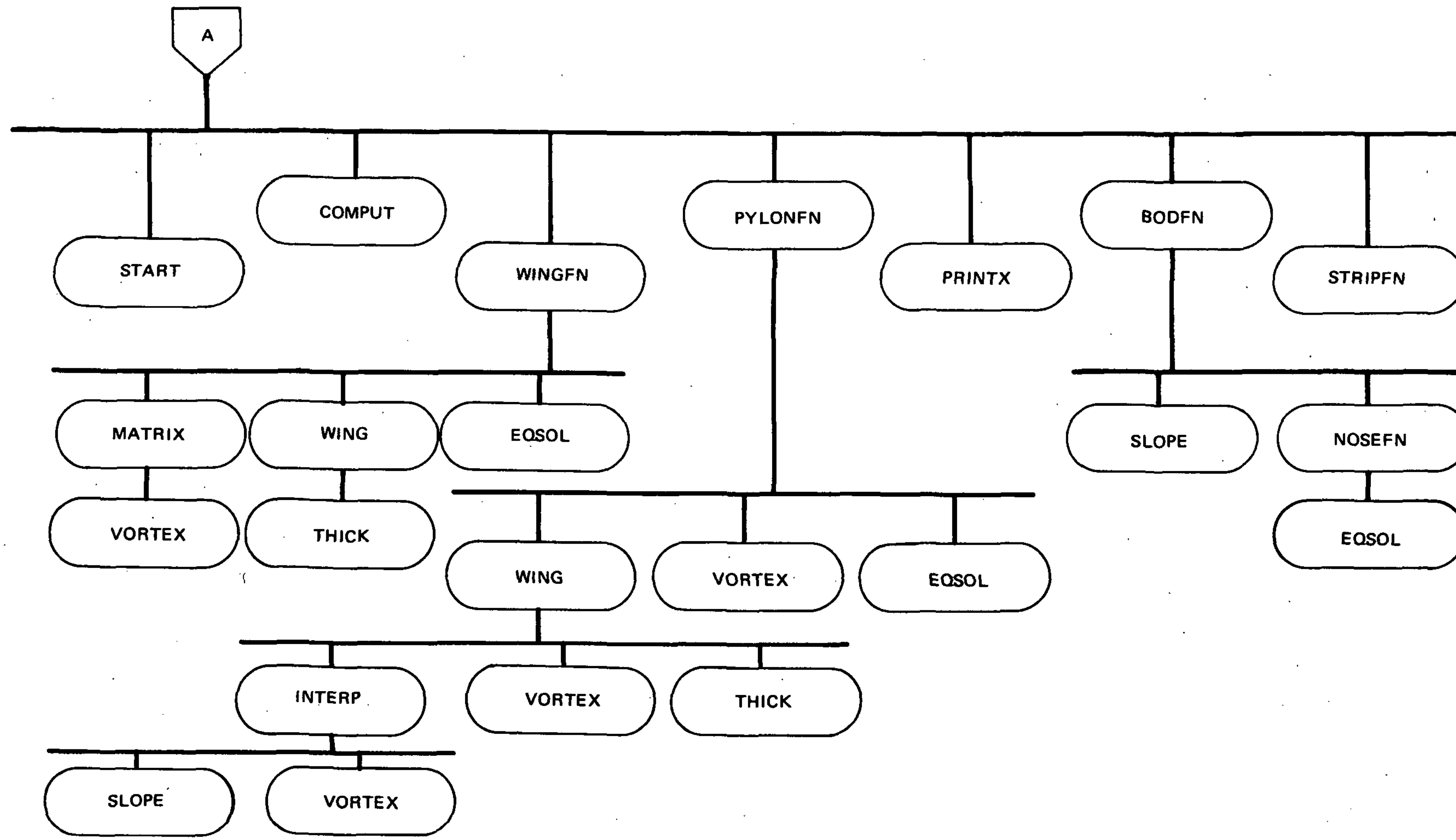


FIGURE 3
SUBROUTINE AIRCFT COMMUNICATION NETWORK, SUBSONIC FLOW

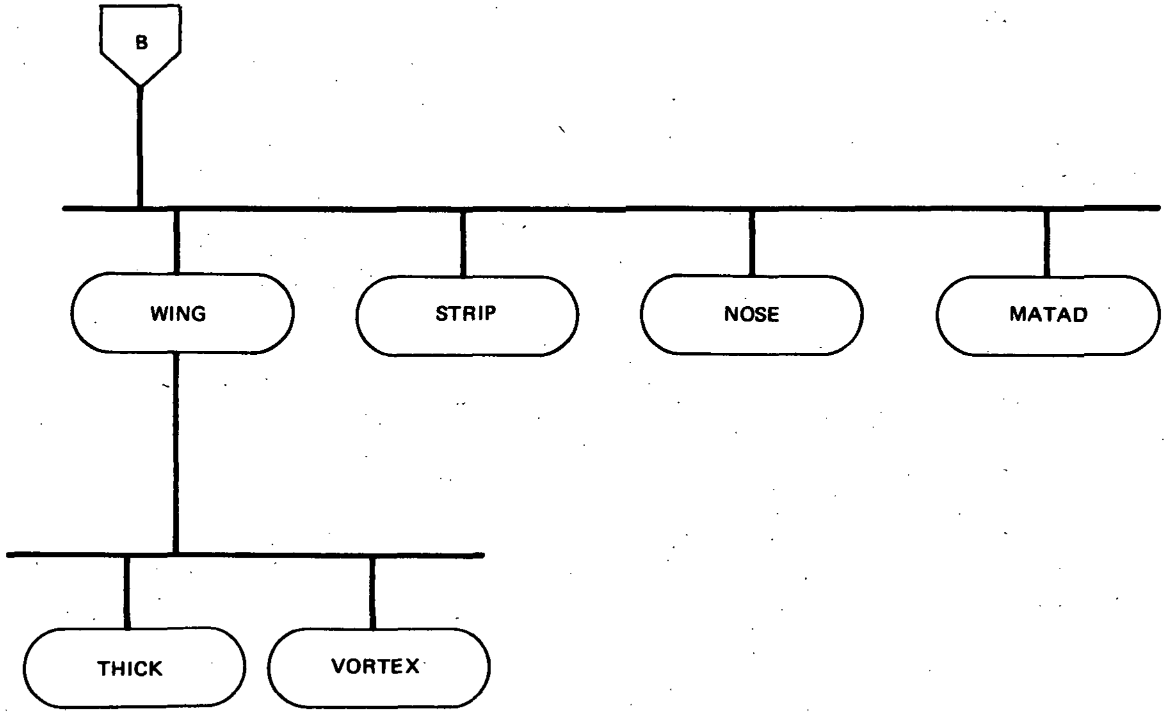


FIGURE 4
SUBROUTINE PARTS COMMUNICATION NETWORK, SUBSONIC FLOW

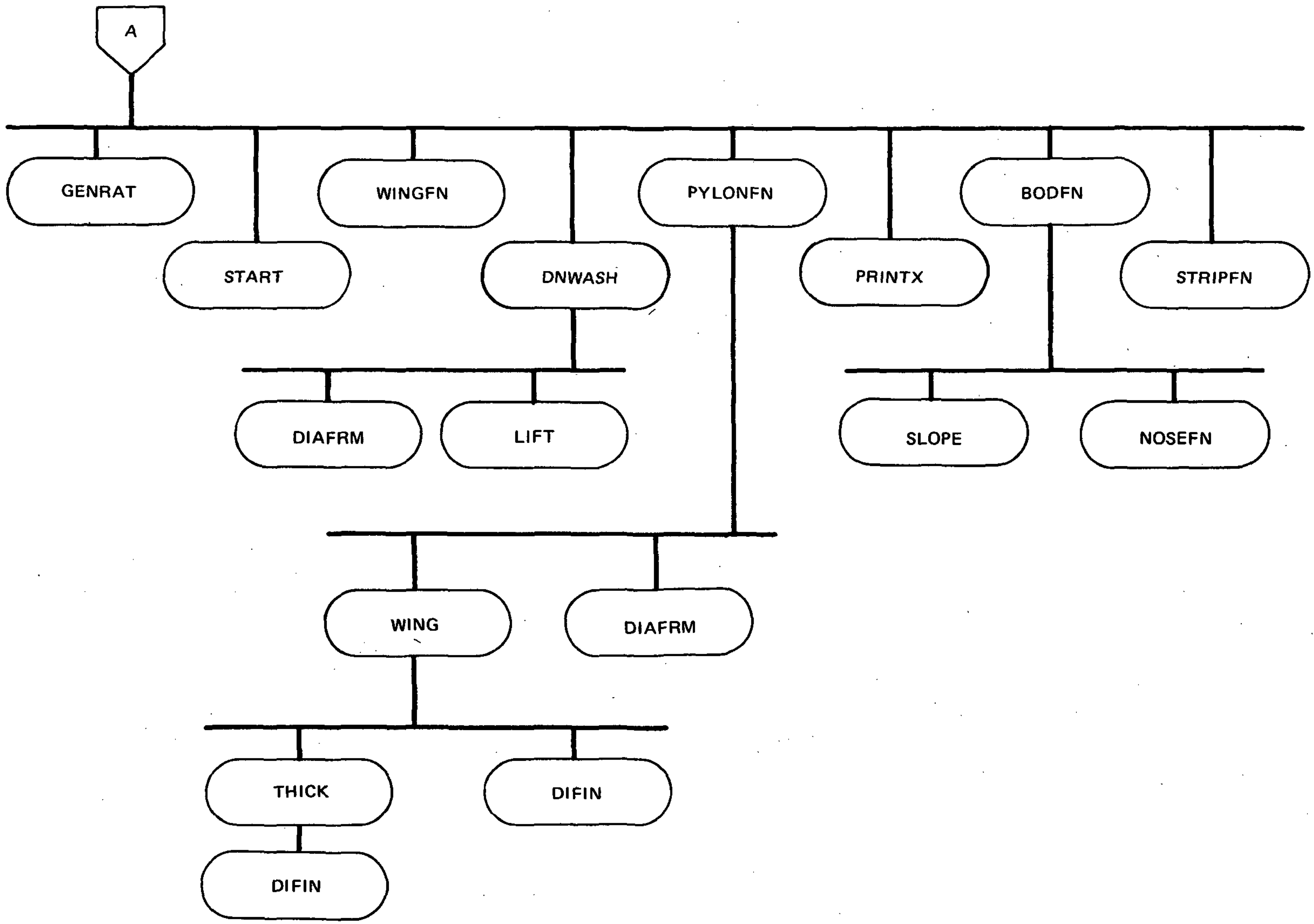


FIGURE 5
SUBROUTINE AIRCFT COMMUNICATION NETWORK, SUPERSONIC FLOW

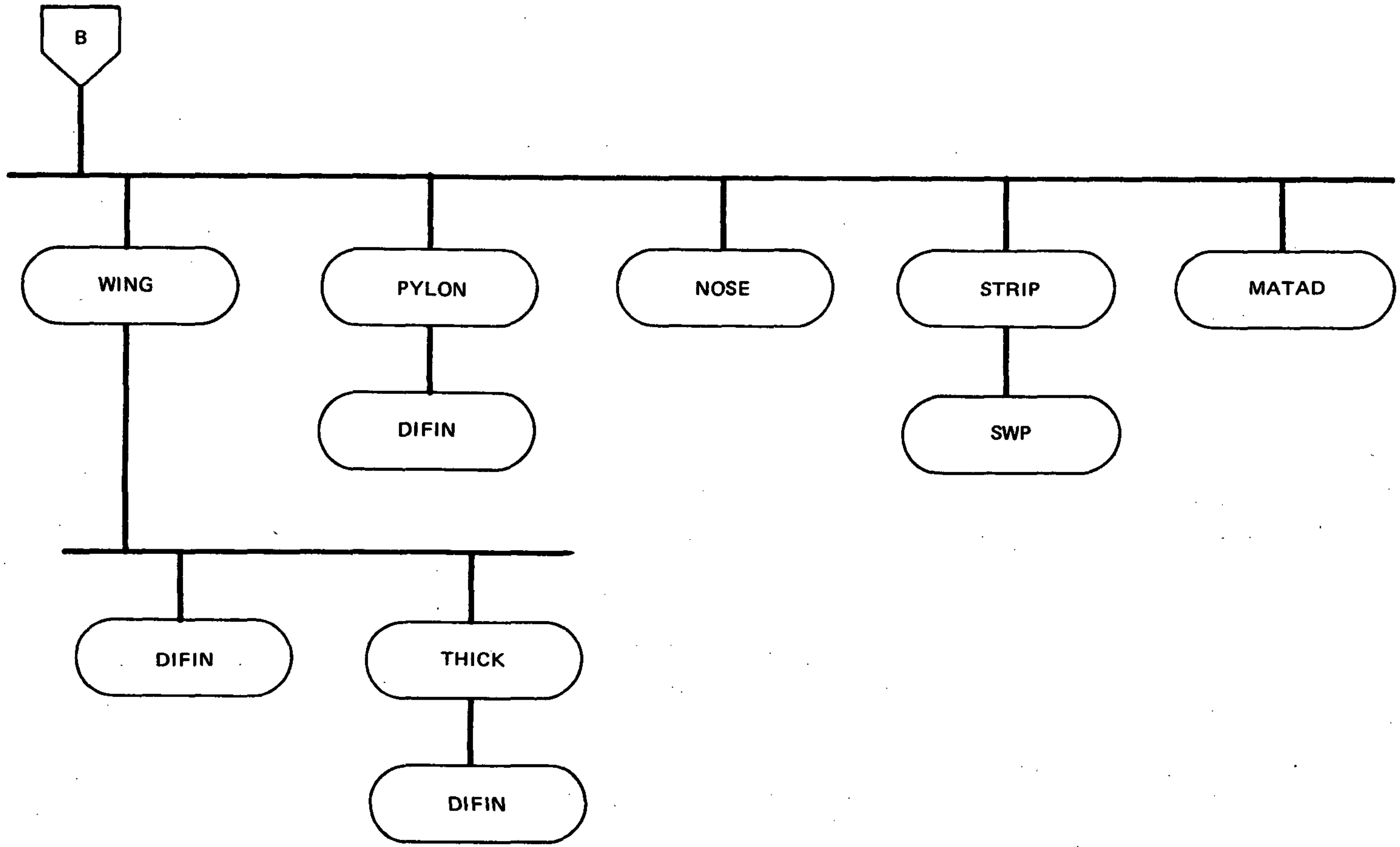


FIGURE 6
SUBROUTINE PARTS COMMUNICATION NETWORK, SUPERSONIC FLOW

SUBROUTINE EXPLANATIONS

The purpose of each subroutine will now be explained. An attempt has been made to give enough information here so that the computer coding can be examined with some knowledge of what computations are being performed and how they relate to the total program. Flowcharts for many subroutines are included. However, flowcharts are omitted in cases where they would be trivial, such as for subroutines with straight-forward flow logic. In these cases, a verbal explanation is used. Definitions to key variables are given to help in quick understanding of the operations in each subroutine. A more extensive list of variables is given in the next section.

The subroutines for Program STORLD are presented in alphabetical order in three groups, listed in Table I.

TABLE I

Subroutine List for Program STORLD

DUAL GROUP (subsonic and supersonic)

		Page
1.	BODFN	13
2.	CRSFLW	14
3.	DISTURB	16
4.	INFLUN	19
5.	MATAD	21
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7.	STORE	24
8.	STRIPFN	24
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10.	TITLES	25

SUBSONIC GROUP

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1.	AIRCFT	26
2.	COMPUT	26
3.	EQSOL	27
4.	INTERP	29
5.	MATRIX	32
6.	NOSE	33
7.	NOSEFN	34
8.	PARTS	35
9.	PRINTX	35
10.	PYLONFN	36
11.	START	37
12.	STRIP	37
13.	THICK	38
14.	VORTEX	39
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SUPERSONIC GROUP

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1.	AIRCFT	44
2.	DIAFRM	45
3.	DIFIN	51
4.	DNWASH	52
5.	GENRAT	54
6.	LIFT	54
7.	NOSE	55
8.	NOSEFN	56
9.	PARTS	56
10.	PRINTX	57
11.	PYLON	57
12.	PYLONFN	58
13.	START	60
14.	STRIP	60
15.	SWP	61
16.	THICK	62
17.	WING	63
18.	WINGFN	65

Dual Group

Subroutine BODFN (body function)

Purpose: to read in nose geometric parameters

Called from: AIRCFT

Calls: SLOPE, NOSEFN

Input: nose data

Output: Computes nose surface slopes through SLOPE; computes nose source and doublet strengths through NOSEFN; prints all input and computed data; transforms nose to an equivalent shape to account for shock effects in supersonic flow.

Subroutine CRSFLW (crossflow)

Prupose: To perform operations on the interference velocity field necessary for computing store loads.

Called from: INFLUN

Calls: SLOPE

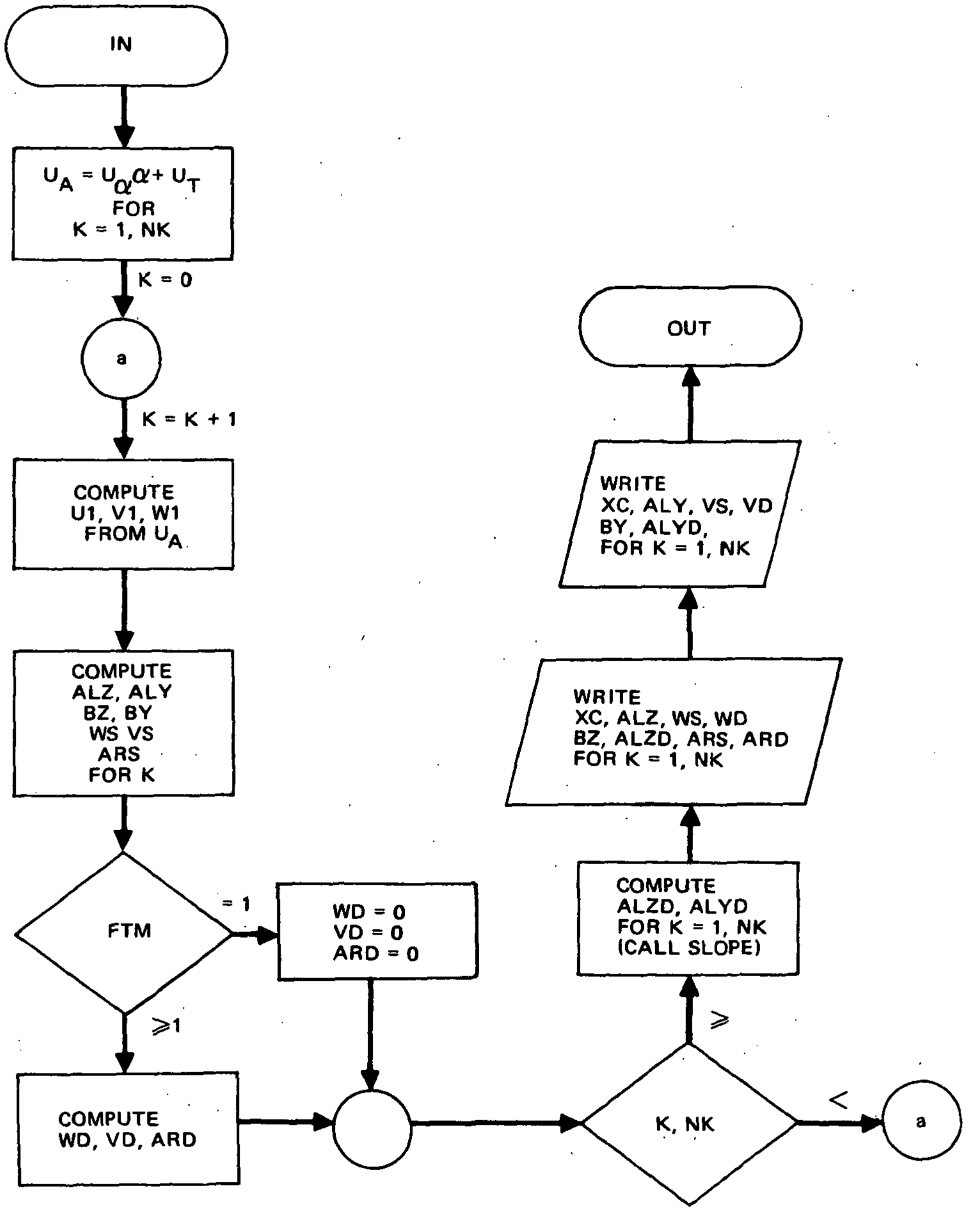
Input: Velocity field, store roll angle.

Output: 1) crossflow angle of attack field in pitch and yaw acting at store body; 2) crossflow angle of attack field in pitch and yaw acting on store fins; 3) buoyancy pressure field acting on store body; 4) axial derivitive of body crossflow field; 5) roll velocity field acting on store fins.

Definitions

K = index for axial location of field point.
U_α = velocity field due to aircraft angle of attack (U(I=1, 2, 3) = u, v, w).
U_T = velocity field due to aircraft thickness (U(I=4, 5, 6) = u_T, v_T, w_T).
U_A = total velocity field due to aircraft
U1, V1, W1 = velocity field (u, v, w) averaged axially so that trapezoidal integration of the velocity versus XC curve gives correct area.
ALZ, ALY = vertical and lateral crossflow angle acting on store body.
BZ, BY = vertical and lateral buoyancy parameter acting on store body.
WS, VS = vertical and lateral velocity parameter at store fin root (skinline)
WD, VD = spanwise rate of change of vertical and lateral velocity parameter from fin root to tip.
ARS = roll velocity parameter at fin root.
ARD = spanwise rate of change of fin roll velocity parameter from root to tip
ALZD, ALYD = axial derivitive of ALZ, ALY.
XC = field at axial location in wing coordinates.
FTM = maximum fin span from axis to tip, divided by body radius.

FIGURE 7
ROUTINE CRSFLW LOGICAL FLOW



Subroutine DISTURB

Purpose: To calculate aircraft interference velocity field acting at the store over the length of the traverse line.

Called from: STORLD (main program)

Calls: PARTS (through PARTS to WING, PYLON, STRIP, NOSE).

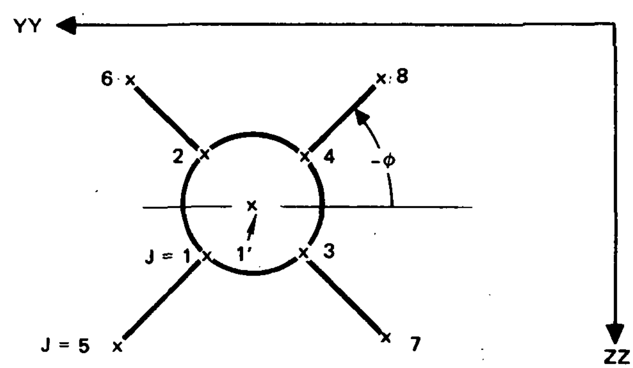
Input: Store traverse line location, computation mode indicators.

Output: Crossflow perturbation velocities, U.

