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AN IMPROVED METHOD FOR THE AERODYNAMIC ANALYSIS OF WING-BODY-TAIL CONFIGURATIONS IN SUBSONIC AND SUPERSONIC FLOW

Part II - Computer Program Description

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16. Abstract

A new method has been developed for calculating the pressure distribution and aerodynamic characteristics of wing-body-tail combinations in subsonic and supersonic potential flow. A computer program has been developed to perform the numerical calculations.

The configuration surface is subdivided into a large number of panels, each of which contains an aerodynamic singularity distribution. A constant source distribution is used on the body panels, and a vortex distribution having a linear variation in the streamwise direction is used on the wing and tail panels. The normal components of velocity induced at specified control points by each singularity distribution are calculated and make up the coefficients of a system of linear equations relating the strengths of the singularities to the magnitude of the normal velocities.

The singularity strengths which satisfy the boundary condition of tangential flow at the control points for a given Mach number and angle of attack are determined by solving this system of equations using an iterative procedure. Once the singularity strengths are known, the pressure coefficients are calculated, and the forces and moments acting on the configuration determined by numerical integration.

This report describes the computer program developed to perform the numerical calculations.

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INTRODUCTION

A new method has been developed for calculating the pressure distribution and aerodynamic characteristics (lift, drag, and pitching moment) of wing-body-tail combinations in subsonic and supersonic potential flow. This report describes the computer program developed to perform the numerical calculations.

METHOD OF SOLUTION

The configuration surface is subdivided into a large number of panels, each of which contains an aerodynamic singularity distribution. A constant source distribution is used on the body panels, and a vortex distribution having a linear variation in the streamwise direction is used on the wing and tail panels. The normal components of velocity induced at specified control points by each singularity distribution are calculated and make up the coefficients of a system of linear equations relating the strengths of the singularities to the magnitude of the normal velocities.

The singularity strengths which satisfy the boundary condition of tangential flow at the control points for a given Mach number and angle of attack are determined by solving this system of equations using an iterative procedure. Once the singularity strengths are known, the pressure coefficients are calculated, and the forces and moments acting on the configuration determined by numerical integration. A detailed description of the method is given in Part I of this report.

PROGRAM DESCRIPTION

The computer program is written in CDC FORTRAN IV, version 2.3 for a SCOPE 3.0 operating system and library file. It is designed for the CDC 6000 series of computers, occupies 70,000 (octal) words, and operates in OVERLAY mode. The program requires five peripheral disc files in addition to the input and output files.

PROGRAM INPUT DATA

The input to this program consists of two basic parts, namely, the numerical description of the configuration geometry as adapted from reference 1, and an auxiliary data set specifying the singularity paneling scheme, program options, Mach number, and angle of attack. The program input is illustrated by the sample case presented in Appendix III.

Description of Input Geometry Cards

The configuration is defined to be symmetrical about the xz plane, therefore only one side of the configuration need be described. The convention used in this program is to present that half of the configuration located on the positive y side of the xz plane. The number of input cards depends on the number of components used to describe the configuration, and the amount of detail used to describe each component.

Card 1 - Identification.- Card 1 contains any desired identifying information in columns 1-80.

Card 2 - Control integers.- Card 2 contains 24 integers, each punched right justified in a 3-column field. Columns 73-80 may be used in any desired manner. Card 2 contains the following:

Columns	Variable	Value	Description
1-3	J0	0	No reference area
		1	Reference area to be read
4-6	J1	0	No wing data
		1	Cambered wing data to be read
		-1	Uncambered wing data to be read
7-9	J2	0	No fuselage data
		1	Data for arbitrarily shaped fuselage to be read
		-1	Data for circular fuselage to be read (With J6=0, fuselage will be cambered. With J6=-1, fuselage will be symmetrical with xy-plane. With J6=1, entire configuration will be symmetrical with xy-plane)
10-12	J3	0	No pod (nacelle) data
		1	Pod (nacelle) data to be read

Columns	Variable	Value	Description
13-15	J4	0	No fin (vertical tail) data
		1	Fin (vertical tail) data to be read
16-18	J5	0	No canard (horizontal tail) data
		1	Canard (horizontal tail) data to be read
19-21	J6	0	A cambered circular or arbitrary fuselage if J2 is nonzero
		1	Complete configuration is symmetrical with respect to xy-plane, which implies an uncambered circular fuselage if there is a fuselage
		-1	Uncambered circular fuselage with J2 nonzero
22-24	NWAF	2-20	Number of airfoil sections used to describe the wing
25-27	NWAFOR	3-30	Number of ordinates used to define each wing airfoil section. If the value of NWAFOR is input with a negative sign, the program will expect to read lower surface ordinates also
28-30	NFUS	1-4	Number of fuselage segments
31-33	NRADX(1)	3-30	Number of points used to represent half-section of first fuselage segment. If fuselage is circular, the program computes the indicated number of y- and z-ordinates
34-36	NFORX(1)	2-30	Number of stations for first fuselage segment
37-39	NRADX(2)	3-30	Same as NRADX(1), but for second fuselage segment
40-42	NFORX(2)	2-30	Same as NFORX(1), but for second fuselage segment
43-45	NRADX(3)	3-30	Same as NRADX(1), but for third fuselage segment

Columns	Variable	Value	Description
46-48	NFORX(3)	2-30	Same as NFORX(1), but for third fuselage segment
49-51	NRADX(4)	3-30	Same as NRADX(1), but for fourth fuselage segment
52-54	NFORX(4)	2-30	Same as NFORX(1), but for fourth fuselage segment
55-57	NP	0-9	Number of pods described
58-60	NPODOR	4-30	Number of stations at which pod radii are to be specified
61-63	NF	0-6	Number of fins (vertical tails) to be described
64-66	NFINOR	3-10	Number of ordinates used to describe each fin (vertical tail) airfoil section
67-69	NCAN	0-2	Number of canards (horizontal tails) to be described
70-72	NCANOR	3-10	Number or ordinates used to define each canard (horizontal tail) airfoil section. If the value of NCANOR is input with a negative sign, the program will expect to read lower surface ordinates also, otherwise the airfoil is assumed to be symmetrical

Cards 3, 4, . . . - remaining input data cards.- The remaining input data cards contain a detailed description of each component of the configuration. Each card contains up to 10 values, each value punched in a 7-column field with a decimal point and may be identified in columns 73-80. The cards are arranged in the following order: reference area, wing data cards, fuselage data cards, pod data cards, fin (vertical tail) data cards, and canard (horizontal tail) data cards.

Reference area card: The reference area value is punched in columns 1-7 and may be identified as REFA in columns 73-80.

Wing data cards: The first wing data card (or cards) contains the locations in percent chord at which the ordinates of all the wing airfoils are to be specified. There will be exactly NWAFOR locations in percent chord given. Each card may be identified in columns 73-80 by the symbol XAFJ where J denotes the last location in percent chord given on that card.

The next wing data cards (there will be NWAF cards) each contain four numbers which give the origin and chord length of each of the wing airfoils that is to be specified. The card representing the most inboard airfoil is given first, followed by the cards for successive airfoils. These cards contain the following:

Columns	Contents
1-7	x-ordinate of airfoil leading edge
8-14	y-ordinate of airfoil leading edge
15-21	z-ordinate of airfoil leading edge
22-28	airfoil streamwise chord length
73-80	card identification, WAFORGJ where J denotes the particular airfoil, thus WAFORG1 denotes the most inboard airfoil

If a cambered wing has been specified, the next set of wing data cards is the mean camber line cards. There will be NWAFOR values of delta z referenced to the z-ordinate of the airfoil leading edge, each value corresponding to a specified percent chord location on the airfoil. These cards are arranged in the order which begins with the most inboard airfoil and proceeds outboard. Each card may be identified in columns 73-80 as TZORDJ where J denotes the particular airfoil. Note that the z-ordinates are dimensional.

Next are the wing ordinate cards. There will be NWAFOR values of half-thickness specified for each airfoil expressed as percent chord. These cards are arranged in the order which begins with the most inboard airfoil and proceeds outboard. Each card may be identified in columns 73-80 as WAFORDJ where J denotes the particular airfoil.

Fuselage data cards: The first card (or cards) specifies the x values of the fuselage stations of the first segment. There will be NFORX(1) values and the cards may be identified in columns 73-80 by the symbol XFUSJ where J denotes the number of the last fuselage station given on that card.

If the fuselage is circular, the next card (or cards) gives the fuselage cross sectional areas, and may be identified in columns 73-80 by the symbol FUSARDJ where J denotes the number of the last fuselage station given on that card. If the fuselage is of arbitrary shape, NRADX(1) values of the y-ordinates for a half-section are given and identified in columns 73-80 as YJ where J is the station number. Following the y-ordinates are the NRADX(1) values of the corresponding z-ordinates for the half-section identified in columns 73-80 as ZJ where J is the station number. Each station will have a set of y and z, and the convention of ordering the ordinates from bottom to top is observed.

For each fuselage segment a new set of cards as described must be provided. The segment descriptions should be given in order of increasing values of x.

Pod data cards: The first pod (nacelle) data card specifies the location of the origin of the first pod. The card contains the following:

Columns	Contents
1-7	x-ordinate of origin of first pod
8-14	y-ordinate of origin of first pod
15-21	z-ordinate of origin of first pod
73-80	card identification, PODORGJ where J denotes the pod number

The next pod input data card (or cards) contains the x-ordinates, referenced to the pod origin, at which NPODOR values of the pod radii are to be specified. The first x value must be zero and the last x value is the length of the pod. These cards may be identified in columns 73-80 by the symbol XPODJ where J denotes the pod number.

For each additional pod, new PODORG, XPOD, and PODR cards must be provided. Only single pods are described but the program assumes that if the y-ordinate is not zero an exact duplicate is located symmetrically with respect to the xz-plane, a y-ordinate of zero implies a single pod.

Fin data cards: Exactly three data input cards are used to describe a fin (vertical tail). The first fin data card contains the following:

Columns	Contents
1-7	x-ordinate on inboard airfoil leading edge
8-14	y-ordinate of inboard airfoil leading edge
15-21	z-ordinate of inboard airfoil leading edge
22-28	chord length of inboard airfoil
29-35	x-ordinate of outboard airfoil leading edge
36-42	y-ordinate of outboard airfoil leading edge
43-49	z-ordinate of outboard airfoil leading edge
50-56	chord length of outboard airfoil
73-80	card identification, FINORGJ where J denotes the fin number

The second fin input data card contains NFINOR values of x expressed in percent chord at which the fin airfoil ordinates are to be specified. The card may be identified in columns 73-80 as XFINJ where J denotes the fin number.

The third fin input data card contains NFINOR values of the fin airfoil half-thickness expressed in percent chord. Since the fin airfoil must be symmetrical, only the ordinates on the positive y side of the fin chord plane are specified. The card identification FINORDJ may be given in columns 73-80 where J denotes the fin number.

For each fin, new FINORG, XFIN, and FINORD cards must be provided. Only single fins are described but the program assumes that if the y-ordinate is not zero an exact duplicate is located symmetrically with respect to the xz-plane, a y-ordinate of zero implies a single fin.

Canard data cards: If the canard (or horizontal tail) airfoil is symmetrical, exactly three cards are used to describe a canard, and the input is given in the same manner as for a fin. If, however, the canard airfoil is not symmetrical (indicated by a negative value of NCANOR), a fourth canard input data card will be required to give the lower ordinates. The information presented on the first canard input data card is as follows:

Columns	Contents
1-7	x-ordinate of inboard airfoil leading edge
8-14	y-ordinate of inboard airfoil leading edge
15-21	z-ordinate of inboard airfoil leading edge
22-28	chord length of inboard airfoil
29-35	x-ordinate of outboard airfoil leading edge
36-42	y-ordinate of outboard airfoil leading edge
43-49	z-ordinate of outboard airfoil leading edge
50-56	chord length of outboard airfoil
73-80	card identification, CANORGJ where J denotes the canard number

The second canard input data card contains NCANOR values of x expressed in percent chord at which the canard airfoil ordinates are to be specified. The card may be identified in columns 73-80 as XCANJ where J denotes the canard number.

The third canard input data card contains NCANOR values of the canard airfoil half-thickness expressed in percent chord. This card may be identified in columns 73-80 as CANORDJ where J denotes the canard number. If the canard airfoil is not symmetrical, the lower ordinates are presented on a second CANORD card. The program expects both upper and lower ordinates to be punched as positive values in percent chord.

For another canard, new CANORG, XCAN, and CANORD cards must be provided.

Description of Auxiliary Input Cards

Card 1.1 - Identification.- Card 1.1 contains any desired identifying information in columns 1-80.

Card 1.2 - Boundary condition and control point definition.- Non planar boundary conditions are always applied on a body, however card 1.2 permits the selection of boundary conditions to apply on a wing, fin (vertical tail), or canard (horizontal tail). This card also selects the output print options. This card contains the following:

Columns	Variable	Value	Description
1-3	LINBC	0	Control points on surface of wing, fin (vertical tail), and canard (horizontal tail). This is referred to as the nonplaner boundary condition option.
		1	Control points in plane of wing, fin (vertical tail), and canard (horizontal tail). This is referred to as the planar boundary condition option.
4-6	THICK	0	Do not calculate wing thickness matrix
		1	Calculate wing thickness matrix if LINBC = 1
7-9	PRINT	0	Print out the pressures and the forces and moments
		1	Print out option 0 and the spanwise loads on the wing, fins, and canards
		2	Print out option 1 and the velocity components and source and vortex strengths
		3	Print out option 2 and the steps in the iterative solution
		4	Print out option 3 and the axial and normal velocity matrices

A negative value of print adds the panel geometry print out to the output indicated for options 1 through 4.

LINBC, THICK, and PRINT are punched as right justified integers. THICK is not used if LINBC = 0.

Card 2.1 - Revised configuration paneling description control integers.- The contents of card 2.1 are punched as right justified integers as follows:

Columns	Variable	Value	Description
1-3	K0	0	No reference lengths
		1	Reference length data to be read
4-6	K1	0	No wing data
		1	Wing data to be read, wing has a sharp leading edge
		3	Wing data to be read, wing has a round leading edge
7-9	K2	0	No body data
		1	Body data follows
10-12	K3		Not used
13-15	K4	0	No fin (vertical tail) data
		1	Fin (vertical tail) data to be read, fin has a sharp leading edge
		3	Fin (vertical tail) data to be read, fin has a round leading edge
16-18	K5	0	No canard (horizontal tail) data
		1	Canard (horizontal tail) data to be read, canard has a sharp leading edge
		3	Canard (horizontal tail) data to be read, canard has a round leading edge
19-21	K6		Not used
22-24	KWAF	0, 2-20	Number of wing sections used to define the inboard and outboard panel edges. If KWAF = 0, the panel edges are defined by NWAF in the geometry input
25-27	KWAFOR	0, 3-30	Number of ordinates used to define the leading and trailing edges of the wing panels. If KWAFOR = 0, the panel edges are defined by NWAFOR in the geometry input

Columns	Variable	Value	Description
28-30	KFUS		The number of fuselage segments. The program sets KFUS = NFUS
31-33	KRADX(1)	0, 3-20	Number of meridian lines used to define panel edges on first body segment. There are three options for defining the panel edges. If KRADX(1) = 0, the meridian lines are defined by NRADX(1) in the geometry input. If KRADX(1) is positive, the meridian lines are calculated at KRADX(1) equally spaced PHIKs. If KRADX(1) is negative, the meridian lines are calculated at specified values of PHIK
34-36	KFORX(1)	0, 2-30	Number of axial stations used to define leading and trailing edges of panels on first body segment. If KFORX(1) = 0, the panel edges are defined by NFORX(1) in the geometry input
37-39	KRADX(2)	0, 3-20	Same as KRADX(1), but for second body segment
40-42	KFORX(2)	0, 2-30	Same as KFORX(1), but for second body segment
43-45	KRADX(3)	0, 3-20	Same as KRADX(1), but for third body segment
46-48	KFORX(3)	0, 2-30	Same as KFORX(1), but for third body segment
49-51	KRADX(4)	0, 3-20	Same as KRADX(1), but for fourth body segment
52-54	KFORX(4)	0, 2-30	Same as KFORX(1), but for fourth body segment

The program is restricted to 600 body singularity panels. For this program there is an additional restriction that the total number of singularity panels in the axial direction on the body (fuselage) cannot exceed 30. The arbitrary body (fuselage) capability of this program is limited to those shapes for which the radius is a single-valued function of PHIK for each cross section of the body.

Card 2.2 - Additional revised configuration paneling description control integers.- The contents of card 2.2 are punched as right justified integers as follows:

Columns	Variable	Value	Description
1-3	KF(1)	0, 2-20	Number of fin sections used to define the inboard and outboard panel edges on the first fin. If KF(1) = 0, the root and tip chords define the panel edges
4-6	KFINOR(1)	0, 3-30	Number of ordinates used to define the leading and trailing edges of the fin panels on the first fin. If KFINOR(1) = 0, the panel edges are defined by NFINOR
7-9	KF(2)	0, 2-20	Same as for KF(1), but for second fin
10-12	KFINOR(2)	0, 3-30	Same as for KFINOR(1), but for second fin
13-15	KF(3)	0, 2-20	Same as for KF(1), but for third fin
16-18	KFINOR(3)	0, 3-30	Same as for KFINOR(1), but for third fin
19-21	KF(4)	0, 2-20	Same as for KF(1), but for fourth fin
22-24	KFINOR(4)	0, 3-30	Same as for KFINOR(1), but for fourth fin
25-27	KF(5)	0, 2-20	Same as for KF(1), but for fifth fin
28-30	KFINOR(5)	0, 3-30	Same as for KFINOR(1), but for fifth fin
31-33	KF(6)	0, 2-20	Same as for KF(1), but for sixth fin
34-36	KFINOR(6)	0, 3-30	Same as for KFINOR(1), but for sixth fin

Columns	Variable	Value	Description
37-39	KCAN(1)	0, 2-20	Number of canard sections used to define the inboard and outboard panel edges on the first canard. If KCAN(1) = 0, the root tip chords define the panel edges. If KCAN(N) negative, no vortex sheets carry through the body and concentrated vortices are shed from the inboard edge of the canard or tail surface
40-42	KCANOR(1)	0, 3-30	Number of ordinates used to define the leading and trailing edges of the first canard. If KCANOR(1)=0, the panel edges are defined by NCANOR
43-45	KCAN(2)	0, 2-20	Same as for KCAN(1), but for second canard
46-48	KCANOR(2)	0, 3-30	Same as for KCANOR(1), but for second canard
49-51	KCAN(3)	0, 2-20	Same as for KCAN(1), but for third canard
52-54	KCANOR(3)	0, 3-30	Same as for KCANOR(1), but for third canard
55-57	KCAN(4)	0, 2-20	Same as for KCAN(1), but for fourth canard
58-60	KCANOR(4)	0, 3-30	Same as for KCANOR(1), but for fourth canard
61-63	KCAN(5)	0, 2-20	Same as for KCAN(1), but for fifth canard
64-66	KCANOR(5)	0, 3-30	Same as for KCANOR(1), but for fifth canard
67-69	KCAN(6)	0, 2-20	Same as for KCAN(1), but for sixth canard
70-72	KCANOR(6)	0, 3-30	Same as for KCANOR(1), but for sixth canard

The program is restricted to a total of 600 singularity panels on the wing-fin-canard combination.

For this program there is an additional restriction that the total number of singularity panels in the spanwise direction on the wing-fin-canard combination cannot exceed 20.

Cards 3, 4, . . . - remaining input data cards.- The remaining input data cards contain a detailed description of the singularity paneling of each component of the configuration. Each card contains up to 10 values, each value punched in a 7-column field with a decimal point and may be identified in columns 73-80. The cards are arranged in the following order: reference lengths, wing data cards, fin (vertical tail) data cards, canard (horizontal tail) data cards, fuselage (body) data cards, and finally Mach number and angle of attack case cards. Note that the present program will not handle a pod and therefore there are no pod panel inputs. However, if the geometry input contains a pod description it will be read and ignored.

Reference length card: This card may be identified as REFL in columns 73-80 and contains the following:

Columns	Variable	Description
1-7	REFA	Wing reference area. If REFA = 0, the reference area is defined by the value of REFA in the geometry input
8-14	REFB	Wing semispan. If REFB = 0, a value of 1.0 is used for the reference semispan
15-21	REFC	Wing reference chord. If REFC = 0, a value of 1.0 is used for the reference chord
22-28	REFD	Body (fuselage) reference diameter. If REFD = 0, a value of 1.0 is used for the reference diameter
29-35	REFL	Body (fuselage) reference length. If REFL = 0, a value of 1.0 is used for the reference length
36-42	REFX	X coordinate of moment center
43-49	REFZ	Z coordinate of moment center

Wing data cards: The first wing data card is the wing leading edge radius card and is required only when K1 = 3. This card contains NWAF values of leading edge radius expressed in percent chord. It may be identified in columns 73-80 as RHOJ where J denotes the number of the last radius given on that card.

Next is the wing panel leading edge card. This card contains KWAFOR values of wing panel leading edge locations expressed in percent chord. This card may be identified in columns 73-80 as XAFKJ where J denotes the last location in percent chord given on that card. Omit if KWAFOR = 0.

The last wing data card gives the wing panel side edge data. This card contains KWAF values of the y ordinate of the panel inboard edges. This card may be identified in columns 73-80 as YKJ where J denotes the last y ordinate on that card. These values are arranged in the order which begins with the most inboard panel edge and proceeds outboard. Omit if KWAF = 0.

Fin (vertical tail) data cards: The first fin data card is the fin leading edge radius card and is required only when K4 = 3. This card contains NF values of leading edge radius expressed in percent chord, one value for each fin. It may be identified in columns 73-80 as RHOFIN.

Next is the fin panel leading edge card for the first fin. This card contains KFINOR(1) values of fin panel leading edge locations expressed in percent chord. This card may be identified in columns 73-80 as XFINKJ where J denotes the fin number. Repeat this card for each fin.

The last fin data card gives the fin panel side edge data for the first fin. This card contains KF(1) values of the z ordinate of the panel inboard edges. This card may be identified in columns 73-80 as ZFINKJ where J denotes the fin number. These values are arranged in the order that begins with the most inboard panel edge and proceeds outboard. Repeat this card for each fin.

Canard (horizontal tail) data cards: The first canard data card is the canard leading edge radius card and is required only when K5 = 3. This card contains NCAN values of leading edge radius expressed in percent chord, one value for each canard. It may be identified in columns 73-80 as RHOCAN.

Next is the canard panel leading edge card for the first canard. This card contains KCANOR(1) values of canard panel leading edge locations expressed in percent chord. This card may be identified in columns 73-80 as XCANKJ where J denotes the canard number. Repeat this card for each canard.

The last canard data card gives the canard panel side edge data for the first canard. This card contains KCAN(1) values of the y ordinate of the panel inboard edges. This card may be identified in columns 73-80 as YCANKJ where J denotes the canard number. These values are arranged in the order that begins with the most inboard panel edge and proceeds outboard. Repeat this card for each canard.

Fuselage (body) data cards: The first body card is the body meridian angle card. This card contains KRADX(1) values of body meridian angle expressed in degrees and may be identified in columns 73-80 as PHIKJ where J denotes the body segment number. The convention is observed that PHIK = 0. at the bottom of the body and PHIK = 180. at the top of the body. Omit unless KRADX(1) is negative. Repeat this card for each fuselage segment.

The second body card is the body axial station card. This card contains KFORX(1) values of the x ordinate of the body axial stations and may be identified in columns 73-80 as XFUSKJ where J denotes the body segment number. Omit if KFORX(1) = 0. Repeat this card for each fuselage segment.

Mach number and angle of attack card: This card may be identified in columns 73-80 as MALPHA and contains the following:

Columns	Variable	Description
1-7	MACH	The subsonic Mach number (including the value MACH = 0.) or the supersonic Mach number at which it is desired to calculate the aerodynamic data
8-14	ALPHA	The angle of attack expressed in degrees at which it is desired to calculate the aerodynamic data

A series of Mach number and angle of attack combinations for the same geometry may be calculated by repeating this card with the desired values.

A value of MACH = -1. on this card signifies the termination of the present case. Geometry cards for a new case can follow such a terminal card.

PROGRAM OUTPUT DATA

All output is processed by a standard 132 characters-per-line printer. The output from each run is always preceded by a complete list of the input data cards. The amount and type of the remaining output depend on the PRINT option selected, the number of panels used, and whether the configuration being analyzed is an isolated wing, an isolated body, or a complete wing-body-tail combination. The program output options are described below:

PRINT = 0 The program prints the case description, Mach number and angle of attack, followed by a table listing the panel number, control point coordinates (both dimensional and non-dimensional), pressure coefficient, normal force, axial force, and pitching moment. Separate tables are printed for the body and wing panels, noting that any tail, fin or canard panels are included with the wing output. If the planar boundary condition option has been selected, the results for the wing upper surface are given in one table, followed by a separate table giving the results for the wing lower surface. Additional tables giving the total coefficients on the body, the wing and the complete configuration follow the pressure coefficient tables. These include the reference area, reference span and reference chord, the normal force, axial force, pitching moment, lift, and drag coefficients, and the center of pressure of the component.