Definitions

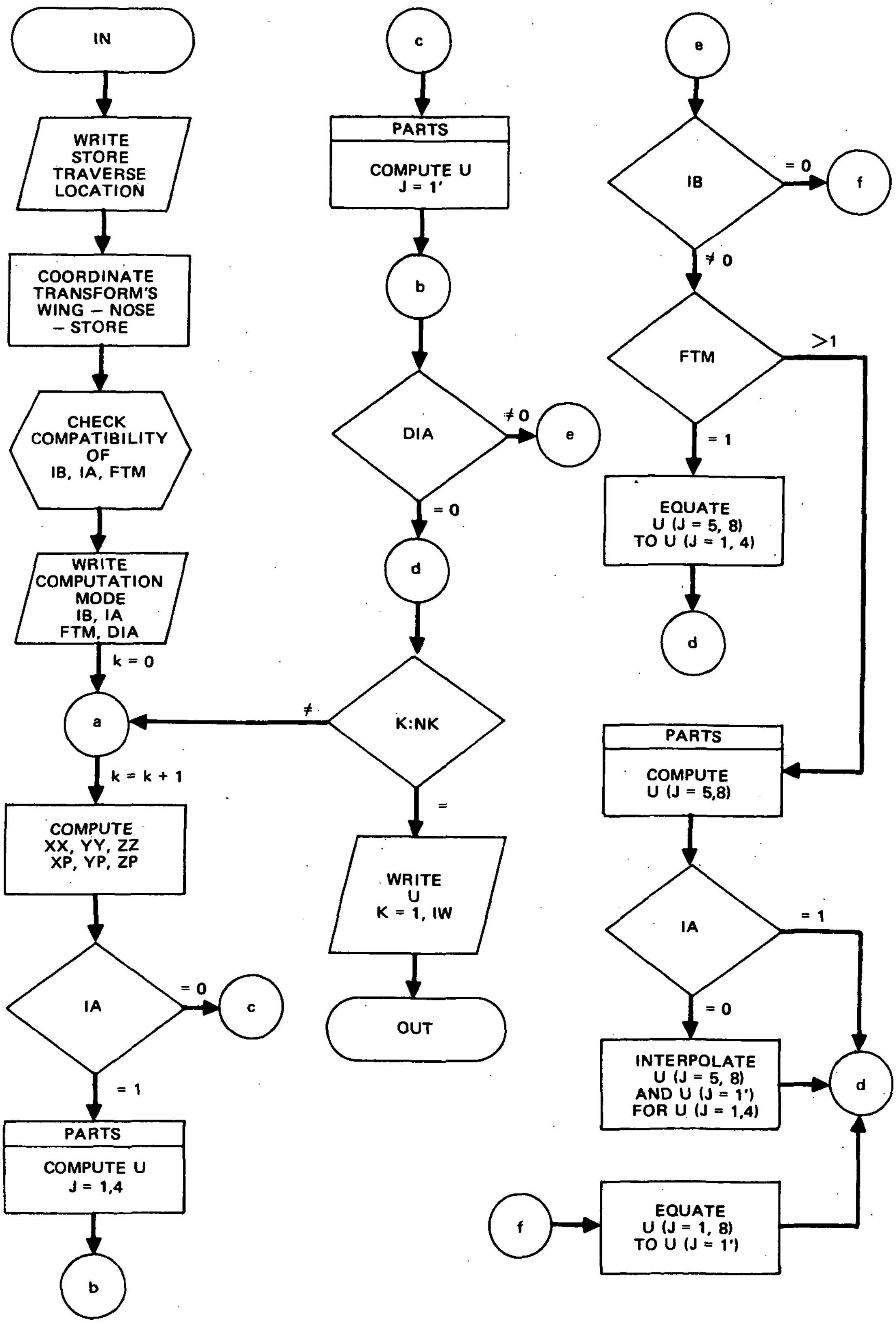
U	:	interference velocity field (u, v, w, u_T, v_T, w_T)
IB	:	if IB = 1, compute velocities at J = 1, 4 so that buoyancy on store may be computed. IB = 0, compute velocity at J = 1' only (see sketch)
IA	:	if IA = 0, compute velocity at J = 1' and interpolate from J = 6, 8 to get J = 1, 4 reducing computing time by 5/8 (see sketch)
IW	:	number of axial sections at which to write velocities
FTM	:	maximum store fin span from axis to tip, divided by body radius
DIA	:	store diameter
X	:	distance along traverse line from reference point to field point (+ = forward)
XT	:	length of traverse line
K	:	X index
NK	:	number of axial sections on traverse line
J	:	index of field point location in Y-Z plane (see sketch)
ϕ	:	store roll angle
XX, YY, ZZ	:	field point location in wing coordinates
XP, YP, ZP	:	field point location in nose coordinates

STORE CROSS SECTION SHOWING
FIELD POINT LOCATION AS A
FUNCTION OF INDEX J FOR
$\phi = -45^\circ$



SKETCH 1
ROUTINE DISTURB

FIGURE 8
ROUTINE DISTURB LOGICAL FLOW



Subroutine INFLUN (influence)

Purpose: to calculate the interference force and moment coefficients on the store

Called from: STORLD (main program)

Calls: CRSFLW

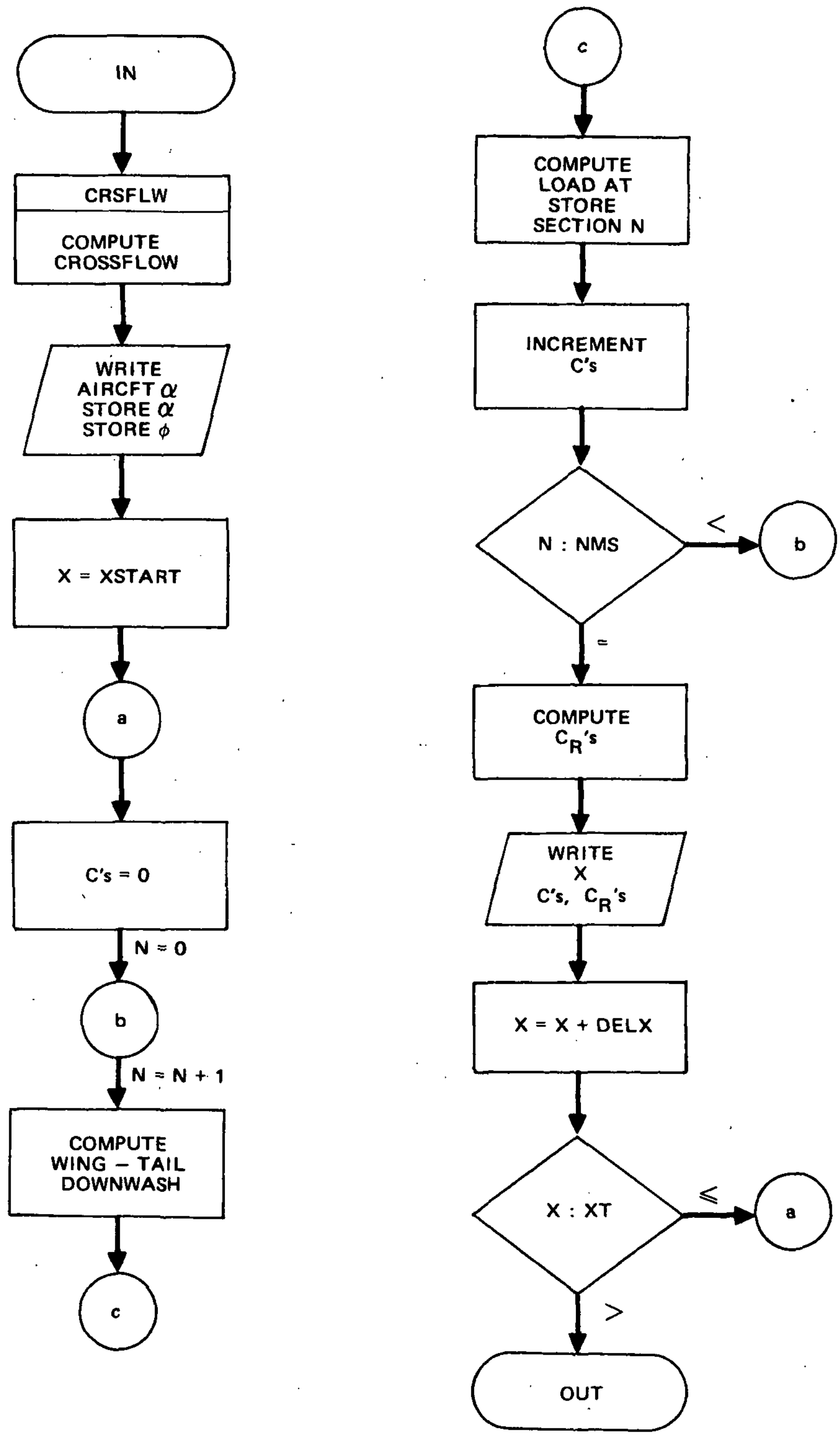
Input: store geometry and aerodynamics, interference crossflow velocity field

Output: interference force and moment coefficients

Definitions (FORTRAN names noted)

α = angle of attack (ALFW, ALFM)
X = distance along traverse line from store CG to reference point location
C's = force and moment coefficients in pitch and yaw, summed over store length (CNZ, CNY, CMZ, CMY)
NMS = number of store axial sections
DELX = store section axial length
ϕ = store fin roll angle (ROLL)
C_R's = C's rotated to ϕ orientation (body axis) (CNZR, CNYR, CMZR, CMYR)
XT = traverse length

FIGURE 9
ROUTINE INFLUN LOGICAL FLOW



Subroutine MATAD (matrix addition)

Purpose: add column matrix B to column matrix A

$$\{A\} = \{A\} + \{B\}$$

Called from: PARTS

Calls: (nothing)

Input: A, B

Output: A

Comments: When called from PARTS, B is the velocity at one field point produced by one aircraft component (wing, strip, pylon, or nose). B(I = 1, 6) = u, v, w, u_T, v_T, w_T. B is accumulated in A to get the total flow velocity. When B is the nose velocity field, (u, w) and (u_T, w_T) are rotated through the angle ALFNW to transform from nose coordinates to wing coordinates.

Subroutine SLOPE

Purpose: to compute the first derivative of array R versus array X.

Called from: (subsonic program) INTERP; (dual program) BODFN, CRSFLW.

Calls: (none)

Input: N, X, R

Output: D, A

Comment: SLOPE curve - fits R versus X with a quadratic, using 3 points at a time, then equates the slope at the middle point to the analytic derivative of the quadratic at that point. The analytic derivative at the first and last point of the array is also used. Coefficients A for only the last 3-point set are returned as output. If any adjacent values in array X are identical, an error signal (infinite slope) is printed.

Definitions

N = number of points in arrays X and R
X = independdnt variable array
R = dependent variable array
D = first derivitive, dR/dX
A = three coefficients in the quadratic equation $R = A_1X^2 + A_2X + A_3$
H , A , B : writing the above quadratic equation for three adjacent points and eliminating A_3 gives the matrix equation

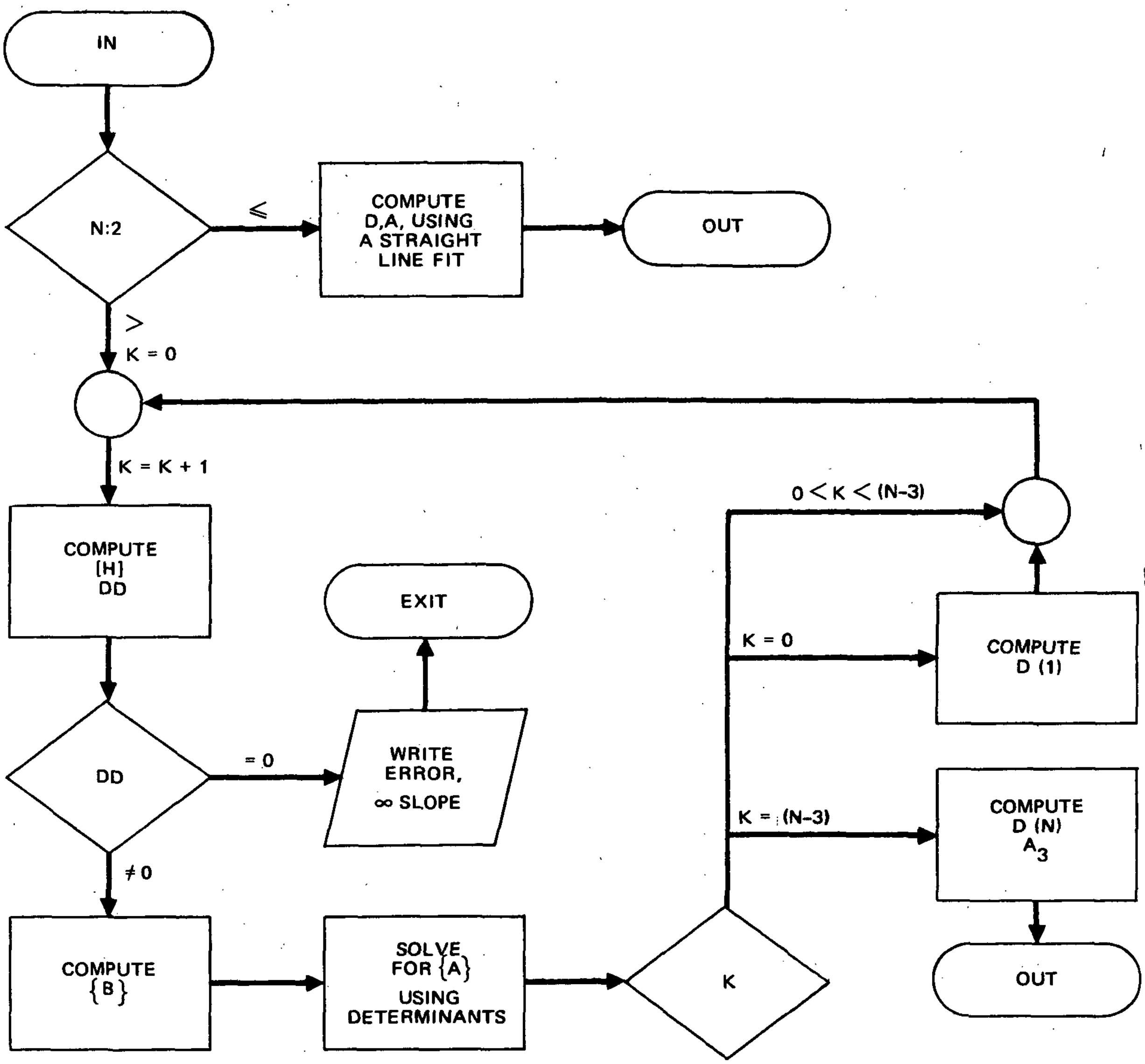
$$[H] \cdot \{A\} = \{B\}$$

where $$[H] = \begin{bmatrix} (x_2^2 - x_1^2) & (x_2 - x_1) \\ (x_3^2 - x_1^2) & (x_3 - x_1) \end{bmatrix}$$

$$A = \begin{Bmatrix} A_1 \\ A_2 \end{Bmatrix} \qquad B = \begin{Bmatrix} R_2 - R_1 \\ R_3 - R_1 \end{Bmatrix}$$

K = index for grouping arrays R, X, in sets of three
DD = value of the determinant of H

FIGURE 10
ROUTINE SLOPE LOGICAL FLOW



Subroutine STORE

Purpose: to read in store geometric and aerodynamic properties

Called from: STORLD (main program)

Calls: (nothing)

Input: store data

Output: prints all input data; makes input data available to program through common. Also, computes variables defined below

SETY, SETZ = store fin roll angle sine and cosine parameters, used in repeated location of field point for velocity calculations in DISTURB

XBAR = distance from store section to reference CG divided by reference diameter

Subroutine STRIPFN (strip function)

Purpose: to read input parameters which define the elementary source strips used to represent the aircraft thickness envelope (other than wing and nose thickness). This includes inlets and pylons.

Called from: AIRCFT

Calls: (none)

Input: strip data

Output: Writes all input data

Comment: If Mach number is greater than one, STRIPFN checks for strip sweep equal to Mach line sweep, and if so, increments the tangent of the sweep angle by 10%. This is done to avoid error in subroutine SWP.

Subroutine TIMEX

Purpose: to print the expired time used in central processing (CP time)

Called from: STORLD

Calls: SECOND (a system subroutine)

Input: (none)

Output: print CP time and its increment from the last time called (in seconds)

Comment: permits easy determination of calculation time taken by each separate calculation in the program.

Subroutine TITLES

Purpose: to read and write aircraft title, store title, and store location title

Called from: STORLD (main program)

Calls: (none)

Input: mode signals IA, IS, IL

Output: titles are printed

Comments: "IA" is mode signal for aircraft title, "IS" for store title, "IL" for store location title

IA = 2 aircraft title is read and printed

IA = 1 title is printed, not read

IA = 0 title is not read or printed

Similarly for IS and IL

Subsonic Group

Subroutine AIRCFT

Purpose: to call the subroutines used to compute the aircraft representation

Called from: STORLD

Calls: START, COMPUT, WINGFN, PYLONFN, PRINTX, BODFN, STRIPFN

Comment: AIRCFT is an interface subroutine used for calling other subroutines.

Subroutine COMPUT

Prupose: to perform preliminary computations on the aircraft wing input data, necessary for representation of the wing by source and vortex distributions.

Called from: AIRCFT

Calls: (none)

Input: wing input geometry, Mach number

Output: trigonometric functions of the wing section sweep and dihedral angles; horseshoe vortex locations and control point locations to represent the wing in compressible flow.

Comment: The Prandtl-Glauert transformation is used to account for the effects of compressibility.

Subroutine EQSOL (equation solver)

Purpose: solves N simultaneous linear equations for N unknowns by the augmented method of matrix inversion

Called from: (subsonic program) WINGFN, PYLONFN, NOSEFN

Calls: (nothing)

Input: H and B of matrix equation

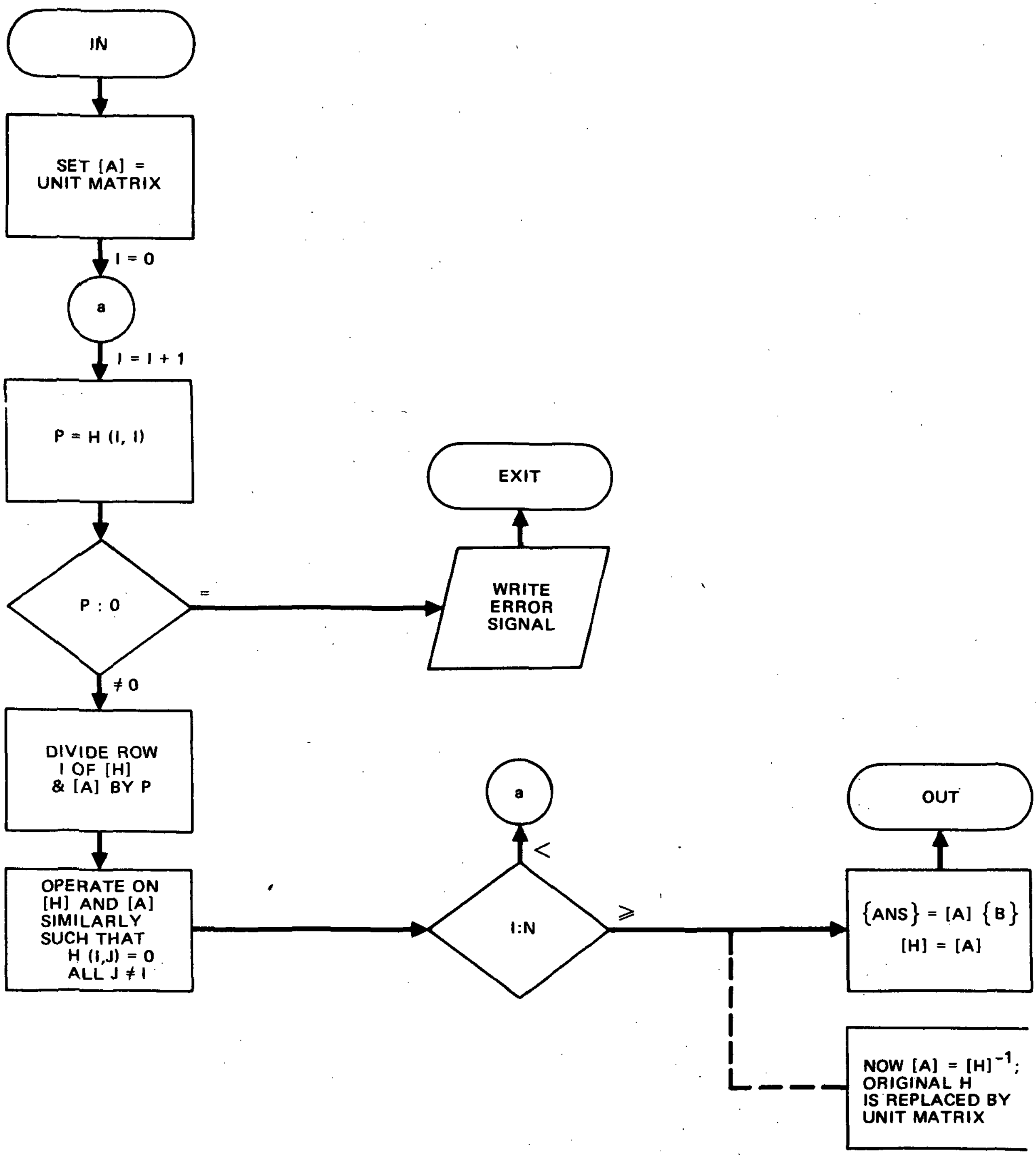
$$[H] \cdot \{ANS\} = \{B\}$$

Output: $[H]^{-1}$, $\{ANS\}$

Definitions

A : matrix used to augment H ; becomes H^{-1} by the calculation
H : input matrix of coefficients; H^{-1} is returned in the same storage location to save space
I : row index of H and A
P : pivot element
N : number of unknowns ANS (= number of rows and columns in H)

FIGURE 11
ROUTINE EQSOL LOGICAL FLOW



Subroutine INTERP

Purpose: To accurately calculate the lateral velocity induced by a horseshoe vortex and acting at a field point which is close to the plane of the vortex.

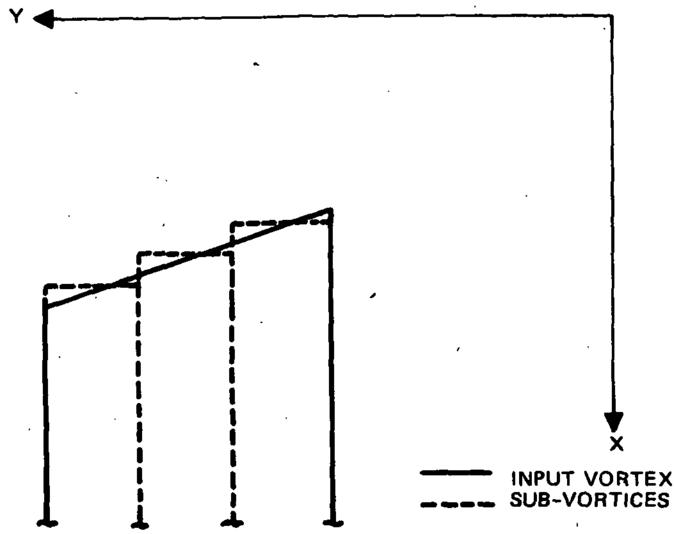
Called from: WING

Calls: VORTEX, SLOPE

Input: Vortex location and strength; adjacent vortex locations and strengths, field point location.

Output: Perturbation velocities (u, v, w, u_T, v_T, w_T)

Comment: This subroutine is used to calculate wing-induced velocities normal to the pylon. The calculation is necessary because of the close proximity of the pylon to the wing vortices. The input vortex is divided spanwise into to a number of smaller horseshoe "sub-vortices," as shown in the sketch. Circulations for these sub-vortices are taken from a quadratic curve fit through the input vortex and two adjacent vortices. In this way, the spanwise rate of change of vorticity is numerically approximated, which permits accurate calculation of spanwise velocity. Since vorticity is not interpolated chordwise, the vertical and lateral perturbation velocity values do not have comparable accuracy; however, these are not used in pylon calculations.

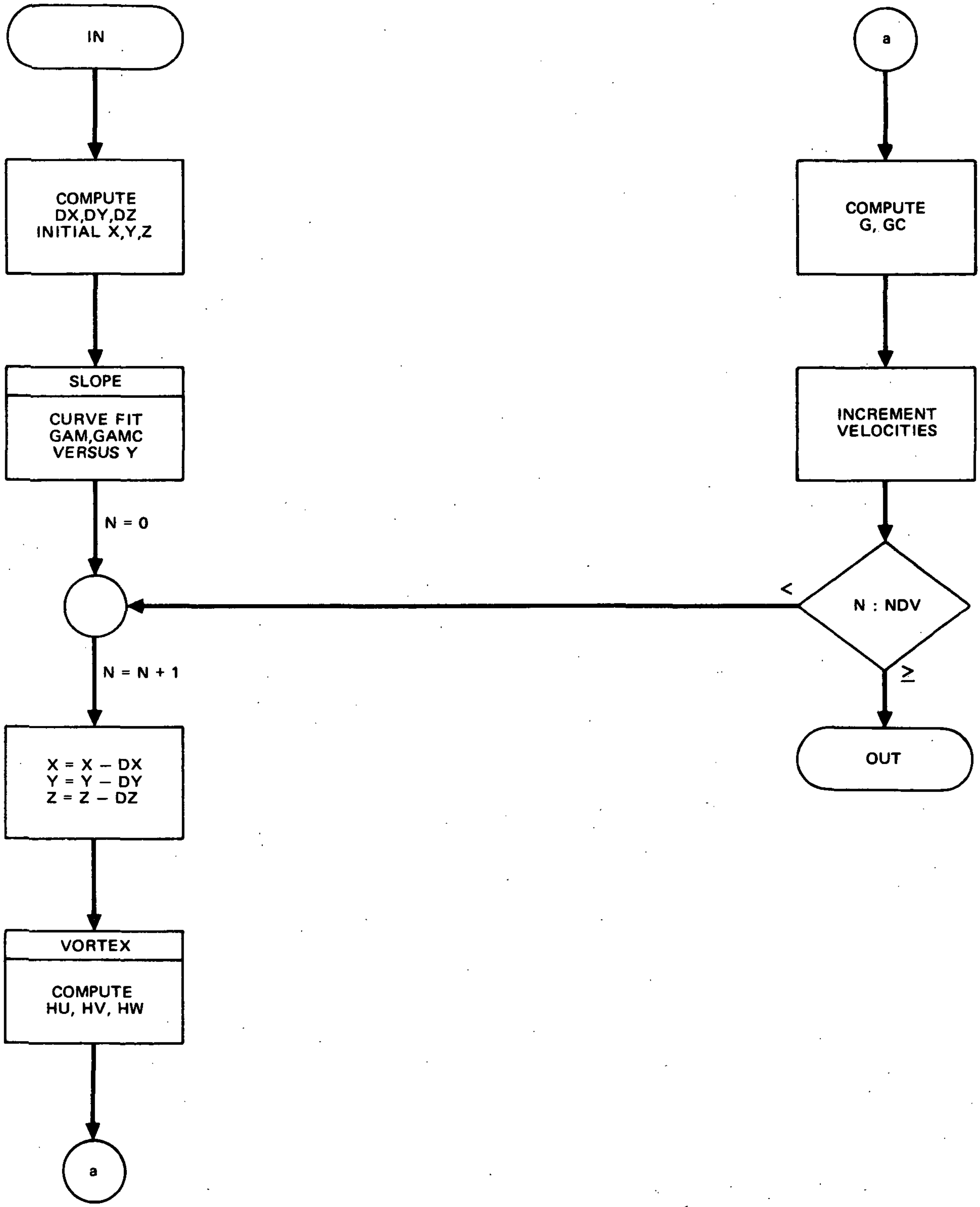


SKETCH 2
ROUTINE INTERP

Definitions

DX, DY, DZ	:	coordinate distances between sub-vortex locations
X, Y, Z	:	field point location with origin at the sub-vortex
GAM, GAMC	:	circulation strengths of input vortex and two adjacent vortices
HU, HV, HW	:	sub-vortex induced velocities per unit circulation strength
G, GC	:	interpolated values of GAM and GAMC from curve fit
NDV	:	number of sub-vortices

FIGURE 12
ROUTINE INTERP LOGICAL FLOW



Subroutine MATRIX

Purpose: to compute the matrix of coefficients which relate the wing vortex circiulation strengths to the induced velocities at the wing control points

Called from: WINGFN

Calls: VORTEX

Input: wing control point locations, wing horseshoe vortex geometry and locations.

Output: coefficient matrix $[H]$, where

H(I, J) = velocity induced normal to wing at control point I, by horseshoe vortex J.

Comments: a maximum of 40 horseshoe vortices are used to represent the left wing. These vortices are mirror-imaged about the Y = 0 plane to represent the right wing. The horseshoe vortex lattice is distributed chordwise and spanwise.

Definitions

NU: vortex chordwise index
MU: vortex spanwise index
I : control point chordwise index
J : control point spanwise index
KC: control point combined index
JC: vortex combined index

Subroutine NOSE

Purpose: To compute the perturbation velocities produced by the nose at a field point.

Called from: PARTS

Calls: (none)

Input: field point location in nose coordinates; locations and strengths of the nose line singularities.

Output: velocities due to nose thickness and crossflow.

Definitions

UA, VA, WA	:	velocities due to nose thickness
UC, VC, WC	:	velocities due to nose crossflow
XA, YP, ZP	:	field point location in nose coordinates, with origin at nose apex and x-axis the axis of symmetry
N	:	number of nose singularities
SUB 2	:	Mach function $(1 - M^2)$
XBL	:	nose length
XU	:	singularity apex locations
SNA	:	source strength
SNC	:	doublet strength

Subroutine NOSEFN

Purpose: To compute source and doublet strengths used to represent the aircraft fuselage nose

Called from: BODFN

Calls: EQSOL

Input: nose geometry; Mach number

Output: source and doublet strengths and locations

Comments: A distribution of line sources along the nose axis of symmetry represents the flow field due to thickness. A similar distribution of doublets represents the crossflow field. A system of NBP linear simultaneous equations is used to satisfy the boundary conditions, and these are solved in EQSOL by matrix inversion to obtain the singularity strengths.

Definitions

NBP : number of body points (input)
XB, RB: nose geometry input
DRDXB : slope of RB versus XB
XU : apex locations of line source and doublets
XBL : axial termination point of line singularities
G, H : matrices of coefficients in the matrix equations

$$[G] \cdot \{SNA\} = \{DRDXB\}$$
$$[H] \cdot \{SNC\} = \{B\}$$

SNA : line source strengths
SNC : line doublet strengths
B : distribution of crossflow, taken constant at one degree

Subroutine PARTS

Purpose: to sum the velocity field contributed by the various parts of the aircraft to obtain the total interference flow field at each field point.

Called from: DISTURB

Calls: WING, STRIP, NOSE, MATAD

Input: field point location in wing coordinates and nose coordinates

Output: total interference velocity field at the field point

Comment: PARTS is an interface subprogram used to call other subprograms.

Subroutine PRINTX

Purpose: To print out the aircraft wing and pylon input parameters and computed parameters

Called from: AIRCFT

Calls: (none)

Subroutine PYLONFN

Purpose: to read pylon location and to compute vortex lattice used to represent the pylon in the presence of the wing

Called from: AIRCFT

Calls: WING, VORTEX, EQSOL

Input: pylon vortex locations (read in), wing crossflow field at pylon.

Output: pylon vortex circulation strengths.

Comment: subroutine PYLONFN computes the pylon vortex lattice by the procedure very similar to that used to compute the wing vortex lattice in subroutines COMPUT-WINGFN-MATRIX

Procedure: The following steps are performed by the subroutine in order. FORTRAN variables are indicated.

1. Read the pylon vortex locations
2. Locate the pylon vortex images above the wing, using the wing as a plane of symmetry (YI, ZI, SI, etc.).
3. Compute the wing interference crossflow at the pylon face at control points XP. Compute DW = crossflow due to wing angle of attack. Compute DT = crossflow due to wing thickness.
4. Compute H = matrix of influence coefficients between pylon vortex strengths and control point crossflow values; H(I, J) = crossflow velocity at control point I produced by vortex J of unit strength.
5. Invert H matrix (call EQSOL).
6. Use H^{-1} to compute vortex circulation strengths (GAM due to wing unit angle of attack, GAMC due to wing thickness).

Subroutine START

Purpose: to read wing input geometry.

Called from: AIRCFT

Calls: (none)

Input: wing data

Output: Part of the data is printed out

Comment: Array size input parameters are checked to verify that they do not exceed dimensions.

Subroutine STRIP

Purpose: to compute the perturbation velocities at a field point, produced by the line source strips used to represent the aircraft thickness envelope (other than wing and nose thickness).

Called from: PARTS

Calls: (none)

Input: field point location

Output: velocities (u_T, v_T, w_T)

Comments: Source strips representing the inlet ramp are omitted from the calculation if the field point is behind the inlet lip (by use of index limit N1).

Subroutine THICK

Purpose: to compute the velocity at a field point, produced by one spanwise section of the wing thickness envelope.

Called from: WING

Calls: (none)

Input: field point location; wing spanwise section location

Output: perturbation velocities (u_T, v_T, w_T)

Subroutine VORTEX

Purpose: to compute the velocity at one field point, produced by one horseshoe vortex of unit circulation strength for incompressible flow.

Called from: MATRIX, PYLONFN, WING

Calls: (none)

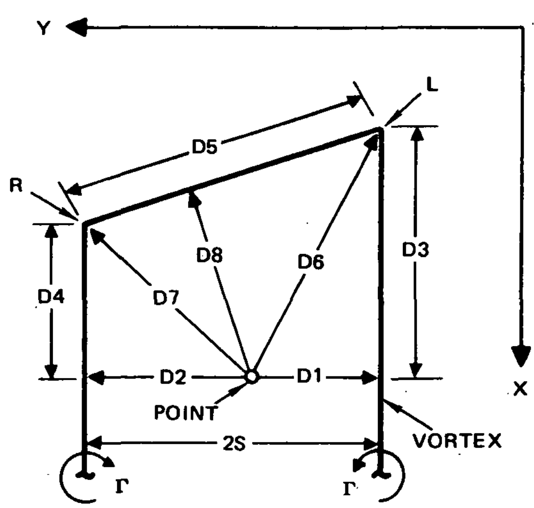
Input: field point location, horseshoe vortex location and geometry

Output: perturbation velocities (u, v, w) per unit circulation parameter $\Gamma/4\pi$

Comments: The method used is to apply the Biot-Savart law to each of the three linear segments of the horseshoe vortex. Sweep and dihedral of the bound vortex is included. The two trailing vortices are assumed to be parallel to the wing X-coordinate axis. An error signal is printed if the field point lies on a vortex filament.

Definitions

XP, Y, Z	:	field point coordinates referenced to the midpoint of the bound vortex as the origin. System is assumed parallel to the wing coordinate system.
S	:	half-distance between trailing vortices
SAL, CAL	:	sine and cosine of the sweep angle of the bound vortex
SPH, CPH	:	sine and cosine of the dihedral angle of the bound vortex
HU, HV, HW	:	perturbation velocities (u, v, w), per unit vortex circulation parameter $\Gamma/4\pi$
D1 through D8	:	distances shown in the sketch below



SKETCH 3
ROUTINE VORTEX

Subroutine WING

Purpose: to compute the perturbation velocities at a field point, induced by the aircraft wing-pylon combination.

Called from: PARTS, PYLONFN, WINGFN

Calls: THICK, INTERP, VORTEX

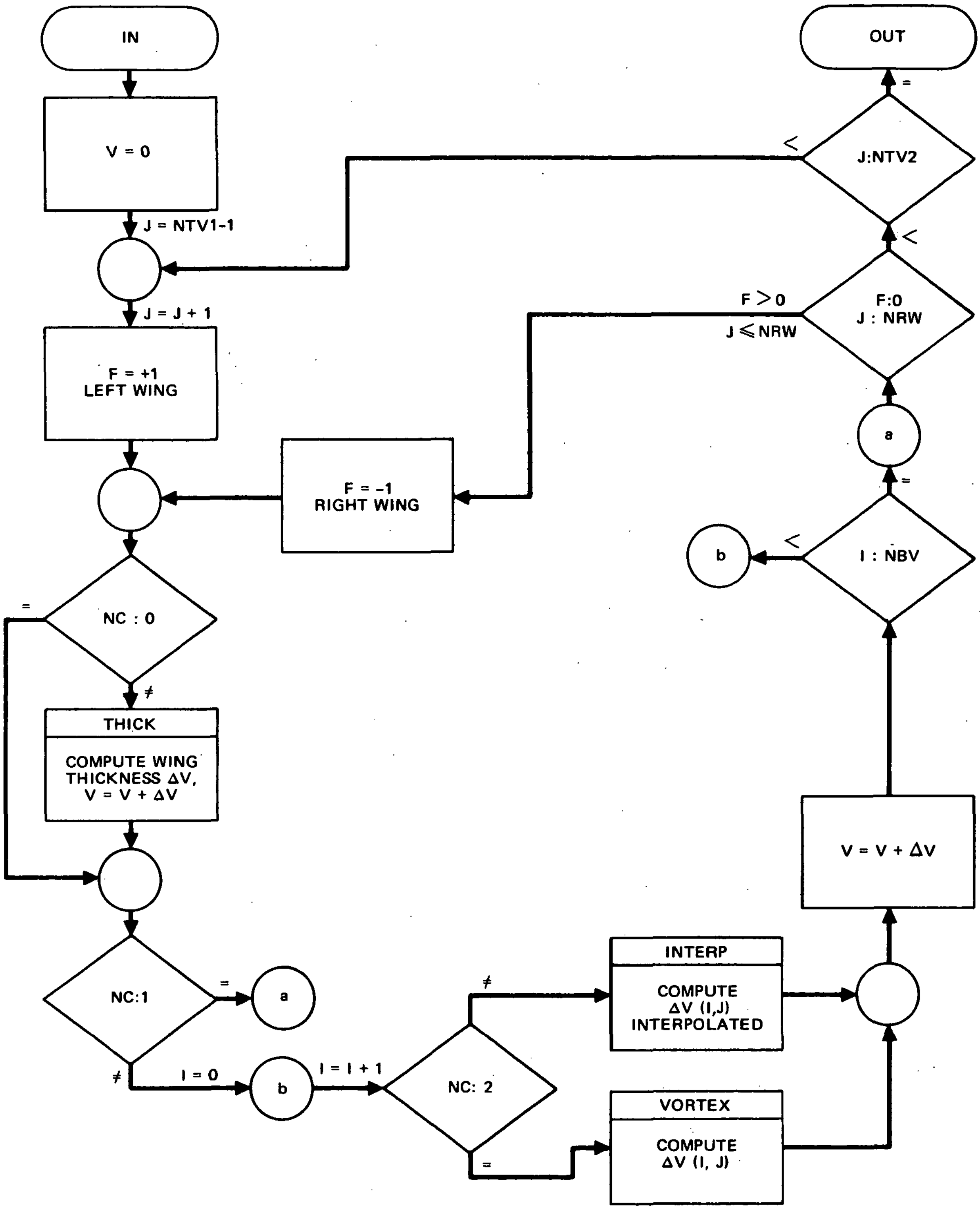
Input: field point location

Output: perturbation velocities

Definitions (for flow diagram)

V	:	perturbation velocities (u, v, w, u_T, v_T, w_T)
J	:	wing vortex spanwise index
F	:	factor used to image right wing with left wing
NC	:	index value supplied by the calling subroutine in order to specify the wing features to be included or omitted in the calculation (NC = 1, 2, or 3)
ΔV	:	increment in perturbation velocities due to each wing element
NTV1	:	lower limit of index J, as defined by subroutine PYLONFN. Using NTV1 = NTV + 1 removes the wing from the computation and allows the wing-pylon interference alone to be calculated.
I	:	wing vortex chordwise index
NRW	:	number of right wing spanwise sections included for flow field calculations

FIGURE 13
ROUTINE WING LOGICAL FLOW (subsonic)



Subroutine WINGFN

Purpose: To compute the circulation strengths of the wing horseshoe vortex lattice; to compute wing lift and wing spanwise lift distribution.

Called from: AIRCFT

Calls: WING, MATRIX, EQSOL

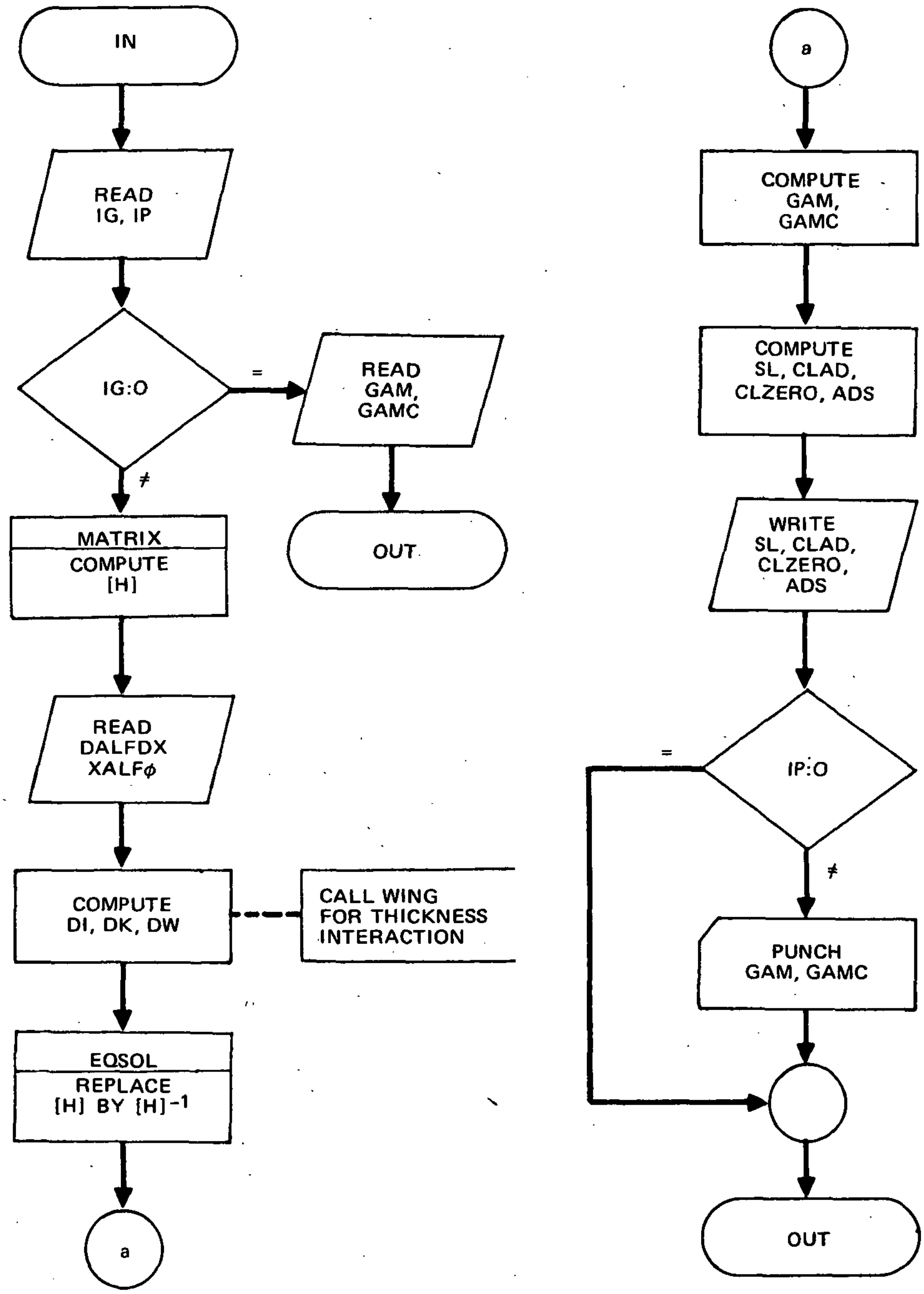
Input: Wing geometry, Mach number

Output: vortex circulation, and lift coefficient

Definitions (for flow diagram)

IG, IP	:	input control parameters
GAM	:	vortex circulation $\Gamma/4\pi$ per unit angle of attack in degrees
GAMC	:	vortex circulation $\Gamma/4\pi$ at zero aircraft angle of attack
H	:	matrix of coefficients relating vortex circulation strengths to the crossflow at the control points, by the equations $[H]\{GAM\} = \{DW\}$ $[H]\{GAMC\} = \{DK\} + \{DI\}$
DW	:	crossflow per unit wing angle of attack
DK	:	crossflow due to wing camber, thickness, and linear axial change of angle of attack
DI	:	crossflow due to wing incidence
DALFDX, XALFO	:	input for linear axial change of angle of attack
SL	:	wing spanwise lift distribution
CLAD	:	wing lift coefficient per degree angle of attack
CLZERO	:	wing lift coefficient at zero aircraft angle of attack
ADS	:	wing area over reference area

FIGURE 14
ROUTINE WINGFN LOGICAL FLOW (subsonic)



Supersonic Group

Subroutine AIRCFT

Purpose: To call the routines required to represent the aircraft wing, pylon, nose, and other thickness surfaces.

Called from: STORLD

Calls: GENRAT, START, WINGFN, DNWASH, PYLONFN, BODFN, STRIPFN

Comment: AIRCFT is an interface routine used for calling other routines. It makes no computations.

Subroutine DIAFRM

Purpose: To compute the source strengths in the Mach boxes on the diaphragm used to represent the crossflow field of the wing and pylon.

Called from: DNWASH, PYLONFN

Calls: (none)

Input: source values on the planform; Mach box indexing defining the planform and the size of diaphragm.

Output: source values on the diaphragm; spanwise pressure distribution on the planform.

Definitions

DW	:	matrix of source values (downwash) known on the planform, and to be calculated on the diaphragm
B	:	BETA
II	:	index limit for I, defining diaphgram size (see sketch 5)
NSS	:	J index at planform tip (sketch 5)
JDI	:	J index at diaphragm tip (sketch 5)
ILE, ITE	:	I index of planform leading edge and trailing edge, arrays versus J
IMODE	:	signal that defines diaphragm size (see sketch 5)
I	:	chordwise index of DW (sketch 4)
J	:	spanwise index of DW (sketch 4)
L	:	up-index for C (sketch 4)
M	:	over-index for C (sketch 4)
LU, MO	:	limit indices for L, M for which values of C(L, M) and CU(L) have been computed in Routine GENRAT.
C, CU	:	aerodynamic influence coefficients (see routine GENRAT)
Planform	:	a planar wing (or pylon) surface
diaphgram	:	surface behind the Mach line coplanar with (and excluding) the planform
UV	:	axial perturbation velocity divided by free stream velocity
SL	:	negative of chordwise sum of UV at each spanwise section
NS	:	number of Mach boxes on the planform at each spanwise section.

Comments: routine DIAFRM computes the value of the parameter "SUM" at each box I, J, defined as

$$SUM(I, J) = \sum_{\substack{MACH \\ FORECONE}} \left[DW(I', J') * C(L, M) + DW(I', J) * CU(L) \right]$$

where (I', J') are all Mach boxes in the Mach forecone of box (I, J), and (L, M) are the corresponding index values of the aerodynamic influence coefficients which relate box (I', J') to box (I, J) (see sketch 1 for indexing convention).

If box (I, J) is on the diaphragm, its value of downwash, DW, is computed by the equation for zero axial perturbation velocity:

$$DW\ (I, J) = SUM$$

If the box (I, J) is on the planform, its value DW is known at call time, and therefore the axial perturbation velocity may be computed by the equation:

$$UV = \frac{SUM - DW\ (I, J)}{B}$$

By calculating the value of DW (I, J) using the I, J order explained in Reference 1, the values of DW (I', J') used in the computation for SUM are always known.

Computation of the parameter SUM is done in 4 parts, corresponding to the 4 numbered areas marked by dashed lines in sketch 2. The equations used to compute SUM in each of these 4 areas are:

$$SUM_1 = \sum_{L=1}^{I-1} \sum_{M=1}^{\frac{I-L+1}{2}} C(L, M + J - 1) \times DW(I - L + 2 - 2M, M)$$

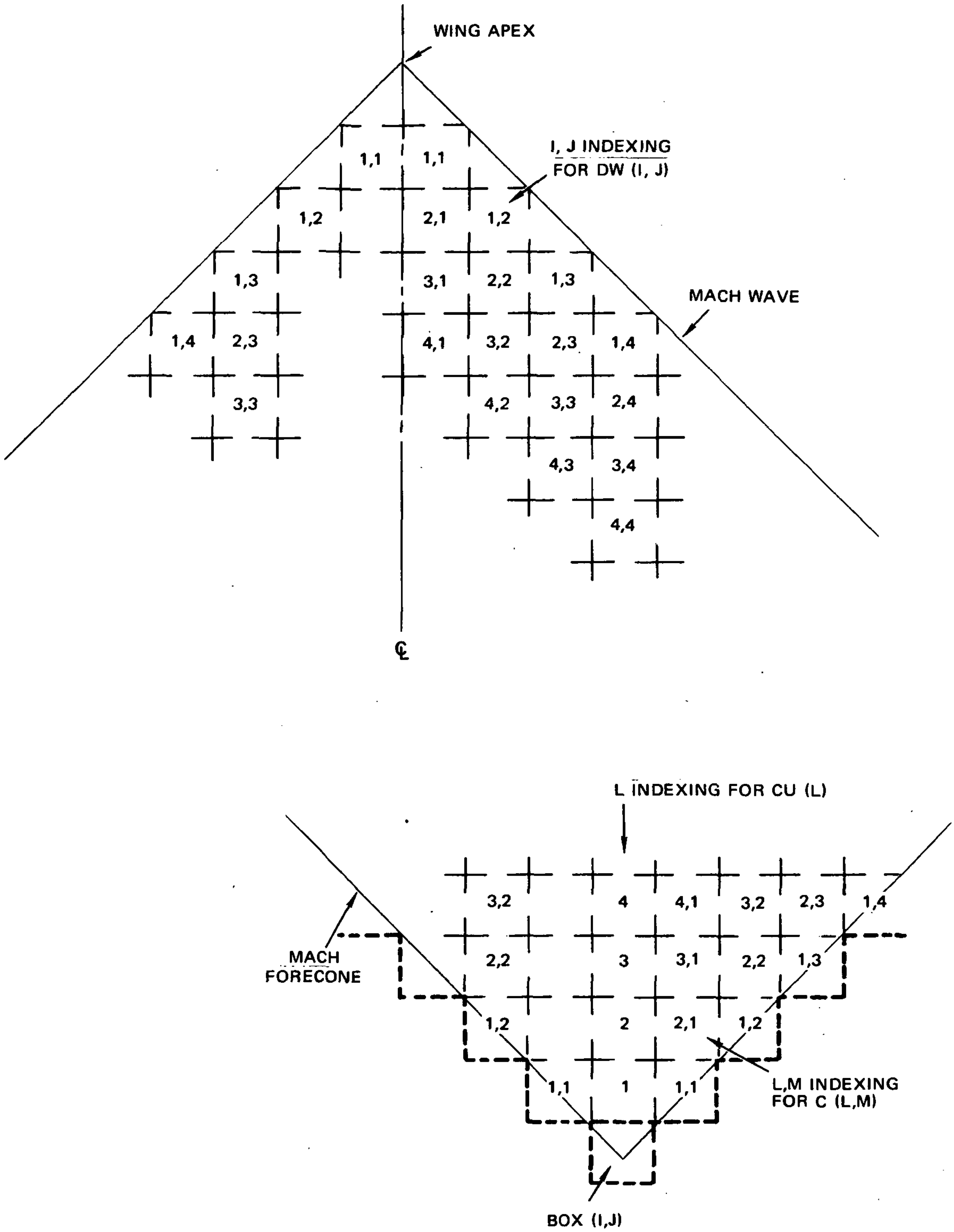
$$SUM_2 = \sum_{L=1}^{I-2} \sum_{M=1}^{(I-L)/2} C(L, M) \times DW(I - L + 1 - 2M, J + M)$$

$$SUM_3 = \sum_{L=1}^{I} \sum_{M=1}^{J-1} C(L, M) \times DW(I - L + 1, J - M)$$

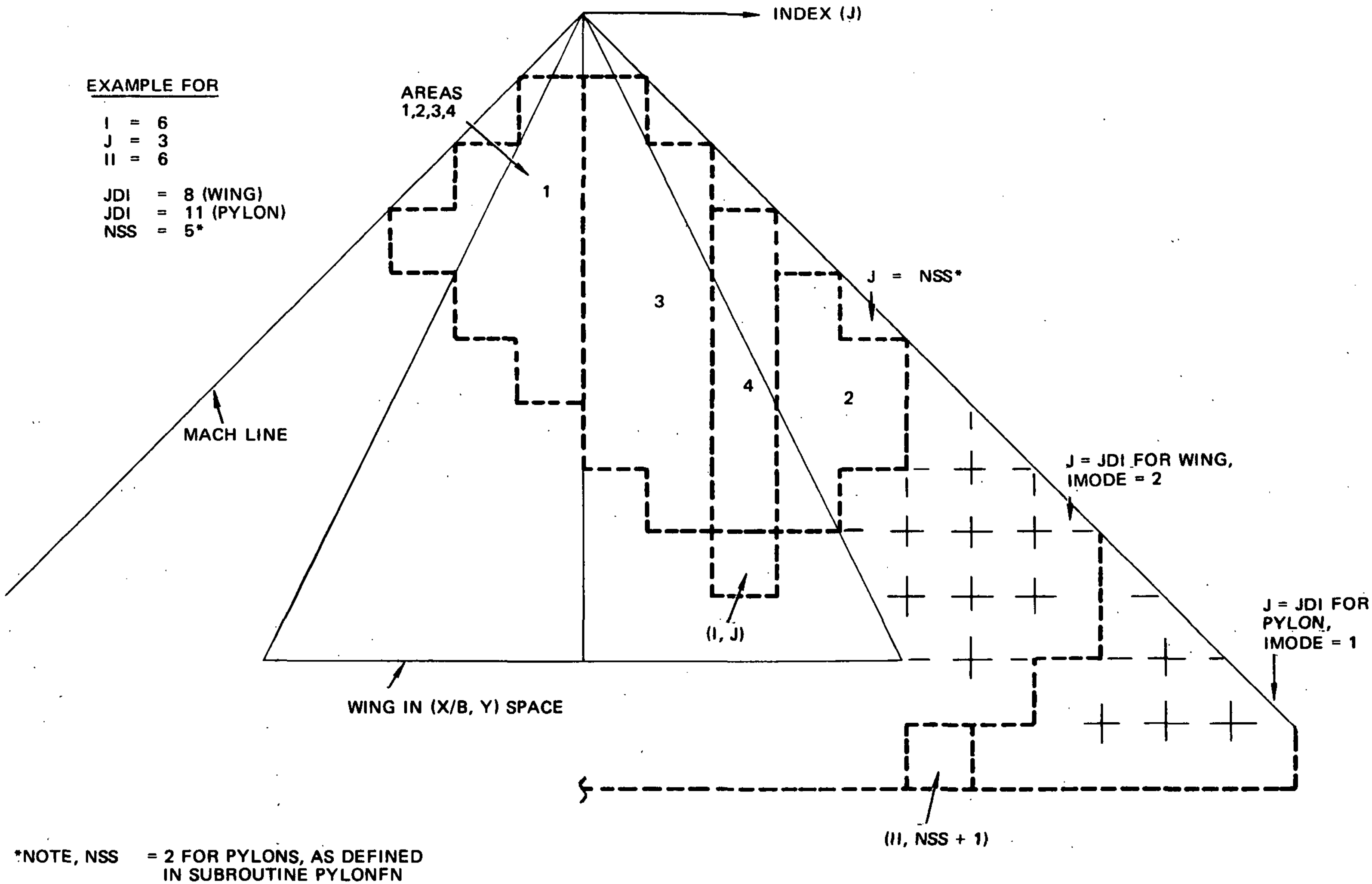
$$SUM_4 = \sum_{L=1}^{I-1} CU(L) \times DW(I - L, J)$$

and $SUM = SUM_1 + SUM_2 + SUM_3 + SUM_4$

The computation of SUM in the first 3 areas is accomplished by multiple indexing of one double-DO loop in routine DIAFRM. The values of the index parameters used to accomplish this are listed in Table II. The area numbers 1 - 4 are in the order of computation.



SKETCH 4
ROUTINE DIAFRM



SKETCH 5
ROUTINE DIAFRM

TABLE II

ROUTINE DIAFRM

INDEX VALUES FOR COMPUTATION OF "SUM"

Area Number*	1	2	3
N	0	1	1
K1	0	0	1
K2	1	1	0
K3	1	1	-1
K4	J-1	0	0

*Corresponds to Numbered areas on Sketch 5.

Subroutine DIFIN

Purpose: To compute the geometric functions GX, GY, GZ, relating field point location to source box location, and which are required to calculate the velocities at the field point induced by the source box.