PRINT = 1 In addition to the output described for PRINT = 0, the program prints out additional tables giving the normal force, axial force, pitching moment, lift and drag coefficients, and the center of pressure of each column of panels on the wing and tail surfaces. In addition, the indices of the first and last panel in the column are listed, together with the span, chord and origin of the column.

PRINT = 2 In addition to the output described for PRINT = 1, the program prints out tables listing the panel number, the source or vortex strength of that panel, and the axial velocity u, lateral velocity v, and vertical velocity w at the panel control point. The normal velocity is also calculated for body panels. Separate tables are printed for the body and wing panels, noting again that any tail, fin, or canard panels are included with the wing output. If the planar boundary condition option has been selected, separate tables are given for the wing upper and lower surfaces.

PRINT = 3 In addition to the output described for PRINT = 2, the program prints out the iteration number, and the source and vortex strength arrays obtained at each step of the iterative solution procedure.

PRINT = 4 In addition to the output described for PRINT = 3, the program prints out tables of the axial and normal velocity components which make up the elements of the aerodynamic matrices. The program prints out the matrix row number, and gives the number of elements in that row. A maximum of four matrix partitions will be printed if this option is selected, each of which is identified by number and its influence description prior to printing the velocity component tables.

If a negative value of PRINT is selected, the program prints all the information described above for the positive values, together with the complete panel geometry description of the configuration following the list of input cards. This consists of tables giving the wing panel corner points, control points, inclination angles, areas, and chords. If the configuration has a horizontal tail, fin or canard, additional tables are printed giving the same information as listed above for the wing. Finally, if the configuration includes a body, the body panel corner points, control points, areas, and inclination angles are listed.

The program output is illustrated by the sample case presented in Appendix III.

PROGRAM STRUCTURE

The program is designed to operate in OVERLAY mode. The main overlay program is designated USSAERO, and calls the three primary overlay programs GEOM, VELCMP, and SOLVE. In turn, GEOM calls seven secondary overlay programs CONFIG, NEWORD, WNGPAN, NEWRAD, BODPAN, NUTORD, and TALPAN; while VELCMP calls three secondary overlay programs BODVEL, LINVEL, and WNGVEL. The overlay structure is illustrated on Figure 1.

The complete program consists of 14 overlay programs and 19 subroutines. Detailed descriptions of each program and subroutine are given in Appendix I. These descriptions give the purpose of the program or subroutine, outline the method used, and list the names of the principal variables and constants.

AUXILIARY FILES

The program designates TAPE 5 as the input file and TAPE 6 as the output file. In addition, five auxiliary files are utilized for temporary storage and data transfer within the program. These files are designated TAPE 7, TAPE 8, TAPE 9, TAPE 10, and TAPE 11.

TAPE 7 is used primarily for the storage of the panel geometry data. The first three records are written by program WNGPAN, and contain the wing panel geometry data. If the configuration has a fin, canard, or horizontal tail, the first three records are rewritten by program TALPAN, and subsequently contain all wing and tail panel geometry data. The fourth record is written by program BODPAN, and contains the body panel geometry data. Additional records are written on this file in program VELCMP if the aerodynamic matrix partitions are further subdivided into blocks. The elements of the diagonal block matrices are stored in individual records on this file, behind the panel geometry data.

TAPE 8 is used exclusively to store the u, v, w velocity component arrays, and each record in this file contains one row of the velocity component arrays from a given matrix partition. In the first partition, NBODY records are written on this file by program BODVEL. In the second partition, another NBODY records are written by either program LINVEL or WNGVEL. However,

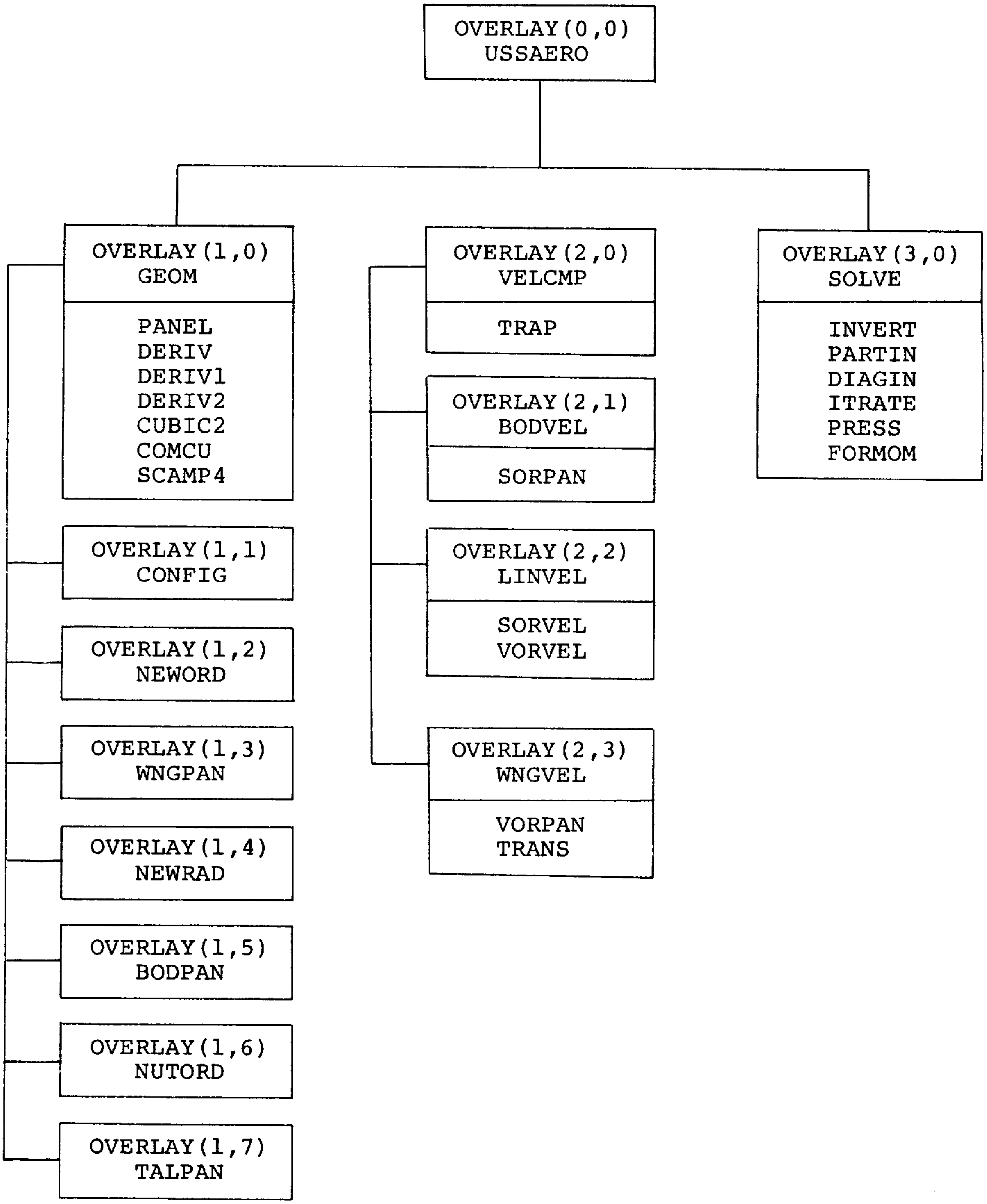

Figure 1 - Program Overlay Structure

if the planar boundary condition option with thickness is selected, program LINVEL writes an additional NBODY records on the file. In the third partition, NWING records are written by program BODVEL, and in the fourth partition, another NWING records are written by programs LINVEL or WNGVEL. As before, LINVEL writes an additional NWING records on this file if the planar boundary condition option with thickness is selected. Thus, a total of 2(NBODY + NWING) records are always written on TAPE 8, and a maximum of 3(NBODY + NWING) records if the planar boundary condition option with wing thickness is selected.

TAPE 9 is first used in program CONFIG to store the configuration geometry data. Five records are written on this file, containing the reference area, wing geometry data, body geometry data, fin geometry data, and canard or horizontal tail geometry data. Dummy records are written for missing components. TAPE 9 is re-initialized in program VELCMP, and used to store the normal velocity arrays. Each record contains one row of normal velocities from a given matrix partition. In the first partition, NBODY records are written on this file by program BODVEL. In the second partition, another NBODY records are written by program LINVEL or WNGVEL. In the third partition, NWING records are written by program BODVEL, and in the fourth partition, an additional NWING records are written by program LINVEL or WNGVEL. Thus, a total of 2(NBODY + NWING) records are written on TAPE 9.

TAPE 10 is first used in program NEWRAD as temporary storage for the body panel corner point coordinates. It is re-initialized by program VELCMP, and then used to store the elements of the diagonal block matrices, if the matrix partitions are further subdivided into blocks. Each record contains one row of normal velocities from a given diagonal block matrix partition. The records are written at the same time the normal velocity arrays for the remainder of the row are written on TAPE 9. Thus, a total of 2(NBODY + NWING) records are also written on TAPE 10. These records are subsequently read by program VELCMP, transferred to TAPE 7, and the file re-initialized a second time. TAPE 10 is finally used to store the elements of the inverse diagonal block matrices, or the inverse diagonal partition matrices, if the matrix is not subdivided into blocks. In the former case, the elements of each inverse diagonal block matrix are written as a single record on TAPE 10 by subroutine DIAGIN, or in the latter case, the elements of each inverse diagonal partition matrix are written on the file by subroutine PARTIN.

TAPE 11 is used to transfer two geometry parameter arrays, written as a single record in program VELCMP, to program SOLVE. No further use is made of this file.

OPERATING INSTRUCTIONS

The program deck and data deck are loaded in the following sequence: job card, system control cards, end-of-record card, program deck, end-of-record card, data deck, end-of-file card. The data deck is described above in the Program Input Data section.

APPENDIX I

PROGRAM AND SUBROUTINE DESCRIPTIONS

(Arranged in Alphabetical Order)

This appendix contains a brief outline of the purpose, method, and use of each program or subroutine. The principal variables and constants in each are listed in the order of their first appearance, and identified as input or output data.

PROGRAM BODPAN

PURPOSE: To revise the axial spacing on the body and compute the body panel geometry.

METHOD: For each body segment, the x, y, and z coordinates of the cross sections are read from TAPE 10. If the value of KFORX of the segment is positive, an array of new axial stations for the segment is read in; otherwise the original axial stations are retained.

The body panel geometry is established by a linear interpolation along body meridian lines of the y and z coordinates at the new axial stations. The interpolation is started with the first ring of panels at the nose and continued until the last ring of panels on the last segment is reached. The corner point coordinates, the control point coordinates, the inclination angles, and area are calculated for each panel in sequence.

The panel control point coordinates, the panel dihedral angle θ, the panel inclination angle δ, the corner point coordinates and the panel areas are stored in the COMMON block POINT, and the entire sequence of arrays written as a single record on TAPE 7 following the wing and tail panel geometry arrays. The remaining body geometry parameters are stored in COMMON blocks PARAM and BTHET. Finally, if the print option is negative, the corner point coordinates, control point coordinates, inclination angles, and areas are written on the output file.

USE: CALL OVERLAY (LWB, 1, 5)

<u>Input</u>:

PRINT	Print option
NFUS	Number of body segments
KFORX, NFORX, JMAX	Number of axial stations on segment

KRADX, NRADX, KRAD	Number of meridian lines on segment
XB, XFUS	Array of original axial stations on segment
XJ	Array of revised axial stations on segment
YB, ZB	Arrays of y and z coordinates on segment

Output:

NBODY	Total number of body panels
NFU	Body segment number
NP	Panel number
IP, IQ	Panel identification constants
XC, YC, ZC	Arrays of panel corner points
XPT, YPT, ZPT	Arrays of panel control points
THET, THETA	Array of panel dihedral angles
DELTA	Array of panel inclination angles
AP, AREA	Array of panel areas

SUBROUTINES CALLED: PANEL

ERROR RETURNS: The program calls EXIT if NBODY > 600.

PROGRAM BODVEL

PURPOSE: To compute the three components of velocity induced at specified control points by the body panels.

METHOD: The x, y, and z coordinates of the control point, and the corresponding panel inclination angles θ and δ are read from COMMON block POINT.

Starting with the first body segment, the body panel corner point coordinates and inclination angles are also read from COMMON block POINT for each row and column of panels. Considering a single body panel, the corner point and control point coordinates are transformed to a new coordinate system with origin at the first corner of the panel and inclined at an angle θ with respect to the horizontal. The velocity components induced by this inclined constant source panel at the given control point are computed in the panel coordinate system by subroutine SORPAN, which is called twice to obtain the influence of panels located on both right and left sides of the body. These velocity components are combined and transformed back to the reference coordinate system to obtain the final u, v, and w components of velocity, and the velocity normal to the panel at the control point. This process is repeated for each panel on the body, following which the u, v, and w velocity component arrays are written on TAPE 8, and the array of normal velocities on TAPE 9.

If the control point is in the same ring of panels on the body as the influencing panel and the body has more than 60 panels, the normal velocity at the control point is written on TAPE 10, and its value set to zero in the array written on TAPE 9. This procedure sets up the diagonal blocks of the aerodynamic matrix for later use in the iterative solution procedure. If the print option is selected, the axial and normal velocity arrays are written on the output tape.

The process is repeated for each control point.

USE: CALL OVERLAY (LWB, 2, 1)

Input:

EM, MACH	Mach number
NBODY	Number of body panels
LBC	Planar boundary condition option parameter (logical)
PRINT	Print option parameter
NPART	Matrix partition number
NMAX	Maximum order of diagonal block matrices
KFUS	Number of body segments
KRADX	Number of body panel meridian lines in segment
KFORX	Number of body axial stations in segment
JMAX, MAX	Total number of axial stations on body
NPOINT	Number of control points
IT	Array of wing supersonic trailing edge indicators
THET	Array of panel inclination angles at control point
THETA	Array of body panel inclination angles
DELTA	Array of body panel incidence angles
DELTI	Array of wing panel incidence angles
XPT, YPT, ZPT	Arrays of wing control point coordinates
XBT, YBT, ZBT	Arrays of body panel control point coordinates

XC, YC, ZC	Arrays of body panel corner points

<u>Output</u>:

I	Control point index
J	Body panel index
ISKIP	Wing supersonic trailing edge indicator
KF	Body segment index
L, NC	Column index
N	Row index
NROW, NS	Number of rows of panels on body
NCOL	Number of columns of panels on body
J1, J2, JS1, JS2	Body panel numbers in diagonal block matrices
K	Panel corner index
SINTI	sin θ(I)
COSTI	cos θ(I)
XPTI, YPTI, ZPTI	Coordinates of control point I
DI	tan δ(I)
DA	tan δ(J)
SINT	sin θ(J)
COST	cos θ(J)
SINTR	sin (θ(J) - θ(I))

SINTL	sin $(\theta(J) + \theta(I))$
COSTR	cos $(\theta(J) - \theta(I))$
COSTL	cos $(\theta(J) + \theta(I))$
XCOR, YCOR, ZCOR	Coordinates of panel corner points in panel coordinate system
CX	Panel chord length
XI, YI, ZI	Coordinates of control point I in panel coordinate system
XJ, YJ, ZJ	Coordinates of body panel J control point in panel coordinate system
UR, VR, WR	Velocity components at control point I induced by body panel J on right side of body, in body panel coordinate system
UL, VL, WL	Velocity components at control point I induced by body panel J on left side of body, in body panel coordinate system
UB, VB, WB	Arrays of velocity components at control point I in reference coordinate system
VI, WI	Arrays of velocity components at control point I in control point panel coordinate system
AN	Array of velocities normal to control point panel I
DN	Array of normal velocities in diagonal block matrices

SUBROUTINES CALLED: SORPAN

ERROR RETURNS: None

SUBROUTINE COMCU

PURPOSE: To fit a composite cubic through n points (x_i, y_i) i.e., a separate cubic between each pair of adjacent points, such that the n-1 cubics are so determined that each matches its neighbors in function value and in the first two derivatives.

METHOD: Rather than solve simultaneously for the 4(n-1) cubic coefficients, the approach here is to solve simultaneously for the slopes of the composite cubic at the given n points. Thus a linear system of order n, rather than 4n-4 is involved. It can be shown that a necessary and sufficient condition for continuity of the second derivative is that

$$(x_{i+1}-x_i)y'_{i-1} + 2(x_{i+1}-x_{i-1})y'_i + (x_i-x_{i-1})y'_{i+1}$$

$$= \frac{3}{(x_i-x_{i-1})\ (x_{i+1}-x_i)} \Big[(x_i-x_{i-1})^2(y_{i+1}-y_i) + (x_{i+1}-x_i)^2(y_i-y_{i-1}) \Big]$$

for i = 2, 3, . . ., n-1

This yields n-2 equations in the n unknowns, y'_i, i = 1, 2, . . ., n. For the 1st and nth equations of the linear system, the boundary conditions on y'_1 and y'_n are used. This has been generalized to permit any combination of a given y' or y'' at the end points, e.g., y'_1 and y''_n can be given as the boundary conditions. The second derivative of a cubic through two points can be expressed as a function of the first derivatives and of the given point coordinates as follows:

$$\frac{x_2-x_1}{2}\, y''_1 = 3\frac{y_2-y_1}{x_2-x_1} - 2y'_1 - y'_2$$

and

$$\frac{x_n-x_{n-1}}{2}\, y''_n = -3\,\frac{y_n-y_{n-1}}{x_n-x_{n-1}} + y'_{n-1} + 2y'_n$$

Whether the boundary conditions involve first or second derivatives (or both) and no matter what the spacing of the x_i so long as the x_i form a strictly monotone sequence, the coefficient matrix of the linear system is tridiagonal (all elements are zero except on the principal diagonal, the first subdiagonal, and the first superdiagonal). When n is large, a considerable time saving and an enormous storage saving can result if the special structure of this matrix is taken advantage of. Hence, this subroutine stores the matrix elements in 4n locations (as opposed to n^2) and then solves the system.

The actual coefficients of the n-1 cubics of the composite cubic are not found by COMCU. Since on any subinterval x_i, x_{i+1}, a cubic is uniquely determined by the known two points and two slopes, the calling program can find the four coefficients of each cubic independently and may often need to do so for only one of the n-1 cubics. In any case, the subroutine CUBIC2 specifically finds a cubic, given two points and the slope at each point.

USE: CALL COMCU (DA, DB, S, X, Y, L, M, N, NDA,NDB)

Input:

X	Array of x-abscissae of input points
Y	Array of y-ordinates of input points
N	Number of input points
NDA	Order (1 or 2) of derivative at X(1)
NDB	Order (1 or 2) of derivative at X(N)
DA	Value of derivative at X(1)
DB	Value of derivative at X(N)
L	Code
	= 1, if single precision is to be used
	= 2, if double precision is to be used

Output:

S	Array of first derivatives
M	Error return
	= 0 - success
	$\neq$ 0 - error detected

SUBROUTINES CALLED: None

ERROR RETURNS: If overflow occurred, M = 1. Otherwise, M = 0.

RESTRICTIONS: The x-abscissae must form a strictly monotone sequence. $N \leqslant 400$.

PROGRAM CONFIG

PURPOSE: To input the geometrical description of the configuration using the same input data as program START of reference 1.

METHOD: The configuration reference area is read from the input file if $J0 \neq 0$, otherwise the reference area is set equal to unity. The reference area is then written on TAPE 9. If $J1 \neq 0$, the wing geometry data is read from the input file in the order specified in reference 1. The program computes the upper and lower surface coordinates of the wing airfoils, and writes the entire wing geometry array as one record on TAPE 9.

If $J2 \neq 0$, the body geometry data is also read from the input file in the order specified in reference 1 for each body segment. For arbitrary cross-sections, the y and z ordinates of the body segment are read in, but for circular cross-sections, the body cross-sectional area is read in and the corresponding radius calculated by the program. The entire body geometry array is then written as one record on TAPE 9.

If $J3 \neq 0$, the pod geometry is read in, but no further use is made of this data.

If $J4 \neq 0$, the fin geometry data is read in. The program computes the coordinates of the fin airfoils and writes the fin geometry array as one record on TAPE 9. Similarly, if $J5 \neq 0$, the tail or canard geometry data is read in, the tail airfoil coordinates calculated, and the tail geometry array written on TAPE 9.

If one or more of the above components is missing, the program writes a dummy record on TAPE 9 and continues.

USE: CALL OVERLAY (LWB, 1, 1)

Input:

J0	Reference area parameter
J1	Wing definition parameter

J2	Body definition parameter
J3	Pod definition parameter
J4	Fin definition parameter
J5	Canard or tail definition parameter
J6	Body camber parameter
REFA	Reference area
ABCD	Dummy array
NWAF	Number of wing airfoil sections
NWAFOR	Number of ordinates used to define each wing airfoil section
WAFORG	Origin and chord length of each wing airfoil (x, y, z, c)
XAF	Array of percent chords for wing airfoil ordinates
WAFORD	Array of half-thickness ordinates in percent chord
TZORD	Array of mean camber line ordinates
NFUS	Number of body segments
NRADX, NRAD	Number of points used to define half-section of body segment
NFORX, NFUSOR	Number of axial stations on body segment
XFUS	Array of axial stations on body segment
ZFUS	Array of body camber ordinates
SFUS	Array of y and z ordinates used to define half-section of arbitrary body segment
FUSARD	Array of body cross-sectional areas
NP	Number of pods
NPODOR	Number of axial stations on pod

NF	Number of fins
NFINOR	Number of ordinates used to define fin airfoil sections
FINORG	Origin and chord lengths of fin airfoils (x, y, z, c)
XFIN	Array of percent chords for fin airfoils
FINORD	Array of fin airfoil half-thickness ordinates in percent chord
NCAN	Number of tails or canards
NCANOR	Number of ordinates used to define tail or canard airfoil sections
CANORG	Origin and chord lengths of tail or canard airfoils (x, y, z, c)
XCAN	Array of percent chords for tail or canard airfoils
CANORD	Array of airfoil half-thickness ordinates

Output:

REFA	Reference area
WAFOR	Array of wing half-thickness ordinates (percent chord)
TZORD	Array of wing camber line ordinates
WAFORD	Array of x, y, z, coordinates defining upper and lower surfaces of wing (not used)
J2TEST	Parameter to specify body camber and cross-section definition
FUSRAD	Array of body radii (circular cross-sections only)
FINOR	Array of fin half-thickness ordinates (percent chord)

FINCR	Array of fin camber line ordinates (set zero)
FINORD, FINX2, FINX3	Arrays of x, y, z coordinates defining left and right surfaces of fin (not used)
CANOR	Array of tail or canard half-thickness ordinates
CANCR	Array of tail or canard camber line ordinates
CANORX, CANORD, CANOR1	Arrays of x, y, z coordinates defining upper and lower surfaces of tail or canard (not used)
BLOCK	Dummy array used for storing geometry data on TAPE 9

SUBROUTINES CALLED: None

ERROR RETURNS: None

SUBROUTINE CUBIC2

PURPOSE:	To fit a cubic to two points, being given the slope at each.
METHOD:	The subroutine sets up the system of four simultaneous equations expressing the four given conditions and solves it for the coefficients of the cubic.
USE:	CALL CUBIC2 (X, Y, D, C, M)

Input:

X	Array of x-coordinates
Y	Array of y-coordinates
D	Array of first derivatives

Output:

C	Array of cubic coefficients
M	Error return = 1 - success $\neq$ 1 - error detected

SUBROUTINES CALLED:	None
ERROR RETURNS:	If M = 2, overflow occurred. If M = 3, X(1) = X(2). Otherwise, call is successful, and M = 1
RESTRICTIONS	X(1) $\neq$ X(2)

SUBROUTINE DERIV

PURPOSE: To fit a chain of cubic curves through a set of N points (x_i, y_i) having continuous first and second derivatives at the intermediate points and specified first or second derivative at the end points.

METHOD: The method outlined in subroutine SCAMP4 is applied.

USE: CALL DERIV (X, Y, N, NDA, DA, FD)

<u>Input</u>:

X	Array of x values
Y	Array of y values
N	Number of points
NDA	The order of the derivative to be specified at the first point
DA	The value of the derivative to be specified at the first point

<u>Output</u>:

FD	Array of first derivatives at the points

SUBROUTINES CALLED: SCAMP4

ERROR RETURNS: None

FUNCTION DERIV1

PURPOSE:	To find the first derivative of the quadratic through three given points at a specified one of these points. This provides a good approximation to the slope of a function at a point, particularly if the other two points used are nearby.
METHOD:	The subroutine simply finds the unique polynomial of degree two through the given points then evaluates its first derivative at the specified point.
USE:	D = DERIV1 (X, Y, N)

Input:

X	Array of x-coordinates
Y	Array of y-coordinates
N	Code = 1, 2, or 3 indicating point at which derivative is desired

SUBROUTINES CALLED:	None
ERROR RETURNS:	None
RESTRICTIONS	The x-coordinates must be distinct, but need not be in any order or evenly spaced

FUNCTION DERIV2

PURPOSE:	To find the second derivative of the cubic through four given points (x_i, y_i) at an arbitrary point whose x coordinates if given.
METHOD:	The subprogram simply finds the unique polynomial of degree three through the given points, then evaluates its second derivative at the desired x, which need not be one of the four given x_i.
USE:	D = DERIV2 (X, Y, XX)
	Input:
	X Array of x coordinates
	Y Array of y coordinates
	XX x coordinate of point at which second derivative is desired
SUBROUTINES CALLED:	None
ERROR RETURNS:	None
RESTRICTIONS:	The x coordinates must be distinct but can be in any order and unevenly spaced.