Called from: WING, PYLON, THICK

Calls: (none)

Input: Field point location; source box location; S; BETA

Output: GX, GY, GZ, SIG

Comment: Mathematical development of the functions GX, GY, GZ is contained in Reference 2. Routine DIFIN relates only two corners of the source box to the field point each time it is called. Thus, X1, Y1, Z1 is the location of the leading edge or the trailing edge of the source box. The calling routine calls DIFIN once for the leading edge and once for the trailing edge of the source box, then uses the increment in GX, GY, GZ to compute the induced velocities.

Definitions

X, Y, Z : field point location
X1, Y1, Z1: source strip location
S : half-width of source strip
GX, GY, GZ: geometric functions used in computing u, v, w, respectively
SIG : signal which, when non-zero, indicates to the calling routine that the field point is out of the Mach cone influence of the source strip

Subroutine DNWASH (downwash)

Purpose: To compute the source strength distribution over the wing leading edge diaphragm and tip diaphragm; to read/write/punch same; to compute wing lift coefficient

Called from: AIRCFT

Calls: DIAFRM, LIFT

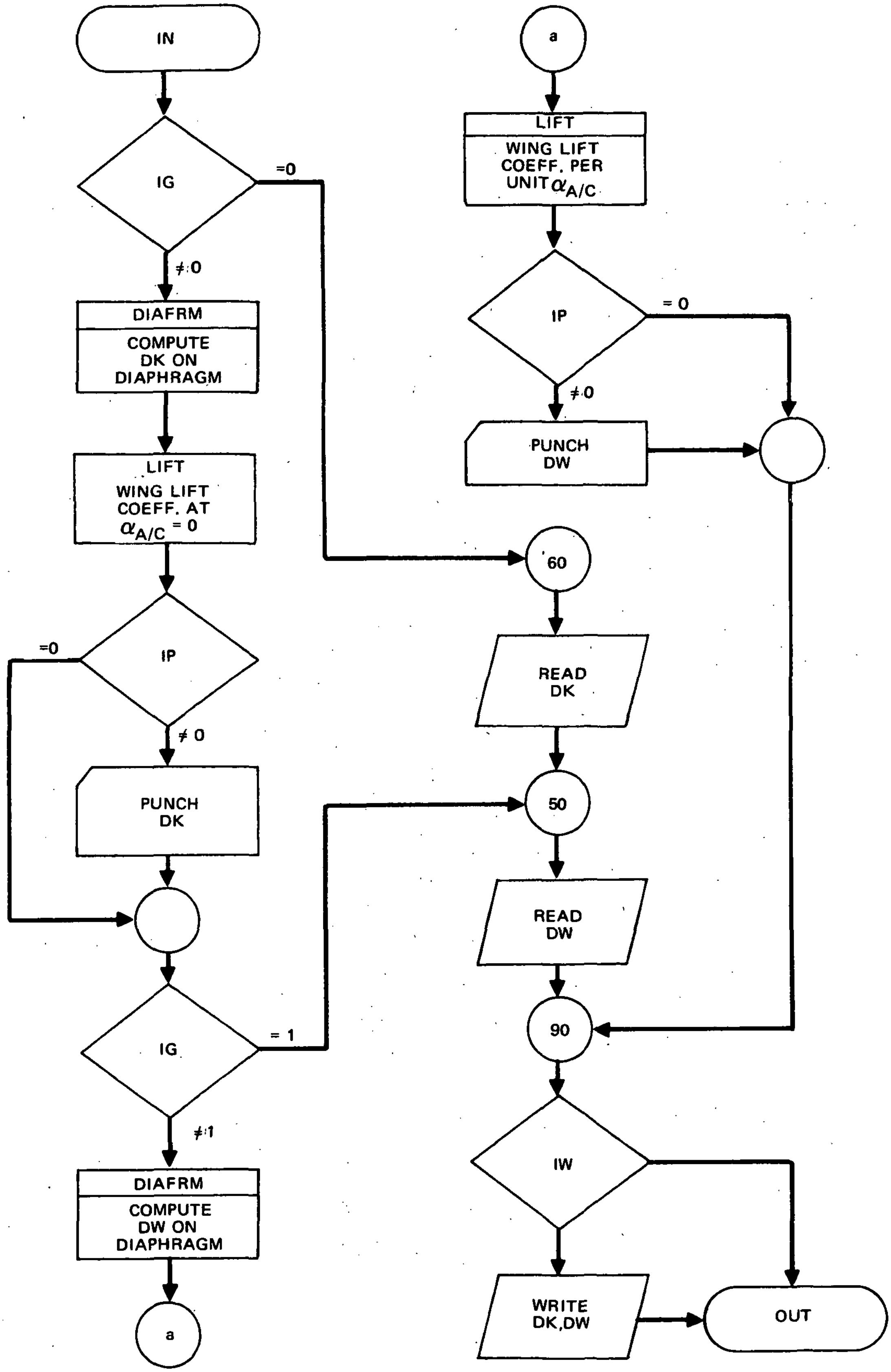
Input: Mach box source strength and locations on the wing

Output: Source strengths on the diaphragm

Definitions (for flowchart)

IG, IP, IW	:	input control numbers for generate-punch-write DK and DW
DK	:	diaphragm Mach box source strengths due to wing camber, twist, linear axial change of crossflow
DW	:	diaphragm source strengths due to unit aircraft angle of attack
$\alpha_{A/C}$	:	aircraft angle of attack

FIGURE 15
ROUTINE DNWASH LOGICAL FLOW



Subroutine GENRAT

Purpose: To generate the Zartarian constants, the Mach box influence coefficients used in routine DIAFRM for computing the Mach box source strengths on the wing and pylon diaphragms.

Called from: AIRCFT

Calls: (none)

Input: Number of rows and columns of coefficients to be generated (LU and MO read in).

Subroutine LIFT

Purpose: To compute wing lift coefficient.

Called from: DNWASH

Calls: (none)

Input: Spanwise pressure distribution

Output: Spanwise lift distribution and total lift coefficient

<u>Definitions</u>

NSS	:	number of spanwise wing sections
SL	:	axial perturbation velocity summed in chordwise direction at each spanwise section (negative of)
NS	:	number of Mach boxes on the wing surface at each spanwise section
CLAD	:	lift coefficient referenced to wing surface area (Mach box approximation)
CL	:	sectional lift coefficient referenced to local chord at each spanwise section

Subroutine NOSE

Purpose: To compute the field point velocity produced by the nose

Called from: PARTS

Calls: (none)

Input: Field point location; strengths and locations of line sources and doublets representing the nose

Output: Velocities u, v, w, u_T, v_T, w_T

Definitions

UA, VA, WA	:	velocities due to axial flow
UC, VC, WC	:	velocities due to crossflow
XP, YP, ZP	;	field point location in nose coordinates, nose apex as origin and X-axis the axis of symmetry
N	:	number of line singularities
B	:	$\sqrt{M^2 - 1}$
XBL	:	dummy variable, for compatibility with subsonic program
XU	:	line singularity apex locations
SNA, SNC	:	line source and doublet strength parameters

Subroutine NOSEFN

Purpose: To compute the strengths of the line sources and doublets used to represent flow field about the nose

Called from: BODFN

Calls: (none)

Input: Nose geometry

Output: Source and doublet strengths and locations

Comments: Input points which do not fall inside the Mach cone of the apex are omitted from the calculation. An error signal results if the nose points are not in order of ascending axial location.

Subroutine PARTS

Purpose: To call the routines used to compute the velocities produced by the various aircraft components; to sum these component effects.

Called from: DISTURB

Calls: WING, PYLON, STRIP, NOSE, MATAD

Input: Field point location in wing coordinates and in nose coordinates.

Output: Field point perturbation velocities u, v, w due to aircraft angle of attack, and u_T, v_T, w_T due to aircraft thickness.

Subroutine PRINTX

Purpose: To print out wing input parameters and wing computed parameters.

Called from: AIRCFT

Calls: (none)

Subroutine PYLON

Purpose: To compute the field point velocity produced by the pylon

Called from: PARTS

Calls: DIFIN

Input: Field point location

Output: Velocities (u, v, w, u_T, v_T, w_T)

Comment: The calculation procedure for routine PYLON is the same as routine WING and will not be repeated here. The only difference is that routine PYLON removes the field point from the tip diaphragm if necessary, then interpolates the resulting u, w, u_T, w_T velocities toward zero on the diaphragm. This is done to avoid numerical inaccuracies of the Mach box method.

Subroutine PYLONFN

Purpose: To compute the Mach box source values used to represent the pylon in the presence of wing crossflow.

Called from: AIRCFT

Calls: WING, DIAFRM

Input: Pylon geometry (read in); wing crossflow

Output: Pylon Mach box locations and strengths

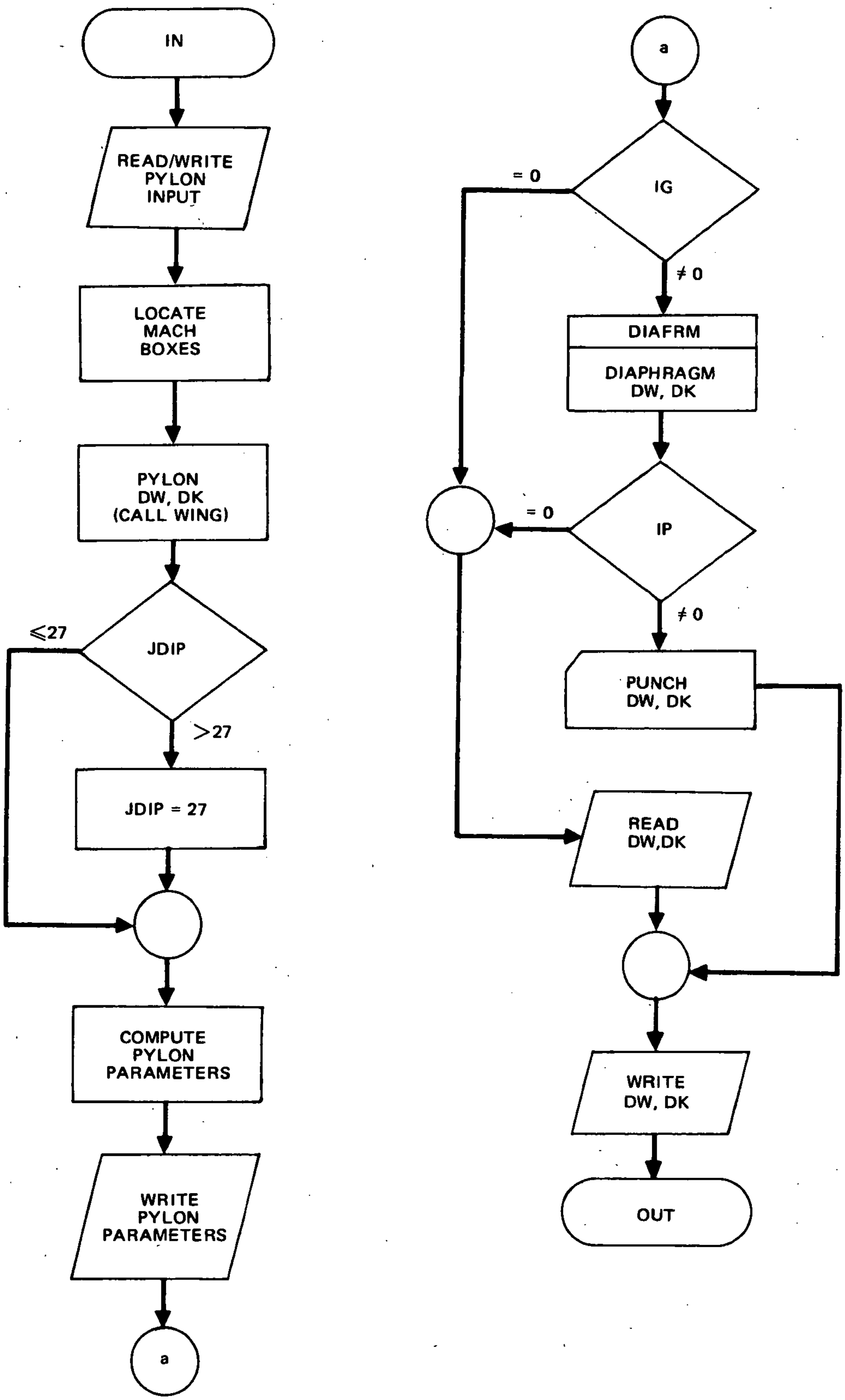
Comments: The organization of PYLONFN and the notation are very similar to that of the routines WINGFN - DNWASH for computing wing source values.

<u>Definitions</u> (for flowchart)

DW	:	matrix of pylon Mach box source strengths proportional to wing angle of attack (=DWP)
DK	:	matrix of pylon Mach box source strengths proportional to wing camber, twist, and thickness (=DKP)*
JDIP	:	number of spanwise divisions of Mach boxes used to represent the pylon and its tip diaphragm
IG, IP	:	input control variables for generating and punching the DW and DK matrices

*The indexing for matrices DW and DK is that required by routine DIAFRM. The DW, DK values are then transferred to the DWP, DKP matrices, which have indexing for more efficient use of space.

FIGURE 16
ROUTINE PYLONFN LOGICAL FLOW (supersonic)



Subroutine START

Purpose: To read wing geometric inputs

Called from: AIRCFT

Calls: (none)

Input: Wing data

Output: Dimensions are checked; some variables are printed

Subroutine STRIP

Purpose: To compute the field point velocity produced by the source strips used to represent the aircraft thickness envelope (other than wing and nose).

Called from: PARTS

Calls: SWP

Input: Field point location

Output: Velocities (u_T, v_T, w_T)

Comment: Strips representing the inlet ramp are excluded from the calculation of the field point inside the Mach cone of the inlet lip (using index N1). If the field point lies on the body surface of the store, STRIP shifts the field point X-coordinate to be on the Mach cone intersecting the store section midpoint and with apex being on the nearest tip edge of the strip being computed (by use of control index ISW). This is done to avoid large erroneous body pressure loading predictions as discussed in Reference 2 (Part II).

Subroutine SWP (sweep)

Purpose: To compute the flow velocities at a field point induced by a planar source strip of parallelogram planform.

Called from: STRIP

Calls: (none)

Input: Field point location ; source strip location, geometry, and strength

Output: Velocities (u_T, v_T, w_T)

Comment: The mathematics of computing the velocity field are taken from Woodward (Reference 12 of Reference 2 (Part II)). The source strip is here allowed to be swept, as opposed to subroutine DIFIN, where only rectangular source strips are considered. The strip sweep may be either greater or less than the Mach wave sweep. The case of the strip sweep equal to the Mach wave sweep is not considered, and is excluded by subroutine STRIPFN. The strip leading and trailing edges have the same sweep, and the tip edges are parallel to the X-coordinate direction.

Definitions

F, G	:	unit values changing sign alternately as each of the four corners of the strip is considered.
XP, YP, RP, DP:		corresponds to the notation used in Reference 12 of Reference 2 (Part II), for the transformed coordinates X', Y', r', d'.
DX, DY, DZ, R, D:		corresponds to the notation used in Reference 12 of Reference 2 (Part II), for the geometric distances X, Y, r, d.

Subroutine THICK

Purpose: To compute the field point velocity produced by the distribution of wing thickness located at one spanwise section.

Called from: WING

Calls: DIFIN

Input: Field point location; index of wing section used; velocity functions GX, GY, GZ at the wing leading edge.

Output: Velocities (u_T, v_T, w_T)

Comments: Routine THICK computes velocity due to sources on the wing using a procedure similar to that used in routine WING for computing velocity due to sources on the diaphragm of the wing.

Definitions

X, Y, Z : field point location
X1, YSJ : X-Y location of wing section leading edge
J : wing section spanwise index
XT, YYSS : geometric parameters which determine if and where the Mach forecone of the field point intersects the wing section
TH2, DW2 : incremental velocity parameters used depending on tests of XT, YYSS
UT, VT, WT: field point velocities
GX2, GY2, GZ2: geometric velocity functions relating field point to wing section leading edge (computed in DIFIN)

Subroutine WING

Purpose: To compute the field point velocity produced by the wing.

Called from: PARTS, PYLONFN

Calls: DIFIN, THICK

Input: Field point location

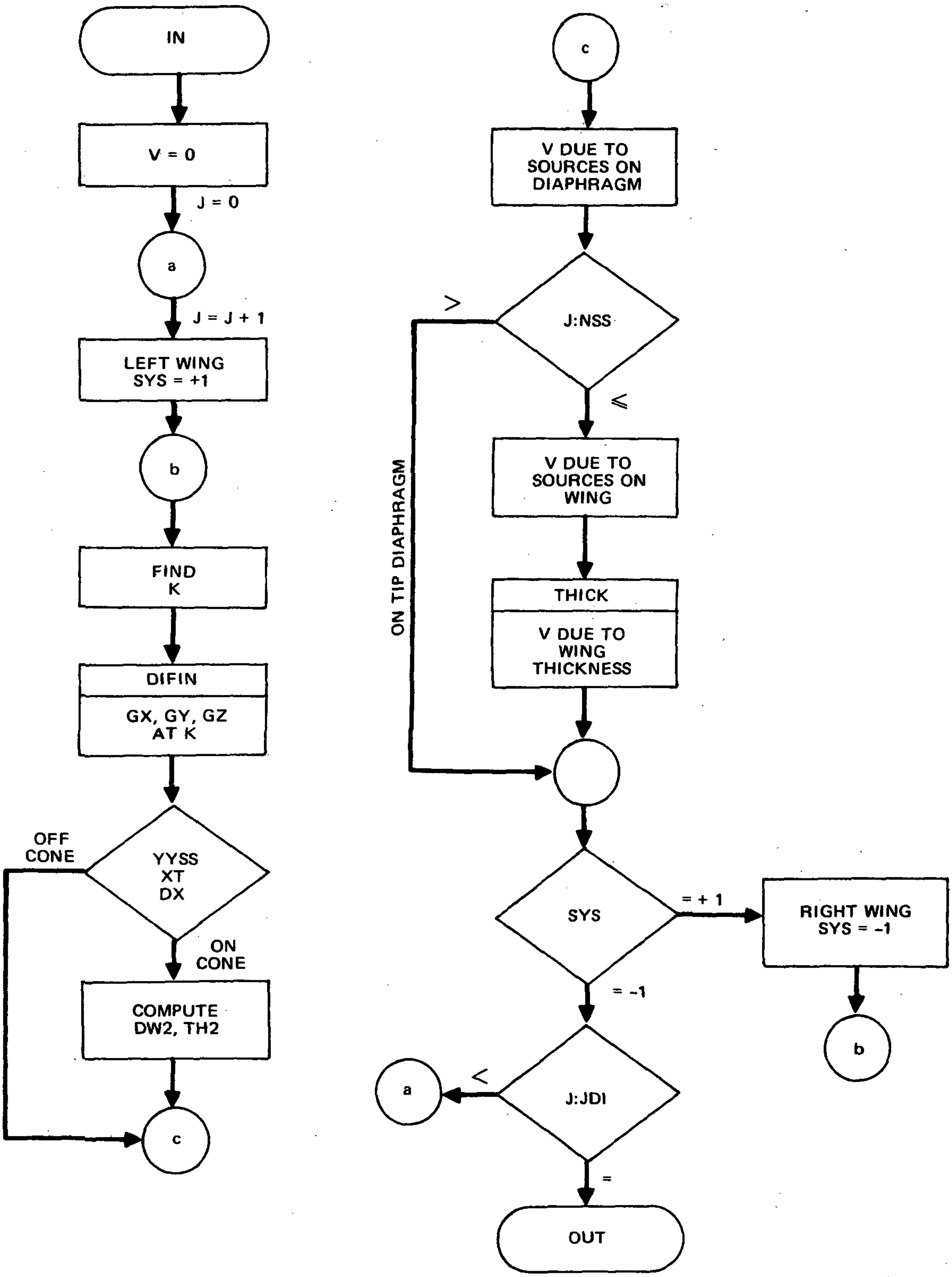
Output: Velocities (u, v, w), (u_T, v_T, w_T)

Comment: The wing is represented by a rectangular grid of Mach boxes, and routine WING sums the influence of these to compute velocity. Mach boxes located ahead of the wing and off the wing tip form a diaphragm which accounts for the flow field due to angle of attack. The field point is assumed not to be within the zone of influence of the wing wake. Wing symmetry about Y = 0 is assumed. See Reference 2 for a geometric and mathematical explanation.

Definitions (for flow chart)

V	:	velocities u, v, w, u_T, v_T, w_T
SYS	:	sign factor for coordinate Y, determining left or right wing
J	:	Mach box spanwise index
K	:	chordwise index of first non-zero source strength
GX, GY, GZ	:	geometric factors from corners of Mach box to field point, proportional to induced velocities
YSS, XT, DX	:	parameters which determine if the Mach forcone of the field point intersects the Mach box
DW2, TH2	:	additional velocity components at the field point if the Mach box lies on the Mach forcone of the field point
NSS	:	maximum value of J on wing
JDI	:	maximum value of J on tip diaphragm

FIGURE 17
ROUTINE WING LOGICAL FLOW (supersonic)



Subroutine WINGFN

Purpose: To compute the Mach box source representation on the wing.

Called from: AIRCFT

Calls: (none)

Input: Wing geometry

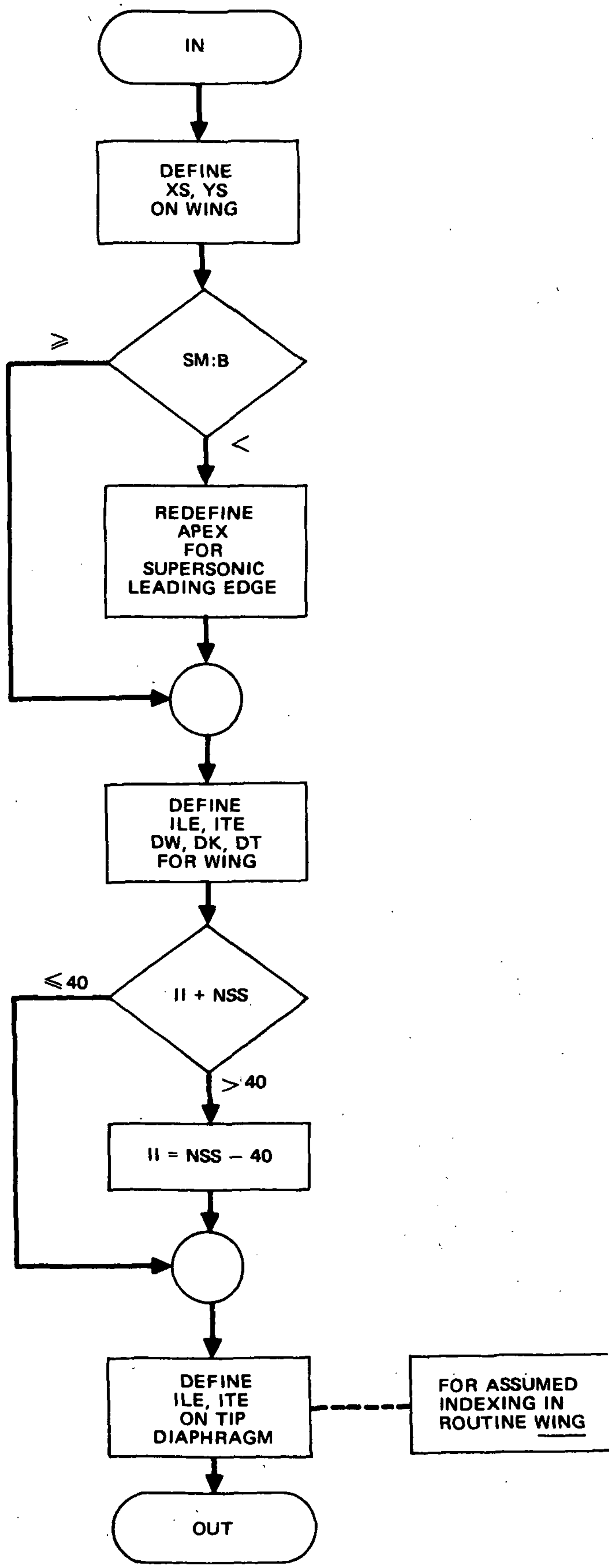
Output: Mach box source strengths on wing; coordinate locations and indexing for Mach box grid on wing and on diaphragm.

Comment: Note from the list of definitions that wing camber and twist are included in both matrices DK and DT. This is done to save computing time when these values are used in routine WING. Thus, DT uses fewer boxes (not Mach boxes) and accounts for all wing geometric properties; it is used on the wing. This allows DK to be used only on the diaphragm.

Definitions (for flowchart)

XS, YS	: X-Y locations of Mach box spanwise sections at leading edge of wing
SM	: tangent of leading edge sweep angle
B	: Beta
APEX	: wing diaphragm Mach forecone apex, X location at Y = 0
ILE, ITE	: chordwise index values of Mach boxes on leading edge and on trailing edge of wing at each spanwise section
DW	: Mach box source strengths due to angle of attack
DK	: source strengths due to camber, twist, and/or linear axial variation of crossflow
DT	: source strengths due to thickness, camber, and twist
II	: Mach box chordwise index at the first spanwise section of the wing tip (see routine DIAFRM)
NSS	: input, number of spanwise sections

FIGURE 18
ROUTINE WINGFN LOGICAL FLOW (supersonic)



VARIABLE DEFINITIONS

The program makes extensive use of labeled COMMON statements. The variables contained in these COMMON statements are defined in this section. These definitions are intended as an aid to the understanding of the FORTRAN coding. For this purpose the definitions are concise. Additional definitions pertinent to each subroutine are contained in the previous section. A more detailed list of definitions for the input and output variables is presented in Reference 1.

As variables are encountered in the coding, it is sometimes desired to know where they originate. This information for the variables in the COMMON lists is presented in Table III.

TABLE III

COMMON VARIABLE PLACE OF ORIGIN

COMMON NAME	ROUTINE WHERE VARIABLES ORIGINATE
- DUAL SUBSONIC-SUPERSONIC PROGRAM -	
BLANK	DISTURB, CRSFLW
C5	STORLD
C10	STORLD
C11	STORE
C12, C13	BODFN, NOSEFN
C14	STRIPFN
C17	STORE, DISTURB
C21	STORE
- SUBSONIC PROGRAM -	
C1	START
C2	COMPUT, WINGFN
C3	START
C4	START, PYLONFN
C7	START
C18	START
C19	COMPUT
- SUPERSONIC PROGRAM -	
C1	START, WINGFN
C2	GENRAT
C4	START, WINGFN
C8	WINGFN, DNWASH, START
C15	PYLONFN

Dual Group

blank Common - velocity field and store crossflow parameters

H	- used in matrix operations
U (I, J, K)	- interference velocity field I for u, v, w, u_T, v_T, w_T J for Y-Z location K for X location
ALY, ALZ	- Y, Z crossflow at body
BY, BZ	- Y, Z buoyancy factors
VS, WS	- Y, Z crossflow at fin root
VD, WD	- spanwise rate of change of crossflow at fin
ARS	- fin roll crossflow
ARD	- spanwise rate of change of ARS
ALYD, ALZD	- X derivative of ALY, ALZ
XC	- X location of crossflow field point

Common C5

RAD	- 1/57.3
PI	- $\pi = 3.14159$
BETA	- Mach function
BM	- Mach number
SUB	- BETA

Common C10 - store traverse parameters

XM, YM, ZM	- reference point location
XT	- traverse length
XLFMW	- store incidence relative to wing

Common C11 - store geometry

XCG	- store reference CG distance from nose
DIA	- reference diameter
NMS	- number of store axial sections
XMS	- NMS
DELX	- section length
XSTART	- CG X-location at start of traverse
FTM	- fin tip maximum span ÷ body radius

Common C12 - nose parameters

XB	- control point location
RB	- nose radius at XB
D	- nose slope at XB
SNA	- source strength
SNC	- doublet strength
XU	- line singularity apex

Common C13 - nose parameters

NBP	- number of body (control) points
XNOSE, YNOSE, ZNOSE	- apex location
ALFNW	- nose angle relative to wing
SNW, CNW	- sine and cosine of ALFNW
SUP	- BETA
SUB2	- BETA squared
XBL	- body length

Common C14 - thickness strip parameters

XST, YST, ZST	- X, Y, Z location
SST	- semi-span
NST	- number of strips
NIN	- number of inlet ramp strips
XLIP, YLIP, ZLIP	- inlet lip location
SPHST, CPHST	- sine and cosine of dihedral angle
THST	- slope of thickness surface
DXST	- chord
SALST, CALST	- sine and cosine of sweep angle
GAST	- parameter combining DXST, THST

Common C17 - store location parameters

SETY, SETZ	- trig functions of roll angle, defined in STORE, used in DISTURD-PARTS to locate fins

SRA, CRA	- sine and cosine of ROLL
ROLL	- store fin roll angle (+ clockwise)
NK	- number of axial sections in the traverse line

<u>Common C21</u> - store section properties

CNF	- fin force coefficient in constant crossflow
CNPF	- fin force coefficient in crossflow changing spanwise linearly
FCP	- fin spanwise CP ÷ ref. diameter
CNLA	- body force coefficient per unit length in constant crossflow
RS	- local body radius ÷ ref. radius
FT	- local fin span ÷ ref. radius
IDW	- index of sections affected by downwash of the wing-tail type
EP (I, J)	- downwash at section I ÷ crossflow at section J
CNLD	- section force coefficient per unit axial rate of change of crossflow
XBAR	- section moment arm to ref. CG ÷ ref. diameter

Subsonic Group

Common C1 - wing spanwise section parameters and chordwise geometry. All are input but SL.

YV	- section Y
XLE	- section X leading edge
C	- chord length
SL	- section lift
Z	- section Z
PH	- dihedral angle
SV	- semi-span
SWP	- sweep factor
CS	- chord divisions
DZDX	- mean line slopes (camber)

Common C2 - wing vortex properties

XV	- vortex X location
GAM	- circulation per degree α
GAMC	- circulation at zero α

Common C3 - wing parameters (input)

AR	- aspect ratio
BW	- wing span
CR	- root chord
ALAMDA	- quarter chord sweep angle
TRATIO	- taper ratio

Common C4 - index limits for wing and pylon. All are input but NTV1

For Wing

NTV	- number of trailing vortices
NBV	- number of bound vortices
NCP	- number of control points
XTV	- NTV
XBV	- NBV
NRW	- number of right wing trailing vortices
NTV1	- NTV + 1, or 1

For Pylon

NJI	- number of wing vortices to be interpolated
JI	- J index of wing vortices to be interpolated
NPL	- number = 1
NVP	- NPV
NPV	- number of pylon (trailing) vortices
NTV2	- NTV + NPV + NPV
IWING	- input control parameter

Common C7 - wing section input parameters

TTC	- thickness scale factor
ALFV	- section incidence angle
XCAM	- camber scale factor

Common C18 - wing thickness envelope parameters

THU	- thickness envelope slopes
NTC	- number of thickness sections per chord
XTC	- NTC

Common C19 - wing and pylon vortex and source trig functions

SSA, SCA	- sine and cosine of source strip sweep angle
SDA, CDA	- sine and cosine of source strip dihedral angle
SVA, CVA	- sine and cosine of wing vortex sweep angle

Blank Common - pylon horseshoe vortex image parameters (multi-use of space)

YI	- Y location
ZI	- Z location
SI	- semi-span
PHI	- dihedral angle
SDI	- sine of dihedral angle
CDI	- cosine of dihedral angle

Supersonic Group

Common C1 - wing geometry

XS	- section leading edge X-location
YS	- section Y-location
ZW	- wing Z-location
CS	- section chord length

Common C2 - Mach box aerodynamic influence coefficients (AIC's)

CU	- influence coefficients from boxes at same axial section, forward of box being influenced.
C	- influence coefficients from boxes to either side and forward of box being influenced
LU, MO	- limit index of influencing box, L-up and M-over, from box being influenced

Common C4 - wing parameters

NSS	- number of spanwise sections
NSC	- number of sections per chord
XSS	- NSS
XSC	- NSC
NSS2	- not used
JDI	- number of sections, including tip diaphragm
II	- Mach box chordwise limit index at section NSS + 1
XMAX	- Mach box maximum X location
APEX	- X location of wing apex
SM	- tangent of leading edge sweep angle
S	- section semi-span
BS	- 2 x BETA x S

Common C8 - wing matrix of source strengths

DW	- Mach box source strengths per degree angle of attack
DK	- Mach box source strengths due to camber, twist, linear axial crossflow variation

DT - source strengths due to camber, twist, and thickness (not Mach Box)
CF - chord fractional parts
ILE - section leading edge index

Common C15 - pylon parameters

DWP - Mach Box source strengths per degree aircraft angle of attack
DKP - Mach Box source strength due to wing camber, twist, thickness
ILE - section leading edge index
ITE - section trailing edge index
IPS - chordwise index for printing, punching, writing of DWP, DKP
XS - section leading edge X-location
ZS - section Z-location
CS - section chord length
YP - pylon Y-location
Z1 - pylon upper Z location
APEXP - apex X location
SP - section semi-spn
BSP - 2 x BETA · SP
IIP - maximum chordwise index at section NSSP + 1
JDIP - maximum section index at diaphragm tip
NSSP - number of sections in pylon span (= 2)

Blank Common - wing section parameters (multi-use of space)

TTC - section thickness scale factor
ALFS - section incidence angle
THU - chordwise thickness distribution
DZDX - mean line slopes for camber
XCAM - camber scale factor
ITE - section trailing edge index
SL - proportional to section lift
NS - number of Mach Boxes per section

APPENDIX A: SHOCK PROGRAM

Program SHOCK is separate from program STORLD. Its purpose is to compute the locations of the aircraft shock waves in supersonic flow. This information is outputted in the form of the parameter DSHIFT, defined as the distance of the shock wave ahead of the forward Mach wave at the store traverse location. Values of DSHIFT are outputted for the aircraft nose, inlet, and pylons. These values are used as input to program STORLD in supersonic flow.

Program Organization

Figure A-1 presents the overall logical flow of program SHOCK. This is a flowchart of the main program. Provision for run stacking of store location, aircraft geometry, and Mach number has been included.

Figure A-2 is a communication diagram for program SHOCK. This shows the calling relationships between subroutines. General calling sequence is from left to right. The purpose of each of these subroutines is presented in the next section.

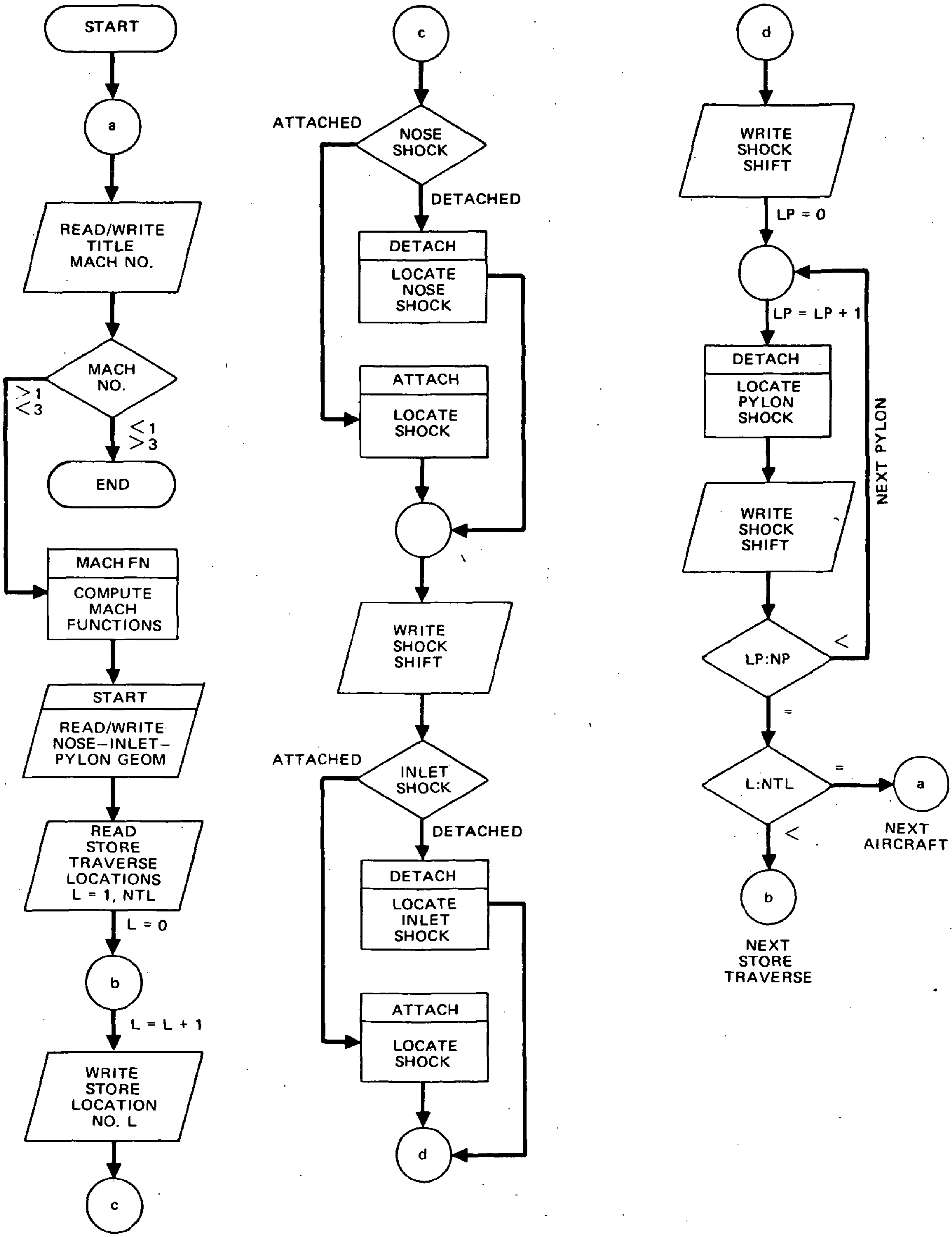
Subroutine Explanations

Following is a list of the routines used with Program SHOCK.

1. ATTACH
2. CCALC
3. DETACH
4. MACHFN
5. PERCPT
6. SLOPE
7. START
8. TABLEA (function)

Each routine will now be explained, with the exception of routine SLOPE, which is identical to that explained in the main text of this manual.

FIGURE A-1
PROGRAM SHOCK LOGICAL FLOW



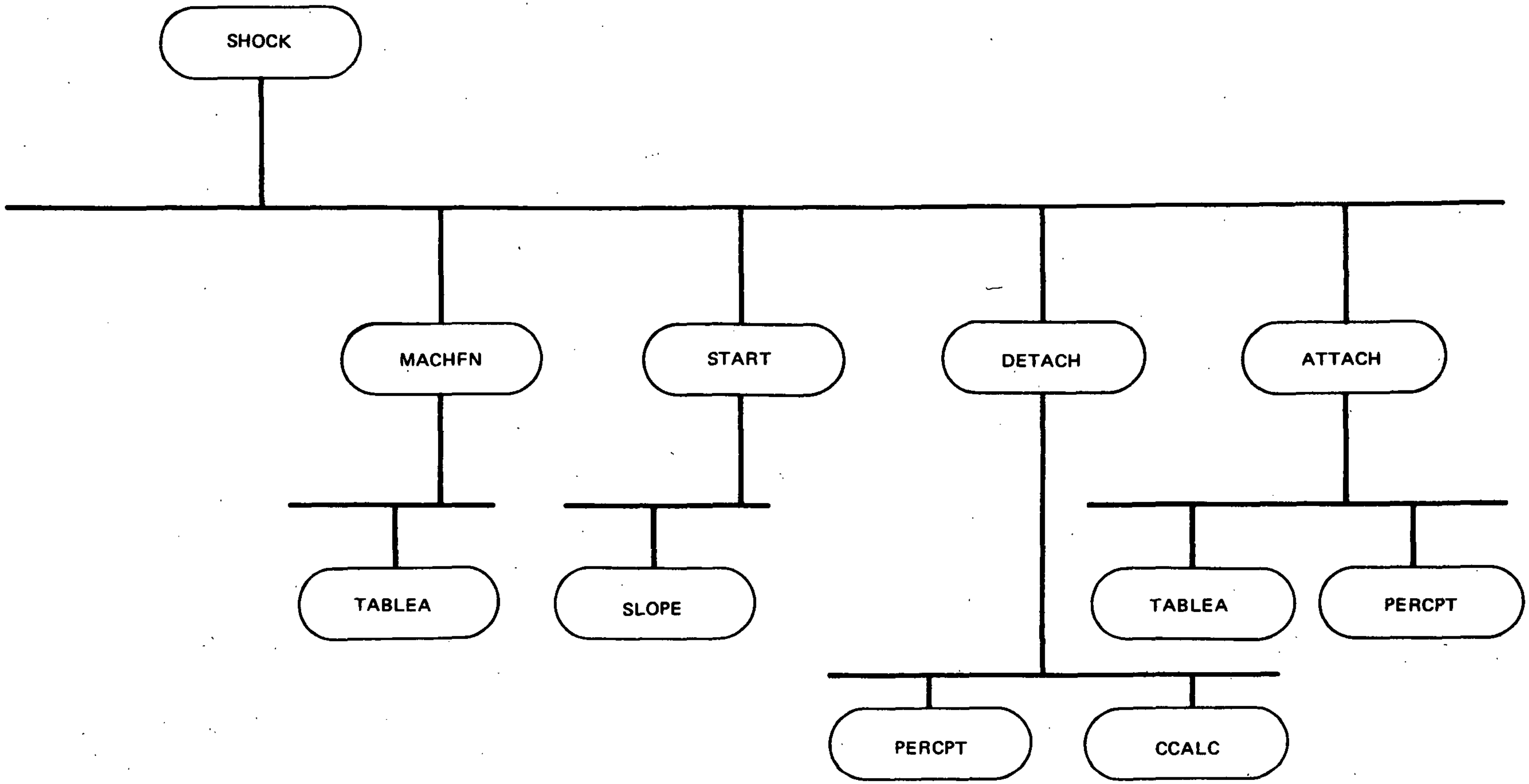


FIGURE A-2
PROGRAM SHOCK COMMUNICATION NETWORK

Subroutine ATTACH

Purpose: To compute the shock wave distance ahead of the Mach wave at the store traverse line for the case of the shock attached to the body.

Called from: SHOCK

Calls: TABLEA, PERCPT

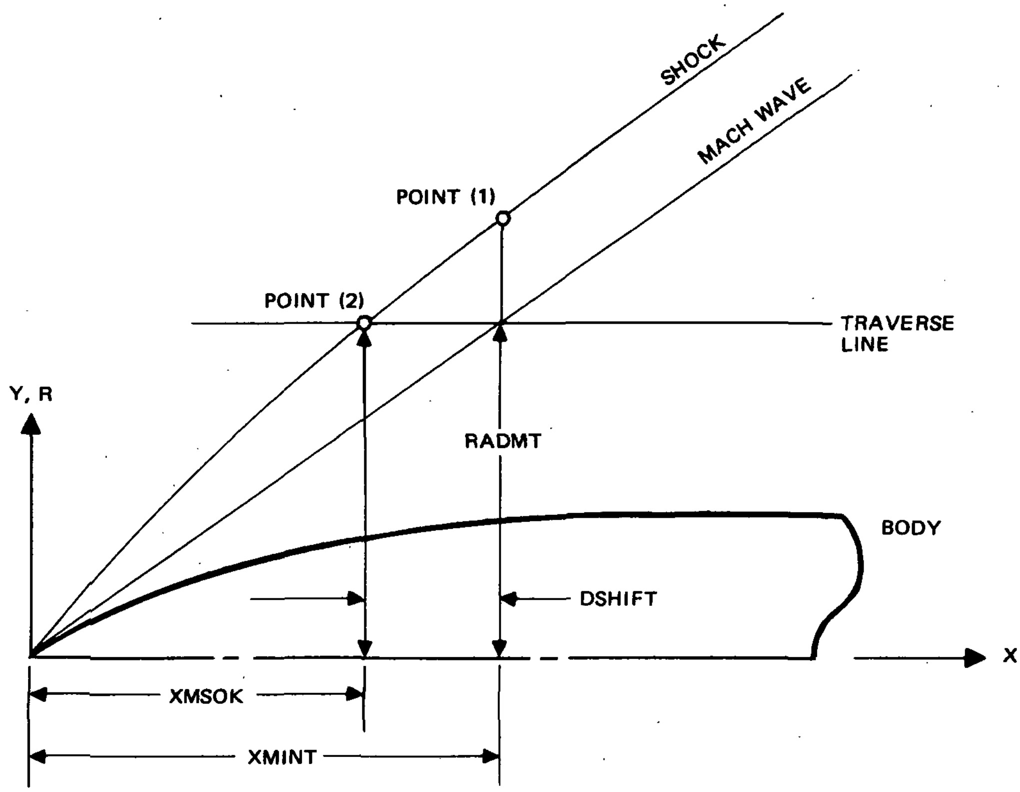
Input: Body apex location; body shape; shock apex angle; Mach number

Output: DSHIFT, distance along traverse line from Mach wave to shock wave.

Comment: Routine ATTACH uses a step-increment procedure to locate the shock intersection with the traverse line, starting at point (1) in the sketch and decreasing X until point (2) is reached.

Definitions

XO, YO, ZO	:	shock apex location, same as body apex location
ESO	:	input, shock apex angle (half cone)
DATTH	:	body apex half-cone angle
XARC	:	circular arc length from body apex to shoulder, used to approximate the body shape
A, B	:	geometric constants defining traverse line
YMO	:	traverse line Y-coordinate
BETASQ	:	$M^2 - 1$
BM	:	Mach number, M
XKAYD	:	K value used as shock scale factor (see APPENDIX A of Reference 2)
XMINT	:	X-coordinate of intersection of traverse line with Mach wave
RADMT	:	traverse line radial coordinate at XMINT
RADSOK	:	radial coordinate of shock wave (initially at X = XMINT)
XMSOK	:	X-coordinate of shock wave at radial distance = RADMT



SKETCH A-1
ROUTINE ATTACH

Subroutine CCALC

Purpose: To compute the shock stand-off distance parameter, XPDP, for detached shocks.

Called from: DETACH

Calls: (none)

Input: Call parameters defined below

Output: XPDP defined below

Comment: The value of XPDP is computed by the equation

$$XPDP = (.5)\ (C)\ \cot\ (DDET)$$

where C is a function of DELTA such that

At DELTA = DDET, C = 1.0

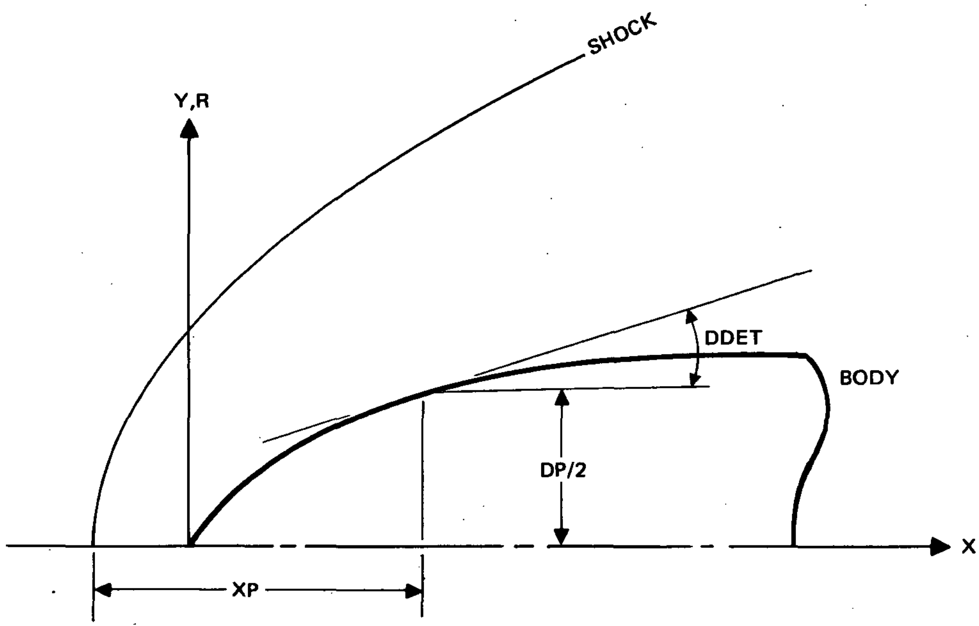
At DELTA = 90°, C = .7

And the variation of XPDP with DELTA is elliptic. The shape of the elliptic curve is determined by the conditions that (1) the slope of the curve is zero at DELTA = 0, and (2) the slope at DELTA = DDET is the same as the slope of the curve

$$XPDP = .5\ \cot\ (DELTA)$$

Definitions

DDET	:	body slope at which shock would just detach (δ_{DET} OF Reference 2)
DELTA	:	body apex half-angle (input)
TAND	:	tangent of DDET
XPDP	:	ratio XP/DP (see sketch)
XP	:	distance from shock apex to effective shoulder of body
DP	:	diameter of body at effective shoulder (effective diameter)



SKETCH A-2
ROUTINE CCALC

Subroutine DETACH

Purpose: To compute the shock wave distance ahead of the Mach wave at the store traverse line for the case of the shock detached from the body.

Called from: SHOCK

Calls: PERCPT, CCALC

Input: Body defined as nose, inlet, or pylon; store traverse line location; Mach functions.

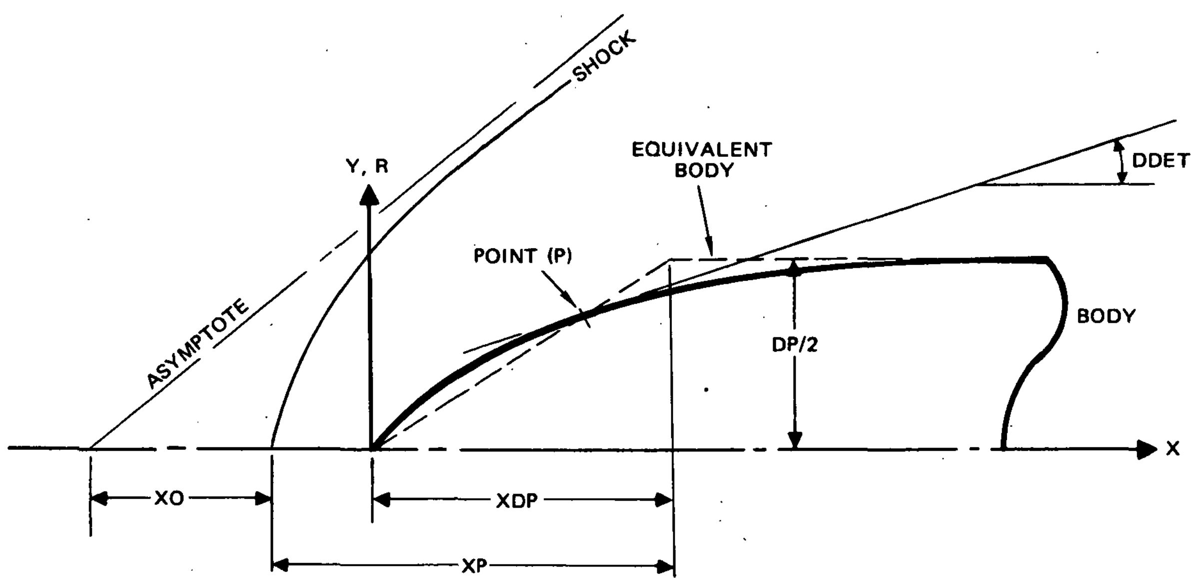
Output: DSHIFT = distance between Mach wave and shock wave at traverse line.

Comment: To define the nose shock, an equivalent body is constructed, using a cone-cylinder (see sketch). The cone passes through point (P), defined as the point where the body slope angle equals DDET (compare with sketch of routine CCALC). This is done to better locate the shock in the far field for shocks that are nearly attached, as explained in Reference 2.