SUBROUTINE DIAGIN

PURPOSE: To invert the diagonal blocks of the matrix and store the results on TAPE 10.

METHOD: If the order of the body matrix partition exceeds 60, the diagonal blocks of the body matrix are read from TAPE 7, the block matrices inverted, and the inverse matrices stored on TAPE 10. Otherwise, the complete body matrix partition is read from TAPE 9, the matrix inverted, and the inverse stored on TAPE 10.

A similar procedure is followed for the wing matrix partition.

USE: CALL DIAGIN

Input:

NWING Number of wing panels

NBODY Number of body panels

NMAX Maximum order of diagonal block matrices (60)

NDIM Matrix dimension statement size

NBBLOK Number of diagonal blocks in body matrix partition

NWBLOK Number of diagonal blocks in wing matrix partition

NBROW Order of diagonal blocks in body matrix partition

NWROW Order of diagonal blocks in wing matrix partition

D Array of matrix elements

Output:

NB Body diagonal block number

NW	Wing diagonal block number
NROW	Number of rows in diagonal block
NCOL	Number of columns in diagonal block
D	Array of inverse matrix elements

SUBROUTINES CALLED: None

ERROR RETURNS: None

SUBROUTINE FORMOM

PURPOSE: To calculate the force and moment coefficients on body, wing and tail components.

METHOD: Depending on the component being analyzed and the boundary condition option selected, execution of this subroutine follows one of three paths. In all three paths, the panel inclination angles, control point coordinates, areas and chords are obtained from COMMON block POINT. The pressure coefficients are obtained from COMMON block SCRAT.

If the component is a body, the normal force, axial force, and moment about the origin of coordinates is computed for each panel and the results summed. The total axial force, normal force and pitching moment of the body are stored in COMMON block FORM. The body panel force and moment arrays are written on the output file, together with the panel number, control point coordinates, and pressure coefficient. The control point coordinates are non-dimensionalized by dividing by the body reference length or diameter, and both dimensional and non-dimensional coordinates are presented in this array. Finally, the normal and axial force coefficients, the pitching moment coefficient about the origin of coordinates, the lift and drag coefficients, and the center of pressure of the body expressed as a fraction of the reference chord are computed and written on the output file.

If the component is a wing or tail, and the non-planar boundary condition option has been selected, the subroutine first calculates the chord length of each column of panels, and assigns the chord length and the axial coordinate of the leading edge to each panel in the column. The normal force, axial force and moment about the origin of coordinates is computed for each panel, and the results summed. The wing panel force and moment arrays are then written on the output file, together with the panel number, control point coordinates, and pressure coefficient. The control point coordinates are non-dimensionalized by dividing them by the chord length or reference semi-span, and both dimensional and non-dimensional coordinates are presented in the array. Next, the normal and axial force coefficients, the pitching moment coefficient about the origin of coordinates, the lift and drag coefficients and the center of pressure of the wing, expressed as a fraction of the reference chord, are computed and written on the output file. If a non-zero print option has been selected, the subroutine proceeds to calculate the spanwise load distribution on the wing and tail. The forces and moment acting on each panel in a given column are summed, and the force and moment coefficients and center of pressure of the column computed and written on the output file. The summation includes panels on both the upper and lower surfaces of the column.

If the component is a wing or tail and the planar boundary condition option has been selected, the subroutine is called twice. On the first pass, the forces and moment acting on the upper surface is calculated, followed by the forces and moment on the lower surface in the second pass. In this case, the subroutine performs an interpolation to determine the wing or tail panel slope, pressure coefficient, and control point at the panel centroid prior to the panel force and moment calculations. The remainder of the calculation procedure is similar to that described above for the wing with non-planar boundary condition option. The axial force, normal force, and pitching moment of the wing upper surface are stored in COMMON block FORM on the first pass, and added to those calculated on the lower surface in the second pass to obtain the total forces and moments acting on the wing. This information is then used to calculate the total force and moment coefficients, lift, drag, and center of pressure of the wing and tail, and the results stored on the output file. The spanwise load distribution on the wing and tail is also calculated if the print option is other than zero, using the procedure described above.

USE: CALL FORMOM (NPAN, NPASS, ALFA, COMPT)

Input:

NPAN	Number of panels on the component being analyzed
NPASS	Pass number
COMPT	Component identification integer COMPT = 1 Body component COMPT = 2 Wing or tail component
ALFA	Angle of attack (radians)
ALPHA	Angle of attack (degrees)
PRINT	Print option (integer)
LBC	Planar boundary condition option parameter (logical)
MACH	Mach number
NBODY	Number of body panels
NWING	Number of wing and tail panels
ARRAY	Array of panel geometrical parameters
CHORD	Array of wing panel chord lengths
DZTDX	Array of wing panel half-thickness slopes
XC	Array of panel corner point coordinates
TITLE1, TITLE2	Case identification arrays
DELTA	Array of panel incidence angles, or panel camber slopes on wing with planar boundary condition option
THET	Array of panel inclination angles
NSEG	Number of wing and tail segments

NCOL	Number of columns of panels in segment
NROW	Number of rows of panels in segment
SINS, COSS	Array of sines and cosines of segment inclination angle
XCPT	Array of chord fractions for control point location
LOCPT	Array of control point location indicators
CP	Array of panel pressure coefficients
XPT, YPT, ZPT	Arrays of control point coordinates
XLEW	Array of wing column leading edge origins
SPNW	Array of wing column spanwise widths
AREA	Array of panel areas
REFA	Reference wing area
REFB	Reference wing span
REFC	Reference wing chord
REFD	Reference body diameter
REFL	Reference body length
REFX, REFZ	Coordinates of moment reference point

Output:

XON	x coordinate of body nose
SGN	Wing upper and lower surface sign parameter array
SIND, COSD	Trigonometric function arrays of panel incidence angle δ
SINT, COST	Trigonometric function arrays of panel inclination angle θ

SIAL, COAL	Trigonometric functions of angle of attack α
NC	Number of columns of panels in segment
NR	Number of rows of panels in segment
NR1	NR + 1
TAND	Slope of wing upper or lower surface at centroid, planar boundary condition option
XS, PT	Control point location in chord fractions
RL	Chord fraction of control point from leading edge
RT	Chord fraction of control point from trailing edge
CHD	Array of wing column chord lengths
XLE	Array of wing column leading edge origins
NP	Number of panels on component
IP	Panel number
CN	Normal force coefficient
CT	Axial force coefficient
CM	Pitching moment coefficient
XP, YP, ZP	Panel control point coordinates
F1, F2, F3	Direction cosines of panel normal vector
FAK	Panel area factor
DCN	Panel normal force

DCT	Panel axial force
DCM	Panel pitching moment
XQ, YQ, ZQ	Non-dimensional panel control point coordinates
CL	Lift coefficient
CD	Drag coefficient
DXN	Distance of center of pressure from origin, in reference chord lengths
I1	Number of first panel in wing column
I2	Number of last panel in wing column
IZ	Index counter
DELY	Wing column spanwise width
XL	Wing column leading edge origin
CNS	Normal force on wing upper surface
CTS	Axial force on wing upper surface
CMS	Pitching moment on wing upper surface

SUBROUTINES CALLED: None

ERROR RETURNS: None

PROGRAM GEOM

PURPOSE:	To input configuration geometry and specify panel subdivision of the components. A complete description of the input geometry cards is given in the program listing.
METHOD:	The case identification and initial configuration parameters are read from the input file. The secondary overlay program CONFIG is then called to complete the input of the configuration description. The auxiliary case identification is then read, followed by the boundary condition and print option. Finally, the revised configuration parameters used for specifying the panel subdivisions are read. Depending on the values of the revised configuration parameters, the program calls the secondary overlay programs NEWORD, WNGPAN, NEWRAD, BODPAN, NUTORD or TALPAN, which interpolate the input geometry and calculate the corner points, control points and inclination angles of the panels on the wing, body, or tail.
USE:	CALL OVERLAY (LWB, 1, 0)

<u>Input</u>:

TITLE1	Case description.
TITLE2	Auxiliary case description.
J0, K0	Reference area and length parameters.
J1, K1	Wing definition parameters.
J2, K2	Body definition parameters.
J3, K3	Pod definition parameters.
J4, K4	Fin definition parameters.
J5, K5	Canard or tail definition parameters.
J6, K6	Body camber parameters.
NWAF	Number of wing airfoil sections.
NWAFOR	Number of ordinates used to define each wing airfoil section.

NFUS, KFUS	Number of body segments
NRADX	Number of points used to define half-section of body segment
NFORX	Number of axial stations on body segment
NP	Number of pods
NPODOR	Number of axial stations on pod
NF	Number of fins
NFINOR	Number of ordinates used to define each fin airfoil section
NCAN	Number of tails (canards)
NCANOR	Number of ordinates used to define each tail airfoil section
KWAF	Number of streamwise panel edges on wing
KWAFOR	Number of ordinates used to define the leading and trailing edges of the wing panels
KRADX	Number of meridian lines used to define panel edges on body segment
KFORX	Number of axial stations used to define leading and trailing edges of panels on body segment
KF	Number of sections used to define the streamwise panel edges on fin
KFINOR	Number of ordinates used to define the leading and trailing edges of the panels on fin
KAN	Number of ordinates used to define the leading and trailing edges of the panels on tail or canard
REFA, REFAR	Wing reference area
REFB	Wing reference span
REFC	Wing reference chord

REFD	Body reference diameter
REFL	Body reference length
REFX, REFZ	Coordinates of moment reference point
LINBC	Boundary condition selection parameter (integer)
THICK	Wing thickness selection parameter (integer)
PRINT	Output print selection parameter (integer)

Output:

NBODY	Number of body panels
NWING	Number of wing and tail panels
NTAIL	Number of tail panels (not used)
NCPT	Number of control points on wing and tail
LBC	Boundary condition parameter (logical)
THK	Wing thickness parameter (logical)
TAIL	Tail parameter (logical)
KOL	Number of columns of panels on wing and tail
NSEG	Number of wing and tail segments
BLOCK	Dummy array used for storing geometry data on TAPE 9

PROGRAMS CALLED:

OVERLAY (LWB, 1, 1) (CONFIG)
OVERLAY (LWB, 1, 2) (NEWORD)
OVERLAY (LWB, 1, 3) (WNGPAN)
OVERLAY (LWB, 1, 4) (NEWRAD)
OVERLAY (LWB, 1, 5) (BODPAN)
OVERLAY (LWB, 1, 6) (NUTORD)
OVERLAY (LWB, 1, 7) (TALPAN)

ERROR RETURNS:

The program is terminated if:

(a) An end of file is read on TAPE 5
(B) KOL > 20
(c) KRADX(1) > 21

SUBROUTINE ITRATE

PURPOSE: To solve the boundary condition equations by an iterative procedure and determine the strengths of the body sources, and wing and tail vortices.

METHOD: The first approximation to the body panel source strengths is obtained by post-multiplying the inverted body diagonal block matrices written on TAPE 10 by the body normal velocity array. The first approximation to the wing and tail panel vortex strengths is obtained in a similar manner. If the absolute value of the print option is greater than two, the approximate source and vortex strengths are written on the output file.

The body normal velocity array is then revised by subtracting an incremental normal velocity array from the original normal velocity array. The incremental values are obtained in two steps. In the first step, the matrix giving the influence of the body sources on the body panel control points is read from TAPE 9 and multiplied by the approximate body source strengths. In the second step, the matrix giving the influence of the wing and tail vortices on the body panel control points is read from TAPE 9 and post-multiplied by the approximate wing and tail vortex strengths. The incremental normal velocity array on the body control points is the sum of these two contributions.

The wing and tail normal velocity array is revised in a similar manner. The revised normal velocity arrays are then used to obtain a second approximation to the source and vortex strengths by repeating the above procedure. This iteration procedure is repeated until the maximum number of iterations has been completed.

If the order of the body partition does not exceed 60, the same procedure is followed except that the first step in the determination of the incremental normal velocities on the body is omitted. If the order of the wing partition does not exceed 60, the same procedure is followed except that the second step in the determination of the incremental normal velocities on the wing is omitted.

USE: CALL ITRATE

Input:

IMAX	Maximum number of iterations
NBODY	Number of body panels
NWING	Number of wing panels
NBBLOK	Number of diagonal blocks in body matrix partition
NWBLOK	Number of diagonal blocks in wing matrix partition
NBROW	Number of rows in diagonal blocks in body matrix partition
NWROW	Number of rows in diagonal blocks in wing matrix partition
NB	Array of body normal velocities
NW	Array of wing normal velocities
D	Array of diagonal block matrix elements
A	Array of normal velocity matrix elements
PRINT	Print option parameter

Output:

RB	Array of revised normal velocities on body
RW	Array of revised normal velocities on wing
NBLOK	Number of diagonal block matrices
NROW	Number of rows in diagonal block matrix
NCOL	Number of columns in diagonal block matrix
GB	Array of body source strengths
GW	Array of wing vortex strengths

DNB	Incremental normal velocities on body
DNW	Incremental normal velocities on wing
TIME	Elapsed time

SUBROUTINES CALLED: SECOND

ERROR RETURNS: None

SUBROUTINE INVERT

PURPOSE: Matrix inversion subroutine

METHOD: Subroutine INVERT is a simple matrix inversion procedure based on Gauss-Jordan elimination without pivoting.

USE: CALL INVERT (A, IA, NMAX)

Input:

A	Name of matrix to be inverted
IA	Number of rows and columns in matrix A
NMAX	Maximum dimensions specified for A in calling subroutine

Output:

A	Inverse of A

SUBROUTINES CALLED: None

RESTRICTIONS: NMAX not greater than 115

ERROR RETURNS: Subroutine calls EXIT if matrix is singular

PROGRAM LINVEL

PURPOSE: To calculate the three components of velocity induced at specified control points by source and vortex distributions on panels located in the plane of the wing or tail surfaces.

METHOD: The x, y, and z coordinates of the control point, and the corresponding panel inclination angles θ and δ are read from COMMON block POINT.

Starting with the first wing segment, the panel leading and trailing edge slopes are calculated and stored. The program then computes the velocity components induced by the panel corner points along the <u>inboard</u> edge of the first column of panels. These calculations are performed by subroutines VORVEL and SORVEL, which return the three components of velocity induced by constant and linearly varying vortex and source distributions. These subroutines are called twice to obtain the contributions of both left and right wing panels. In addition, a second call to subroutine VORVEL is required at panel trailing edge corner points if the panel spacing is not uniform.

To compute the velocity components induced by the panel corner points along the <u>outboard</u> edge of this and the remaining columns of panels, the procedure is repeated. However, for the remaining columns of panels, advantage is taken of the fact that the velocity components along the inboard edges of a given column of panels are the same as those computed at the outboard edges of the previous column of panels. Therefore, the inboard velocity components are not recomputed, but stored in temporary arrays prior to the calculation of the outboard velocity component arrays.

Once the velocity components induced by the panel corner points along the outboard edge of a given column of panels are computed, the inboard and outboard influences of each panel in the column are combined to obtain the resultant panel velocity components. First the velocity components induced by the right and left wing panels are calculated, using appropriate combination rules for the source and vortex panels, and applying special rules for leading and trailing edge panels. Finally the contributions of the left and right wing panels are combined, the velocity components transformed back to the reference coordinate system, and the velocity normal to the panel at the control point computed.

The procedure is repeated for each column of panels in each wing segment, until all wing panels are accounted for. At this point the u, v, and w components of velocity induced by the source panels are written as a single record on TAPE 8, followed by the u, v, and w components of velocity induced by the vortex panels. If the thickness option is not requested, only the vortex panel arrays are written on this tape. The normal velocities are then written as a single record on TAPE 9. If the control point is in the same column of panels on the wing as the influencing panel, and the wing has more than 60 panels, the normal velocity at the control point is written on TAPE 10 and its value set to zero in the array written on TAPE 9. This procedure sets up the diagonal blocks of the aerodynamic matrix for later use in the iterative solution procedure. Finally, if the print option is selected, the axial and normal velocity component arrays induced by the vortex panels and source panels are written on the output tape.

The process is repeated for each control point.

USE: CALL OVERLAY (LWB, 2, 2)

Input:

Note: The word wing includes any tail, fin, or canard in the following descriptions

MACH Mach number

PRINT Print option parameter

THK Wing thickness option parameter (logical)

NPART	Matrix partition number
NMAX	Maximum order of diagonal block matrices
NWING	Number of wing panels
NSEG	Number of wing segments
NROW	Number of rows of panels in segment
NCOL	Number of columns of panels in segment
NWT	Tail segment identification parameter
NPOINT	Number of control points
IT	Array of wing supersonic trailing edge indicators
XPT, YPT, ZPT	Arrays of control point coordinates
THET	Array of panel inclination angles at control points
DELTA	Array of panel incidence angles at control points
XC, YC, ZC	Arrays of wing panel corner point coordinates
COSS	cos θ(J)
SINS	sin θ(J)
CHORD	Array of wing panel chords

<u>Output</u>:

I, II	Control point index
J, JSAVE	Wing panel index (vortex panels)
K, KSAVE	Wing panel index (source panels)
L	Panel row index

M	Panel column index
N	Wing segment index
NP, NPSAVE	Panel number
NWTHK	Number of wing panel source distributions
BETA	Mach number parameter
SUB	Subsonic flow parameter (logical)
SUPTE	Supersonic trailing edge parameter (logical)
CON, BCON	Constants for vortex panel velocity components
CONT, BCONT	Constants for source panel velocity components
ISKIP	Wing supersonic trailing edge indicator
NR,NS	Number of rows of panels in segment
NC	Number of columns of panels in segment
NT	Tail segment identification parameter
J1,J2, JS1, JS2	Wing panel numbers of diagonal block matrices
SINTI	sin θ(I)
COSTI	cos θ(I)
XI,YI, ZI	Coordinates of control point I
DI	tan δ(I)
BLE,BL	Array of panel leading edge slopes
BTE	Panel trailing edge slope
FLAG	Logical variable denoting presence of additional column of vortex panels extending from the center line to the inboard edge of the wing

BPOS	Panel leading edge slope sign parameter (logical)
COST	cos $\theta(J)$
SINT	sin $\theta(J)$
SINTR	sin $(\theta(J) - \theta(I))$
COSTR	cos $(\theta(J) - \theta(I))$
SINTL	sin $(\theta(J) + \theta(I))$
COSTL	cos $(\theta(J) + \theta(I))$
XC, YC, ZC	Arrays of panel corner point coordinates
DX, DY, DZ	Control point coordinates in panel reference system
AL, AB, AT	Difference between panel leading and trailing edge slopes
CL, CT, CC	Panel chord length along edge
ABA	Absolute value of (AL - AT)
ACL	Absolute value of (CL - CT)
ML	Panel edge indicator
AMP	Reciprocal of panel chord
X	Dummy variable
UCOR, VCOR, WCOR	Velocity components induced by outboard corners of right wing panels containing constant vortex distributions
ULOR, VLOR, WLOR	Velocity components induced by outboard leading edge corner of right wing panels containing linearly varying vortex distributions

UTOR, VTOR, WTOR	Velocity components induced by outboard trailing edge corner of right wing panels containing linearly varying vortex distributions
RCOR, SCOR, TCOR	Velocity components induced by outboard corners of right wing panels containing constant source distributions
RLOR, SLOR, TLOR	Velocity components induced by outboard corners of right wing panels containing linearly varying source distributions
UCOL, VCOL, WCOL	Same as UCOR, VCOR, WCOR for outboard corners of left wing panels
ULOL, VLOL, WLOL	Same as ULOR, VLOR, WLOR for outboard corners of left wing panels
UTOL, VTOL, WTOL	Same as UTOR, VTOR, WTOR for outboard corners of left wing panels
RCOL, SCOL, TCOL	Same as RCOR, SCOR, TCOR for outboard corners of left wing panels
RLOL, SLOL, TLOL	Same as RLOR, SLOR, TLOR for outboard corners of left wing panels
UCIR, VCIR, WCIR	Same as UCOR, VCOR, WCOR for inboard corners of right wing panels
ULIR, VLIR, WLIR	Same as ULOR, VLOR, WLOR for inboard corners of right wing panels
UTIR, VTIR, WTIR	Same as UTOR, VTOR, WTOR for inboard corners of right wing panels
RCIR, SCIR, TCIR	Same as RCOR, SCOR, TCOR for inboard corners of right wing panels

RLIR, SLIR, TLIR	Same as RLOR, SLOR, TLOR for inboard corners of right wing panels
UCIL, VCIL, WCIL	Same as UCOR, VCOR, WCOR for inboard corners of left wing panels
ULIL, VLIL, WLIL	Same as ULOR, VLOR, WLOR for inboard corners of left wing panels
UTIL, VTIL, WTIL	Same as UTOR, VTOR, WTOR for inboard corners of left wing panels
RCIL, SCIL, TCIL	Same as RCOR, SCOR, TCOR for inboard corners of left wing panels
RLIL, SLIL, TLIL	Same as RLOR, SLOR, TLOR for inboard corners of left wing panels
ULR, RCR, VLR, SCR, WLR, TCR	Velocity components induced by right wing panels containing linearly varying vortex distributions with zero strength along leading edge
ULL, RCL, VLL, SCL, WLL, TCL	Same as above for left wing panels
UCR, VCR, WCR	Velocity components induced by right wing panels containing linearly varying vortex distributions with zero strength along trailing edge
UCL, VCL, WCL	Same as above for left wing panels

RLR, RTR, SLR, STR, TLR, TTR	Velocity components induced by right wing panels containing linearly varying source distributions with zero strength along leading edge
RLL, RTL, SLL, STL, TLL, TTL	Same as above for left wing panels
UTR, VTR, WTR	Velocity components induced by right wing panels containing linearly varying source distributions with zero strength along trailing edge
UTL, VTL, WTL	Same as above for left wing panels
UC, VC, WC	Arrays of velocity components induced by vortex panels at control point I
USAVE, VSAVE, WSAVE	Velocity component storage arrays
AC	Array of normal velocities induced by vortex panels at control point I
ASAVE	Normal velocity storage array
BC, BT	Velocity tangential to control point panel I
UT, VT, WT	Arrays of velocity components induced by source panels at control point I
AT	Array of normal velocities at control point I induced by source panels
DC	Array of normal velocities induced by vortex panels in diagonal block matrices

SUBROUTINES CALLED:	VORVEL, SORVEL
ERROR RETURNS:	None

PROGRAM NEWORD

PURPOSE: To revise chordwise panel spacing on the wing and to compute new airfoil ordinates by interpolation.

METHOD: The program first checks the input data to determine if the wing has a round leading edge. If so, an array of wing leading edge radii are read in. The program then checks if the percent chord locations of the panel edges are to be redefined. If so, an array of revised chordwise locations are read in, otherwise the panel edges are used as originally defined.

For each wing section, the original camber and thickness distributions are rewritten as one dimensional arrays. A chain of cubic curves having continuous first derivatives is fitted between each pair of points on these two curves, and the four coefficients of the cubic curve calculated within each interval. For wing sections having round leading edges with infinite leading edge slope, the slope at the second percent chord location is calculated by fitting the curve $z = \sqrt{2\rho x} + ax + bx^2$ through the first three points. The program then calculates the coefficients of the cubic curves through the remaining points in the usual way, starting with the slope determined from the first derivative of the above formula.

The revised camber and thickness ordinates and slopes are then calculated at the new chordwise locations by the formulas

$$z = c_1 + c_2 x + c_3 x^2 + c_4 x^3$$

$$dz/dx = c_2 + 2c_3 x + 3c_4 x^2$$

where the coefficients correspond to the interval of the curve under consideration. For wings having round leading edges, the formula given in the previous paragraph is used in the first interval.