Definitions

LTYPE	:	index for type of body to be considered (nose = -1, inlet = 0, pylon = 1)
DELTA	:	nose semi-vertex angle
DDET	:	maximum DELTA for attached shock
XDP, DP	:	see sketch
XPDP	:	ratio XP/DP defined in CCALC
XSN, XMN	:	X location of intersection of traverse line with shock wave and Mach wave, respectively, for nose shock
DSHIFT	:	see output
DELTAI	:	DELTA for inlet
XP, XO	:	see sketch
XSI, XMI	:	corresponding values of XSN, XMN for inlet shock
XQ	:	same as XP
XSP, XMP	:	corresponding values of XSN, XMN for pylon shock

TAND, C, XOTHERM: defined in MACHFN
BETASQ : Mach Function
LP : pylon index
A, B : see routine PERCPT



SKETCH A-3
ROUTINE DETACH

FIGURE A-3
ROUTINE DETACH LOGICAL FLOW

(continued on next page)

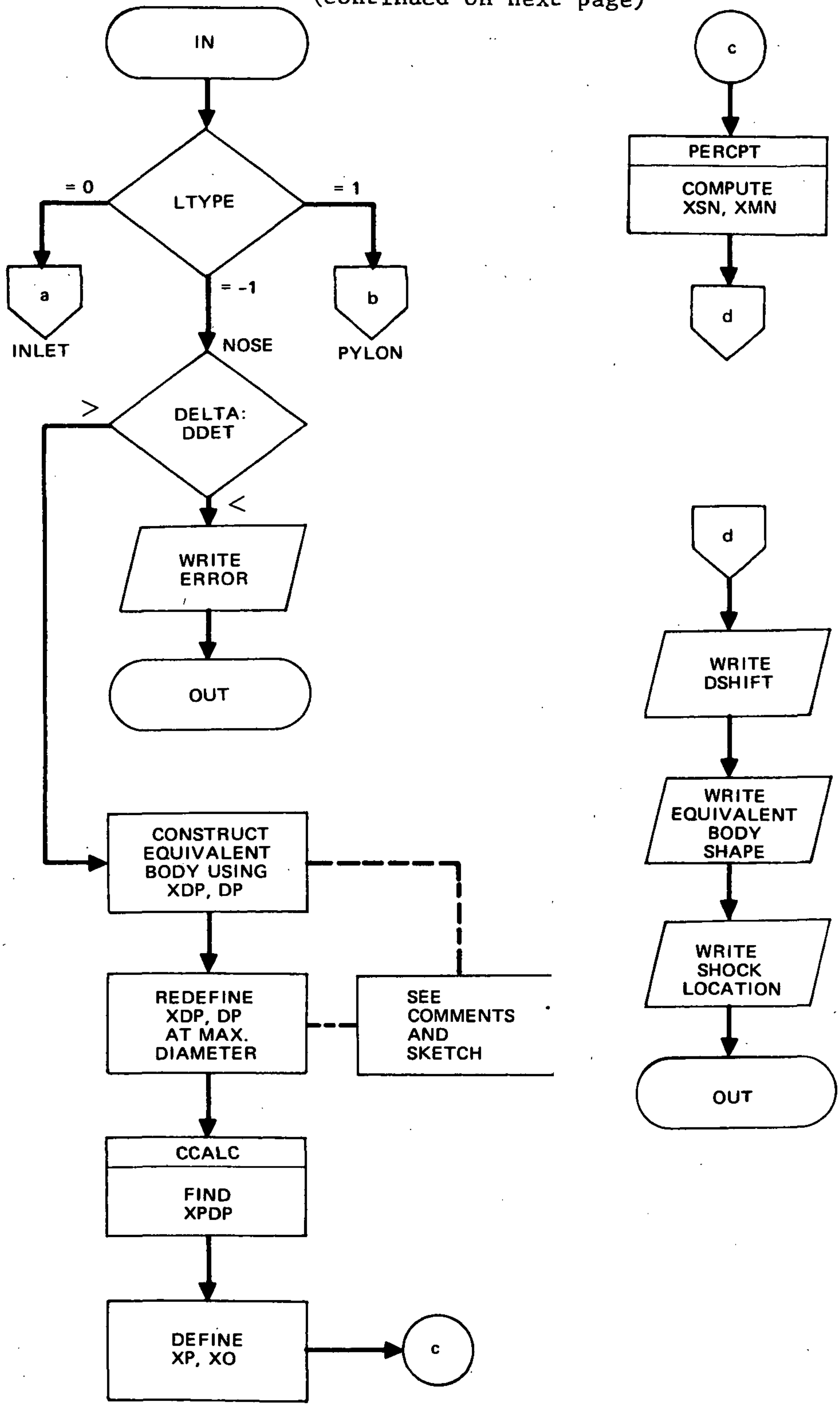
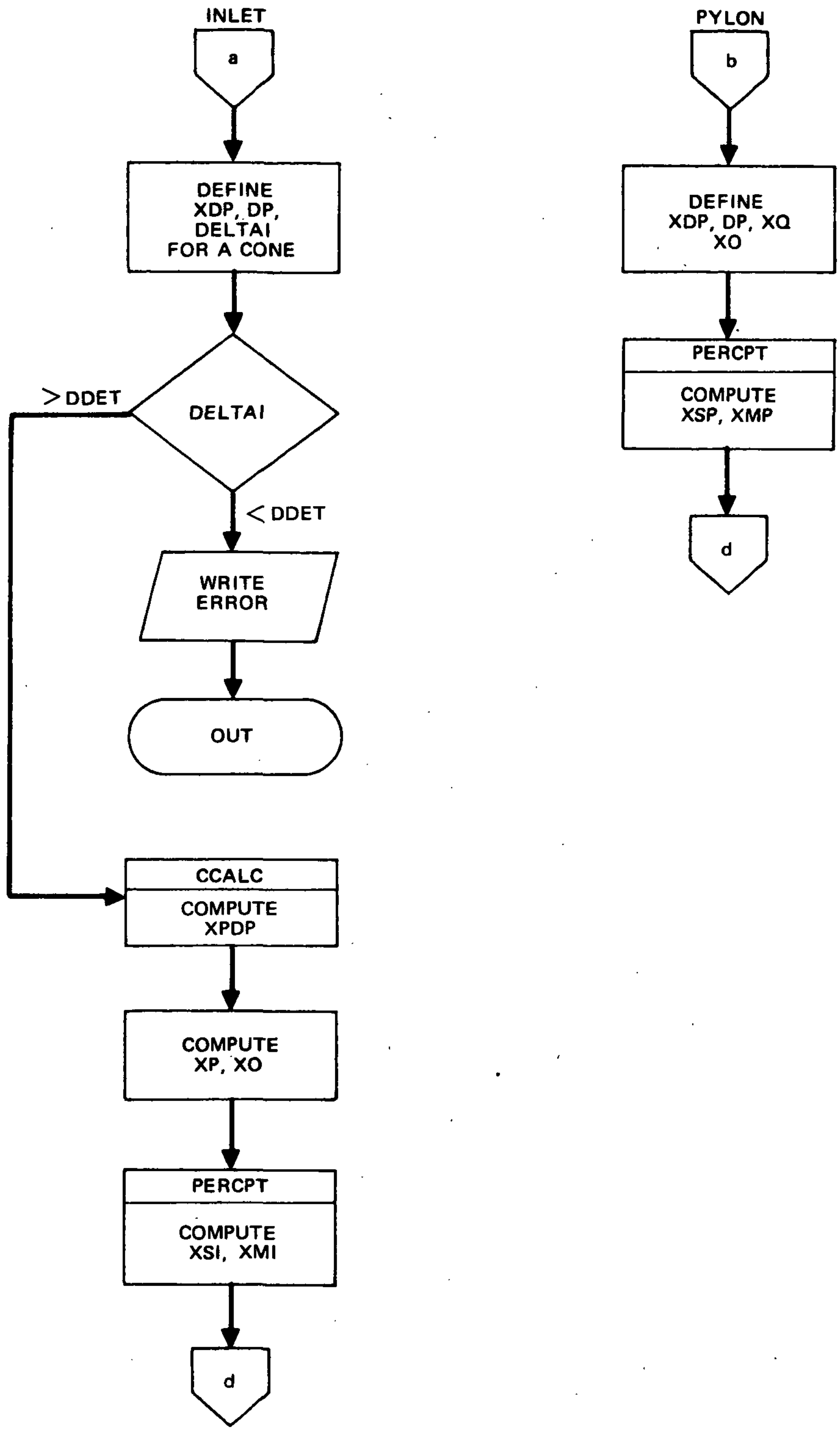


FIGURE A-3 (Continued)
ROUTINE DETACH LOGICAL FLOW



Subroutine MACHFN

Purpose: To calculate those parameters required by the program which are functions of Mach number.

Called from: SHOCK

Calls: TABLEA

Input: Mach number, BM

Output: Parameters defined below

Definitions (for output)

TAND	:	tangent of DDET
TANETA	:	tangent of ETA
TANES	:	tangent of ES
C	:	empirical parameter used to determine shock stand-off distance (defined in appendix A, Reference 2)
DDET	:	maximum body slope angle for attached shock
XOTHERM	:	a function of BETA, ES, and ETA, used in the equation for X0, the detached shock asymptote apex location (see sketch with routine DETACH).

Additional Definitions

BETA	:	$\sqrt{M^2 - 1}$
M	:	Mach number
ETA, ES	:	parameters η and ϵ_s used in the equation for detached shock asymptote location (see appendix A, Reference 2)

Subroutine PERCPT

Purpose: To compute the axial coordinate of the intersection of a detached shock wave surface, or Mach wave surface, with the store traverse line. This intersection is called the piercing point.

Called from: DETACH

Calls: (none)

Input: Parameters defining equation of surface and line.

Output: XS, piercing point X-coordinate

Comment: The shock wave surface is a hyperboloid and the Mach wave surface is a cone, both with symmetry about the X axis. Combining the equation for this surface with the equation of the line gives an equation for XS of the form

$$A1\ (XS)^2 + B1\ (XS) + C1 = 0$$

which is solved by the quadratic formula.

Definitions

A1 : parameter $1 - (\beta A)^2$
BETASQ : $M^2 - 1 = \beta^2$
A, B, YM : parameters defining the traverse line as follows

$$Y = YM \text{ (constant)}$$

$$Z = B + A \cdot X$$

XT, YT, ZT: coordinates of apex of shock (Mach) surface
ATERM : distance from XT to asymptote (=XO in sketch with routine DETACH), which defines the equation of the shock surface as follows

$$X^2 = (ATERM)^2 + \beta^2\ Y^2 + \beta^2\ Z^2$$

Note ATERM = 0 for the Mach cone

Subroutine START

Purpose: To read input parameters defining the nose, inlet, and pylons.

Called from:: SHOCK

Calls: SLOPE

Output: Input variables are written; dimensions are checked for over-run; parameters defined below are computed.

Definitions

RNOSE	:	maximum nose radius
XARC	:	X-length of circular arc used to approximate nose for attached shock calculations (as tangent ogive with semi-vertex angle DELTA)
DRDXB	:	slope of body, derivative of RB versus XB

Function TABLEA

Purpose: To compute the value of the dependent variable at a specified value of the independent variable using a table of given values.

Called from: MACHFN, ATTACH

Calls: (none)

Input: XIN; X; Y; NPTS

Output: TABLEA

Comment: Linear interpolation is used

Definitions

XIN	:	specified value of the independent variable
X	:	independent variable array
Y	:	dependent variable array
NPTS	:	number of points in each array X, Y
TABLEA	:	value of Y at X = XIN

APPENDIX B - Test Cases

This Appendix presents input data and output listings for test case runs of programs STORLD - subsonic, STORLD - supersonic, and program SHOCK. The purpose of these test case runs is to provide a sample output the reader may use to verify that the programs are running properly. For this purpose. the test cases have been constructed to include all major computing modes with as short a run time as possible. Test case aircraft input geometry is based on the F-4 aircraft. However, the condition of short run times disallowed an accurate representation of the aircraft. Store geometry for the test case runs is taken from Figure 14 of Reference 1, part I.

Program STORLD - Subsonic

Figure B-1 lists the test case input data for program STORLD - subsonic. Refer to Reference 1, Part I for data format. The subsonic version of program STORLD occupies less than 50,000 octal storage spaces. The test case runs require 6.1 seconds of computing time on a CDC 6400 computer. The test cases consist of three stacked runs labeled:

1. Wing with camber, twist, and pylon
2. Fuselage nose
3. Inlet

Figure B-2 lists the output for these data. These runs are separate to aid in isolating any difficulty in matching the test case output. Subroutines exclusively affecting the output for each run are:

run 1: START, COMPUT, WINGFN, PYLONFN, INTERP, VORTEX, WING, THICK, EQSOL

run 2: BODFN, NOSEFN, NOSE, SLOPE

run 3: STRIPFN, STRIP

Program STORLD - Supersonic

Figure B-3 lists the test case input data for program STORLD - supersonic. Refer to Reference 2 (Part II)for data format. The supersonic version of program STORLD occupies less than 55,000 octal storage spaces. The test case runs require 8 seconds* of computing time on a CDC 6400 computer. The test cases consist of three stacked runs, labeled the same as the subsonic test cases and similarly used to isolate the effectiveness of various portions of the program.

Figure B-4 lists the output for these data. Subroutines exclusively affecting the output for each run are:

run 1: DIAFRM, DNWASH, GENRAT, LIFT, PYLON, PYLONFN, START, THICK, WING, WINGFN, DIFIN

run 2: BODFN, NOSEFN, NOSE, SLOPE

run 3: STRIPFN, STRIP, SWP

Program SHOCK

Program SHOCK occupies less than 27,000 octal storage spaces. Figure B-5 lists the test case input data. Refer to Reference 2

*Run time is greatly reduced by use of the input values LU = 5, MO = 10, though larger values are required to accurately calculate wing and pylon crossflow.

(Part II) for input format. Figure B-6 lists the output for these data. The test case runs require less than one second of computing time on a CDC 6400 computer.

The test cases consist of two stacked runs. The first run features the F-4 aircraft nose, inlet, and pylon at Mach 1.2. This run demonstrates the detached shock capability of the program. The second run features the nose at Mach 2.0 and serves to check-out the attached shock capability of the program. Subroutines used exclusively by each run are:

run 1: DETACH, PERCPT, CCALC

run 2: ATTACH, TABLEA, PERCPT

```
TEST CASE WING WITH CAMBER, TWIST, AND PYLON
  .8                                                                              BM
        6         4         10         6                                          NTV
 2.73      45.0      .1885     530.                                               AR
 2.0       0.        2.        0.        2.5       21.5      1.0                  YV WING
 5.4                 1.4                 6.7       18.       .3
 7.9                 1.1                 9.8       15.5      .3
 10.125              1.125               12.6      13.2      .3
 12.325              1.075               15.3      11.       .3
 16.2      -.595     2.86      12.       19.7      7.9       .3
           1.        1.        1.        1.        1.                             XCAM
 1.        1.        1.        1.        1.        1.                             SWP
 0.        .9        .85       .8        .75       .65                            TTC
  .23      .057      .031      0.        0.        -.034     -.055                THU
 -.075     -.078     -.078                                                        THU
 .12       .18       .3        .4                                                 CS
 -.09      .0122     .0122     .0122                                              DZDX
       1         0                                                                IG IP
 0.                                                                               DALFDX
       2         4         2         3         1  0.2                             NPV
 6.8       .6        .4        90.       9.        6.8                           YV PYLON
 6.8       1.4       .4        90.       7.6       8.2                           YV PYLON
       0                                                                          NBP
 0.                                                                               XNOSE
       0                                                                          NST
 0.                                                                               XLIP
SAMPLE STORE, FIGURE 14 OF REF 1, PART I
       5                                                                        NMS
  2.0      5.6       1.0       0.        3.0       -45.0                        DELX
  1.5      0.        0.        0.        0.5                                    CNLA
  0.7      1.        1.        1.        1.                                     RS
  1.       1.        1.        1.        3.                                     FT
                                         2.                                     CNF
                                         1.5                                    CNPF
                                         1.0                                    FCP
  1.5      2.0       2.0       2.0       4.0                                    CNLD
       0         0         0         0         0                                IDW
       1                                                                        NTL
 STORE UNDER WING AND PYLON
 8.7       6.8       3.08      0.        0.                                     XW
       2         0         0         5                                          NALF
 0.        2.                                                                   ALFW
       2                                                                        IGO
 TEST CASE  FUSELAGE NOSE
 0.8                                                                            BM
       0                                                                        NTV
       0                                                                        IS
       0                                                                        NPV
      16                                                                        NBP
 -14.75    0.        1.06      7.5       50.                                    XNOSE
 .639      .403                                                                 XB
 1.28      .71
 1.92      .99
 2.55      1.21
 3.19      1.39
 3.83      1.54
 4.67      1.67
 5.75      1.78
 7.07      1.87
 10.15     2.02
 15.       2.62
```

FIGURE B-1
Program STORLD - subsonic,
test case input data

```
 20.       2.02
 25.       2.02
 30.       2.02
 35.       2.02
 40.       2.02
        0                                                                      NST
 0.0                                                                           XLIP
        1                                                                      NTL
STORE OPPOSITE NOSE
-12.     6.8      3.08      0.       0.                                         XM
        1        1        0        1                                           NALF
 0.                                                                            ALFW
        2                                                                      ISO
TEST CASE INLET
 0.8                                                                           BM
        0                                                                      NTV
        0                                                                      IS
        0                                                                      NPV
        0                                                                      NBP
 0.0                                                                           XNOSE
        2        2                                                             NST
 1.2     4.4      0.67                                                         XLIP
-1.5     2.5      -1.1      2.1      .227      1.6      90.      -10.
-.15     3.       -1.1      2.1      .332      1.3      90.      -10.
        1                                                                      NTL
STORE OPPOSITE INLET
-2.0     6.8      3.08      0.       0.                                         XM
        1        1        1        2                                           NALF
 0.                                                                            ALFW
        0                                                                      ISO
```

FIGURE B-1 (concluded)

0THIS PROGRAM PREDICTS AERO INTERFERENCE ON AIRCRAFT STORES,

METHOD FORMULATED AND PROGRAMMED BY F DAN FERNANDES

1
0AIRCRAFT TITLE-   TEST CASE WING WITH CAMBER, TWIST, AND PYLON
0ELAPSED CP TIME =   1.646 SECONDS, INCREMENT =   1.646 SECONDS
0MACH NUMBER= .800   BETA= .6000
0 WING PARAMETERS

NTV= 6   NBV= 4   NTC=10   NRW= 6

0 WING ASPECT RATIO = 2.730
0 QUARTER CHORD SWEEP ANGLE= 45.0000
0 TAPER RATIO= .1885
0 REFERENCE AREA = 530.000

0WING THICKNESS SLOPES THU=
.2300 .0570 .0310 0.0000 0.0000 -.0340 -.0550 -.0750 -.0780
-.0780

0CHORD SECTION X/C LENGTHS CS=
.1200 .1800 .3000 .4000

0WING MEAN LINE SLOPES DZDX =
-.0900 .0122 .0122 .0122

0 WING CROSSFLOW AXIAL RATE OF CHANGE, DALFDX = 0.000   ALPHA = 0 AT X = -0.000
1 WING CL= .05830 PLUS .05084 TIMES AIRCRAFT ALPHA IN DEGREES
WING AREA OVER REFERENCE AREA = 1.0115

WING NORMALIZED SECTIONAL LIFT DIST, SL = CL-LC TIMES C / CL CBAR

J	Y/B/2	SL
1	.1053	1.2016
2	.2843	1.1651
3	.4159	1.1087
4	.5330	1.0339
5	.6489	.9283
6	.8529	.7282

0 PYLON PARAMETERS

NPV= 2
0 NDV= 4   JI1= 2   JI2= 3   IWING= 1   ZW= .200

1WING PARAMETERS

J	YV	ZV	SV	PH	XLE	C	ALFV	XCAM	SWP	TTC	SDA	CDA
1	2.000	0.000	2.000	0.000	2.500	21.500	1.000	-0.000	1.000	0.300	0.000	1.000
2	5.400	-0.000	1.400	0.000	6.700	18.000	.300	1.000	1.000	.900	0.000	1.000
3	7.900	-0.000	1.100	0.000	9.800	15.500	.300	1.000	1.000	.950	0.000	1.000
4	10.125	-0.000	1.125	0.000	12.600	13.200	.300	1.000	1.000	.800	0.000	1.000
5	12.325	-0.000	1.075	0.000	15.300	11.000	.300	1.000	1.000	.750	0.000	1.000
6	16.200	-.595	2.860	12.000	19.700	7.300	.300	1.000	1.000	.650	.208	.978
0 PYLON PARAMETERS												
7	6.800	.600	.400	90.000	9.000	6.800	0.000	0.000	0.000	0.000	1.000	-.000
8	6.800	1.400	.400	90.000	7.600	8.200	0.000	0.000	0.000	0.000	1.000	-.000
9	6.800	-.200	.400	90.000	9.000	6.800	0.000	0.000	0.000	0.000	1.000	.000
10	6.800	-1.000	.400	90.000	7.600	8.200	0.000	0.000	0.000	0.000	1.000	.000

0WING VORTEX LATTICE

J	XV	XV*BETA	GAM	GAMC	SVA	CVA
1						
	5.2417	3.1450	.1065E-01	.8540E-02	.8974E+00	.4413E+00
	10.0792	6.0475	.8344E-02	.4449E-02	.8751E+00	.4839E+00
	17.6042	10.5625	.1151E-01	.1284E-01	.8247E+00	.5656E+00

FIGURE B-2
Program STORLD - subsonic, test case output data

	17.6042	10.5625	.1191E-01	.1264E-01	.8247E+00	.5656E+00
	29.2500	17.5500	.1007E-01	.1250E-01	.6756E+00	.7373E+00
2						
	12.0667	7.2400	.1196E-01	-.1307E-01	.8974E+00	.4413E+00
	16.1167	9.6700	.8686E-02	.2487E-01	.8751E+00	.4839E+00
	22.4167	13.4500	.1007E-01	.1441E-01	.8247E+00	.5656E+00
	32.1667	19.3000	.8628E-02	.1103E-01	.6756E+00	.7373E+00
3						
	17.1083	10.2650	.1224E-01	-.1104E-01	.8974E+00	.4413E+00
	20.5958	12.3575	.8507E-02	.2312E-01	.8751E+00	.4839E+00
	26.0208	15.6125	.9286E-02	.1374E-01	.8247E+00	.5656E+00
	34.4167	20.6500	.7411E-02	.9762E-02	.6756E+00	.7373E+00
4						
	21.6600	12.9960	.1204E-01	-.8255E-02	.8974E+00	.4413E+00
	24.6300	14.7780	.8196E-02	.2055E-01	.8751E+00	.4839E+00
	29.2500	17.5500	.8388E-02	.1251E-01	.8247E+00	.5656E+00
	36.4000	21.8400	.6294E-02	.8607E-02	.6756E+00	.7373E+00
5						
	26.0500	15.6300	.1146E-01	-.5883E-02	.8974E+00	.4413E+00
	28.5250	17.1150	.7590E-02	.1797E-01	.8751E+00	.4839E+00
	32.3750	19.4250	.7090E-02	.1086E-01	.8247E+00	.5656E+00
	38.3333	23.0000	.5214E-02	.7516E-02	.6756E+00	.7373E+00
6						
	33.2283	19.9370	.8922E-02	-.2933E-02	.8974E+00	.4413E+00
	35.0058	21.0035	.6005E-02	.1339E-01	.8751E+00	.4839E+00
	37.7708	22.6625	.6174E-02	.8949E-02	.8247E+00	.5656E+00
	42.0500	25.2300	.4042E-02	.5284E-02	.6756E+00	.7373E+00

0 PYLON VORTEX LATTICE

7						
	15.3400	9.2040	-.4933E-02	.3491E-02	0.	.1000E+01
	16.8700	10.1220	-.3672E-03	-.4794E-02	0.	.1000E+01
	19.2500	11.5500	.1940E-02	.2791E-02	0.	.1000E+01
	22.9333	13.7600	-.1530E-02	-.3180E-02	0.	.1000E+01
8						
	13.0767	7.8460	-.1754E-02	-.2092E-02	0.	.1000E+01
	14.9217	8.9530	-.1904E-02	.2408E-02	0.	.1000E+01
	17.7917	10.6750	.5579E-03	-.3594E-03	0.	.1000E+01
	22.2333	13.3400	-.3597E-03	-.9206E-03	0.	.1000E+01
9						
	15.3400	9.2040	-.4933E-02	.3491E-02	0.	.1000E+01
	16.8700	10.1220	-.3672E-03	-.4794E-02	0.	.1000E+01
	19.2500	11.5500	.1940E-02	.2791E-02	0.	.1000E+01
	22.9333	13.7600	-.1530E-02	-.3180E-02	0.	.1000E+01
10						
	13.0767	7.8460	-.1754E-02	-.2092E-02	0.	.1000E+01
	14.9217	8.9530	-.1904E-02	.2408E-02	0.	.1000E+01
	17.7917	10.6750	.5579E-03	-.3594E-03	0.	.1000E+01
	22.2333	13.3400	-.3597E-03	-.9206E-03	0.	.1000E+01

0NOSE PARAMETERS

NBP= 0 XNOSE= 0.00 YNOSE= -0.00 ZNOSE= -0.00 ALFNN= -0.00 DEG.

XBL OR XS = -0.000 XO = 0.000

0THICKNESS STRIP PARAMETERS

NST= 0 NIN=-0 XLIP= 0.00 YLIP= -0.00 ZLIP= -0.00

0ELAPSED CP TIME = 5.985 SECONDS, INCREMENT = 4.339 SECONDS

1

0STORE TITLE- SAMPLE STORE, FIGURE 14 OF REF 1, PART I

0STORE INPUT

NO OF STORE BODY STATIONS, NMS= 5

00ELX= 2.0000 XCG= 5.6000 DIA= 1.0000 XSTART= 0.0000 FTM= 3.0000

0 STORE ROLL ANGLE = -45.000

0	CNLA	RS	FT	CNF	CNPF	FCP	CNLO	XBAR
1	1.500	.700	1.000	-0.000	-0.000	-0.000	1.500	4.600
2	0.000	1.000	1.000	-0.000	-0.000	-0.000	2.000	2.600

FIGURE B-2 (continued)

```
  2   0.000  -1.000   1.000  -0.000  -0.000  -0.000   2.000  -2.600

  3   0.000   1.000   1.000  -0.000  -0.000  -0.000   2.000    .600

  4   0.000   1.000   1.000  -0.000  -0.000  -0.000   2.000  -1.400

  5    .500   1.000   3.000   2.000   1.500   1.000   4.000  -3.400

1FLOW FIELD COMPUTATION

 STORE TRAVERSE LINE LOCATED THROUGH POINT (X,Y,Z) =    8.700    6.800    3.080
     TRAVERSE LENGTH =    0.000 FT  AT INCIDENCE =    0.000 DEG
0COMPUTATION MODE      IB=  0     IA=  0      IW=  5      NK=  5      FTM=  3.000      DIA=  1.000
0DISTURBANCE FLOW FIELD HAS BEEN COMPUTED
0  XC      K  J        U           V           W           UT          VT          WT
  12.100   1  1 -.1251E-01  .1496E-01  .5797E-02  .6893E-02  .4932E-02  .2110E-01
  10.100   2  1 -.1229E-01  .1489E-01  .1709E-02 -.3153E-02  .7958E-02  .2322E-01
   8.100   3  1 -.9863E-02  .1026E-01 -.2393E-02 -.1453E-01  .1205E-01  .2022E-01
   6.100   4  1 -.6402E-02  .5483E-02 -.3862E-02 -.2083E-01  .1032E-01  .1301E-01
   4.100   5  1 -.3822E-02  .2697E-02 -.3347E-02 -.1596E-01  .5475E-02  .2328E-02
0ELAPSED CP TIME =      6.793 SECONDS, INCREMENT =       .808 SECONDS
1
0AIRCRAFT TITLE-   TEST CASE WING WITH CAMBER, TWIST, AND PYLON
0STORE     TITLE-   SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-   STORE UNDER WING AND PYLON
0MACH NUMBER=  .800      RESULTS FOR
0AIRCRAFT ALPHA =    0.000        STORE  ALPHA =    0.000     UNDER LEFT WING


0 XC       K        ALZ          WS          WD           BZ          ALZD         ARS          ARD
  12.100   1   .2137E-01   .4274E-01 0.          0.          -.1725E-02 0.          0.
  10.100   2   .2258E-01   .4517E-01 0.          0.           .5113E-03 0.          0.
   8.100   3   .1932E-01   .3864E-01 0.          0.           .3054E-02 0.          0.
   6.100   4   .1032E-01   .2065E-01 0.          0.           .4077E-02 0.          0.
   4.100   5   .3012E-02   .6023E-02 0.          0.           .2493E-02 0.          0.
0 XC       K        ALY          VS          VD           BY          ALYD
  12.100   1   .5311E-02   .1062E-01 0.          0.          -.1273E-02
  10.100   2   .8092E-02   .1618E-01 0.          0.          -.1503E-02
   8.100   3   .1132E-01   .2265E-01 0.          0.          -.4603E-03
   6.100   4   .9933E-02   .1987E-01 0.          0.           .1394E-02
   4.100   5   .5747E-02   .1149E-01 0.          0.           .1638E-02
0              /--                 PHI = 0                  --/          /--                    PHI=-45.000       --/
      X      NORMAL-F     SIDE-F   PITCH-M     YAW-M     ROLL-M                 NORMAL-F     SIDE-F   PITCH-M       YAW-M
    0.000      -.140       -.036      .194      -.069     0.000                    -.073       -.125      .186        .088
0ELAPSED CP TIME =      6.877 SECONDS, INCREMENT =       .084 SECONDS
1
0AIRCRAFT TITLE-   TEST CASE WING WITH CAMBER, TWIST, AND PYLON
0STORE     TITLE-   SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-   STORE UNDER WING AND PYLON
0MACH NUMBER=  .800      RESULTS FOR
0AIRCRAFT ALPHA =    2.000        STORE  ALPHA =    2.000     UNDER LEFT WING


0 XC       K        ALZ          WS          WD           BZ          ALZD         ARS          ARD
  12.100   1   .3194E-01   .6388E-01 0.          0.           .1757E-02 0.          0.
  10.100   2   .2600E-01   .5199E-01 0.          0.           .4187E-02 0.          0.
   8.100   3   .1519E-01   .3039E-01 0.          0.           .5725E-02 0.          0.
   6.100   4   .3096E-02   .6193E-02 0.          0.           .4694E-02 0.          0.
   4.100   5  -.3583E-02  -.7167E-02 0.          0.           .1951E-02 0.          0.
0 XC       K        ALY          VS          VD           BY          ALYD
  12.100   1   .3522E-01   .7044E-01 0.          0.          -.2351E-02
  10.100   2   .3673E-01   .7345E-01 0.          0.           .8531E-03
   8.100   3   .3181E-01   .6361E-01 0.          0.           .3333E-02
   6.100   4   .2140E-01   .4279E-01 0.          0.           .5095E-02
   4.100   5   .1147E-01   .2294E-01 0.          0.           .3853E-02
0              /--                 PHI = 0                  --/          /--                    PHI=-45.000       --/
```


FIGURE B-2 (continued)

```
0           /--                  PHI = 0                       --/       /--                        PHI=-45.000       --/
     X-    NORMAL-F    SIDE-F    PITCH-M     YAW-M     ROLL-M              NORMAL-F    SIDE-F   PITCH-M     YAW-M
   0.000     -.227     -.242      .574        .265      0.000                 .011      -.332      .218       .594
0ELAPSED CP TIME =     6.961 SECONDS, INCREMENT =       .084 SECONDS
                       END OF RUN       1

1
0AIRCRAFT TITLE-     TEST CASE  FUSELAGE NOSE
0ELAPSED CP TIME =     6.973 SECONDS, INCREMENT =       .012 SECONDS
0MACH NUMBER=  .800       BETA=  .6000
0 WING PARAMETERS


     NTV= 0       NBV=-0      NTC=-0      NRW= -0
0                       PYLON PARAMETERS


     NPV= 0
1
0NOSE PARAMETERS
     NBP= 16      XNOSE= -14.75      YNOSE=    0.00       ZNOSE=    1.06       ALFNW=   7.50 DEG.
     XBL OR XS =    50.000       XO =    0.000
0     XB          RB       SLOPE         SNA          SNC        J
     .63900      .40300     .49967   .6994E-01  -.1326E-02   1
    1.28000      .71000     .45820   .5236E-01  -.2093E-02   2
    1.92000      .99000     .39361   .7079E-01  -.3266E-02   3
    2.55000     1.21000     .31550   .2611E-02  -.4143E-02   4
    3.19000     1.39000     .25781   .7419E-02  -.3800E-02   5
    3.83000     1.54000     .19995  -.1139E-02  -.4633E-02   6
    4.67000     1.67000     .13161  -.1009E+00  -.4107E-02   7
    5.75000     1.78000     .08670  -.2886E-01  -.3534E-02   8
    7.07000     1.87000     .06234  -.1635E-01  -.3288E-02   9
   10.15000     2.02000     .02979  -.2720E-01  -.4909E-02  10
   15.00000     2.02000    0.00000  -.3080E-01  -.3626E-03  11
   20.00000     2.02000    0.00000   .1874E-02  -.7387E-04  12
   25.00000     2.02000    0.00000   .1185E-03  -.1951E-04  13
   30.00000     2.02000    0.00000   .4800E-04   .1745E-06  14
   35.00000     2.02000    0.00000   .2047E-04   .1896E-04  15
   40.00000     2.02000    0.00000   .1059E-04   .6145E-04  16
0THICKNESS STRIP PARAMETERS


     NST= 0       NIN=-0      XLIP=   0.00       YLIP=  -0.00       ZLIP=  -0.00
0ELAPSED CP TIME =     7.742 SECONDS, INCREMENT =       .769 SECONDS
1FLOW FIELD COMPUTATION

 STORE TRAVERSE LINE LOCATED THROUGH POINT (X,Y,Z) = -12.000    6.800    3.080
     TRAVERSE LENGTH =    0.000 FT   AT INCIDENCE =    0.000 DEG
0COMPUTATION MODE        IB=  1       IA=  0       IW=  1       NK=  5       FTM=  3.000       DIA=  1.000
0DISTURBANCE FLOW FIELD HAS BEEN COMPUTED
0  XC       K  J        U             V            W            UT           VT            WT
   -8.600   1  1 -.3188E-03   .5894E-03 -.4608E-03   .1211E-01   .1306E-01   .9934E-02
   -8.600   1  2 -.2963E-03   .5302E-03 -.5605E-03   .1225E-01   .1459E-01   .9475E-02
   -8.600   1  3 -.3785E-03   .7430E-03 -.4468E-03   .1421E-01   .1325E-01   .1131E-01
   -8.600   1  4 -.3593E-03   .6633E-03 -.7016E-03   .1498E-01   .1606E-01   .1153E-01
   -8.600   1  5 -.2802E-03   .4933E-03 -.3022E-03   .9770E-02   .1074E-01   .8422E-02
   -8.600   1  6 -.2127E-03   .3155E-03 -.6013E-03   .1019E-01   .1535E-01   .7345E-02
   -8.600   1  7 -.4593E-03   .9539E-03 -.2602E-03   .1605E-01   .1133E-01   .1285E-01
   -8.600   1  8 -.4017E-03   .7750E-03 -.1025E-02   .1637E-01   .1976E-01   .1351E-01
0ELAPSED CP TIME =     7.996 SECONDS, INCREMENT =       .254 SECONDS
1
0AIRCRAFT TITLE-     TEST CASE  FUSELAGE NOSE
0STORE    TITLE-    SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-    STORE OPPOSITE NOSE
0MACH NUMBER=  .800       RESULTS FOR
0AIRCRAFT ALPHA =   0.000        STORE  ALPHA =    0.000      UNDER LEFT WING
```


FIGURE B-2 (continued)

```
0 XC      K       ALZ         WS          WD          BZ
  -8.600  1  .1071E-01  .2073E-01 -.6866E-03  .1043E-02 -.8659E-03 -.5850E-03 -.5850E-03
0 XC      K       ALY         VS          VD          BY          A_YD
  -8.600  1  .1500E-01  .2975E-01 -.1762E-03  .6469E-02 -.3379E-02
0              /--               PHI = 0                    --/        /--                   PHI=-45.000        --/
      X      NORMAL-F.   SIDE-F   PITCH-M     YAW-M     ROLL-M                NORMAL-F    SIDE-F   PITCH-M     YAW-M
    0.000     -.088      -.096     -.001      -.146      -.003                   .005      -.130      .103      -.104
0ELAPSED CP TIME =     8.053 SECONDS, INCREMENT =     .057 SECONDS
                    END OF RUN      2

1
0AIRCRAFT TITLE-     TEST CASE INLET
0ELAPSED CP TIME =     8.066 SECONDS, INCREMENT =     .013 SECONDS
0MACH NUMBER=  .800      BETA=  .6000
0 WING PARAMETERS  .


     NTV= 0      NBV=-0      NTC=-0      NRW= -0
0                     PYLON PARAMETERS


     NPV= 0
0NOSE PARAMETERS
     NBP=  0  .  XNOSE=   0.00      YNOSE=  -0.00      ZNOSE=  -0.00      ALFNW=  -0.00 DEG.
     XBL OR XS =   -0.000      XO =   0.000
1
0THICKNESS STRIP PARAMETERS


     NST= 2      NIN= 2      XLIP=   1.20      YLIP=   4.40      ZLIP=    .67


       XST          YST          ZST          SST          THST         DXST        PHST         ALST
     -1.5000       2.5000      -1.1000       2.1000        .2270       1.6000      90.0000     -10.0000
     -.1500        3.0000      -1.1000       2.1000        .3320       1.3000      90.0000     -10.0000
0ELAPSED CP TIME =     8.129 SECONDS, INCREMENT =     .063 SECONDS
1FLOW FIELD COMPUTATION

 STORE TRAVERSE LINE LOCATED THROUGH POINT (X,Y,Z) =  -2.000    6.800    3.380
     TRAVERSE LENGTH =   0.000 FT  AT INCIDENCE =   0.000 DEG
0COMPUTATION MODE      IB=  1      IA=  1      IW=  2      NK=  5      FTM=  3.000      DIA=  1.000
0DISTURBANCE FLOW FIELD HAS BEEN COMPUTED
0  XC      K  J        U           V           W          UT          VT          WT
    1.400  1  1 0.          0.          0.          0.          0.          0.
    1.400  1  2 0.          0.          0.          0.          0.          0.
    1.400  1  3 0.          0.          0.          0.          0.          0.
    1.400  1  4 0.          0.          0.          0.          0.          0.
    1.400  1  5 0.          0.          0.          0.          0.          0.
    1.400  1  6 0.          0.          0.          0.          0.          0.
    1.400  1  7 0.          0.          0.          0.          0.          0.
    1.400  1  8 0.          0.          0.          0.          0.          0.
    -.600  2  1 0.          0.          0.       .1535E-03   .1586E-01   .1481E-01
    -.600  2  2 0.          0.          0.       .8870E-04   .1975E-01   .1532E-01
    -.600  2  3 0.          0.          0.       .9400E-05   .1724E-01   .1988E-01
    -.600  2  4 0.          0.          0.      -.2007E-03   .2243E-01   .2027E-01
    -.600  2  5 0.          0.          0.       .2297E-03   .1179E-01   .1124E-01
    -.600  2  6 0.          0.          0.       .2366E-03   .2037E-01   .1117E-01
    -.600  2  7 0.          0.          0.       .5382E-04   .1322E-01   .2083E-01
    -.600  2  8 0.          0.          0.      -.1544E-02   .3393E-01   .2996E-01
0ELAPSED CP TIME =     8.358 SECONDS, INCREMENT =     .229 SECONDS
1
0AIRCRAFT TITLE-     TEST CASE INLET
0STORE    TITLE-   SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-   STORE OPPOSITE INLET
0MACH NUMBER=  .800      RESULTS FOR
0AIRCRAFT ALPHA =   0.000      STORE  ALPHA =   0.000      UNDER LEFT WING
```


FIGURE B-2 (continued)

```
                                                                    .9406E-05  .1724E-01  .1988E-01
   -.600  2  4 0.          0.          0.                          -.2007E-03  .2243E-01  .2027E-01
   -.600  2  5 0.          0.          0.                           .2297E-03  .1179E-01  .1124E-01
   -.600  2  6 0.          0.          0.                           .2366E-03  .2037E-01  .1117E-01
   -.600  2  7 0.          0.          0.                           .5382E-04  .1322E-01  .2083E-01
   -.600  2  8 0.          0.          0.                          -.1544E-02  .3393E-01  .2996E-01
0ELAPSED CP TIME =     8.358 SECONDS, INCREMENT =      .229 SECONDS
1
0AIRCRAFT TITLE-    TEST CASE INLET
0STORE    TITLE-   SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-   STORE OPPOSITE INLET
0MACH NUMBER=  .800     RESULTS FOR
0AIRCRAFT ALPHA =   0.000     STORE  ALPHA =   0.000    UNDER LEFT WING

0 XC      K       ALZ          WS          WD          BZ         A_ZD        ARS         ARD
   1.400  1  .2165E-02  .4248E-02 -.2469E-03 -.4860E-04 -.9305E-02 -.6107E-05 -.9162E-04
   -.600  2  .1448E-01  .2845E-01 -.1589E-02 -.1265E-02 -.2410E-02 -.3797E-04 -.5062E-03
0 XC      K       ALY          VS          VD          BY         A_YD
   1.400  1  .2352E-02  .4649E-02 -.1036E-03 -.7654E-04 -.1080E-01
   -.600  2  .1569E-01  .3102E-01 -.6930E-03 -.1552E-02 -.2534E-02
0                 /--                PHI = 0                    --/        /--                  PHI=-45.000       --/
       X      NORMAL-F     SIDE-F   PITCH-M     YAW-M     ROLL-M                  NORMAL-F     SIDE-F   PITCH-M      YAW-M
     0.000       .020       .024      -.368     -.393      -.000                    -.001       .033      .018       -.538
0ELAPSED CP TIME =     8.424 SECONDS, INCREMENT =      .066 SECONDS
                     END OF RUN      3
```


FIGURE B-2 (concluded)

```
TEST CASE WING WITH CAMBER, TWIST, AND PYLON
 1.2                                                                              BM
       5        10                                                                LU MO
      14         4                                                                NSS
 0.       .679     1.235     0.                                                   APEX
 23.1     21.7     20.3      18.9      17.6      16.2      14.9                   CS
 13.5     12.2     10.8      9.6       8.3       6.9       5.7                    CS
                             .90       .87       .84       .81                    TTC
  .77      .75      .72      .69       .66       .63       .60                    TTC
 1.       1.       1.        .3        .3        .3        .3                     ALFS
  .3       .3       .3       .3        .3        .3        .3                     ALFS
                             1.        1.        1.        1.                     XCAM
 1.       1.       1.        1.        1.        1.        1.                     XCAM
 .204     .0415              -.08                                                 THU
 -.09     .0122    .0122     .0122                                                DZDX
  .12      .18      .3       .4                                                   CF
 0.       0.                                                                      DALFDX
 15.8                                                                             XMAX
       2         0         1                                                      IG IP IW
 9.77     6.75     15.8      15.8      0.2       1.8       6.8                    15.8
       1         0                                                                IG IP
       0                                                                          NBP
 0.                                                                               XNOSE
       0                                                                          NST
 0.                                                                               XLIP
SAMPLE STORE, FIGURE 14 OF REF 1, PART I
       5                                                                          NMS
  2.0     5.6      1.0       0.        3.0       -45.0                            DELX
  1.5     0.       0.        0.        0.5                                        CNLA
  0.7     1.       1.        1.        1.                                         RS
  1.      1.       1.        1.        3.                                         FT
                                       2.                                         CNF
                                       1.5                                        CNPF
                                       1.0                                        FCP
  1.5     2.0      2.0       2.0       4.0                                        CNLD
       0         0         0         0         0                                  IDW
       1                                                                            NTL
 STORE UNDER WING AND PYLON
 8.7      6.8      3.02      0.        0.                                          XM
       2         0         0         5                                             NALF
 0.       2.                                                                       ALFW
       2                                                                          IGO
 TEST CASE  FUSELAGE NOSE
 1.2                                                                              BM
       0         0                                                                LU, MO
       0                                                                          NSS
       0                                                                          IG
 0.0
       0                                                                          IG
      16                                                                              NBP
 -14.75   0.       1.06      7.5       10.15     4.66                              XNOSE
 .639     .403                                                                     XB
1.28      .71
1.92      .99
2.55      1.21
3.19      1.39
3.83      1.54
4.67      1.67
5.75      1.78
7.07      1.87
10.15     2.02
15.       2.02
```

FIGURE B-3
Program STORLD - supersonic, test case input data

```
 20.        2.02
25.         2.02
 30.        2.02
 35.        2.02
40.         2.02
           0                                                                           NST
 0.0                                                                                   XLIP
           1                                                                            NTL
 STORE OPPOSITE NOSE
-12.        6.8         3.08       0.         0.                                       XM
           1         1          0         1                                            NALF
 0.                                                                                    ALFW
           2                                                                           IGO
 TEST CASE INLET
 1.2                                                                                  BM
           0         0                                                                LU, MO
           0                                                                          NSS
           0                                                                          IG
 0.0
           0                                                                          IG
           0                                                                           NBP
 0.0                                                                                   XNOSE
           2         2                                                                 NST
 1.2        4.4       0.67                                                             XLTP
 -1.5      2.4         -1.1       2.1       .227       1.6       90.                  -10.
 -.15      2.4         -1.1      2.1         .332     1.3        90.                  -10.
           1                                                                            NTL
 STORE OPPOSITE INLET
 -2.0       6.8        3.08       0.         0.                                        XM
           1         1          1         2                                            NALF
 0.                                                                                    ALFW
           0                                                                           IGO
```

FIGURE B-3 (concluded)

0THIS PROGRAM PREDICTS AERO INTERFERENCE ON AIRCRAFT STORES,

METHOD FORMULATED AND PROGRAMMED BY F DAN FERNANDES

1

0AIRCRAFT TITLE- TEST CASE WING WITH CAMBER, TWIST, AND PYLON

0ELAPSED CP TIME = 1.630 SECONDS, INCREMENT = 1.630 SECONDS

0MACH NUMBER= 1.200 BETA= .6633

0 ZARTARIAN COEFFICIENTS (A.I.C.'S) USING LU = 5 MO= 10

0	..78365	.08816	.03693	.02038	.01293
1	-.39183	.25109	.04538	.02262	.01378
2	-.29517	.18290	.03294	.01705	.01073
3	-.24675	.15059	.02679	.01404	.00896
4	-.21635	.13089	.02304	.01212	.00779
5	-.19498	.11730	.02048	.01079	.00695
6	-.17891	.10721	.01859	.00980	.00633
7	-.16626	.09933	.01713	.00903	
8	-.15596	.09297	.01596		
9	-.14736	.08769			
10	-.14005				

0WING PARAMETERS

NSS= 14 NSC= 4

0 SM= 1.2350 APEX= 0.0000 S= .6790 ZW= 0.0000

0 WING CROSSFLOW AXIAL RATE OF CHANGE, DALFDX = 0.000 ALPHA = 0 AT X = 0.000

0XMAX = 15.8000 II= 3 JOI= 15

0WING LIFT DUE TO CAMBER, TWIST, AND/OR LINEAR AXIAL CROSSFLOW VARIATION

0WING SECTION CL VERSUS SPAN

J	CL
1	.03706
2	.03370
3	.03530
4	.04971
5	.03633
6	.03205
7	.06634
8	.05808
9	.13319
10	0.00000
11	0.00000
12	0.00000
13	0.00000
14	0.00000

0WING TOTAL CL = .04253

0WING LIFT DUE TO ONE DEGREE ANGLE OF ATTACK

0WING SECTION CL VERSUS SPAN

J	CL
1	.05636
2	.06529
3	.07313
4	.07717
5	.08316
6	.09151
7	.09888
8	.14852
9	.24135

FIGURE B-4
Program STORLD - supersonic, test case output data

```
      9    [illegible]
     10      0.00000
     11      0.00000
     12      0.00000
     13      0.00000
     14      0.00000
 0WING TOTAL CL =     .08060
 0 J      WING DK MATRIX
     1
       .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745   .01745
     2
      -.00684   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745
     3
      -.00247  -.01676   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
     4
      -.00132  -.00694  -.02127  -.08476  -.08476   .01744   .01744   .01744   .01744   .01744   .01744   .01744
       .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744
     5
      -.00084  -.00401  -.00905  -.08476  -.08476  -.08476   .01744   .01744   .01744   .01744   .01744   .01744
       .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744
     6
      -.00059  -.00269  -.00531   .04392  -.08476  -.08476   .01744   .01744   .01744   .01744   .01744   .01744
       .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744
     7
      -.00045  -.00196  -.00360   .01601   .06653  -.08476  -.08476   .01744   .01744   .01744   .01744   .01744
       .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744
     8
      -.00035  -.00151  -.00265   .00844   .02524   .06432  -.08476  -.08476   .01744   .01744   .01744   .01744
       .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744
     9
      -.00029  -.00121  -.00235   .00489   .01418   .02303   .03313  -.08476   .01744   .01744   .01744   .01744
       .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744
    10
      -.00024  -.00100  -.00337  -.00081   .00495   .00783   .00438   .02229  -.08476   .01744   .01744   .01744
       .01744   .01744   .01744   .01744   .01744   .01744   .01744   .01744
    11
      -.00020   .00004  -.00157   .00044   .00493   .00552   .00076  0.00000  0.00000  -.08476   .01744   .01744
       .01744   .01744   .01744   .01744   .01744   .01744   .01744
    12
       .00216   .00451   .00410   .00609   .00838   .00918  0.00000  0.00000  0.00000  -.08476  -.08476   .01744
       .01744   .01744   .01744   .01744   .01744   .01744   .01744
    13
       .00025   .00411   .00677   .00970   .01164  0.00000  0.00000  0.00000  0.00000  0.00000  -.08476   .01744
       .01744   .01744   .01744   .01744   .01744   .01744
    14
      -.00004   .00020   .00474   .01054  0.00000  0.00000  0.00000  0.00000  0.00000  0.00000  0.00000  -.08476
       .01744   .01744   .01744   .01744   .01744

    15
      -.00012  -.00043
 0 J      WING DW MATRIX
     1
       .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745   .01745
     2
      -.00684   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745
     3
      -.00247  -.01676   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
       .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745   .01745
```


FIGURE B-4 (continued)

J												
	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745
4												
	-.00132	-.00694	-.02127	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	
5												
	-.00084	-.00401	-.00905	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	
6												
	-.00059	-.00269	-.00531	-.02630	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745		
7												
	-.00045	-.00196	-.00360	-.01187	-.03431	.01745	.01745	.01745	.01745	.01745	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745		
8												
	-.00035	-.00151	-.00265	-.00724	-.01612	-.03721	.01745	.01745	.01745	.01745	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745			
9												
	-.00029	-.00121	-.00205	-.00545	-.00946	-.01835	-.04321	.01745	.01745	.01745	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745				
10												
	-.00024	-.00100	-.00337	-.00628	-.01079	-.01573	-.02482	-.05146	.01745	.01745	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745	.01745	.01745				
11												
	-.00020	.00004	-.00157	-.00527	-.00659	-.01012	-.01515	0.00000	0.00000	.01745	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745	.01745					
12												
	.00216	.00451	.00410	.00154	-.00039	-.00217	0.00000	0.00000	0.00000	.01745	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745	.01745					
13												
	.00025	.00411	.00677	.00597	.00463	0.00000	0.00000	0.00000	0.00000	0.00000	.01745	.01745
	.01745	.01745	.01745	.01745	.01745	.01745						
14												
	-.00004	.00020	.00474	.00740	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.01745
	.01745	.01745	.01745	.01745	.01745							
15												
	-.00012	-.00043										

1MORE WING PARAMETERS

J	ILE	ITE	YS	XS	CS	ALFS	TTC	XCAM
1	1	26	.6790	.8386	23.1000	1.0000	-0.0000	-0.0000
2	2	25	2.0370	2.5157	21.7000	1.0000	-0.0000	-0.0000
3	3	24	3.3950	4.1928	20.3000	1.0000	-0.0000	-0.0000
4	4	23	4.7530	5.8700	18.9000	.3000	.9000	1.0000
5	4	23	6.1110	7.5471	17.6000	.3000	.8700	1.0000
6	5	22	7.4690	9.2242	16.2000	.3000	.8400	1.0000
7	6	22	8.8270	10.9013	14.9000	.3000	.8100	1.0000
8	7	21	10.1850	12.5785	13.5000	.3000	.7700	1.0000
9	8	20	11.5430	14.2556	12.2000	.3000	.7500	1.0000
10	9	20	12.9010	15.9327	10.8000	.3000	.7200	1.0000
11	10	19	14.2590	17.6099	9.6000	.3000	.6900	1.0000
12	10	19	15.6170	19.2870	8.3000	.3000	.6600	1.0000
13	11	18	16.9750	20.9641	6.9000	.3000	.6300	1.0000
14	12	17	18.3330	22.6413	5.7000	.3000	.6000	1.0000
15	3	2	19.6910					

0 I	THU	DZDX	CF
1	.20400	-.09000	.12000
2	.04150	.01220	.18000
3	-0.00000	.01220	.30000
4	-.08000	.01220	.40000

WING DT MATRIX

0 J				
1	.01745	.01745	.01745	.01745
2	.01745	.01745	.01745	.01745
3	.01745	.01745	.01745	.01745
4	.09984	.05479	.01744	-.05456
5	.09272	.05354	.01744	-.05216
6	.08660	.05230	.01744	-.04976
7	.08048	.05165	.01744	-.04736

FIGURE B-4 (continued)

```
   8      .07232    .04939    .01744   -.04416
   9      .06824    .04856    .01744   -.04256
  10      .06212    .04732    .01744   -.04016
  11      .05600    .04607    .01744   -.03776
  12      .04988    .04483    .01744   -.03536
  13      .04376    .04358    .01744   -.03296
  14      .03764    .04234    .01744   -.03056
1
0PYLON INPUT
                         X1=  9.770      X2=  6.750      X3= 15.800      X4= 15.800
                         Z1=   .200      Z2=  1.800      YP=  6.800      XMAXP= 15.800
0PYLON PARAMETERS

                         APEXP=    6.2049   SP=     .400   IIP=  15    JDIP=  17
0 J      ILEP      ITEP       IPS
   1        5        17        17
   2        1        16        16
   3       15        14        15
   4       14        13        14
   5       13        12        13
   6       12        11        12
   7       11        10        11
   8       10         9        10
   9        9         8         9
  10        8         7         8
  11        7         6         7
  12        6         5         6
  13        5         4         5
  14        4         3         4
  15        3         2         3
  16        2         1         2
  17        1         0         1
0PYLON DKP MATRIX

    1
   0.00003  0.00000   .00119   .01369  -.04354  -.01690  -.00189   .00497   .00743  -.00086   .00043   .01307
    .02985   .01732   .00679  -.00033   .00209

    2
   -.00303  -.03341  -.05063  -.03432  -.02148  -.00574  -.00118  -.00353   .00242  -.00240   .00206   .01464
    .01115  -.00084   .00590  -.00137
    3
    .00119   .01326   .02129   .01183   .02574   .03261   .01368   .00225  -.00515  -.00602  -.00558  -.01359
   -.01864  -.01365  -.01149
    4
    .00043   .00475   .00715   .00330   .01072   .01427   .00525   .00019  -.00301  -.00385  -.00388  -.00799
   -.00903  -.00714
    5
    .00023   .00252   .00365   .00150   .00630   .00858   .00298  -.00006  -.00198  -.00267  -.00290  -.00493
   -.00613
    6
    .00015   .00160   .00227   .00086   .00429   .00593   .00200  -.00008  -.00123  -.00176  -.00211  -.00372
    7
    .00010   .00113   .00157   .00057   .00318   .00443   .00149   .00017  -.00086  -.00166  -.00247
    8
    .00008   .00085   .00117   .00041   .00248   .00352   .00147  -.00135  -.00366  -.00534
    9
    .00006   .00067   .00091   .00032   .00228   .00632   .01155   .01833   .01907
   10
    .00005   .00054   .00074  -.00013  -.00281  -.00743  -.00481  -.00283
   11
    .00004   .00045   .00066   .00048  -.00045  -.00610  -.00199
   12
    .00004   .00064   .00382   .01057   .00860   .00770
   13
   -.00037  -.00441  -.00958  -.01176  -.01715
```