USE: CALL OVERLAY (LWB, 1, 2)

<u>Input</u>:

K1	Wing leading edge definition parameter
NWAF	Number of wing airfoil sections
NWAFOR	Number of ordinates used to define wing airfoil section
KWAFOR	Number of ordinates used to define wing panel leading and trailing edges. If KWAFOR = 0, NWAFOR ordinates are used.
XAF	Array of percent chords for airfoil ordinates (NWAFOR values)
XAFK	Array of percent chords for panel leading and trailing edges (KWAFOR values)
TZORD	Array of camber line ordinates
WAFORD	Array of half-thickness ordinates
RHO	Array of leading edge radii

<u>Output</u>:

NWAR	Number of intervals in curve
ZORD	Array of camber line ordinates
TORD	Array of half-thickness ordinates
NDA, DA	Number and value of derivative at initial point on curve
DZC, DZCDX	Array of camber line slopes
DZT, DZTDX	Array of half-thickness slopes
A, B	Coefficients of leading edge curve
C, CC	Coefficients of cubic curves in each interval

TZORK	Array of revised camber line ordinates
DZCDXK	Array of revised camber slopes ordinates
WAFORK	Array of revised half-thickness ordinates
DZTDXK	Array of revised half-thickness slopes

SUBROUTINES
CALLED: DERIV

ERROR
RETURNS: None

PROGRAM NEWRAD

PURPOSE: To revise the body meridian line spacing.

METHOD: For each body segment, there are three options for redefining the meridian lines. Considering the first segment, if KRADX(1) = 0, the meridian lines are not changed. If KRADX(1) is positive, the meridian lines are relocated at KRADX(1) equally spaced values of the meridian angle ϕ. If KRADX(1) is negative, an array of arbitrary meridian angles is read in.

If the body has a circular cross section, the y and z coordinates are calculated at each axial station as follows:

$$y = r \cos\phi$$

$$z = z_c + r \sin\phi$$

where the body radius r and camber z_c have been previously calculated in program CONFIG.

If the body has an arbitrary cross section, the y and z coordinates are obtained by linear interpolation at the new values of ϕ of the original y and z coordinates read in program CONFIG.

The x, y, and z coordinates are written on TAPE 10, and the procedure repeated for the remaining body segments.

USE: CALL OVERLAY (LWB, 1, 4)

<u>Input</u>:

J2TEST	Parameter to specify body cross section and camber definition
NFUS	Number of body segments
NRADX, KRADX	Number of meridian lines on segment
PHIK	Array of meridian angles on segment

NFORX, NFUSOR	Number of axial stations on segment
XFUS	Array of axial stations on segment
FUSRAD	Array of body radii on segment
ZFUS	Array of body camber ordinates on segment
SFUS	Array of y and z coordinates used in arbitrary cross section definition

Output:

KFUS	Number of body segments
NF, NFU	Body segment number
NRAD, KRAD	Number of meridian lines in segment
KTEST	Arbitrary body indicator
NEWPHI	Logical variable controlling input of new meridian angles
PHIR	Meridian angle (radians)
DELE	Incremental meridian angle
XB	Array of axial stations on segment
YB, ZB	Arrays of y and z coordinates on segment
YF, ZF	Temporary arrays of y and z coordinates
RAD	Body radius
CAM, ZC	Body camber ordinate
PHIN	Array of original meridian angles for arbitrary cross section body
MAX	Maximum number of body axial stations

SUBROUTINES
CALLED: None

ERROR
RETURNS: The program will call EXIT if KRAD > 60.

PROGRAM NUTORD

PURPOSE: To revise chordwise panel spacing on fin, canard or tail and compute new airfoil ordinates.

METHOD: The program first tests to determine if the component under consideration is a fin (vertical tail), a canard, or a horizontal tail. The program then initializes the appropriate constants, and reads in an array of leading edge radii if the component has a round leading edge.

Each horizontal or vertical tail component is then treated as an additional wing segment, and the procedure follows the steps described under program NEWORD.

USE: CALL OVERLAY (LWB, 1, 6)

Input:

J4	Fin definition parameter
J5	Tail or canard definition parameter
K4	Fin leading edge definition parameter
K5	Tail or canard leading edge definition parameter
NF	Number of fins
NC	Number of tails and canards
NFINOR	Number of ordinates defining fin airfoil
NCANOR	Number of ordinates defining tail and canard airfoils
KFINOR	Number of ordinates defining fin panel leading and trailing edges
KANOR	Number of ordinates defining tail or canard panel leading and trailing edges
XAF, XT	Array of percent chords for airfoil ordinates

XAFK	Array of percent chords for panel leading and trailing edges
TALCR	Array of airfoil camber line ordinates
TALOR	Array of airfoil half-thickness ordinates
RHO	Array of airfoil leading edge radii

Output:

FIN	Fin identification variable (logical)
NT	Number of fins, tails or canards
J1	Tail or canard camber identifier
JL	Tail definition integer
KL	Airfoil leading edge definition integer
NWAFOR	Number of ordinates defining airfoil
KWAFOR	Number of ordinates defining fin, tail or canard panel leading and trailing edges
NWAR	Number of intervals in curve
NDA, DA	Number and value of derivative at initial point on curve
ZORD	Array of camber line ordinates
TORD	Array of half-thickness ordinates
DZC, DZCDX	Array of camber line slopes
DZT, DZTDX	Array of half-thickness slopes
A, B	Coefficients of leading edge curve
C, CC	Coefficients of cubic curves in each interval
TZORK	Array of revised camber line ordinates

	DZCDXK	Array of revised camber line slopes
	WAFORK	Array of revised half-thickness ordinates
	DZTDXK	Array of revised half-thickness slopes
SUBROUTINES CALLED:	DERIV	
ERROR RETURNS:	None	

SUBROUTINE PANEL

PURPOSE: To calculate direction cosines of the normal vector, the centroid, area, and inclination angles of an arbitrary quadrilateral panel.

METHOD: The four corners of the panel are numbered in a clockwise direction. A diagonal vector T_1 connects points 1 and 3, and a diagonal vector T_2 connects points 2 and 4. The normal vector N is obtained by taking the cross product of these diagonal vectors, and the direction cosines determined by calculating the projections of this vector in the reference coordinate system. The plane of the panel is defined to be perpendicular to the normal vector and to pass through a point whose coordinates are the averages of the coordinates of the four input points. The input points are then projected into the plane of the panel, and transformed to the reference coordinate system. A new panel coordinate system ξ, η is introduced with the average point of the panel as origin. The coordinates of the centroid and the panel area are calculated in this new system, and the centroid transformed to the reference system. Two angles are used to define the panel orientation. The incidence δ is the angle between the x axis and the line of intersection with the panel of a plane passing through the x axis and perpendicular to the panel. The inclination θ is the angle between the y axis and the line of intersection of the panel with the yz plane. These two angles are calculated in terms of the direction cosines of the normal vector.

USE: CALL PANEL (IP, IQ, J, K, L, NP, AP)

<u>Input</u>:

IP, IQ	Panel identification code
J	Panel row number
K	Panel column number
L	Surface identification code
NP	Panel number

XC	x coordinate of panel corner point
YC	y coordinate of panel corner point
ZC	z coordinate of panel corner point

<u>Output</u>:

NX, NY, NZ	Direction cosines of the normal vector
AVX, AVY, AVZ	Coordinates of average point
D	Distance from corner point to plane of panel
XI, ETA	Coordinates of corner point in panel coordinate system
XIO, ETAO	Coordinates of centroid in panel co-ordinate system
XPT, YPT, ZPT	Coordinates of centroid in reference coordinate system
DELTA	Panel incidence angle
THET	Panel inclination angle
AP	Panel area

SUBROUTINES CALLED: None

ERROR RETURNS: None

SUBROUTINE PARTIN

PURPOSE: For wing-body combinations, to invert the matrix partitions and store the results on TAPE 10. For isolated wings or bodies, to solve the boundary condition equations and determine the body source strengths or wing vortex strengths.

METHOD: This subroutine is called only if the order of the matrix partition (or the full matrix in the case of isolated wings or bodies) does not exceed 60.

For wing-body combinations, the partitions are read from TAPE 9, inverted, and the inverse matrix written on TAPE 10.

For isolated wings or bodies, the matrix is read from TAPE 9, inverted, and the inverse post-multiplied by the normal velocity array to obtain the body source strengths or wing vortex strengths.

USE: CALL PARTIN

<u>Input</u>:

NWING	Number of wing and tail panels
NBODY	Number of body panels
NDIM	Matrix dimension statement size
A, D	Array of matrix elements
NW	Array of wing and tail normal velocities
NB	Array of body normal velocities

<u>Output</u>:

NPANEL	Total number of panels
A, D	Array of inverse matrix elements

	TIME	Elapsed time in seconds
	GW	Array of wing and tail vortex strengths
	GB	Array of body source strengths
SUBROUTINES CALLED:	SECOND	
ERROR RETURNS:	None	

SUBROUTINE PRESS

PURPOSE: To compute the pressure coefficient at a panel control point.

METHOD: The u, v, and w components of velocity are given in terms of the reference coordinate system. They are transformed into a new coordinate system aligned with the free stream velocity vector, and used to determine the pressure coefficient by means of the exact isentropic formula:

$$CP = \frac{2}{\gamma M^2}\left\{\left[1 + \frac{\gamma-1}{2} M^2 (1 - Q^2)\right]^{3.5} - 1\right\}$$

where $Q^2 = (1 + u')^2 + v^2 + w'^2$

$$u' = u \cos\alpha + w \sin\alpha$$

$$w' = w \cos\alpha - u \sin\alpha$$

If the Mach number M is zero, the pressure coefficient is determined by the incompressible formula:

$$CP = 1 - Q^2$$

The subroutine also calculates the stagnation pressure coefficient, the critical pressure coefficient, and the vacuum pressure coefficient by the following formulas:

$$CPSTAG = \frac{2}{\gamma M^2}\left\{\left[1 + \frac{\gamma-1}{2} M^2\right]^{3.5} - 1\right\}$$

$$CPCRIT = \frac{2}{\gamma M^2}\left\{\left[\frac{2}{\gamma+1} + \frac{\gamma-1}{\gamma+1} M^2\right]^{3.5} - 1\right\}$$

$$CPVAC = -\frac{2}{\gamma M^2}$$

USE:	CALL PRESS (NP, XMACH, ARA, U, V, W, CPP, CPSTAG, CPCRIT, CPVAC)	
	Input:	
	NP	Panel number
	XMACH	Mach number
	ARA	Angle of attack in radians
	U, V, W	Velocity components at panel control point
	Output:	
	CPP	Pressure coefficient at panel control point
	CPSTAG	Stagnation pressure coefficient
	CPCRIT	Critical pressure coefficient
	CPVAC	Vacuum pressure coefficient
SUBROUTINES CALLED:	None	
ERROR RETURNS:	None	

SUBROUTINE SCAMP4

PURPOSE: Given a set of n points (x_i, y_i) whose abscissae form a strictly monotone sequence, a first or second derivative at x_1, and a first or second derivative at x_n, to find the smoothest possible curve passing rigorously through the given points, satisfying the specified boundary conditions, and possessing continuous first and second derivatives. The criterion for smoothness is the minimization of the integral of the square of the second derivative, from x_1 to x_n, over all functions having the stated properties. Accordingly, the curve found is a chain of cubics, i.e., a separate cubic defined on each interval (x_i, x_{i+1}). The coefficients of each such cubic are explicitly found in the form

$$y = c_0 + c_1 x + c_2 x^2 + c_3 x^3$$

METHOD: The most economical (in time and space) and most accurate method of finding such a chain of cubics is to solve first for the n slopes y_i of the curve. This is done by the composite cubic subroutine COMCU, which solves an n^{th} order linear system, the coefficient matrix of which is tridiagonal. Having found the slopes at each of the n given x_i, one can determine the coefficients of each cubic separately by using CUBIC2, which finds the cubic through two points, being given the slope at each. The coefficients of all the n-1 cubics can be obtained by using the subject routine (SCAMP4) which serves as a vehicle for calling COMCU (once) and CUBIC2 (n-1 times). SCAMP4 has an option to compute the required boundary conditions (first or second derivatives at the end points) if these are not known by the calling program; in this case, the computation of first derivatives at x_1 and x_n is recommended.

The cubic coefficients found by SCAMP4 are either stored in a 4 by n-1 array or are arranged in the composite curve format, i.e., in a single linear array where each segment is specified by a block of seven consecutive words: x_i, x_{i+1}, 3., c_0, c_1, c_2, c_3. The calling program should dimension the coefficient array as a doubly subscripted variable in the former case and singly subscripted in the latter case.

USE: CALL SCAMP4 (X, Y, N, NDA, NDB, DA, DB, C, S, M)

<u>Input</u>:

X	Array of x values
Y	Array of y values
N	Number of points
NDA	The order (1 or 2) of the derivative to be given at X(1). If derivative is to be computed by SCAMP4, NDA < 0.
NDB	The order of the derivative to be given at X(N). Similar to NDA.
DA	The value of the derivative at X(1). If derivative is to be computed by SCAMP4, leave blank.
DB	The value of the derivative at X(N). Similar to NDA.
	Code.
M	$\neq$ 12, if the cubic chain coefficients are to be stored in a doubly dimensioned 4 x (N-1) array. = 12, if the cubic chain coefficients are to be stored in a singly dimensioned array

<u>Output</u>:

C	Array of cubic chain coefficients
S	Array of first derivatives
M	Error return = 0 - success $\neq$ 0 - error detected

SUBROUTINES CALLED: COMCU, CUBIC2, DERIV1, DERIV2

ERROR RETURNS: $M = -1$ indicates $N < 2$. $1 \leqslant M \leqslant 7$ indicates an error return from COMCU. M large indicates error return k on the j^{th} call to CUBIC2 $(M = 100 \cdot j + k)$.

SUBROUTINE SECOND

PURPOSE:	To return elapsed CPU time in seconds.
METHOD:	Control Data Corporation SCOPE Library subroutine.
USE:	CALL SECOND (TIME)
	<u>Output</u>:
	TIME Elapsed CPU time in seconds
SUBROUTINES CALLED:	None
ERROR RETURNS:	None
RESTRICTIONS:	Limited to CDC computers using SCOPE 3.0 operating system and library tape.

PROGRAM SOLVE

PURPOSE: To solve for the strengths of the body sources and wing vortices which satisfy the boundary condition of tangential flow at the panel control points, and to determine the corresponding pressure distribution, forces and moments on the configuration.

METHOD: The program first calculates the array of normal velocities required to satisfy the boundary conditions at the wing and body panel control points. The panel inclination angles θ and δ are obtained from the geometry arrays on TAPE 7, and the angle of attack α from COMMON block PARAM.

If the planar boundary condition and wing thickness options have been selected, the program next computes the normal velocities induced on the body and non-coplanar wing or tail segments by the wing source distribution. These normal velocities are subtracted from those previously calculated to obtain the resultant normal velocities at the control points.

The coefficients of the equations to be solved have previously been stored in row order on TAPE 9. Three different procedures are followed to solve the equations depending on the order of the matrix of coefficients. If the configuration to be analyzed consists of an isolated wing or body, and the order of the matrix does not exceed 60, the equations are solved in subroutine PARTIN by direct inversion of the matrix. If the configuration consists of a wing-body combination, and the order of the wing and body partition does not exceed 60, subroutine PARTIN inverts the diagonal partitions of the matrix and writes the inverse matrices on TAPE 10. An iterative procedure described in subroutine ITRATE is then applied to solve the equations. For any configuration for which the order of the wing or body partition exceeds 60, the diagonal blocks of the matrix are read from TAPE 7, inverted, and written on TAPE 10 by subroutine DIAGIN. Subroutine ITRATE is then called to solve the resulting equations by an iterative procedure.

Once the strengths of the source and vortex distributions have been determined, the program calculates the three components of velocity and pressure coefficient at each panel control point, starting with the body panels. The velocity components corresponding to unit strength source and vortex distribution are obtained from TAPE 8. The first three records on this file contains the velocity components at body control points induced by the body source panels, the wing source panels (if present), and the wing vortex panels. The program multiplies these by the corresponding source and vortex strength, and sums the products to obtain the resultant velocity component arrays at each body control point. The magnitude of the normal velocity at the body control points is also calculated at this point. If the absolute value of the print option is greater than one, the three components of velocity and the normals are written on the output file. The program then calls subroutine PRESS to obtain the pressure coefficients at the body panels, and subroutine FORMOM to integrate the pressures and calculate the force and moment acting on the body.

The velocity components at the wing and tail panel control points are computed next. The remaining three records containing the velocity components at wing and tail control points induced by the body source panels, the wing source panels (if present) and the wing vortex panels are read from TAPE 8. The program multiplies these by the corresponding source and vortex strengths and sums the products to obtain the resultant velocity component arrays at the wing and tail panel control points. If the absolute value of the print option is greater than one, the velocity component arrays are written on the output file. The program then calls subroutine PRESS to obtain the pressure coefficients, and subroutine FORMOM to calculate the force and moment acting on the wing.

If the planar boundary condition option has been selected, two passes through this section are required to obtain the velocity components, pressure and forces on both upper and lower surfaces.

The program writes the values of the stagnation pressure coefficient, the critical pressure coefficient, the vacuum pressure coefficient, and the elapsed time on the output file prior to returning.

USE: CALL OVERLAY (LWB, 3, 0)

Input:

NBODY	Number of body panels
NWING	Number of wing and tail panels
NWTHK	Number of wing and tail panel source distributions
NMAX	Maximum order of diagonal block matrices
PRINT	Print option parameter (integer)
MACH	Mach number
MATIN	Matrix inversion parameter
LBC	Planar boundary condition option parameter (logical)
THK	Wing thickness option parameter (logical)
ALPHA	Angle of attack in degrees
CHORD	Array of wing and tail panel chords
DZTDX	Array of wing and tail panel half-thickness slopes
ARRAY	Wing or body panel geometry arrays
DELTA	Array of panel incidence angles
THET	Array of panel inclination angles
UA, VA, WA	Arrays of velocity components induced by unit strength source and vortex distributions

Output:

EM	Mach number

NPASS	Number of passes through program
COMPT	Wing or body component indicator (integer)
ALP	Angle of attack in radians
SINAL, COSAL	Trigonometric functions of angle of attack
SINT, COST	Trigonometric functions of inclination angle θ
TANDEL	tan δ
NW	Array of normal velocities required to satisfy boundary conditions at wing control points
NB	Array of normal velocities required to satisfy boundary conditions at body control points
U, V, W	Arrays of velocity components at control points
NS	Array of normal velocities at control points
GB	Array of body panel source strengths
GW	Array of wing and tail panel vortex Strengths
CP	Array of pressure coefficients at control points
CPSTAG	Stagnation pressure coefficient
CPVAC	Vacuum pressure coefficient
CPCRIT	Critical pressure coefficient
SGN	Wing upper and lower surface sign parameter
TIME	Elapsed time in seconds

SUBROUTINES CALLED:	DIAGIN, PARTIN, ITRATE, PRESS, FORMOM, SECOND
ERROR RETURNS:	None

SUBROUTINE SORPAN

PURPOSE: To calculate the three components of velocity induced at a given control point by a constant source distribution on a quadrilateral panel having longitudinal taper and inclined at an angle δ to the free stream direction.

METHOD: Formulas for the three components of velocity u, v, and w are given in Part I of this report. The subroutine obtains the information necessary to evaluate these formulas through COMMON block BODCOM, and returns the velocity components through the subroutine parameter list.

The first step in the calculation procedure is the adjustment of the z coordinate of each panel corner to ensure that it lies in the plane containing the panel leading edge and its control point. The influence functions F, G, and H are then calculated at the specified control point for each corner point in sequence. The final result is obtained by combining the four values of these functions.

USE: CALL SORPAN (UPM, VPM, WPM)

<u>Input</u>:

EM	Mach number
SA	tan δ (δ is panel inclination angle)
CX	Panel chord length
XC, YC, ZC	Arrays of corner point coordinates
XI, YI, ZI	Coordinates of control point
XJ, ZJ	Coordinates of panel control point

Output:

BT2, BTA	Mach number parameters
SM	Panel side edge slopes
DX, DY, DZ	Coordinates of control point referred to corner point
D	Compressed distance from corner point to control point
DPM	Scaled compressed distance from corner point to control point
XPM, YMX, ZAX, AYM	Transformed control point coordinates
RPM	Compressed distance from side edge to control point
TA	Panel edge slope parameter, $(1. + BT2.SA^2)$
TAM	Panel edge slope parameter, $(1. + BT2(SA^2 + SM^2))$
E, F, G, H	Corner point influence functions
E14, F14, G14	Combined corner point influence functions
R4PI	Reciprocal of 4π (or 2π if EM > 1)
UPM, VPM, WPM	Velocity components at control point in panel coordinate system

SUBROUTINES CALLED: None

ERROR RETURNS: None

SUBROUTINE SORVEL

PURPOSE: To calculate the three components of velocity induced at a given control point by constant and linearly varying source distributions on a swept quadrilateral panel. The subroutine calculates the velocity components induced by one corner of the panel.

METHOD: Formulas for the three components of velocity UC, VC, WC induced by a constant source distribution, and UL, VL, WL induced by a source distribution having a linear chordwise variation are given in Part I of this report. The subroutine obtains the information necessary to evaluate these formulas through COMMON block COMPS, and returns the velocity components through the parameter list. It is assumed that the Gothert Rule compressibility transformation has been applied to the geometrical data prior to calling this subroutine. Both sets of velocity components are expressed in terms of the influence functions F1, G1, G2, and G3 which depend only on the geometrical relationship of the control point to the corner point, the sweep angle, and Mach number.

The subroutine contains three separate branches for evaluating the velocity components, corresponding to the general case, a special case for supersonic leading edges, and a special case if the control point lies in the plane of the panel.

USE: CALL SORVEL (UC, VC, WC, UL, VL, WL)

Input:

DELTAY, DELTAZ	y and z coordinates of control point in reference coordinate system
X, Y, Z	Coordinates of control point with reference to corner point
B	Leading edge slope
BPOS	Leading edge slope sign parameter (logical)

SUB	Subsonic Mach number parameter (logical)
COST, SINT	Sine and cosine of panel dihedral angle θ

<u>Output</u>:

SUP	Supersonic Mach number parameter (logical)
SUPLE	Supersonic leading edge parameter (logical)
BNEG	Leading edge slope sign parameter (logical)
BTERM	Leading edge slope parameter
D	Distance from control point to corner point
R	Distance from control point to side edge
TZ	Distance from control point to leading edge
C1, T2, T3, AT3	Geometrical parameters
F1, G1, G2, G3	Influence functions
UC, VC, WC	Velocity components at control point induced by constant source distribution
UL, VL, WL	Velocity components at control point induced by source distribution with linear chordwise variation

SUBROUTINES CALLED: None

ERROR RETURNS: None

PROGRAM TALPAN

PURPOSE: To revise the spanwise panel spacing on fin, canard, or tail and compute the panel geometry.

METHOD: The program first tests to determine if the component under consideration is a fin (vertical tail), a canard, or a horizontal tail. The program initializes the appropriate constants, then rewinds TAPE 7, reads the wing geometry arrays from that file, and stores them in COMMON block POINT. Each horizontal or vertical tail component is then treated as an additional wing segment, following the steps described under subroutine WNGPAN.

At the completion of the calculation, the combined wing and tail geometry arrays are stored in COMMON block POINT, and the entire sequence of arrays are written as a single record back on TAPE 7. The augmented CHORD and SLOPE arrays are also written on TAPE 7 at this point. The remaining wing and tail geometry parameters are stored in COMMON blocks PARAM and SEG. Finally, if the print option is positive, the fin, canard or tail panel corner point coordinates, control point coordinates, inclination angles, areas, and chords are written on the output file.

USE: CALL OVERLAY (LWB, 1, 7)

Input:

LBC	Boundary condition option (logical)
PRINT	Print option
K4	Fin definition parameter
K5	Tail or canard definition parameter
NF	Number of fins
NK	Number of tails or canards
NCPT	Number of control points on wing
NWING, NINIT	Number of panels in wing (initial value)

KF	Number of streamwise panel edges on fin
KAN	Number of streamwise panel edges on tail or canard
YK	Array of spanwise locations of fin or tail panel streamwise edges
KFINOR	Number of ordinates defining fin panel leading and trailing edges
KANOR	Number of ordinates defining tail or canard panel leading and trailing edges
TALORG	Array of origin and chord length of each fin, tail or canard airfoil (x, y, z, c)
XAFK	Array of percent chords for panel leading and trailing edges
WAFORK	Array of airfoil half-thickness ordinates
TZORK	Array of airfoil camber ordinates
DZTDXK	Array of airfoil half-thickness slopes
DZCDXK	Array of airfoil camber slopes

<u>Output</u>:

Note:	In the following descriptions, the words tail or tail segment may refer to any fin, canard, or tail component
FIN	Fin identification variable (logical)
NTAL	Number of fins, tails, or canards
NT	Tail segment number
KK	Fin identification integer
KL	Leading edge identification integer
KWAF	Number of panel streamwise edges on tail segments

KWAFOR	Number of ordinates defining panel leading and trailing edges on tail segment
WAFORG	Array of origin and chord length of each tail segment airfoil (x, y, z, c)
NWING	Total number of wing and tail panels
NCPT	Total number of wing and tail control points
NP	Panel number
NC	Control point number
NSEG	Number of wing and tail segments
NROW	Number of rows of panels in segment
NCOL	Number of columns of panels in segment
KOL	Number of columns of panels on wing and tail
BL, BLE	Arrays of segment leading edge slopes
BT, BTE	Arrays of segment trailing edge slopes
TH	Array of segment dihedral angles
SINS	Array of sine of segment dihedral angle
COSS	Array of cosine of segment dihedral angle
NWT	Array of wing and tail indicator parameters
XK	Array of x-coordinates of origins of tail panel streamwise edges
ZK	Array of z-coordinates of origins of tail panel streamwise edges
CK	Array of chord lengths of tail panel streamwise edges

CL	Chord length of tail panel streamwise edge divided by one hundred
L	Tail surface indicator L = 1 indicates upper (inner) surface L = 2 indicates lower (outer) surface
SJ	Tail surface sign parameter
IP, IQ	Panel identification constants
XC, YC	Arrays of tail panel corner point x and y coordinates
ZC	Array of tail panel corner point z coordinates or lower (outer) surface coordinates for the non planar boundary condition option
ZU	Array of upper (inner) surface coordinates for the non planar boundary condition option
CR	Panel root chord
CT	Panel tip chord
RI, RO	Centroid ratios
XLE, XLEW	x coordinate of intersection of panel leading edge with streamwise line through centroid
XTE	x coordinate of intersection of panel trailing edge with streamwise line through centroid
CHORD	Array of panel chord lengths passing through centroids
SPN, SPNW	Array of panel spans
AREA	Array of panel areas

XPT, YPT, ZPT	Array of panel control point coordinates
THET	Array of panel dihedral angles
DZCDX	Array of tail camber slopes at panel edges (planar boundary condition option)
DELTA	Array of tail camber slopes at panel control points (planar boundary condition option) or panel incidence angle (non planar boundary condition option)
DZTDX, SLOPE	Array of tail half-thickness slopes at panel edges (planar boundary condition option)
SLE	Leading edge slope for round leading edge airfoils
XE	Array of x coordinates of panel control points
XS, YS, ZS	Array of point source origins (non planar boundary condition option)

SUBROUTINES CALLED: PANEL

ERROR RETURNS: The program calls EXIT if NWING > 600

SUBROUTINE TRANS

PURPOSE: To transform the three components of velocity from the panel coordinate system to the reference coordinate system, to combine the contributions of the left and right wing panels, and to calculate the normal velocity at the control point.

METHOD: The axial and vertical velocity components are transformed by a rotation of the coordinate system about the horizontal axis by the angle δ. The axial velocity components induced by the left and right wing panels are added directly to determine the resultant axial velocity u.

Two additional coordinate rotations about the x axis are required before the v and w components induced by the left and right wing panels can be combined. The first rotation transforms the v and w components from the influencing panel coordinate system to the control point panel coordinate system, and the second transforms the combined normal and tangential velocity at the control point to v and w velocity components in the reference coordinate system.

USE: CALL TRANS (UR, VR, WR, UL, VL, WL, U, V, W, A)

Input:

UR, VR, WR	Three components of velocity at control point in right wing panel coordinate system
UL, VL, WL	Three components of velocity at control point in left wing panel coordinate system

Output:

U, V, W	Three components of velocity at control point in reference coordinate system
A	Normal velocity at control point

SUBROUTINES CALLED:	None
ERROR RETURNS:	None

SUBROUTINE TRAP

PURPOSE: To evaluate an integral by the trapezoidal rule.

METHOD: The x and y coordinates of a curve are read and the integral obtained by summing the areas within each interval for i = 1, NT

$$SUM = \frac{1}{2} \sum_{i=1}^{NT} (x_i - x_{i-1})(y_i + y_{i-1})$$

USE: CALL TRAP (XT, YT, SUM, NT)

<u>Input</u>:

XT	Array of x coordinates (abscissa)
YT	Array of y coordinates (ordinates)
NT	Number of coordinates

<u>Output</u>:

SUM	Integral $\int y\,dx$ by trapezoidal rule

SUBROUTINES CALLED: None

ERROR RETURNS: None

PROGRAM USSAERO

PURPOSE:	This program controls the sequence of calculations required to determine the aerodynamic characteristics of wing-body-tail configurations in subsonic or supersonic potential flow.
METHOD:	The input card deck is read and listed on the output file. The three primary overlay programs GEOM, VELCMP, and SOLVE are then called in sequence to perform the remaining calculations. The lengths of the principal COMMON blocks are also specified in this program.
USE:	OVERLAY (LWB, 0, 0) LWB is overlay file name.
PROGRAMS CALLED:	OVERLAY (LWB, 1, 0) (GEOM) OVERLAY (LWB, 2, 0) (VELCMP) OVERLAY (LWB, 3, 0) (SOLVE)

PROGRAM VELCMP

PURPOSE: To compute the velocity components u, v, and w at panel control points, and form the aerodynamic influence coefficient matrices.

METHOD: The program reads the Mach number and angle of attack from the input file. If the Mach number is negative, or the same as the previous case, a return is executed. Otherwise, the program proceeds to compute the velocity components.

For wing alone, or wing-body configurations, a preliminary calculation is made to determine if the wing control points require relocation, and to compute the number and size of the wing diagonal blocks for later use in the matrix calculations. For wing-body configurations, the body geometry is first placed in temporary storage on TAPE 10. The program then proceeds to recalculate the chordwise locations of the wing control points for wings having supersonic edges, provided the planar boundary condition option has been selected. (An edge is defined to be supersonic if the component of the Mach number normal to the edge is greater than one.) Considering one wing segment at a time, the program tests to determine if either the leading or trailing edge is supersonic. If all edges are subsonic, the control points retain their original locations at the panel centroids. If the leading edge is subsonic and the trailing edge is supersonic, the control points in a given column of panels are adjusted uniformly between the centroid of the leading edge panel and the trailing edge of the last panel in the column. If both edges are supersonic, the control points are relocated at the panel leading edges, and the trailing edge of the last panel in the column. A wing supersonic trailing edge indicator array is also computed at this point in the program. The revised control points are stored in COMMON block POINT, and the entire wing geometry array written on TAPE 7. The body geometry temporarily stored on TAPE 10 is then rewritten on TAPE 7 following the wing geometry arrays.

The velocity component calculations are subdivided into four steps. For wing-alone or body-alone configurations, only the first step is necessary, otherwise all four steps are included. Each step involves the calculation of the influence coefficients of one partition of the complete aerodynamic matrices. The first partition gives the influence of the body panels at the body control points (or the influence of the wing panels at the wing control points for wing-alone configurations). The second partition gives the influence of the wing panels at the body control points, the third gives the influence of the body panels at the wing control points, and the fourth partition gives the influence of the wing panels at the wing control points for wing-body configurations. The program calculates the partition number, reads the appropriate geometry arrays from TAPE 7, and calls the wing or body panel velocity component program to obtain the influence coefficients.

On completion of the influence coefficient calculations, and if the order of any partition is greater than 60, the program writes the diagonal blocks of the aerodynamic matrix on TAPE 7 (following the geometry arrays) in preparation for the iterative solution. The number and size of the body diagonal blocks is calculated at this time, and stored with the wing diagonal block data and other matrix constants in COMMON block VELCOM.

USE: CALL OVERLAY (LWB, 2, 0)

Input:

LBC	Linear boundary condition option parameter (logical)
PRINT	Print option parameter
MACH	Mach number (real)
ALPHA	Angle of attack
NMAX	Maximum order of diagonal block matrices

NBODY	Number of body panels
KFUS	Number of body segments
KRADX	Array of body panel meridian lines in segment
KFORX	Array of body panel axial stations in segment
NWING	Number of wing and tail panels
NCPT	Number of wing and tail control points
NSEG	Number of wing and tail segments
NROW	Number of rows of panels in segment
NCOL	Number of columns of panels in segment
BL	Leading edge sweep of wing segment
BT	Trailing edge sweep of wing segment
ARRAY	Wing or body geometry arrays on TAPE 7
CHORD	Array of wing panel chords
DZTDX	Array of wing thickness slopes
XLE	Array of chordwise locations of wing control points
XPT, YPT, ZPT	Arrays of panel control point coordinates
DELTA	Array of panel incidence angles
D	Array of diagonal block matrix

Output:

MATIN	Matrix inversion indicator
SUB	Subsonic indicator (logical)
SUBLE	Subsonic leading edge indicator (logical)

SUBTE	Subsonic trailing edge indicator (logical)
EM	Mach number
BETA	Mach number parameter
NPOINT	Number of control points
NPANEL	Total number of panels
NWBLOK	Number of diagonal block matrices in wing partition
NBBLOK	Number of diagonal block matrices in body partition
NWROW, NK	Number of rows in wing diagonal block matrix
NBROW	Number of rows in body diagonal block matrix
NC	Number of columns of panels in segment
NR	Number of rows of panels in segment
BLE	Leading edge sweep of wing segment
BTE	Trailing edge sweep of wing segment
IT	Array of wing supersonic trailing edge indicators
XPT	Array of x coordinates of wing control points
XCPT	Array of chord fractions for control point location
LOCPT	Array of control point location indicators
NPART	Matrix partition number
XBT, YBT, ZBT	Temporary array of panel control point coordinates
TIME	Elapsed time in seconds

PROGRAMS CALLED:	OVERLAY (LWB, 2, 1)	(BODVEL)
	OVERLAY (LWB, 2, 2)	(LINVEL)
	OVERLAY (LWB, 2, 3)	(WNGVEL)
	SECOND	
ERROR RETURNS:	None	

SUBROUTINE VORPAN

PURPOSE: To calculate the three components of velocity induced at a given control point by constant and linearly varying vortex distributions on a swept quadrilateral panel. In addition, the subroutine calculates the three components of velocity induced by the concentrated vortex lying along the downstream extension of the inboard edge, and the vortex sheet located downstream of the trailing edge between the inboard edge and the intersection of the leading and trailing edges of the panel.

METHOD: Formulas for the velocity components UC, VC, WC induced by a constant vortex distribution, UL, VL, WL, and ULT, VLT, WLT induced by the leading and trailing edge corners respectively of a vortex distribution having a linear chordwise variation are given in Part I of this report. The subroutine obtains the information necessary to evaluate these formulas through COMMON block COMPS, and returns the velocity components through the parameter list. It is assumed that the Gothert Rule compressibility transformation has been applied to the geometrical data prior to calling this subroutine.

The subroutine first performs the coordinate transformations and calculates the geometrical parameters required by the velocity component formulas. It then evaluates the downwash velocity induced by the trailing vortex sheet by numerical integration. Eleven chordwise stations are used in the trapezoidal rule integration.

Three separate branches are provided for evaluating the velocity coefficients. The first branch is a special case for supersonic leading edges, the second contains the formulas for the general case, and the third contains special formulas used if the control point lies in the plane of the panel. In the latter two branches, the velocity components are expressed in terms of the six influence functions F1, G1, G2, G3, H1, and H2 which depend on the geometrical relationship of the control point to the corner point, the leading edge sweep angle, and the Mach number.

The v and w velocity components induced by the vortex sheet in the wake are expressed in terms of the influence functions F1 and H2, while those induced by the concentrated vortex in the wake are expressed in terms of the parameter C6. The wake vortices induce no axial component of velocity.

USE:

```
CALL VORPAN (UC, VC, WC, UL, VL, WL, ULT,
             VLT, WLT, VE, WE, VA, WA)
```

Input:

DELTAY, DELTAZ	y and z coordinates of control points in reference coordinate system
X, Y, Z	Coordinates of control point with reference to leading edge corner point
A	Difference between leading and trailing edge slopes
B	Leading edge slope
C	Panel chord length along inboard edge
BPOS	Leading edge slope sign parameter (logical)
SUB	Subsonic Mach number parameter (logical)
LBC	Planar boundary condition option parameter (logical)
COST, SINT	Sine and cosine of panel dihedral angle θ
ML	Panel leading or trailing edge indicator
MAX	Number of arguments in numerical evaluation of downwash integral

Output:

SUP	Supersonic Mach number parameter (logical)
SUPLE	Supersonic leading edge parameter (logical)

AB, AZ, CC	Geometrical parameters
R	Distance from control point to side edge
D	Distance from control point to corner point
E	Distance from control point to intersection of leading and trailing edges of panel
T8	E^2
TZ	Distance from control point to leading edge squared
B1, SB1	Mach number parameters
B2 ↓ B4	Geometrical parameters
C1 ↓ C6	Geometrical parameters
T1 ↓ T9	Geometrical parameters
XI	Array of x coordinates used in evaluation of downwash integral
Q, QX	Array of arguments used in evaluation of downwash integral
WQ	Value of downwash integral at leading edge
WQT	Value of downwash integral at trailing edge
SL, TL	Intermediate values of velocity functions at leading edge

ULS, VLS, WLS, TT, TLT	Intermediate values of velocity functions at trailing edge
F1, G1, G2, G3, H1, H2	Influence functions
VS, WS	Intermediate values of velocity components
UC, VC, WC	Velocity components at control point induced by constant vortex distribution
UL, VL, WL	Velocity components at control point induced by the leading edge corner of a vortex distribution with linear chordwise variation
ULT, VLT, WLT	Velocity components at control point induced by the trailing edge corner of a vortex distribution with linear chordwise variation
VA, VB, WA, WB	Velocity components at control point induced by the trailing vortex sheet
VE, VD, WE, WD	Velocity components at control point induced by concentrated vortex in wake

SUBROUTINES CALLED: TRAP

ERROR RETURNS: None

SUBROUTINE VORVEL

PURPOSE: To calculate the three components of velocity induced at a given control point by constant and linearly varying vortex distributions on a swept quadrilateral panel. The subroutine calculates the velocity components induced by the leading and trailing corners of one edge of the panel.

METHOD: Formulas for the velocity components UC, VC, WC induced by a constant vortex distribution, UL, VL, WL, and ULT, VLT, WLT induced by the leading and trailing edge corners respectively of a vortex distribution having a linear chordwise variation are given in Part I of this report. The subroutine obtains the information necessary to evaluate these formulas through COMMON block COMPS, and returns the velocity components through the parameter list. It is assumed that Gothert Rule compressibility transformation has been applied to the geometrical data prior to calling this subroutine.

The subroutine first performs the coordinate transformations and calculates the geometrical parameters required by the velocity component formulas. It then evaluates the downwash velocity induced by the trailing vortex sheet by numerical integration. Eleven chordwise stations are used in the trapezoidal rule integration.

Three separate branches are provided for evaluating the velocity coefficients. The first branch is a special case for supersonic leading edges, the second contains the formulas for the general case, and the third contains special formulas used if the control point lies in the plane of the panel. In the latter two branches, the velocity components are expressed in terms of the six influence functions F1, G1, G2, G3, H1, and H2 which depend on the geometrical relationship of the control point to the corner point, the leading edge sweep angle, and the Mach number.

USE:	CALL VORVEL (UC, VC, WC, UL, VL, WL, ULT, VLT, WLT)	
	Input:	
	DELTAY, DELTAZ	y and z coordinates of control points in reference coordinate system
	X, Y, Z	Coordinates of control point with reference to leading edge corner point
	A	Difference between leading and trailing edge slopes
	B	Leading edge slope
	C	Panel chord length along inboard edge
	BPOS	Leading edge slope sign parameter (logical)
	SUB	Subsonic Mach number parameter (logical)
	LBC	Planar boundary condition option parameter (logical)
	COST, SINT	Sine and cosine of panel dihedral angle θ
	ML	Panel leading or trailing edge indicator
	MAX	Number of arguments in numerical evaluation of downwash integral
	Output:	
	SUP	Supersonic Mach number parameter (logical)
	SUPLE	Supersonic leading edge parameter (logical)
	AB, AZ, CC	Geometrical parameters
	R	Distance from control point to side edge
	D	Distance from control point to corner point

E	Distance from control point to intersection of leading and trailing edges of panel
T8	E^2
TZ	Distance from control point to leading edge squared
B1, SB1	Mach number parameters
B2 ↓ B4	Geometrical parameters
C1 ↓ C6	Geometrical parameters
T1 ↓ T9	Geometrical parameters
XI	Array of x coordinates used in evaluation of downwash integral
Q, QX	Array of arguments used in evaluation of downwash integral
WQ	Value of downwash integral at leading edge
WQT	Value of downwash integral at trailing edge
SL, TL	Intermediate values of velocity functions at leading edge
ULS, VLS, WLS, TT, TLT	Intermediate values of velocity functions at trailing edge
F1, G1, G2, G3, H1, H2	Influence functions

VS, WS	Intermediate values of velocity components
UC, VC, WC	Velocity components at control point induced by constant vortex distribution
UL, VL, WL	Velocity components at control point induced by the leading edge corner of a vortex distribution with linear chordwise variation
ULT, VLT, WLT	Velocity components at control point induced by the trailing edge corner of a vortex distribution with linear chordwise variation

SUBROUTINES CALLED: TRAP

ERROR RETURNS: None

PROGRAM WNGPAN

PURPOSE: To revise the spanwise panel spacing on the wing and compute the panel geometry.

METHOD: The program first checks if the spanwise panel spacing is to be revised. If so, an array of revised panel edge locations is read in; otherwise, the panel edges are used as originally defined.

The wing panel geometry is established by considering regions defined by sequential pairs of the originally defined airfoil sections. The leading and trailing edge slopes and dihedral angle of the region are calculated, and the origins and chord lengths of any intermediate panel edges obtained by linear interpolation in the spanwise direction.

The individual panel geometry is then calculated. For the planar boundary condition option, the corner points and control points are calculated in the plane of the wing, while the wing camber and thickness slopes at the panel edges are obtained by a linear interpolation of the slopes determined in the program NEWORD. For the non planar boundary condition, the corner points and control points are calculated on the upper and lower surfaces of the wing, and the panel inclination angles determined by subroutine PANEL. In addition, both options calculate the panel area, chord, span, and leading edge x coordinate.

The same procedure is followed for each of the regions between the remaining airfoil sections. Prior to each step, the leading and trailing edge slopes and dihedral angles of the region are compared with those calculated for the previous region. If all these quantities are the same, the calculation proceeds normally. Otherwise, a new wing segment is defined, and the leading and trailing edge slopes, sine and cosine of the dihedral angle, and a wing indicator parameter for the segment are stored in a special array before continuing the calculations. The program also computes the number of rows and columns of panels in each wing segment, the total number of panels, and the total number of segments on the wing.

The three coordinates of the control points, the panel dihedral angles θ, the panel inclination angles δ, the three coordinates of the panel corner points, the panel areas, and x coordinates of the panel leading edges are stored in the COMMON block POINT, and the entire sequence of arrays written as a single record on TAPE 7. The CHORD and SLOPE arrays are also written on TAPE 7 at this point. The remaining wing geometry parameters are stored in COMMON blocks PARAM, and SEG. Finally, if the print option is positive, the corner point coordinates, control point coordinates, inclination angles, areas, and chords are written in the output file for reference.

USE: CALL OVERLAY (LWB, 1, 3)

Input:

LBC	Boundary condition option (logical)
PRINT	Print option
KL	Leading edge radius parameter
NWAF	Number of wing airfoil sections
KWAF	Number of wing panel streamwise edges
KWAFOR	Number of ordinates defining wing panel leading and trailing edges
WAFORG	Array of origin and chord length of each wing airfoil (x, y, x, c)
XAFK	Array of percent chord locations of panel leading and trailing edges
YK	Array of spanwise locations of wing panel streamwise edges
WAFORK	Array of airfoil half-thickness ordinates
TZORK	Array of airfoil camber ordinates
DZTDXK	Array of airfoil half-thickness slopes
DZCDXK	Array of airfoil camber slopes

Output:

NWING	Total number of wing panels
NCPT	Total number of control points
NP	Panel number
NC	Control point number
NSEG	Number of wing segments
NROW	Number of rows of panels in segment
NCOL	Number of columns of panels in segment
KOL	Number of wing panel streamwise edges
BL, BLE	Leading edge slope of wing segment array
BT, BTE	Trailing edge slope of wing segment array
TH	Dihedral angle of wing segment array
SINS	Sine of segment dihedral angle array
COSS	Cosine of segment dihedral angle array
NWT	Wing indicator parameter array
XK	Array of x-coordinates of origins of wing panel streamwise edges
ZK	Array of z-coordinates of origins of wing panel streamwise edges
CK	Array of chord lengths of wing panel streamwise edges
CL	Chord length of wing panel streamwise edge divided by one hundred
L	Wing surface indicator L = 1 indicates upper surface L = 2 indicates lower surface

SJ	Wing surface sign parameter
IP, IQ	Panel identification constants
XC, YC	Arrays of wing panel corner point x and y coordinates
ZC	Array of wing panel corner point z coordinates or lower surface z co-ordinates for the non planar boundary condition option
ZU	Array of upper surface z coordinates for the non planar boundary condition option
CR	Panel root chord
CT	Panel tip chord
RI, RO	Centroid ratios
XLE, XLEW	x coordinate of intersection of panel leading edge with streamwise line through centroid
XTE	x coordinate of intersection of panel trailing edge with streamwise line through centroid
CHORD	Array of panel chord lengths passing through centroids
SPN, SPNW	Array of panel spans
AREA	Array of panel areas
XPT, YPT, ZPT	Arrays of panel control point coordinates
THET	Array of panel dihedral angles
DZCDX	Array of wing camber slopes at panel edges (planar boundary condition option)

DELTA	Array of wing camber slopes at panel control point (planar boundary condition option) or panel incidence angle (non planar boundary condition option)
DZTDX, SLOPE	Array of wing half-thickness slopes at panel edges (planar boundary condition option)
SLE	Leading edge slope for round leading edge airfoils
XE	Array of x coordinates of panel control points
XS, YS, ZS	Arrays of point source origins (non planar boundary condition option)

SUBROUTINES CALLED: PANEL

ERROR RETURNS: The program calls EXIT if NWING > 600

PROGRAM WNGVEL

PURPOSE: To calculate the three components of velocity induced at specified control points by vortex panels located on wing or tail surfaces.

METHOD: The program first applies the Gothert rule compressibility transformation to the tangent of the panel inclination angles, and computes trigonometric functions of the revised angles. If the product β tan δ is greater than one in supersonic flow, the panel lies outside the Mach cone from its apex, an error message is written and the program terminated.

The three coordinates of the first control point, and the corresponding panel inclination angles θ and δ are read from COMMON block POINT. If the control point is on the body, the inclination angle θ is obtained from COMMON block BTHET.

The program then computes the influence of each panel at the control point. The panels on the upper surface of each chordwise column are considered first, followed by those on the lower surface. This process is repeated for each column of panels on a wing segment, starting with the inboard panel, and continued until all wing and tail segments have been included.

The coordinates of the four corner points of the influencing panel are obtained from COMMON block POINT in the reference coordinate system. They are indexed according to the panel row and column numbers. They are first used to calculate the leading and trailing edge slopes and the chord lengths of the inboard and outboard edges of the panel in a panel coordinate system lying in the plane of the panel and originating at the inboard leading edge corner. The control point is also transformed to the panel coordinate system, and the velocity components induced at the control point by each of the four corners computed by subroutine VORPAN. The subroutine is called twice for each corner point to obtain the contributions of both left and right wing panels.

The contribution of a wake consisting of two concentrated edge vortices with a constant strength vortex sheet between them is calculated following the last panel in each column. The wake vortices are all oriented in a streamwise direction, and are assumed to lie in a plane parallel to the reference axis and containing the trailing edge of the last panel in the column. The velocity components at the control point induced by the upstream corners of the wake are obtained by four additional calls to VORPAN.

The velocity components induced by the four corners of the panel and the wake are now combined to obtain the resultant velocities at the control point. The velocity components induced by the right and left wing panels are combined and the results transformed back to the reference coordinate system by subroutine TRANS. This subroutine calculates the u, v, and w velocity components and the normal velocity at the control point. A similar procedure is applied to calculate the transformed velocity components induced by the three components of the wake. The wake velocity components are then multiplied by the appropriate strength factors and added to obtain the net contribution of the wake. The wake velocities are then added to the panel velocities to obtain the final values of the velocity components at the control point.

Special rules are applied to obtain the velocity components of the leading and trailing edge panels in each column. These rules are designed to provide a continuous vortex distribution around the nose of the airfoil, and to enforce the Kutta condition at the trailing edge.

The procedure is repeated for each column of panels of each wing segment. When all panel influences have been computed, the u, v, and w components of velocity are written as a single record on TAPE 8, and the normal velocities written in one array on TAPE 9. If the control point is in the same column of panels on the wing as the influencing panel, and the wing has more than 60 panels, the normal velocity at the control point is written on TAPE 10, and its value set equal to zero in the array written on TAPE 9. This procedure sets up the diagonal blocks of the aerodynamic matrix for later use in the iterative solution procedure. Finally, if the print option is selected, the axial and normal velocity component arrays are written on the output file.

This process is repeated for each control point.

USE: CALL OVERLAY (LWB, 2, 3)

Input:

Note: The word wing includes any tail, fin, or canard in the following descriptions.