FIGURE B-4 (continued)

```
[illegible]  -.01719
     14
      -.00004  -.00049  -.00084  -.00106
     15
       .00001   .00009   .00022
     16
       .00002   .00023
     17
       .00002
 0PYLON DWP MATRIX

       1
      0.00000  0.00000   .00119   .00540  -.03077  -.01220  -.01084  -.01277  -.02284  -.02544  -.00573  -.00630
      -.00844  -.01726  -.02182  -.00432  -.00704

       2
      -.00303  -.01224  -.01910  -.01965  -.01772  -.00542  -.00987  -.01638  -.02292  -.00931  -.00144  -.00724
      -.01476  -.02013  -.00617  -.00396
       3
       .00119   .00497   .00775   .00721   .01798   .01976   .01540   .01699   .02067   .01802   .01070   .00906
       .00973   .01272   .01314
       4
       .00043   .00175   .00259   .00229   .00725   .00835   .00614   .00656   .00761   .00652   .00361   .00271
       .00232   .00303
       5
       .00023   .00092   .00132   .00114   .00416   .00493   .00352   .00369   .00414   .00350   .00162   .00113
       .00059
       6
       .00015   .00058   .00082   .00070   .00279   .00337   .00237   .00246   .00274   .00233   .00121   .00059
       7
       .00010   .00041   .00057   .00048   .00204   .00250   .00176   .00187   .00196   .00170   .00059
       8
       .00008   .00031   .00042   .00036   .00158   .00200   .00136   .00084   .00064  -.00043
       9
       .00006   .00024   .00033   .00028   .00154   .00719   .00530   .00917   .01086
      10
       .00005   .00019   .00027  -.00015  -.00078  -.00251  -.00080   .00024
      11
       .00004   .00016   .00027   .00014   .00014  -.00261  -.00013
      12
       .00004   .00039   .00173   .00428   .00245   .00238
      13
      -.00037  -.00179  -.00373  -.00539  -.00928

      14
      -.00004  -.00018  -.00034  -.00050
      15
       .00001   .00004   .00007
      16
       .00002   .00009
      17
       .00002
 0NOSE PARAMETERS
       NBP=  0      XNOSE=    0.00      YNOSE=  -0.00       ZNOSE=  -0.00       ALFNW=  -0.00 DEG.
       XBL OR XS =    -0.000       XD =   -0.000
 0THICKNESS STRIP PARAMETERS


       NST= 0      NIN=-0      XLIP=    0.00      YLIP=  -0.00      ZLIP=  -0.00
 0ELAPSED CP TIME =    7.643 SECONDS, INCREMENT =     6.013 SECONDS
 1
 0STORE    TITLE-   SAMPLE STORE, FIGURE 14 OF REF 1, PART I
 0STORE INPUT

  NO OF  STORE  BODY STATIONS, NMS=   5
 0DELX=  [illegible]   XCG=   5.6000   DIA=  [illegible]   XSTART=  0.0000   FIN=  [illegible]
```


FIGURE B-4 (continued)

```
0                       STORE  ROLL ANGLE = -45.000
0    CNLA      RS       FT      CNF     CNPF     FCP     CNLD    XBAR
  1  1.500    .700    1.000  -0.000  -0.000  -0.000   1.500   4.600

  2  0.000   1.000    1.000  -0.000  -0.000  -0.000   2.000   2.600

  3  0.000   1.000    1.000  -0.000  -0.000  -0.000   2.000    .600

  4  0.000   1.000    1.000  -0.000  -0.000  -0.000   2.000  -1.400

  5   .500   1.000    3.000   2.000   1.500   1.000   4.000  -3.400

1FLOW FIELD COMPUTATION

 STORE TRAVERSE LINE LOCATED THROUGH POINT (X,Y,Z) =    8.700    6.800    3.080
     TRAVERSE LENGTH =    0.000 FT   AT INCIDENCE =    0.000 DEG
0COMPUTATION MODE       IB=  0      IA=  0      IW=  5      NK=  6      FTM=  3.000        DIA=  1.000
0DISTURBANCE FLOW FIELD HAS BEEN COMPUTED
0  XC      K  J         U           V           W           UT          VT          WT
  12.100   1  1 -.1444E-01  .1690E-01  .1039E-01 -.2370E-01  .7259E-02  .2955E-01
  10.100   2  1 -.1355E-01  .1116E-01  .8691E-02 -.4224E-01  .2149E-01  .3372E-01
   8.100   3  1 -.4869E-03  .2823E-02 -.1216E-02 -.4869E-03  .2823E-02 -.1216E-02
   6.100   4  1 -.3722E-02  .2604E-02  .7398E-03 -.3722E-02  .2604E-02  .7398E-03
   4.100   5  1 0.          0.          0.          0.          0.          0.
0ELAPSED CP TIME =      8.144 SECONDS, INCREMENT =       .501 SECONDS
1
0AIRCRAFT TITLE-    TEST CASE WING WITH CAMBER, TWIST, AND PYLON
0STORE    TITLE-    SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-    STORE UNDER WING AND PYLON
0MACH NUMBER= 1.200       RESULTS FOR
0AIRCRAFT ALPHA =     0.000        STORE  ALPHA =    0.000      UNDER LEFT WING


0 XC       K        ALZ          WS          WD           BZ          ALZD           ARS          ARD
  12.100   1  .3007E-01  .6014E-01 0.            0.               -.5433E-02 0.            0.
  10.100   2  .2883E-01  .5767E-01 0.            0.                .6668E-02 0.            0.
   8.100   3  .3396E-02  .6792E-02 0.            0.                .7107E-02 0.            0.
   6.100   4  .4029E-03  .8058E-03 0.            0.                .8258E-03 0.            0.
   4.100   5  .9248E-04  .1850E-03 0.            0.                .1007E-03 0.            0.
0 XC       K        ALY          VS          VD           BY          ALYD
  12.100   1  .9039E-02  .1808E-01 0.            0.               -.9316E-02
  10.100   2  .1738E-01  .3475E-01 0.            0.                .9773E-03
   8.100   3  .5129E-02  .1026E-01 0.            0.                .3768E-02
   6.100   4  .2306E-02  .4612E-02 0.            0.                .1201E-02
   4.100   5  .3256E-03  .6511E-03 0.            0.                .5765E-03
0             /--                     PHI = 0                       --/         /--                          PHI=-45.000         --/
        X      NORMAL-F     SIDE-F   PITCH-M      YAW-M     ROLL-M                 NORMAL-F     SIDE-F   PITCH-M        YAW-M
     0.000       -.166       .003      .372       -.128      0.000                    -.119      -.115      .354         .173
0ELAPSED CP TIME =      8.229 SECONDS, INCREMENT =       .085 SECONDS
1
0AIRCRAFT TITLE-    TEST CASE WING WITH CAMBER, TWIST, AND PYLON
0STORE    TITLE-    SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-    STORE UNDER WING AND PYLON
0MACH NUMBER= 1.200       RESULTS FOR
0AIRCRAFT ALPHA =     2.000        STORE  ALPHA =    2.000      UNDER LEFT WING


0 XC       K        ALZ          WS          WD           BZ          ALZD           ARS          ARD
  12.100   1  .5042E-01  .1008E+00 0.            0.               -.5366E-02 0.            0.
  10.100   2  .4416E-01  .8832E-01 0.            0.                .1162E-01 0.            0.
   8.100   3  .3930E-02  .7860E-02 0.            0.                .1074E-01 0.            0.
   6.100   4  .1209E-02  .2417E-02 0.            0.                .9131E-03 0.            0.
   4.100   5  .2774E-03  .5549E-03 0.            0.                .3022E-03 0.            0.
0 XC       K        ALY          VS          VD           BY          ALYD
  12.100   1  .4140E-01  .8279E-01 0.            0.               -.4800E-02
  10.100   2  .3906E-01  .7812E-01 0.            0.                .7448E-02
```

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FIGURE B-4 (continued)

8.100	3	.1281E-01	.2561E-01	0.	0.	.8033E-02
6.100	4	.6919E-02	.1384E-01	0.	0.	.2957E-02
4.100	5	.9767E-03	.1953E-02	0.	0.	.1730E-02

0 /-- PHI = 0 --/ /-- PHI=-45.000 --/

X	NORMAL-F	SIDE-F	PITCH-M	YAW-M	ROLL-M	NORMAL-F	SIDE-F	PITCH-M	YAW-M
0.000	-.304	-.249	.733	.526	0.000	-.039	-.391	.146	.890

0ELAPSED CP TIME = 8.311 SECONDS, INCREMENT = .082 SECONDS

END OF RUN 1

1

0AIRCRAFT TITLE- TEST CASE FUSELAGE NOSE

0ELAPSED CP TIME = 8.323 SECONDS, INCREMENT = .012 SECONDS

0MACH NUMBER= 1.200 BETA= .6633

0 ZARTARIAN COEFFICIENTS (A.I.C.'S) USING LU = 0 MO= 0

0WING PARAMETERS

NSS= 0 NSC= -0

0PYLON INPUT

X1= 0.000 X2= -0.000 X3= -0.000 X4= -0.000

Z1= -0.000 Z2= -0.000 YP= -0.000 XMAXP= -0.000

1

0NOSE PARAMETERS

NBP= 16 XNOSE= -14.75 YNOSE= 0.00 ZNOSE= 1.06 ALFNW= 7.50 DEG.

XBL OR XS = 10.150 XO = 4.660

0 XB	RB	SLOPE	SNA	SNC	J
.93237	.58802	.49967	.2273E+00	-.7950E-02	1
1.86767	1.03597	.45820	-.5664E-01	.2407E-02	2
2.80150	1.44452	.39301	-.4622E-01	.4733E-03	3
3.72074	1.76553	.31550	-.5635E-01	.1032E-02	4
4.65457	2.02817	.25781	-.3587E-01	.1334E-02	5
5.58840	2.24703	.19995	-.3617E-01	.9768E-03	6
6.81406	2.43672	.13161	-.3643E-01	.1696E-02	7
8.38990	2.59722	.08670	-.2770E-02	.1615E-02	8
10.31593	2.72854	.06234	.1192E-01	.6268E-03	9
14.81090	2.94741	.02979	.1044E-01	-.7793E-03	10
21.88670	2.94741	0.00000	.6865E-02	-.5323E-03	11
29.18227	2.94741	0.00000	.1146E-01	-.1045E-02	12
36.47783	2.94741	0.00000	.2082E-02	.8064E-04	13
43.77340	2.94741	0.00000	.4403E-03	.7630E-04	14
51.06897	2.94741	0.00000	.1071E-03	-.6905E-05	15
58.36453	2.94741	0.00000	.3047E-04	-.4688E-05	16

0THICKNESS STRIP PARAMETERS

NST= 0 MIN=-0 XLIP= 0.00 YLIP= -0.00 ZLIP= -0.00

0ELAPSED CP TIME = 8.500 SECONDS, INCREMENT = .177 SECONDS

1FLOW FIELD COMPUTATION

STORE TRAVERSE LINE LOCATED THROUGH POINT (X,Y,Z) = -12.000 6.800 3.080

TRAVERSE LENGTH = 0.000 FT AT INCIDENCE = 0.000 DEG

0COMPUTATION MODE IB= 1 IA= 0 IW= 1 NK= 6 FTM= 3.000 DIA= 1.000

0DISTURBANCE FLOW FIELD HAS BEEN COMPUTED

0 XC	K	J	U	V	W	UT	VT	WT
-8.600	1	1	-.1326E-02	.2005E-02	-.7225E-03	-.1424E-01	.2173E-01	.2813E-01
-8.600	1	2	-.1161E-02	.1861E-02	-.1089E-02	-.1162E-01	.2263E-01	.2667E-01
-8.600	1	3	-.1368E-02	.2339E-02	-.6859E-03	-.5660E-02	.1571E-01	.2687E-01
-8.600	1	4	-.1258E-02	.2296E-02	-.1411E-02	-.2812E-02	.1711E-01	.2856E-01
-8.600	1	5	-.1415E-02	.1752E-02	-.2118E-03	-.2687E-01	.2732E-01	.2975E-01
-8.600	1	6	-.9780E-03	.1321E-02	-.1311E-02	-.1900E-01	.3003E-01	.2536E-01
-8.600	1	7	-.1540E-02	.2756E-02	-.1022E-03	-.1124E-02	.9269E-02	.2598E-01
-8.600	1	8	-.1210E-02	.2627E-02	-.2278E-02	.7420E-02	.1348E-01	.3102E-01

0ELAPSED CP TIME = 8.676 SECONDS, INCREMENT = .176 SECONDS

1

~~0AIRCRAFT TITLE- TEST CASE FUSELAGE NOSE~~

FIGURE B-4 (continued)

```
1
0AIRCRAFT TITLE-     TEST CASE  FUSELAGE NOSE
0STORE     TITLE-   SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-   STORE OPPOSITE NOSE
0MACH NUMBER= 1.200      RESULTS FOR
0AIRCRAFT ALPHA =    0.000        STORE  ALPHA =    0.000      UNDER LEFT WING


0 XC      K       ALZ          WS          WD          BZ          ALZD        ARS         ARD
  -8.600  1  .2956E-01  .5895E-01  .2276E-03  .7904E-02 -.9379E-02 -.1271E-02 -.1271E-02
0 XC      K       ALY          VS          VD          BY          ALYD
  -8.600  1  .2349E-01  .4552E-01 -.8631E-03  .2603E-01 -.1790E-01
0               /--                    PHI = 0                         --/          /--                        PHI=-45.000       --/
       X      NORMAL-F     SIDE-F   PITCH-M      YAW-M     ROLL-M                    NORMAL-F     SIDE-F   PITCH-M      YAW-M
     0.000      -.230       -.025     -.257      -.897      -.006                       -.145       -.181      .453      -.816
0ELAPSED CP TIME =     8.823 SECONDS, INCREMENT =      .058 SECONDS
                    END OF RUN      2
1
0AIRCRAFT TITLE-     TEST CASE INLET
0ELAPSED CP TIME =     8.835 SECONDS, INCREMENT =      .012 SECONDS
0MACH NUMBER= 1.200       BETA=  .6633
0                      ZARTARIAN COEFFICIENTS (A.T.C.'S) USING LU =  0   MO=  0

0WING PARAMETERS

     NSS=  0      NSC= -0
0PYLON INPUT
                        X1=  0.000      X2= -0.000      X3= -0.000      X4= -0.000
                        Z1= -0.000      Z2= -0.000      YP= -0.000      XMAXP= -0.000
0NOSE PARAMETERS
     NBP=  0      XNOSE=    0.00      YNOSE=  -0.00      ZNOSE=  -0.00      ALFNW=  -0.00 DEG.
     XBL OR XS =    -0.000      XO =   -0.000
1
0THICKNESS STRIP PARAMETERS

     NST= 2      NIN= 2      XLIP=    1.20      YLIP=    4.40      ZLIP=     .67


       XST          YST          ZST          SST          THST         DXST         PHST         ALST
     -1.5000       2.4000      -1.1000       2.1000        .2270       1.6000      90.0000     -10.0000
      -.1500       2.4000      -1.1000       2.1000        .3320       1.3000      90.0000     -10.0000
0ELAPSED CP TIME =     8.907 SECONDS, INCREMENT =      .072 SECONDS
1FLOW FIELD COMPUTATION

 STORE TRAVERSE LINE LOCATED THROUGH POINT (X,Y,Z) =  -2.000    6.800    3.080
     TRAVERSE LENGTH =    0.000 FT   AT INCIDENCE =    0.000 DEG
0COMPUTATION MODE      IR=  1       IA=  1       IW=  2       NK=  6       FTM=  3.000      DTA=  1.000
0DISTURBANCE FLOW FIELD HAS BEEN COMPUTED
0  XC      K  J          U            V            W          UT           VT           WT
    1.400  1  1 0.           0.           0.           -.1023E+00   .5875E-01   .3529E-01
    1.400  1  2 0.           0.           0.           -.1464E+00   .8797E-01   .4353E-01
    1.400  1  3 0.           0.           0.           -.9021E-01   .49875-01   .3424E-01
    1.400  1  4 0.           0.           0.           -.1290E+00   .7588E-01   .4173E-01
    1.400  1  5 0.           0.           0.           0.           0.           0.
    1.400  1  6 0.           0.           0.           0.           0.           0.
    1.400  1  7 0.           0.           0.           -.9369E-01   .4270E-01   .4777E-01
    1.400  1  8 0.           0.           0.           -.1877E+00   .1023E+00   .9845E-01
    -.600  2  1 0.           0.           0.           0.           0.           0.
    -.600  2  2 0.           0.           0.           0.           0.           0.
    -.600  2  3 0.           0.           0.           0.           0.           0.
    -.600  2  4 0.           0.           0.           0.           0.           0.
    -.600  2  5 0.           0.           0.           0.           0.           0.
    -.600  2  6 0.           0.           0.           0.           0.           0.
    -.600  2  7 0.           0.           0.           0.           0.           0.
    -.600  2  8 0.           0.           0.           0.           0.           0.
0ELAPSED CP TIME =     9.272 SECONDS, INCREMENT =      .365 SECONDS
1
0AIRCRAFT TITLE-     TEST CASE INLET
0STORE     TITLE-   SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-   STORE OPPOSITE INLET
0MACH NUMBER= 1.200      RESULTS FOR
0AIRCRAFT ALPHA =    0.000        STORE  ALPHA =    0.000      UNDER LEFT WING
```

FIGURE B-4 (continued)

```
0ELAPSED CP TIME =     9.272 SECONDS, INCREMENT =       .365 SECONDS
1
0AIRCRAFT TITLE-     TEST CASE INLET
0STORE    TITLE-   SAMPLE STORE, FIGURE 14 OF REF 1, PART I
0STORE LOCATION-   STORE OPPOSITE INLET
0MACH NUMBER= 1.200      RESULTS FOR
0AIRCRAFT ALPHA =   0.000       STORE  ALPHA =   0.000      UNDER LEFT WING

0 XC      K        ALZ          WS          WD          BZ         ALZD         ARS         ARD
   1.400  1  .3386E-01  .6913E-01 -.1562E-01 -.1025E+00  .2056E-01 -.3593E-01  .4475E-01
   -.600  2  .4837E-02  .9875E-02 -.2232E-02 -.1464E-01  .8465E-02 -.5132E-02  .6393E-02
0 XC      K        ALY          VS          VD          BY         ALYD
   1.400  1  .5960E-01  .1195E+00 -.3913E-01  .3650E-01  .3619E-01
   -.600  2  .8515E-02  .1708E-01 -.5590E-02  .5214E-02  .1490E-01
0              /--                     PHI = 0                   --/       /--                   PHI=-45.000        --
      X      NORMAL-F    SIDE-F   PITCH-M     YAW-M    ROLL-M              NORMAL-F     SIDE-F  PITCH-M       YAW-
    0.000      -.570      -.475     1.794     1.483      .040                -.067       -.739     .220      2.317
0ELAPSED CP TIME =     9.337 SECONDS, INCREMENT =       .065 SECONDS
                    END OF RUN       3
```


FIGURE B-4 (concluded)

```
TEST CASE, PROGRAM SHOCK, NOSE, INLET, PYLON,  DETACHED SHOCKS
1.2                                                                 BM
         12                                                         NBPP
 90.                                                                ESO
-14.75      0.        1.06      35.                                 XNOSE
 .639       .403                                                    XB
1.28        .71
1.92        .99
2.55       1.21
3.19       1.39
3.83       1.54
4.67       1.67
5.75       1.78
7.07       1.87
10.15      2.02
15.        2.02
 20.       2.02
-2.3        1.4      -1.1        2.9      3.34      90.             XIO
         1                                                          NP
 6.75       6.8       1.8        .21                                XP
         1                                                          NTLP
 8.7        6.8       3.08       0.                                 XM
TEST CASE, PROGRAM SHOCK, ATTACHED SHOCK ON NOSE
 2.0                                                                BM
         0                                                          NBPP
 55.0                                                               ESO
 0.                                                                 XIO
         0                                                          NP
         0                                                          NTLP
 ZERO MACH TO END
  0.0                                                               BM
```

FIGURE B-5
Program SHOCK
test case input data

```
0THIS PROGRAM CALCULATES AXIAL SHIFT OF SHOCK WAVE AHEAD OF MACH WAVE (DSHIFT),
 SHOCKS PRODUCED BY AIRCRAFT NOSE,INLET,PYLONS,INTERSECTING STORE AXIAL TRAVERSE LINE,
 DSHIFT TO BE USED IN PREDICTING SUPERSONIC AERO INTERFERENCE ON STORE
1     TITLE,   TEST CASE, PROGRAM SHOCK, NOSE, INLET, PYLON,  DETACHED SHOCKS     (RUN # ONE)
0MACH NO.      M= 1.2000
0MACH FUNCTIONS     DDET= 19.450     ETA= 16.300     ES= 68.000     C= .74500


0NOSE INPUT
      ESC = 90.0000
      NBP= 12      XNOSE= -14.75     YNOSE=    0.00     ZNOSE=    1.06  DELTA=  35.000
0           NOSE COORDINATES

          XB          RB      SLOPE
   1     .6390       .4030     .4997
   2    1.2800       .7100     .4582
   3    1.9200       .9900     .3930
   4    2.5500      1.2100     .3155
   5    3.1900      1.3900     .2578
   6    3.8300      1.5400     .1999
   7    4.6700      1.6700     .1316
   8    5.7500      1.7800     .0867
   9    7.0700      1.8700     .0623
  10   10.1500      2.0200     .0298
  11   15.0000      2.0200    0.0000
  12   20.0000      2.0200    0.0000
0INLET INPUT
      X,Y,Z OF APEX =      -2.300      1.400     -1.100
      HINLT=   2.900     AINLT =    3.340     ESOINT =  90.000
0PYLON INPUT
          XP          YP          ZP          WP
   1     6.7500      6.8000      1.8000      .2100
1       STORE  LOCATION       X=  8.700      Y=  6.800      Z=  3.080     INCIDENCE =   0.000
0                    NOSE ---
0                         DETACHED SHOCK

                          SHIFT FROM MACH WAVE AT STORE TRAVERSE LINE, DSHIFT =     4.66495
0                         EQUIVALENT BODY SHAPE IS A CONE CYLINDER OF MAX RADIUS   2.0200
                          AND WITH SHOULDER AT   4.0805 FROM APEX
0                         SHOCK STANDOFF  DISTANCE =   1.0555
0                         SHOCK APEX LOCATION, X,Y,Z =  -15.8055   0.0000   1.0600

0                         SHOCK ASYMPTOTE ORIGIN, X,Y,Z =  -25.3588   0.0000   1.0600
0                    INLET ---
0                         DETACHED SHOCK

                          SHIFT FROM MACH WAVE AT STORE TRAVERSE LINE, DSHIFT =     3.96749
0                         EQUIVALENT BODY SHAPE IS A CONE CYLINDER OF MAX RADIUS   1.4582
                          AND WITH SHOULDER AT   2.9000 FROM APEX
0                         SHOCK STANDOFF  DISTANCE =    .7956
0                         SHOCK APEX LOCATION, X,Y,Z =   -3.0956   1.4000  -1.1000

0                         SHOCK ASYMPTOTE ORIGIN, X,Y,Z =   -9.9721   1.4000  -1.1000
0                    PYLON NO.  1 AS A HEMISPHERE CYLINDER
0                         DETACHED SHOCK

                          SHIFT FROM MACH WAVE AT STORE TRAVERSE LINE, DSHIFT =      .44746
0                         SHOCK STANDOFF  DISTANCE =    .1388
0                         SHOCK APEX LOCATION, X,Y,Z =    6.6112   6.8000   1.8000
```

FIGURE B-6
Program SHOCK
test case output data

```
0                       SHOCK STANDOFF  DISTANCE =    .7956
0                       SHOCK APEX LOCATION, X,Y,Z =   -3.0956   1.4000  -1.1000

0                       SHOCK ASYMPTOTE ORIGIN, X,Y,Z =   -9.9721   1.4000  -1.1000
0                  PYLON NO. 1 AS A HEMISPHERE CYLINDER
0                       DETACHED SHOCK

                        SHIFT FROM MACH WAVE AT STORE TRAVERSE LINE, DSHIFT =     .44746
0                       SHOCK STANDOFF  DISTANCE =    .1388
0                       SHOCK APEX LOCATION, X,Y,Z =    6.6112   6.8000   1.8000

0                       SHOCK ASYMPTOTE ORIGIN, X,Y,Z =    6.2144   6.8000   1.8000
1      TITLE,   TEST CASE, PROGRAM SHOCK, ATTACHED SHOCK ON NOSE                (RUN # TWO)
0MACH NO.       M= 2.0000
0MACH FUNCTIONS       DDET= 40.650      ETA= 45.400      ES= 61.500      C= .80600


0NOSE INPUT
     ESO = 55.0000
0INLET INPUT
     X,Y,Z OF APEX =        0.000    -0.000    -0.000
     HINLT=  -0.000      AINLT =  -0.000      ESOINT =  -0.000
1      STORE  LOCATION    X=  8.700      Y=  6.500      Z=  3.050      INCIDENCE =   0.000
0                  NOSE ---
0                       ATTACHED SHOCK

                        SHIFT FROM MACH WAVE AT STORE TRAVERSE LINE, DSHIFT =    4.54922
0                       EQUIVALENT BODY SHAPE IS A CIRCULAR ARC NOSE OF APEX ANGLE =  35.0000
                        AND WITH SHOULDER AT   6.4065 FROM APEX
1      TITLE,    ZERO MACH TO END
0MACH NO.       M= 0.0000
0---- MACH VALUE OF   0.00 IS OUTSIDE ACCEPTABLE RANGE OF 1.0 TO 3.0 -----
```


FIGURE B-6 (concluded)