MACH	Mach number
PRINT	Print option parameter
NPART	Matrix partition number
NMAX	Maximum order of diagonal block matrices
NWING	Number of wing panels
NPOINT	Number of control points
NSEG	Number of wing segments
NROW	Number of rows of panels in segment
NCOL	Number of columns of panels in segment
NWT	Tail segment identification parameter
XPT, YPT, ZPT	Arrays of control point coordinates
THET, THETI	Array of panel inclination angles
DELTA, DELTI	Array of panel incidence angles
XC, YC	Arrays of x and y coordinates of wing panel corner points

ZC	Array of z coordinates of lower surface wing panel corner points
ZU	Array of z coordinates of upper surface wing panel corner points
XS, YS, ZS	Arrays of coordinates of point source origins

Output:

I	Control point index
J, JJ	Wing panel index
L	Panel row index
N	Panel column index
NSIDE	Column upper and lower surface index
NS	Wing segment number
BETA	Mach number parameter
SUB	Subsonic flow parameter (logical)
SGN	Supersonic flow sign parameter
CON, BCON	Vortex panel constants
NR	Number of rows of panels in segment
NR1	NR + 1
NR2, NRS	2NR
NC	Number of columns of panels in segment
NC1	NC + 1
NT	Tail segment identification parameter
NI	Number of first column in segment
N2	Number of last column in segment

JL, J1, JS1	Number of first vortex distribution on upper surface of column
JT	Number of last vortex distribution on upper surface of column
J2, JS2	Number of last vortex distribution on lower surface of column
I1	Number of last panel on upper surface of column
I2	Number of last panel on lower surface of column
JK, JM	Temporary panel indices
M	Panel leading or trailing edge index
K	Panel side edge index
BD, TANBD, TAND	Tangent of transformed panel incidence angle, $\beta \tan \delta$
SINBD, SIND, COSBD, COSD	Trigonometric functions of transformed panel incidence angle
SINTI	$\sin \theta(I)$
COSTI	$\cos \theta(I)$
THETA	Inclination angle of panel J
SINT	$\sin \theta(J)$
COST	$\cos \theta(J)$
COSTD	$\cos \theta(J)/(1. + (\beta \tan \delta)^2)^{1/2}$
CONTD	$[(\beta \tan \delta)^2 + \cos^2\theta(J)]^{1/2}$
COSTD	1./(COSD*CONTD)
CONTDD	1./CONTD

XI, YI, ZI	Coordinates of control point I
DXC, DYC, DZC	Differences between panel corner points in reference coordinate system
DXL, DYL, DZL	Differences between panel corner points in panel coordinate system
BL	Panel edge sweep
BLE	Panel leading edge sweep
BTE	Panel trailing edge sweep
AL, A	Difference between panel leading and trailing edge sweeps
CL	Panel edge chord
CI	Chord of inboard edge
CO	Chord of outboard edge
DX, DY, DZ	Control point coordinates with reference to panel corner point
XJ, YJ, ZJ	Control point coordinates in panel coordinate system
X	Dummy variable
UCIR, VCIR, WCIR	Velocity components induced by inboard leading edge corner of right wing panels containing constant vortex distribution
ULIR, VLIR, WLIR	Velocity components induced by inboard leading edge corner of right wing panels containing linearly varying vortex distribution
RCIR, SCIR, TCIR	Same as UCIR, VCIR, WCIR, for inboard trailing edge corner of right wing panel

RLIR, SLIR, TLIR	Same as ULIR, VLIR, WLIR for inboard trailing edge corner of right wing panel
UCIL, VCIL, WCIL	Same as UCIR, VCIR, WCIR for left wing panels
ULIL, VLIL, WLIL	Same as ULIR, VLIR, WLIR for left wing panels
RCIL, SCIL, TCIL	Same as RCIR, SCIR, TCIR for left wing panels
RLIL, SLIL, TLIL	Same as RLIR, SLIR, TLIR for left wing panels
VEIR, WEIR	Velocity components induced by concentrated vortex from leading edge along inboard edge of right wing panel
SEIR, TEIR	Same as VEIR, WEIR for vortex from trailing edge
VEIL, WEIL	Same as VEIR, WEIR for left wing panel
SEIL, TEIL	Same as SEIR, TEIR for left wing panel
VEOR, WEOR	Velocity components induced by concentrated vortex from leading edge along outboard edge of right wing panel
SEOR, TEOR	Same as VEOR, WEOR for vortex from trailing edge
VEOL, WEOL	Same as VEOR, WEOR for left wing panel
SEOL, TEOL	Same as SEOR, TEOR for left wing panel
VAIR, WAIR	Velocity components induced by vortex sheet from inboard leading edge corner of right wing panel

SAIR, TAIR	Same as VAIR, WAIR for vortex sheet from trailing edge
VAIL, WAIL	Same as VAIR, WAIR for left wing panel
SAIL, TAIL	Same as SAIR, TAIR for left wing panel
VAOR, WAOR	Same as VAIR, WAIR for outboard corner of right wing panel
SAOR, TAOR	Same as SAIR, TAIR for outboard corner of right wing panel
VAOL, WAOL	Same as VAOR, WAOR for left wing panel
SAOL, TAOL	Same as SAOR, TAOR for left wing panel
UAR, VAR, WAR	Velocity components induced by vortex sheet behind right wing panels
UAL, VAL, WAL	Same as above for left wing panels
UIR, VIR, WIR	Velocity components induced by inboard concentrated vortex behind right wing panels
UIL, VIL, WIL	Same as above for left wing panels
UOR, VOR, WOR	Velocity components induced by outboard concentrated vortex behind right wing panels
UOL, VOL, WOL	Same as above for left wing panels
ULR, VLR, WLR	Velocity components induced by linearly varying vortex distribution having zero strength along leading edge on right wing panels

ULL, VLL, WLL	Same as above for left wing panels
UCR, VCR, WCR	Velocity components induced by linearly varying vortex distribution having zero strength along trailing edge on right wing panels
UCL, VCL, WCL	Same as above for left wing panels
UC, VC, WC	Arrays of velocity components induced by vortex panels at control point I
US, VS, WS	Velocity components induced by point sources at control point I
AC	Array of normal velocities induced by vortex panels at control point I
AS	Normal velocity induced by point sources at control point I
DC	Array of normal velocities induced by vortex panels in diagonal block matrices

SUBROUTINES CALLED: VORPAN, TRANS

ERROR RETURNS: Program calls EXIT if $\beta \tan \delta > 1.$ in supersonic flow

APPENDIX II

PROGRAM LISTING

```
      OVERLAY(LWB,0,0)
      PROGRAM USSAERO(INPUT=401,OUTPUT=1001,TAPE5=INPUT,TAPE6=OUTPUT,TAP
     1E7=1001,TAPE8=1001,TAPE9=1001,TAPE10=1001,TAPE11=401)
C
C     UNIFIED SUBSONIC-SUPERSONIC AERODYNAMICS PROGRAM
C
C
C     PROGRAM USSAERO COMPUTES THE SUBSONIC AND SUPERSONIC POTENTIAL
C     FLOW AERODYNAMIC CHARACTERISTICS OF CANARD-WING-BODY-TAIL
C     CONFIGURATIONS. THE BODY IS REPRESENTED BY SOURCE PANELS AND THE
C     CANARD, WING, AND TAIL ARE REPRESENTED BY LINEARLY VARYING VORTEX
C     PANELS.
C
C     THIS PROGRAM WAS PREPARED FOR NASA LANGLEY RESEARCH CENTER UNDER
C     CONTRACT NAS1-10408 BY AEROPHYSICS RESEARCH CORPORATION, BELLEVUE,
C     WASHINGTON.
C
C     THE INVESTIGATION WAS CONDUCTED BY MR. FRANK A. WOODWARD OF
C     ANALYTICAL METHODS, INCORPORATED, BELLEVUE, WASHINGTON. AREA CODE
C     206-454-6115.
C
C     ANY ERRORS OR PROBLEMS ENCCUNTERED IN USING THE PROGRAM SHOULD BE
C     DIRECTED TO MR. CHARLES H. FOX, JR. AT NASA LANGLEY. AREA CODE 703
C     -827-3711.
C
C     A CARD DECK AND DOCUMENTATION FOR THE PROGRAM ARE AVAILABLE FROM
C     COSMIC, UNIVERSITY OF GEORGIA, ATHENS, GEORGIA, 30601.
C
C     THIS PROGRAM IS WRITTEN IN CDC FORTRAN IV, VERSION 2.3, TO RUN ON
C     CDC 6600 SERIES COMPUTERS WITH THE SCOPE 3.0 OPERATING SYSTEM AND
C     LIBRARY TAPE.
C
C
      COMMON DUM(72)
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REF(7)
      COMMON /POINT/ ARRAY(6000)
      COMMON /SCRAT/ BLOCK(7500)
      COMMON /HEAD/ TITLE(16)
      COMMON /SEG/ XS(261)
      COMMON /BTHET/ TB(600)
      COMMON /NEWCCM/ K(81)
      COMMON /MATCCM/ MATIN
```

```
      COMMON /VELCCM/ N(5),EM,L(54)                                     A 430
      DIMENSION ICARD(8)                                                A 440
      REAL MACH                                                         A 450
C                                                                       A 460
      LWB=3LLWB                                                         A 470
      EM=-1.0                                                           A 480
      IC=0                                                              A 490
      WRITE (6,70)                                                      A 500
      WRITE (6,100)                                                     A 510
      WRITE (6,80)                                                      A 520
C                                                                       A 530
C     LIST INPUT CARDS                                                  A 540
C                                                                       A 550
10    READ (5,110) ICARD                                                A 560
      IF (ENDFILE 5) 30,20                                              A 570
20    WRITE (6,120) ICARD                                               A 580
      IC=IC+1                                                           A 590
      GO TO 10                                                          A 600
30    CONTINUE                                                          A 610
      WRITE (6,90)                                                      A 620
      WRITE (6,80)                                                      A 630
      DO 40 I=1,IC                                                      A 640
C                                                                       A 660
C     INPUT CONFIGURATION GEOMETRY AND COMPUTE PANELS                   A 670
C                                                                       A 680
40    BACKSPACE 5                                                       A 650
50    CALL OVERLAY (LWB,1,0)                                            A 690
C                                                                       A 700
C     INPUT MACH NUMBER AND COMPUTE AERODYNAMIC MATRIX                  A 710
C                                                                       A 720
60    CALL OVERLAY (LWB,2,0)                                            A 730
C                                                                       A 740
C     MACH = -1. IS USED TO TERMINATE MACH NUMBER ANC ANGLE OF ATTACK   A 750
C     CASES FOR A GIVEN GEOMETRY                                        A 760
C                                                                       A 770
      IF (MACH.LT.0.) GO TO 50                                          A 780
C                                                                       A 790
C     SOLVE RESULTING MATRIX EQUATIONS AND                              A 800
C     COMPUTE PRESSURES, FORCES, AND MOMENTS                            A 810
C                                                                       A 820
      CALL OVERLAY (LWB,3,0)                                            A 830
      GO TO 60                                                          A 840
C                                                                       A 850
```

```
C
70    FORMAT (1H1,10X,48HUNIFIED SUBSONIC-SUPERSONIC AERODYNAMICS PROGRA
     1M,10X,11HVERSICN A00//)
80    FORMAT (10X,80H000000000111111111122222222223333333333444444444455
     15555555566666666667777777777 8/10X,80H1234567890123456789
     2012345678901234567890123456789012345678901234567890//)
90    FORMAT (//)
100   FORMAT (1H0,25X,19HLIST OF INPUT CARDS//)
110   FORMAT (8A10)
120   FORMAT (10X,8A10)
      END
```

```
      OVERLAY(LWB,1,0)
      PROGRAM GEOM
C
C     INPUT CONFIGURATION GECMETRY AND COMPUTE PANELS
C
C
C     THE INPUT TO THIS PROGRAM CONSISTS CF TWO BASIC PARTS, NAMELY,
C     THE NUMERICAL DESCRIPTICN OF THE CONFIGURATION GEOMETRY AND A
C     SPECIFICATION OF THE SINGULARITY PANELING SCHEME ALONG WITH THE
C     DESIRED MACH NUMBER AND ANGLE OF ATTACK COMBINATIONS TO CALCULATE
C
C
C     *******************************************************************
C     DESCRIPTION OF GEOMETRY INPUT CARDS (A MODIFIED VERSION OF THE
C     INPUT GEOMETRY SCHEME OF NASA TM X-2074)
C     *******************************************************************
C
C
C     THE AIRPLANE HAS TO BE SYMMETRICAL ABOUT THE XZ-PLANE, THEREFORE
C     ONLY HALF OF THE AIRPLANE NEED BE DESCRIBED TO THE PROGRAM. THE
C     CONVENTION USED IN PRESENTING THE INPUT DATA IS THAT THE HALF OF
C     THE AIRPLANE CN THE POSITIVE Y-SIDE OF THE XZ-PLANE IS PRESENTED.
C     THE NUMBER OF INPUT CARDS DEPENDS ON THE NUMBER OF COMPCNENTS USED
C     TO DESCRIBE THE CONFIGURATION, WHETHER A COMPONENT HAS BEEN
C     DESCRIBED PREVIOUSLY, AND THE AMOUNT OF DETAIL USED TO DESCRIBE
C     EACH COMPUNENT.
C
C
C     CARD 1 - ICENTIFICATION. CARD 1 CONTAINS ANY DESIRED IDENTIFYING
C     INFORMATICN IN COLUMNS 1-80.
C
C
C     CARD 2 - CCNTROL INTEGERS. CARD 2 CONTAINS 24 INTEGERS, EACH
C     PUNCHED RIGHT JUSTIFIED IN A 3-COLUMN FIELD. COLUMNS 73-80 MAY BE
C     USED IN ANY DESIRED MANNER. CARD 2 CCNTAINS THE FOLLOWING
C
C     COLUMNS     VARIABLE     VALUE     DESCRIPTICN
C
C      1-3          J0           0       NO REFERENCE AREA
C                                1       REFERENCE AREA TO BE READ
C
C      4-6          J1           0       NO WING DATA
```

```
C                                1        CAMBERED WING DATA TO BE READ
C                               -1        UNCAMBERED WING DATA TO BE READ
C
C      7-9         J2            0        NO FUSELAGE CATA
C                                1        DATA FOR ARBITRARILY SHAPED
C                                         FUSELAGE TO BE READ
C                               -1        DATA FOR CIRCULAR FUSELAGE TO BE
C                                         READ (WITH J6=0, FUSELAGE WILL
C                                         BE CAMBERED. WITH J6=-1,
C                                         FUSELAGE WILL BE SYMMETRICAL
C                                         WITH XY-PLANE. WITH J6=1, ENTIRE
C                                         CONFIGURATION WILL BE
C                                         SYMMETRICAL WITH XY-PLANE)
C
C      10-12       J3            0        NO POD (NACELLE) DATA
C                                1        POD (NACELLE) DATA TO BE READ
C
C      13-15       J4            0        NO FIN (VERTICAL TAIL) DATA
C                                1        FIN (VERTICAL TAIL) DATA TO BE
C                                         READ
C
C      16-18       J5            0        NO CANARD (HORIZONTAL TAIL) DATA
C                                1        CANARC (HCRIZONTAL TAIL) CATA TO
C                                         BE READ
C
C      19-21       J6            0        A CAMBERED CIRCULAR OR ARBITRARY
C                                         FUSELAGE IF J2 IS NONZERO
C                                1        CCMPLETE CONFIGURATION IS
C                                         SYMMETRICAL WITH RESPECT TO
C                                         XY-PLANE, WHICH IMPLIES AN
C                                         UNCAMBERED CIRCULAR FUSELAGE IF
C                                         THERE IS A FUSELAGE.
C                               -1        UNCAMBERED CIRCULAR FUSELAGE
C                                         WITH J2 NCNZERO
C
C      22-24       NWAF          2-20     NUMBER OF AIRFOIL SECTIONS USED
C                                         TO DESCRIBE THE WING
C
C      25-27       NWAFOR        3-30     NUMBER OF ORDINATES USED TO
C                                         DEFINE EACH WING AIRFOIL SECTION
C                                         IF THE VALUE OF NWAFOR IS INPUT
C                                         WITH A NEGATIVE SIGN, THE
C                                         PROGRAM WILL EXPECT TO READ
```

```
C                                             LOWER SURFACE ORDINATES ALSO          B 860
C                                                                                   B 870
C       28-30      NFLS          1-4          NUMBER OF FUSELAGE SEGMENTS           B 880
C                                                                                   B 890
C       31-33      NRADX(1)      3-30         NUMBER OF POINTS USED TO              B 900
C                                             REPRESENT HALF-SECTION OF FIRST       B 910
C                                             FUSELAGE SEGMENT. IF FUSELAGE IS      B 920
C                                             CIRCULAR, THE PROGRAM COMPUTES        B 930
C                                             THE INDICATED NUMBER OF Y- AND        B 940
C                                             Z-ORDINATES                           B 950
C                                                                                   B 960
C       34-36      NFORX(1)      2-30         NUMBER OF STATIONS FOR FIRST          B 970
C                                             FUSELAGE SEGMENT                      B 980
C                                                                                   B 990
C       37-39      NRADX(2)      3-30         SAME AS NRADX(1), BUT FOR SECOND      B1000
C                                             FUSELAGE SEGMENT                      B1010
C                                                                                   B1020
C       40-42      NFORX(2)      2-30         SAME AS NFORX(1), BUT FOR SECOND      B1030
C                                             FUSELAGE SEGMENT                      B1040
C                                                                                   B1050
C       43-45      NRADX(3)      3-30         SAME AS NRADX(1), BUT FOR THIRD       B1060
C                                             FUSELAGE SEGMENT                      B1070
C                                                                                   B1080
C       46-48      NFORX(3)      2-30         SAME AS NFORX(1), BUT FOR THIRD       B1090
C                                             FUSELAGE SEGMENT                      B1100
C                                                                                   B1110
C       49-51      NRADX(4)      3-30         SAME AS NRADX(1), BUT FOR FOURTH      B1120
C                                             FUSELAGE SEGMENT                      B1130
C                                                                                   B1140
C       52-54      NFORX(4)      2-30         SAME AS NFORX(1), BUT FOR FOURTH      B1150
C                                             FUSELAGE SEGMENT                      B1160
C                                                                                   B1170
C       55-57      NP            0-9          NUMBER OF PODS DESCRIBED              B1180
C                                                                                   B1190
C       58-60      NPODOR        4-30         NUMBER OF STATIONS AT WHICH POD       B1200
C                                             RADII ARE TO BE SPECIFIED             B1210
C                                                                                   B1220
C       61-63      NF            0-6          NUMBER OF FINS (VERTICAL TAILS)       B1230
C                                             TO BE DESCRIBED                       B1240
C                                                                                   B1250
C       64-66      NFINOR        3-10         NUMBER OF ORDINATES USED TO           B1260
C                                             DESCRIBE EACH FIN (VERTICAL           B1270
C                                             TAIL) AIRFOIL SECTION                 B1280
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C
C     67-69       NCAN            0-6        NUMBER OF CANARDS (HORIZONTAL
C                                            TAILS) TO BE DESCRIBED
C
C     70-72       NCANOR          3-10       NUMBER OF ORDINATES USED TO
C                                            DEFINE EACH CANARD (HORIZONTAL
C                                            TAIL) AIRFOIL SECTION. IF THE
C                                            VALUE OF NCANOR IS INPUT WITH A
C                                            NEGATIVE SIGN, THE PROGRAM WILL
C                                            EXPECT TO READ LOWER SURFACE
C                                            ORDINATES ALSO, OTHERWISE THE
C                                            AIRFOIL IS ASSUMED TO BE
C                                            SYMMETRICAL
C
C
C     CARDS 3,4,... - REMAINING INPUT DATA CARDS. THE REMAINING INPUT
C     DATA CARDS CONTAIN A DETAILED DESCRIPTION OF EACH COMPONENT OF THE
C     AIRPLANE. EACH CARD CONTAINS UP TO 10 VALUES, EACH VALUE PUNCHED
C     IN A 7-COLUMN FIELD WITH A DECIMAL POINT AND MAY BE IDENTIFIED IN
C     COLUMNS 73-80. THE CARDS ARE ARRANGED IN THE FOLLOWING ORDER.
C     REFERENCE AREA, WING DATA CARDS, FUSELAGE DATA CARDS, POD DATA
C     CARDS, FIN (VERTICAL TAIL) DATA CARDS, AND CANARD (HORIZONTAL
C     TAIL) DATA CARDS.
C
C
C     REFERENCE AREA CARD. THE REFERENCE AREA VALUE IS PUNCHED IN
C     COLUMNS 1-7 AND MAY BE IDENTIFIED AS REFA IN COLUMNS 73-80
C
C
C     WING DATA CARDS. THE FIRST WING DATA CARD (OR CARDS) CONTAINS THE
C     LOCATIONS IN PERCENT CHORD AT WHICH THE ORDINATES OF ALL THE WING
C     AIRFOILS ARE TO BE SPECIFIED. THERE WILL BE EXACTLY NWAFOR
C     LOCATIONS IN PERCENT CHORD GIVEN. EACH CARD MAY BE IDENTIFIED IN
C     COLUMNS 73-80 BY THE SYMBOL XAFJ WHERE J DENOTES THE LAST LOCATION
C     IN PERCENT CHORD GIVEN ON THAT CARD.
C
C     THE NEXT WING DATA CARDS (THERE WILL BE NWAF CARDS) EACH CONTAIN
C     FOUR NUMBERS WHICH GIVE THE ORIGIN AND CHORD LENGTH OF EACH OF THE
C     WING AIRFOILS THAT IS TO BE SPECIFIED. THE CARD REPRESENTING THE
C     MOST INBOARD AIRFOIL IS GIVEN FIRST, FOLLOWED BY THE CARDS FOR
C     SUCCESSIVE AIRFOILS. THESE CARDS CONTAIN THE FOLLOWING
C
C     COLUMNS                CONTENTS
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C
C       1-7                          X-ORDINATE OF AIRFOIL LEADING EDGE
C       8-14                         Y-ORDINATE OF AIRFOIL LEADING EDGE
C       15-21                        Z-ORDINATE OF AIRFOIL LEADING EDGE
C       22-28                        AIRFOIL STREAMWISE CHORD LENGTH
C       73-80                        CARD IDENTIFICATION, WAFORGJ WHERE J
C                                    DENOTES THE PARTICULAR AIRFOIL, THUS
C                                    WAFORG1 DENOTES THE MOST INBOARD AIRFOIL.
C
C      IF A CAMBERED WING HAS BEEN SPECIFIED, THE NEXT SET OF WING DATA
C      CARDS IS THE MEAN CAMBER LINE CARDS. THERE WILL BE NWAFOR VALUES
C      OF DELTA Z REFERENCED TO THE Z-ORDINATE OF THE AIRFOIL LEADING
C      EDGE, EACH VALUE CORRESPONDING TO A SPECIFIED PERCENT CHORD
C      LOCATION ON THE AIRFOIL. THESE CARDS ARE ARRANGED IN THE ORDER
C      WHICH BEGINS WITH THE MOST INBOARD AIRFOIL AND PROCEEDS OUTBOARD.
C      EACH CARD MAY BE IDENTIFIED IN COLUMNS 73-80 AS TZORDJ WHERE J
C      DENOTES THE PARTICULAR AIRFOIL.
C
C      NEXT ARE THE WING ORDINATE CARDS. THERE WILL BE NWAFOR VALUES OF
C      HALF-THICKNESS SPECIFIED FOR EACH AIRFOIL EXPRESSED AS PERCENT
C      CHORD. THESE CARDS ARE ARRANGED IN THE ORDER WHICH BEGINS WITH THE
C      MOST INBOARD AIRFOIL AND PROCEEDS OUTBOARD. EACH CARD MAY BE
C      IDENTIFIED IN COLUMNS 73-80 AS WAFORDJ WHERE J DENOTES THE
C      PARTICULAR AIRFOIL.
C
C
C      FUSELAGE DATA CARDS. THE FIRST CARD (OR CARDS) SPECIFIES THE X
C      VALUES OF THE FUSELAGE STATIONS OF THE FIRST SEGMENT. THERE WILL
C      BE NFORX(1) VALUES AND THE CARDS MAY BE IDENTIFIED IN COLUMNS
C      73-80 BY THE SYMBOL XFUSJ WHERE J DENOTES THE NUMBER OF THE LAST
C      FUSELAGE STATION GIVEN ON THAT CARD.
C
C      IF THE FUSELAGE IS CIRCULAR, THE NEXT CARD (OR CARDS) GIVES THE
C      FUSELAGE CROSS SECTIONAL AREAS, AND MAY BE IDENTIFIED IN COLUMNS
C      73-80 BY THE SYMBOL FUSARDJ WHERE J DENOTES THE NUMBER OF THE LAST
C      FUSELAGE STATION GIVEN ON THAT CARD. IF THE FUSELAGE IS OF
C      ARBITRARY SHAPE, NRADX(1) VALUES OF THE Y-ORDINATES FOR A HALF-
C      SECTION ARE GIVEN AND IDENTIFIED IN COLUMNS 73-80 AS YJ WHERE J IS
C      THE STATION NUMBER. FOLLOWING THE Y-ORDINATES ARE THE NRADX(1)
C      VALUES OF THE CORRESPONDING Z-ORDINATES FOR THE HALF-SECTION
C      IDENTIFIED IN COLUMNS 73-80 AS ZJ WHERE J IS THE STATION NUMBER.
C      EACH STATION WILL HAVE A SET OF Y AND Z, AND THE CONVENTION OF
C      ORDERING THE SEGMENTS FROM BOTTOM TO TOP IS OBSERVED.
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C
C     FOR EACH FUSELAGE SEGMENT A NEW SET OF CARDS AS DESCRIBED MUST BE
C     PROVIDED. THE SEGMENT DESCRIPTIONS SHOULD BE GIVEN IN ORDER OF
C     INCREASING VALUES OF X.
C
C
C     POD DATA CARDS. THE FIRST POD (NACELLE) DATA CARD SPECIFIES THE
C     LOCATION OF THE ORIGIN OF THE FIRST POD. THE CARD CONTAINS THE
C     FOLLOWING
C
C     COLUMNS                 CONTENTS
C      1-7                    X-ORDINATE OF ORIGIN OF POD
C      8-14                   Y-ORDINATE OF ORIGIN OF POD
C      15-21                  Z-ORDINATE OF ORIGIN OF POD
C      73-80                  CARD IDENTIFICATION, PODORGJ WHERE J
C                             DENOTES THE POD NUMBER
C
C     THE NEXT POD INPUT DATA CARD (OR CARDS) CONTAINS THE X-ORDINATES,
C     REFERENCED TO THE POD ORIGIN, AT WHICH NPODOR VALUES OF THE POD
C     RADII ARE TO BE SPECIFIED. THE FIRST X VALUE MUST BE ZERO AND THE
C     LAST X VALUE IS THE LENGTH OF THE POD. THESE CARDS MAY BE
C     IDENTIFIED IN COLUMNS 73-80 BY THE SYMBOL XPODJ WHERE J DENOTES
C     THE POD NUMBER.
C
C     THE NEXT POD INPUT DATA CARDS GIVE THE POD RADII CORRESPONDING TO
C     THE POD STATIONS THAT HAVE BEEN SPECIFIED. THESE CARDS MAY BE
C     IDENTIFIED IN COLUMNS 73-80 AS PODRJ WHERE J DENOTES THE POD
C     NUMBER.
C
C     FOR EACH ADDITIONAL POD, NEW PODORG, XPOD, AND PODR CARDS MUST BE
C     PROVIDED. ONLY SINGLE PODS ARE DESCRIBED BUT THE PROGRAM ASSUMES
C     THAT IF THE Y-ORDINATE IS NOT ZERO AN EXACT DUPLICATE IS LOCATED
C     SYMMETRICALLY WITH RESPECT TO THE XZ-PLANE, A Y-ORDINATE OF ZERO
C     IMPLIES A SINGLE POD.
C
C
C     FIN DATA CARDS. EXACTLY THREE DATA INPUT CARDS ARE USED TO
C     DESCRIBE A FIN (VERTICAL TAIL). THE FIRST FIN DATA CARD CONTAINS
C     THE FOLLOWING.
C
C     COLUMNS                 CONTENTS
C      1-7                    X-ORDINATE OF INBOARD AIRFOIL LEADING EDGE
C      8-14                   Y-ORDINATE OF INBOARD AIRFOIL LEADING EDGE
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C       15-21                        Z-CRDINATE CF INBOARD AIRFOIL LEADING EDGE
C       22-28                        CHORD LENGTH OF INBOARD AIRFOIL
C       29-35                        X-ORDINATE OF CUTBOARD AIRFOIL LEADING
C                                    EDGE
C       36-42                        Y-CRDINATE OF OUTBOARD AIRFOIL LEADING
C                                    EDGE
C       43-49                        Z-ORDINATE OF CUTBOARD AIRFOIL LEADING
C                                    EDGE
C       50-56                        CHORD LENGTH OF OUTBOARD AIRFOIL
C
C       73-80                        CARD IDENTIFICATION, FINORGJ WHERE J
C                                    DENOTES THE FIN NUMBER.
C
C     THE SECOND FIN INPUT DATA CARD CONTAINS NFINOR VALUES OF X
C     EXPRESSED IN PERCENT CHORD AT WHICH THE FIN AIRFOIL ORDINATES ARE
C     TO BE SPECIFIED. THE CARD MAY BE IDENTIFIED IN COLUMNS 73-80 AS
C     XFINJ WHERE J DENOTES THE FIN NUMBER.
C
C     THE THIRD FIN INPUT DATA CARD CONTAINS NFINOR VALUES OF THE FIN
C     AIRFOIL HALF-THICKNESS EXPRESSED IN PERCENT CHORD. SINCE THE FIN
C     AIRFOIL MUST BE SYMMETRICAL, ONLY THE ORDINATES ON THE POSITIVE
C     Y SIDE OF THE FIN CHORD PLANE ARE SPECIFIED. THE CARD
C     IDENTIFICATION FINORDJ MAY BE GIVEN IN COLUMNS 73-80 WHERE J
C     DENOTES THE FIN NUMBER.
C
C     FOR EACH FIN, NEW FINORG, XFIN, AND FINORD CARDS MUST BE PROVIDED.
C     ONLY SINGLE FINS ARE DESCRIBED BUT THE PROGRAM ASSUMES THAT IF THE
C     Y-ORDINATE IS NOT ZERO AN EXACT DUPLICATE IS LOCATED SYMMETRICALLY
C     WITH RESPECT TO THE XZ-PLANE, A Y-ORDINATE OF ZERO IMPLIES A
C     SINGLE FIN.
C
C
C     CANARD DATA CARDS. IF THE CANARD (OR HORIZONTAL TAIL) AIRFOIL IS
C     SYMMETRICAL, EXACTLY THREE CARDS ARE USED TO DESCRIBE A CANARD,
C     AND THE INPUT IS GIVEN IN THE SAME MANNER AS FOR A FIN. IF,
C     HOWEVER, THE CANARD AIRFOIL IS NOT SYMMETRICAL (INDICATED BY A
C     NEGATIVE VALUE OF NCANOR), A FOURTH CANARD INPUT DATA CARD WILL BE
C     REQUIRED TO GIVE THE LOWER ORDINATES. THE INFORMATION PRESENTED ON
C     THE FIRST CANARD INPUT DATA CARD IS AS FOLLOWS.
C
C     COLUMNS                        CONTENTS
C       1-7                          X-CRDINATE OF INBOARD AIRFOIL LEADING EDGE
C       8-14                         Y-ORDINATE OF INBOARD AIRFOIL LEADING EDGE
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C      15-21                    Z-ORDINATE OF INBOARD AIRFOIL LEADING EDGE  B3010
C      22-28                    CHORD LENGTH OF INBOARD AIRFOIL             B3020
C      29-35                    X-ORDINATE OF OUTBOARD AIRFOIL LEADING      B3030
C                               EDGE                                        B3040
C      36-42                    Y-ORDINATE OF OUTBOARD AIRFOIL LEADING      B3050
C                               EDGE                                        B3060
C      43-49                    Z-ORDINATE OF OUTBOARD AIRFOIL LEADING      B3070
C                               EDGE                                        B3080
C      50-56                    CHORD LENGTH OF OUTBOARD AIRFOIL            B3090
C      73-80                    CARD IDENTIFICATION, CANORGJ WHERE J        B3100
C                               DENOTES THE CANARD NUMBER.                  B3110
C                                                                           B3120
C     THE SECOND CANARD INPUT DATA CARD CONTAINS NCANOR VALUES OF X         B3130
C     EXPRESSED IN PERCENT CHORD AT WHICH THE CANARD AIRFOIL ORDINATES      B3140
C     ARE TO BE SPECIFIED. THE CARD MAY BE IDENTIFIED IN COLUMNS 73-80      B3150
C     AS XCANJ WHERE J DENOTES THE CANARD NUMBER.                           B3160
C                                                                           B3170
C     THE THIRD CANARD INPUT DATA CARD CONTAINS NCANOR VALUES OF THE        B3180
C     CANARD AIRFOIL HALF-THICKNESS EXPRESSED IN PERCENT CHORD. THIS        B3190
C     CARD MAY BE IDENTIFIED IN COLUMNS 73-80 AS CANORDJ WHERE J DENOTES    B3200
C     THE CANARD NUMBER. IF THE CANARD AIRFOIL IS NOT SYMMETRICAL, THE      B3210
C     LOWER ORDINATES ARE PRESENTED ON A SECOND CANORD CARD. THE PROGRAM    B3220
C     EXPECTS BOTH UPPER AND LOWER ORDINATES TO BE PUNCHED AS POSITIVE      B3230
C     VALUES IN PERCENT CHORD.                                              B3240
C                                                                           B3250
C     FOR ANOTHER CANARD, NEW CANORG, XCAN, AND CANORD CARDS MUST BE        B3260
C     PROVIDED.                                                             B3270
C                                                                           B3280
C                                                                           B3290
C     ******************************************************************   B3300
C     DESCRIPTION OF SINGULARITY PANELING SCHEME AND MACH NUMBER AND        B3310
C     ANGLE OF ATTACK INPUT CARDS                                           B3320
C     ******************************************************************   B3330
C                                                                           B3340
C                                                                           B3350
C     CARD 1.1 - IDENTIFICATION. CARD 1.1 CONTAINS ANY DESIRED              B3360
C     IDENTIFYING INFORMATION IN COLUMNS 1-80.                              B3370
C                                                                           B3380
C                                                                           B3390
C     CARD 1.2 - BOUNDARY CONDITION AND CONTROL POINT DEFINITION.           B3400
C     NON-PLANAR BOUNDARY CONDITIONS ARE ALWAYS APPLIED ON A BODY,          B3410
C     HOWEVER CARD 1.2 PERMITS THE SELECTION OF BOUNDARY CONDITIONS TO      B3420
C     APPLY ON A WING, FIN (VERTICAL TAIL), OR CANARD (HORIZONTAL TAIL).    B3430
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C     THIS CARD ALSO SELECTS THE OUTPUT PRINT OPTIONS. THIS CARD
C     CONTAINS THE FOLLOWING
C
C     COLUMNS      VARIABLE      VALUE     DESCRIPTION
C
C      1-3          LINBC          0       CONTROL POINTS ON SURFACE OF
C                                          WING, FIN (VERTICAL TAIL), AND
C                                          CANARD (HORIZONTAL TAIL). THIS
C                                          IS REFERRED TO AS THE NON-PLANAR
C                                          BOUNDARY CONDITION OPTION.
C                                  1       CONTROL POINTS IN PLANE OF WING,
C                                          FIN (VERTICAL TAIL), AND CANARD
C                                          (HORIZONTAL TAIL). THIS IS
C                                          REFERRED TO AS THE PLANAR
C                                          BOUNDARY CONDITION OPTION.
C
C      4-6          THICK          0       DO NOT CALCULATE WING THICKNESS
C                                          MATRIX
C                                  1       CALCULATE WING THICKNESS MATRIX
C                                          IF LINBC=1
C
C
C      7-9          PRINT          0       PRINT OUT THE PRESSURES AND THE
C                                          FORCES AND MOMENTS
C                                  1       PRINT OUT OPTION 0 AND THE
C                                          SPANWISE LOADS ON THE WING,
C                                          FINS, AND CANARDS
C                                  2       PRINT OUT OPTION 1 AND THE
C                                          VELOCITY COMPONENTS AND SOURCE
C                                          AND VORTEX STRENGTHS
C                                  3       PRINT OUT OPTION 2 AND THE STEPS
C                                          IN THE ITERATIVE SOLUTION
C                                  4       PRINT OUT OPTION 3 AND THE AXIAL
C                                          AND NORMAL VELOCITY MATRICES
C
C     A NEGATIVE VALUE OF PRINT ADDS THE PANEL GEOMETRY PRINT OUT TO THE
C     OUTPUT INDICATED FOR OPTIONS 1, 2, 3, AND 4
C
C     LINBC, THICK, AND PRINT ARE PUNCHED AS RIGHT JUSTIFIED INTEGERS
C     THICK IS NOT USED IF LINBC = 0
C
C
C     CARD 2.1 - REVISED CONFIGURATION PANELING DESCRIPTION CONTROL
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C     INTEGERS. THE CONTENTS OF CARD 2.1 ARE PUNCHED AS RIGHT JUSTIFIED    B3870
C     INTEGERS AS FOLLOWS.                                                 B3880
C                                                                          B3890
C     COLUMNS     VARIABLE     VALUE     DESCRIPTION                       B3900
C                                                                          B3910
C      1-3          K0           0       NO REFERENCE LENGTHS              B3920
C                                1       REFERENCE LENGTH DATA TO BE READ  B3930
C                                                                          B3940
C      4-6          K1           0       NO WING DATA                      B3950
C                                1       WING DATA TO BE READ, WING HAS A  B3960
C                                        SHARP LEADING EDGE.               B3970
C                                3       WING DATA TO BE READ, WING HAS A  B3980
C                                        ROUND LEADING EDGE.               B3990
C                                                                          B4000
C      7-9          K2           0       NO BODY DATA                      B4010
C                                1       BODY DATA FOLLOWS                 B4020
C                                                                          B4030
C      10-12        K3                   NOT USED                          B4040
C                                                                          B4050
C      13-15        K4           0       NO FIN (VERTICAL TAIL) DATA       B4060
C                                1       FIN (VERTICAL TAIL) DATA TO BE    B4070
C                                        READ, FIN HAS A SHARP LEADING     B4080
C                                        EDGE.                             B4090
C                                3       FIN (VERTICAL TAIL) DATA TO BE    B4100
C                                        READ, FIN HAS A ROUND LEADING     B4110
C                                        EDGE.                             B4120
C                                                                          B4130
C      16-18        K5           0       NO CANARD (HORIZONTAL TAIL) DATA  B4140
C                                1       CANARD (HORIZONTAL TAIL) DATA TO  B4150
C                                        BE READ, CANARD HAS A SHARP       B4160
C                                        LEADING EDGE.                     B4170
C                                3       CANARD (HORIZONTAL TAIL) DATA TO  B4180
C                                        BE READ, CANARD HAS A ROUND       B4190
C                                        LEADING EDGE.                     B4200
C                                                                          B4210
C      19-21        K6                   NOT USED                          B4220
C                                                                          B4230
C      22-24        KWAF       0,2-20    NUMBER OF WING SECTIONS USED TO   B4240
C                                        DEFINE THE INBOARD AND OUTBOARD   B4250
C                                        PANEL EDGES. IF KWAF=0, THE       B4260
C                                        PANEL EDGES ARE DEFINED BY NWAF   B4270
C                                        IN THE GEOMETRY INPUT.            B4280
C                                                                          B4290
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C        25-27       KWAFOR        0,3-30       NUMBER OF ORDINATES USED TO        B4300
C                                               DEFINE THE LEADING AND TRAILING    B4310
C                                               EDGES OF THE WING PANELS. IF       B4320
C                                               KWAFOR=0, THE PANEL EDGES ARE      B4330
C                                               DEFINED BY NWAFOR IN THE           B4340
C                                               GEOMETRY INPUT.                    B4350
C                                                                                  B4360
C        28-30       KFUS                       THE NUMBER OF FUSELAGE SEGMENTS.   B4370
C                                               THE PROGRAM SETS KFUS=NFUS.        B4380
C                                                                                  B4390
C        31-33       KRADX(1)      0,3-20       NUMBER OF MERIDIAN LINES USED TO   B4400
C                                               DEFINE PANEL EDGES ON FIRST BODY   B4410
C                                               SEGMENT. IF KRADX(1)=0, THE        B4420
C                                               PANEL EDGES ARE DEFINED BY         B4430
C                                               NRADX(1) IN THE GEOMETRY INPUT.    B4440
C                                               NEGATIVE VALUES OF KRADX(1)        B4450
C                                               INDICATE THAT REVISED MERIDIAN     B4460
C                                               ANGLES FOLLOW.                     B4470
C                                               FOR AN ARBITRARILY SHAPED          B4480
C                                               FUSELAGE (BODY) (J2=1) THERE ARE   B4490
C                                               THREE OPTIONS FOR DEFINING THE     B4500
C                                               PANEL EDGES. IF KRADX(1)=0, THE    B4510
C                                               MERIDIAN LINES ARE DEFINED BY      B4520
C                                               NRADX(1) IN THE GEOMETRY INPUT.    B4530
C                                               IF KRADX(1) IS POSITIVE, THE       B4540
C                                               MERIDIAN LINES ARE CALCULATED AT   B4550
C                                               KRADX(1) EQUALLY SPACED PHIKS.     B4560
C                                               IF KRADX(1) IS NEGATIVE, THE       B4570
C                                               MERIDIAN LINES ARE CALCULATED AT   B4580
C                                               SPECIFIED VALUES OF PHIK.          B4590
C                                                                                  B4600
C                                                                                  B4610
C        34-36       KFORX(1)      0,2-30       NUMBER OF AXIAL STATIONS USED TO   B4620
C                                               DEFINE LEADING AND TRAILING        B4630
C                                               EDGES OF PANELS ON FIRST BODY      B4640
C                                               SEGMENT. IF KFORX(1)=0, THE        B4650
C                                               PANEL EDGES ARE DEFINED BY         B4660
C                                               NFORX(1) IN THE GEOMETRY INPUT.    B4670
C                                                                                  B4680
C        37-39       KRADX(2)      0,3-20       SAME AS KRADX(1), BUT FOR SECOND   B4690
C                                               BODY SEGMENT                       B4700
C                                                                                  B4710
C        40-42       KFORX(2)      0,2-30       SAME AS KFORX(1), BUT FOR SECOND   B4720
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C                                          BODY SEGMENT                         B4730
C                                                                               B4740
C      43-45      KRADX(3)     0,3-20      SAME AS KRADX(1), BUT FOR THIRD      B4750
C                                          BODY SEGMENT                         B4760
C                                                                               B4770
C      46-48      KFORX(3)     0,2-30      SAME AS KFORX(1), BUT FOR THIRD      B4780
C                                          BODY SEGMENT                         B4790
C                                                                               B4800
C      49-51      KRADX(4)     0,3-20      SAME AS KRADX(1), BUT FOR FOURTH     B4810
C                                          BODY SEGMENT                         B4820
C                                                                               B4830
C      52-54      KFORX(4)     0,2-30      SAME AS KFORX(1), BUT FOR FOURTH     B4840
C                                          BODY SEGMENT                         B4850
C                                                                               B4860
C     THIS PROGRAM IS RESTRICTED TO 600 BODY SINGULARITY PANELS.                B4870
C     FOR THIS PROGRAM THERE IS AN ADDITIONAL RESTRICTION THAT THE TOTAL        B4880
C     NUMBER OF SINGULARITY PANELS IN THE AXIAL DIRECTION ON THE BODY           B4890
C     (FUSELAGE) CANNOT EXCEED 30                                               B4900
C     IT IS IMPORTANT TO UNDERSTAND THAT THE ARBITRARY BODY (FUSELAGE)          B4910
C     CAPABILITY OF THIS PROGRAM IS LIMITED TO THOSE SHAPES FOR WHICH           B4920
C     R IS A SINGLE-VALUED FUNCTION OF PHIK FOR EACH CROSS SECTION.             B4930
C                                                                               B4940
C                                                                               B4950
C     CARD 2.2 - ADDITIONAL REVISED CONFIGURATION PANELING DESCRIPTION          B4960
C     CONTROL INTEGERS. THE CONTENTS OF CARD 2.2 ARE PUNCHED AS RIGHT           B4970
C     JUSTIFIED INTEGERS AS FOLLOWS.                                            B4980
C                                                                               B4990
C     COLUMNS     VARIABLE     VALUE       DESCRIPTION                          B5000
C                                                                               B5010
C      1-3          KF(1)      0,2-20      NUMBER OF FIN SECTIONS USED TO       B5020
C                                          DEFINE THE INBOARD AND OUTBOARD      B5030
C                                          PANEL EDGES ON THE FIRST FIN.        B5040
C                                          IF KF(1)=0, THE ROOT AND TIP         B5050
C                                          CHORDS DEFINE THE PANEL EDGES.       B5060
C                                                                               B5070
C      4-6        KFINOR(1)    0,3-30      NUMBER OF ORDINATES USED TO          B5080
C                                          DEFINE THE LEADING AND TRAILING      B5090
C                                          EDGES OF THE FIN PANELS ON THE       B5100
C                                          FIRST FIN. IF KFINOR(1)=0, THE       B5110
C                                          PANEL EDGES ARE DEFINED BY           B5120
C                                          NFINOR.                              B5130
C                                                                               B5140
C      7-9          KF(2)      0,2-20      SAME AS FOR KF(1), BUT FOR           B5150
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C                                              SECOND FIN.                         B5160
C                                                                                  B5170
C    10-12      KFINOR(2)     0,3-30          SAME AS FCR KFINOR(1), BUT FCR       B5180
C                                              SECCND FIN.                         B5190
C                                                                                  B5200
C    13-15       KF(3)        0,2-20          SAME AS FOR KF(1), BUT FOR           B5210
C                                              THIRD FIN.                          B5220
C                                                                                  B5230
C    16-18      KFINCR(3)     0,3-30          SAME AS FCR KFINOR(1), BUT FOR       B5240
C                                              THIRD FIN.                          B5250
C                                                                                  B5260
C    19-21       KF(4)        0,2-20          SAME AS FCR KF(1), BUT FOR           B5270
C                                              FOURTH FIN.                         B5280
C                                                                                  B5290
C    22-24      KFINOR(4)     0,3-30          SAME AS FCR KFINOR(1), BUT FOR       B5300
C                                              FOURTH FIN.                         B5310
C                                                                                  B5320
C    25-27       KF(5)        0,2-20          SAME AS FCR KF(1), BUT FOR           B5330
C                                              FIFTH FIN.                          B5340
C                                                                                  B5350
C    28-30      KFINOR(5)     0,3-30          SAME AS FCR KFINOR(1), BUT FOR       B5360
C                                              FIFTH FIN.                          B5370
C                                                                                  B5380
C    31-33       KF(6)        0,2-20          SAME AS FOR KF(1), BUT FOR           B5390
C                                              SIXTH FIN.                          B5400
C                                                                                  B5410
C    34-36      KFINOR(6)     0,3-30          SAME AS FOR KFINOR(1), BUT FOR       B5420
C                                              SIXTH FIN.                          B5430
C                                                                                  B5440
C    37-39      KCAN(1)       0,2-20          NUMBER OF CANARD SECTIONS USED       B5450
C                                              TO DEFINE THE INBOARD AND           B5460
C                                              OUTBOARD PANEL EDGES ON THE         B5470
C                                              FIRST CANARD. IF KCAN(1)=0, THE     B5480
C                                              ROOT AND TIP CHORDS DEFINE THE      B5490
C                                              PANEL EDGES.IF KCAN(1) NEGATIVE,    B5500
C                                              NO VORTEX SHEET CARRIES THROUGH     B5510
C                                              THE BODY, AND CONCENTRATED          B5520
C                                              VORTICES ARE SHED FROM THE          B5530
C                                              INBOARD EDGE OF THE CANARD OR       B5540
C                                              TAIL SURFACE.                       B5550
C                                                                                  B5560
C    40-42      KCANOR(1)     0,3-30          NUMBER OF ORDINATES USED TO          B5570
C                                              DEFINE THE LEADING AND TRAILING     B5580
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C                                          EDGES OF THE FIRST CANARD. IF      B5590
C                                          KCANOR(1)=0, THE PANEL EDGES ARE   B5600
C                                          DEFINED BY NCANOR.                 B5610
C                                                                             B5620
C     43-45     KCAN(2)      0,2-20        SAME AS FOR KCAN(1), BUT FOR       B5630
C                                          SECOND CANARD.                     B5640
C                                                                             B5650
C     46-48     KCANOR(2)    0,3-30        SAME AS FOR KCANOR(1), BUT FOR     B5660
C                                          SECOND CANARD.                     B5670
C                                                                             B5680
C     49-51     KCAN(3)      0,2-20        SAME AS FOR KCAN(1), BUT FOR       B5690
C                                          THIRD CANARD.                      B5700
C                                                                             B5710
C     52-54     KCANOR(3)    0,3-30        SAME AS FOR KCANOR(1), BUT FOR     B5720
C                                          THIRD CANARD.                      B5730
C                                                                             B5740
C     55-57     KCAN(4)      0,2-20        SAME AS FOR KCAN(1), BUT FOR       B5750
C                                          FOURTH CANARD.                     B5760
C                                                                             B5770
C     58-60     KCANOR(4)    0,3-30        SAME AS FOR KCANOR(1), BUT FOR     B5780
C                                          FOURTH CANARD.                     B5790
C                                                                             B5800
C     61-63     KCAN(5)      0,2-20        SAME AS FOR KCAN(1), BUT FOR       B5810
C                                          FIFTH CANARD.                      B5820
C                                                                             B5830
C     64-66     KCANOR(5)    0,3-30        SAME AS FOR KCANOR(1), BUT FOR     B5840
C                                          FIFTH CANARD.                      B5850
C                                                                             B5860
C     67-69     KCAN(6)      0,2-20        SAME AS FOR KCAN(1), BUT FOR       B5870
C                                          SIXTH CANARD.                      B5880
C                                                                             B5890
C     70-72     KCANOR(6)    0,3-30        SAME AS FOR KCANOR(1), BUT FOR     B5900
C                                          SIXTH CANARD.                      B5910
C                                                                             B5920
C    THIS PROGRAM IS RESTRICTED TO A TOTAL OF 600 SINGULARITY PANELS ON       B5930
C    THE WING-FIN-CANARD COMBINATION.                                         B5940
C    FOR THIS PROGRAM THERE IS AN ADDITIONAL RESTRICTION THAT THE TOTAL       B5950
C    NUMBER OF SINGULARITY PANELS IN THE SPANWISE DIRECTION ON THE            B5960
C    WING-FIN-CANARD COMBINATION CANNOT EXCEED 20.                            B5970
C                                                                             B5980
C                                                                             B5990
C    CARDS 3,4,... - REMAINING INPUT DATA CARDS. THE REMAINING INPUT          B6000
C    DATA CARDS CONTAIN A DETAILED DESCRIPTION OF THE SINGULARITY             B6010
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C      PANELING OF EACH COMPONENT OF THE AIRPLANE. EACH CARD CONTAINS UP
C      TO 10 VALUES, EACH VALUE PUNCHED IN A 7-COLUMN FIELD WITH A
C      DECIMAL POINT AND MAY BE IDENTIFIED IN COLUMNS 73-80. THE CARDS
C      ARE ARRANGED IN THE FOLLOWING ORDER. REFERENCE LENGTHS, WING DATA
C      CARDS, FIN (VERTICAL TAIL) DATA CARDS, CANARD (HORIZONTAL TAIL)
C      DATA CARDS, FUSELAGE (BODY) DATA CARDS, AND FINALLY MACH NUMBER
C      AND ANGLE OF ATTACK CASE CARDS. NOTE THAT THE PRESENT PROGRAM
C      WILL NOT HANDLE A POD AND THEREFORE THERE ARE NO POD PANEL INPUTS,
C      HOWEVER, IF THE GEOMETRY INPUT CONTAINS A POD DESCRIPTION IT WILL
C      BE READ AND IGNORED.
C
C
C      REFERENCE LENGTHS CARD. THIS CARD MAY BE IDENTIFIED AS REFL IN
C      COLUMNS 73-80 AND CONTAINS THE FOLLOWING
C
C      COLUMNS     VARIABLE                  DESCRIPTION
C
C       1-7          REFA                    WING REFERENCE AREA. IF REFA=0,
C                                            THE REFERENCE AREA IS DEFINED BY
C                                            THE VALUE OF REFA IN THE
C                                            GEOMETRY INPUT.
C
C       8-14         REFB                    WING SEMISPAN. IF REFB=0, A
C                                            VALUE OF 1.0 IS USED FOR THE
C                                            REFERENCE SEMISPAN.
C
C       15-21        REFC                    WING REFERENCE CHORD. IF REFC=0,
C                                            A VALUE OF 1.0 IS USED FOR THE
C                                            REFERENCE CHORD.
C
C       22-28        REFD                    BODY (FUSELAGE) REFERENCE
C                                            DIAMETER. IF REFD=0. A VALUE OF
C                                            1.0 IS USED FOR THE REFERENCE
C                                            DIAMETER.
C
C       29-35        REFL                    BODY (FUSELAGE) REFERENCE LENGTH
C                                            IF REFL=0, A VALUE OF 1.0 IS
C                                            USED FOR THE REFERENCE LENGTH.
C
C      36-42         REFX                    X COORDINATE OF MOMENT CENTER
C
C      43-49         REFZ                    Z COORDINATE OF MOMENT CENTER
C
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C                                                                               B6450
C     WING DATA CARDS. THE FIRST WING DATA CARD IS THE WING LEADING EDGE       B6460
C     RADIUS CARD AND IS REQUIRED ONLY WHEN K1=3. THIS CARD CONTAINS           B6470
C     NWAF VALUES OF LEADING EDGE RADIUS EXPRESSED IN PERCENT CHORD. IT        B6480
C     MAY BE IDENTIFIED IN COLUMNS 73-80 AS RHOJ WHERE J DENOTES THE           B6490
C     NUMBER OF THE LAST RADIUS GIVEN ON THAT CARD.                            B6500
C                                                                               B6510
C     NEXT IS THE WING PANEL LEADING EDGE CARD. THIS CARD CONTAINS             B6520
C     KWAFOR VALUES OF WING PANEL LEADING EDGE LOCATIONS EXPRESSED IN          B6530
C     PERCENT CHORD. THIS CARD MAY BE IDENTIFIED IN COLUMNS 73-80 AS           B6540
C     XAFKJ WHERE J DENOTES THE LAST LOCATION IN PERCENT CHORD GIVEN ON        B6550
C     THAT CARD. OMIT IF KWAFOR=0.                                             B6560
C                                                                               B6570
C     THE LAST WING DATA CARD GIVES THE WING PANEL SIDE EDGE DATA. THIS        B6580
C     CARD CONTAINS KWAF VALUES OF THE Y ORDINATE OF THE PANEL INBOARD         B6590
C     EDGES. THIS CARD MAY BE IDENTIFIED IN COLUMNS 73-80 AS YKJ WHERE J       B6600
C     DENOTES THE LAST Y ORDINATE ON THAT CARD. THESE VALUES ARE               B6610
C     ARRANGED IN THE ORDER WHICH BEGINS WITH THE MOST INBOARD PANEL           B6620
C     EDGE AND PROCEEDS OUTBOARD. OMIT IF KWAF=0.                              B6630
C                                                                               B6640
C                                                                               B6650
C     FIN (VERTICAL TAIL) DATA CARDS. THE FIRST FIN DATA CARD IS THE FIN       B6660
C     LEADING EDGE RADIUS CARD AND IS REQUIRED ONLY WHEN K4=3. THIS            B6670
C     CARD CONTAINS NF VALUES OF LEADING EDGE RADIUS EXPRESSED IN              B6680
C     PERCENT CHORD, ONE VALUE FOR EACH FIN. IT MAY BE IDENTIFIED IN           B6690
C     COLUMNS 73-80 AS RHOFIN.                                                 B6700
C                                                                               B6710
C     NEXT IS THE FIN PANEL LEADING EDGE CARD FOR THE FIRST FIN. THIS          B6720
C     CARD CONTAINS KFINOR(1) VALUES OF FIN PANEL LEADING EDGE LOCATIONS       B6730
C     EXPRESSED IN PERCENT CHORD. THIS CARD MAY BE IDENTIFIED IN COLUMNS       B6740
C     73-80 AS XFINKJ WHERE J DENOTES THE FIN NUMBER.                          B6750
C     REPEAT THIS CARD FOR EACH FIN.                                           B6760
C                                                                               B6770
C     THE LAST FIN DATA CARD GIVES THE FIN PANEL SIDE EDGE DATA FOR THE        B6780
C     FIRST FIN.  THIS CARD CONTAINS KF(1) VALUES OF THE Y ORDINATE OF         B6790
C     THE PANEL INBOARD EDGES. THIS CARD MAY BE IDENTIFIED IN COLUMNS          B6800
C     73-80 AS YFINKJ WHERE J DENOTES THE FIN NUMBER.  THESE VALUES ARE        B6810
C     ARRANGED IN THE ORDER THAT BEGINS WITH THE MOST INBOARD PANEL EDGE       B6820
C     AND PROCEEDS OUTBOARD.                                                   B6830
C     REPEAT THIS CARD FOR EACH FIN.                                           B6840
C                                                                               B6850
C                                                                               B6860
C     CANARD (HORIZONTAL TAIL) DATA CARDS. THE FIRST CANARD DATA CARD IS       B6870
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C     THE CANARD LEADING EDGE RADIUS CARD AND IS REQUIRED ONLY WHEN K5=3  B6880
C     THIS CARD CONTAINS NCAN VALUES OF LEADING EDGE RADIUS EXPRESSED IN  B6890
C     PERCENT CHORD, ONE VALUE FOR EACH CANARD. IT MAY BE IDENTIFIED IN   B6900
C     COLUMNS 73-80 AS RHOCAN.                                            B6910
C                                                                         B6920
C     NEXT IS THE CANARD PANEL LEADING EDGE CARD FOR THE FIRST CANARD.    B6930
C     THIS CARD CONTAINS KCANOR(1) VALUES OF CANARD PANEL LEADING EDGE    B6940
C     LOCATIONS EXPRESSED IN PERCENT CHORD. THIS CARD MAY BE IDENTIFIED   B6950
C     IN COLUMNS 73-80 AS XCANKJ WHERE J DENOTES THE CANARD NUMBER.       B6960
C     REPEAT THIS CARD FOR EACH CANARD.                                   B6970
C                                                                         B6980
C     THE LAST CANARD DATA CARD GIVES THE CANARD PANEL SIDE EDGE DATA     B6990
C     FOR THE FIRST CANARD. THIS CARD CONTAINS KCAN(1) VALUES OF THE Y    B7000
C     ORDINATE OF THE PANEL INBOARD EDGES. THIS CARD MAY BE IDENTIFIED    B7010
C     IN COLUMNS 73-80 AS YCANKJ WHERE J DENOTES THE CANARD NUMBER.       B7020
C     THESE VALUES ARE ARRANGED IN THE ORDER THAT BEGINS WITH THE MOST    B7030
C     INBOARD PANEL EDGE AND PROCEEDS OUTBOARD.                           B7040
C     REPEAT THIS CARD FOR EACH CANARD.                                   B7050
C                                                                         B7060
C                                                                         B7070
C     FUSELAGE (BODY) DATA CARDS. THE FIRST BODY CARD IS THE BODY         B7080
C     MERIDIAN ANGLE CARD. THIS CARD CONTAINS KRADX(1) VALUES OF BODY     B7090
C     MERIDIAN ANGLE EXPRESSED IN DEGREES AND MAY BE IDENTIFIED IN        B7100
C     COLUMNS 73-80 AS PHIKJ WHERE J DENOTES THE BODY SEGMENT NUMBER.     B7110
C     THE CONVENTION IS OBSERVED THAT PHIK=0. AT THE BOTTOM OF THE BODY   B7120
C     AND PHIK=180. AT THE TOP OF THE BODY. OMIT UNLESS KRADX(1) IS       B7130
C     NEGATIVE.                                                           B7140
C     REPEAT THIS CARD FOR EACH FUSELAGE SEGMENT.                         B7150
C                                                                         B7160
C     THE SECOND BODY CARD IS THE BODY AXIAL STATION CARD. THIS CARD      B7170
C     CONTAINS KFORX(1) VALUES OF THE X ORDINATE OF THE BODY AXIAL        B7180
C     STATIONS AND MAY BE IDENTIFIED IN COLUMNS 73-80 AS XFUSKJ WHERE J   B7190
C     DENOTES THE BODY SEGMENT NUMBER. OMIT IF KFORX(1)=0.                B7200
C     REPEAT THIS CARD FOR EACH FUSELAGE SEGMENT.                         B7210
C                                                                         B7220
C                                                                         B7230
C     MACH NUMBER AND ANGLE OF ATTACK CARD. THIS CARD MAY BE IDENTIFIED   B7240
C     IN COLUMNS 73-80 AS MALPHA AND CONTAINS THE FOLLOWING               B7250
C                                                                         B7260
C     COLUMN     VARIABLE       CONTENTS                                  B7270
C      1-7         MACH         THE SUBSONIC MACH NUMBER (INCLUDING THE   B7280
C                               VALUE MACH=0.) OR THE SUPERSONIC MACH     B7290
C                               NUMBER AT WHICH IT IS DESIRED TO CALCULATE B7300
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```
      REFD=1.0
      REFL=1.0
      REFX=0.
      REFZ=0.
      REWIND 7
      REWIND 8
      REWIND 9
      REWIND 10
C
C     INPUT CONFIGURATION PARAMETERS
C
      READ (5,140) TITLE1
      IF (ENDFILE 5) 20,10
10    CONTINUE
      WRITE (6,160) TITLE1
      READ (5,140) ABCD
      DECODE (72,170,ABCD) J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,(NRADX(
     1I),NFORX(I),I=1,4),NP,NFODOR,NF,NFINOR,NCAN,NCANOR
      GO TO 30
20    CALL EXIT
C
C     INPUT DESCRIPTION AND INITIALIZATION
C
30    CALL OVERLAY (LWB,1,1)
C
C     SET BOUNDARY CONDITION AND WING THICKNESS OPTIONS
C
      READ (5,140) TITLE2
      READ (5,170) LINBC,THICK,PRINT
      IF (LINBC.GT.0) LBC=.TRUE.
      IF (LBC.AND.THICK.GT.0) THK=.TRUE.
C
C     INPUT REVISED CONFIGURATION PANELING DESCRIPTION CONTROL INTEGERS
C
      READ (5,140) ABCD
      DECODE (72,170,ABCD) K0,K1,K2,K3,K4,K5,K6,KWAF,KWAFOR,KFUS,(KRADX(
     1I),KFORX(I),I=1,4)
      TAIL=.FALSE.
      IF (K4.GT.0.OR.K5.GT.0) TAIL=.TRUE.
      IF (.NOT.TAIL) GO TO 40
      READ (5,140) ABCD
      DECODE (72,170,ABCD) (KF(I),KFINOR(I),I=1,6),(KAN(I),KANOR(I),I=1,
     16)
```

```
C                                          THE AERODYNAMIC DATA.
C        8-14        ALPHA                 THE ANGLE OF ATTACK EXPRESSED IN DEGREES
C                                          AT WHICH IT IS DESIRED TO CALCULATE THE
C                                          AERODYNAMIC DATA.
C
C     A SERIES OF MACH NUMBER AND ANGLE OF ATTACK COMBINATIONS FOR THE
C     SAME GEOMETRY MAY BE CALCULATED BY REPEATING THIS CARD WITH THE
C     DESIRED VALUES.
C
C     A VALUE OF MACH=-1. ON THIS CARD SIGNIFIES THE TERMINATION OF THE
C     PRESENT CASE. GEOMETRY CARDS FOR A NEW CASE CAN FOLLOW SUCH A
C     TERMINAL CARD.
C
C
C     ******************************************************************
C
      COMMON ABC(8),J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,NRADX(4),NFORX
     1(4),NP,NPODOR,NF,NFINOR,NCAN,NCANOR,DUM(36)
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA,REFB,REFC
     1,REFD,REFL,REFX,REFZ
      COMMON /HEAD/ TITLE1(8),TITLE2(8)
      COMMON /SEG/ NSEG,NROW(20),NCOL(20),COSS(20),SINS(20),BT(20)
      COMMON /SCRAT/ BLOCK(7500)
      COMMON /NEWCOM/ K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KRAD,MAX,K4,K5,KF
     1(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT,XCPT
      COMMON /VELCOM/ DUM1(5),EM,PRINT,DUM2(53)
C
      DIMENSION ABCD(8)
      LOGICAL LBC,THK,TAIL
      INTEGER THICK,PRINT
      LWB=3LLWB
      LBC=.FALSE.
      THK=.FALSE.
      EM=-1.
      PRINT=0
      NCPT=0
      NBODY=0
      NWING=0
      NTAIL=0
      NSEG=0
      KOL=0
      REFB=1.0
      REFC=1.0
```

```
40    READ (9) REFA
      IF (K0.EQ.0) GO TO 50
      READ (5,150) REFAR,REFB,REFC,REFD,REFL,REFX,REFZ
      IF (REFAR.NE.0.) REFA=REFAR
      IF (REFB.EQ.0.) REFB=1.0
      IF (REFC.EQ.0.) REFC=1.0
      IF (REFD.EQ.0.) REFD=1.0
      IF (REFL.EQ.0.) REFL=1.0
50    CONTINUE
      READ (9) BLOCK
      IF (K1.EQ.0) GO TO 60
C
C     REVISE CHORDWISE PANEL SPACING ON WING AND COMPUTE NEW AIRFOIL
C     ORDINATES
C
      CALL OVERLAY (LWB,1,2)
C
C     REVISE SPANWISE PANEL SPACING ON WING AND COMPUTE NEW PANEL
C     GEOMETRY
C
      CALL OVERLAY (LWB,1,3)
C
60    CONTINUE
      READ (9) BLOCK
      IF (TAIL) GO TO 80
      IF (K2.EQ.0) GO TO 80
      IF (TAIL) GO TO 80
      IF (K2.EQ.0) GO TO 80
      IF (KRADX(1).LE.21) GO TO 70
      WRITE (6,190)
      CALL EXIT
70    CONTINUE
C
C     REVISE BODY (FUSELAGE) MERIDIAN LINE SPACING
C
      CALL OVERLAY (LWB,1,4)
C
C     REVISE AXIAL PANEL SPACING ON BODY (FUSELAGE) AND COMPUTE NEW
C     PANEL GEOMETRY
C
      CALL OVERLAY (LWB,1,5)
C
      GO TO 130
```

```
80    CONTINUE
      READ (9) BLOCK
      IF (K4.EQ.0) GO TO 90
C
C     REVISE CHORDWISE PANEL SPACING ON FIN (VERTICAL TAIL) AND COMPUTE
C     NEW AIRFOIL ORDINATES
C
      CALL OVERLAY (LWB,1,6)
C
C     REVISE SPANWISE PANEL SPACING ON FIN (VERTICAL TAIL) AND COMPUTE
C     NEW PANEL GECMETRY
C
      CALL OVERLAY (LWB,1,7)
C
90    CONTINUE
      READ (9) BLOCK
      IF (K5.EQ.0) GO TO 100
C
C     REVISE CHORDWISE PANEL SPACING ON CANARD (HCRIZONTAL TAIL) AND
C     COMPUTE NEW AIRFCIL ORDINATES
C
      CALL OVERLAY (LWB,1,6)
C
C     REVISE SPANWISE PANEL SPACING ON CANARD (HORIZONTAL TAIL) AND
C     COMPUTE NEW PANEL GECMETRY
C
      CALL OVERLAY (LWB,1,7)
C
100   CONTINUE
      IF (KOL.LE.20) GC TO 120
110   WRITE (6,180)
      CALL EXIT
120   IF (K2.EQ.0) GC TO 130
      REWIND 9
      TAIL=.FALSE.
      READ (9) REFA
      READ (9) BLOCK
      GO TO 60
130   CONTINUE
      IF (KOL.GT.20) GO TO 110
      REWIND 9
      RETURN
C
```

```
C                                                                       B9030
140   FORMAT (8A10)                                                     B9040
150   FORMAT (10F7.0)                                                   B9050
160   FORMAT (1H1,8A10)                                                 B9060
170   FORMAT (24I3)                                                     B9070
180   FORMAT (1H0,56HERROR- WING AND TAIL HAVE MORE THAN 20 COLUMNS OF P B9080
     1ANELS)                                                            B9090
190   FORMAT (1H0,46HERROR- BODY HAS MORE THAN 20 COLUMNS OF PANELS)    B9100
      END                                                               B9110-
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      SUBROUTINE PANEL (IP,IQ,J,K,L,NP,AP)
C
C     CALCULATE PANEL GEOMETRY (BASED ON THE HYPERSONIC ARBITRARY BODY
C     PROGRAM OF A. E. GENTRY)
C
      COMMCN /POINT/ XPT(600),YPT(600),ZPT(600),THET(600),DELTA(600),XC(
     130,20),YC(30,20),ZC(30,20)
      COMMCN /SCRAT/ BLOCK(6900),ZU(30,20)
      DIMENSICN XIN(4), YIN(4), ZIN(4), XI(4), ETA(4)
      REAL NX,NY,NZ
C
C     REORDER THE PANEL CORNER POINTS TO CORRESPOND TO GENTRY CONVENTION
C
      EPS=1.0E-06
      J1=J-1
      K1=K-1
      XIN(1)=XC(J1,K1)
      XIN(2)=XC(J,K1)
      XIN(3)=XC(J,K)
      XIN(4)=XC(J1,K)
      YIN(1)=YC(J1,K1)
      YIN(2)=YC(J,K1)
      YIN(3)=YC(J,K)
      YIN(4)=YC(J1,K)
      IF (L.EQ.1) GO TO 10
      ZIN(1)=ZC(J1,K1)
      ZIN(2)=ZC(J,K1)
      ZIN(3)=ZC(J,K)
      ZIN(4)=ZC(J1,K)
      GO TO 20
10    ZIN(1)=ZU(J1,K1)
      ZIN(2)=ZU(J,K1)
      ZIN(3)=ZU(J,K)
      ZIN(4)=ZU(J1,K)
20    CONTINUE
C
C     FORM DIAGONAL VECTORS
C
      T1X=XIN(3)-XIN(1)
      T2X=XIN(4)-XIN(2)
      IF (IP.EQ.1) T2X=-T2X
      T1Y=YIN(3)-YIN(1)
```

```
      T2Y=YIN(4)-YIN(2)
      IF (IP.EQ.1) T2Y=-T2Y
      T1Z=ZIN(3)-ZIN(1)
      T2Z=ZIN(4)-ZIN(2)
      IF (IP.EQ.1) T2Z=-T2Z
C
C     FORM VECTOR CROSS PRODUCT, N = T2 X T1
C
      NX=T2Y*T1Z-T1Y*T2Z
      NY=T1X*T2Z-T2X*T1Z
      NZ=T2X*T1Y-T1X*T2Y
      IF (ABS(NX).LE.EPS) NX=0.
      IF (ABS(NY).LE.EPS) NY=0.
      IF (ABS(NZ).LE.EPS) NZ=0.
      VN=SQRT(NX*NX+NY*NY+NZ*NZ)
      IF (VN.EQ.0.) GO TO 30
C
C     FORM UNIT NORMAL VECTOR
C
      VND=1./VN
      NX=NX*VND
      NY=NY*VND
      NZ=NZ*VND
C
C     COMPUTE AVERAGE POINT
C
30    AVX=0.25*(XIN(1)+XIN(2)+XIN(3)+XIN(4))
      AVY=0.25*(YIN(1)+YIN(2)+YIN(3)+YIN(4))
      AVZ=0.25*(ZIN(1)+ZIN(2)+ZIN(3)+ZIN(4))
C
C     COMPUTE PROJECTION DISTANCE
C
      D=NX*(AVX-XIN(1))+NY*(AVY-YIN(1))+NZ*(AVZ-ZIN(1))
      PD=ABS(D)
      T=SQRT(T1X*T1X+T1Y*T1Y+T1Z*T1Z)
      IF (T.EC.0.0) GO TO 40
      TD=1./T
      T1X=T1X*TD
      T1Y=T1Y*TD
      T1Z=T1Z*TD
40    T2X=NY*T1Z-NZ*T1Y
      T2Y=NZ*T1X-NX*T1Z
      T2Z=NX*T1Y-NY*T1X
```

```
C
C     COMPUTE COORDINATES OF CORNER POINTS IN REFERENCE COORDINATE
C     SYSTEM
C
      DO 50 N=1,4
      XPA=XIN(N)+NX*D
      YPA=YIN(N)+NY*D
      ZPA=ZIN(N)+NZ*D
      D=-D
      XDIF=XPA-AVX
      YDIF=YPA-AVY
      ZDIF=ZPA-AVZ
C
C     TRANSFORM CORNER POINT TO ELEMENT COORDINATE SYSTEM (XI,ETA)
C     WITH AVERAGE POINT AS ORIGIN
C
      XI(N)=T1X*XDIF+T1Y*YDIF+T1Z*ZDIF
50    ETA(N)=T2X*XDIF+T2Y*YDIF+T2Z*ZDIF
C
C     COMPUTE CENTROID
C
      ETACK=ETA(2)-ETA(4)
      IF (ETACK.NE.0.0) GO TO 60
      XIO=0.0
      GO TO 70
60    XIO=(XI(4)*(ETA(1)-ETA(2))+XI(2)*(ETA(4)-ETA(1)))/(3.*ETACK)
70    ETAO=-ETA(1)/3.
C
C     OBTAIN CORNER POINTS IN SYSTEM WITH CENTROID AS ORIGIN
C
      XI(1)=XI(1)-XIO
      XI(2)=XI(2)-XIO
      XI(3)=XI(3)-XIO
      XI(4)=XI(4)-XIO
      ETA(1)=ETA(1)-ETAO
      ETA(2)=ETA(2)-ETAO
      ETA(3)=ETA(3)-ETAO
      ETA(4)=ETA(4)-ETAO
C
C     TRANSFORM CENTROID TO REFERENCE COORDINATE SYSTEM
C
      XPT(NP)=AVX+T1X*XIO+T2X*ETAO
      YPT(NP)=AVY+T1Y*XIO+T2Y*ETAO
```

```
      ZPT(NP)=AVZ+T1Z*XI0+T2Z*ETA0
C                                                                       C1290
C     COMPUTE PANEL INCIDENCE AND INCLINATION ANGLE                     C1300
C                                                                       C1310
      DELTA(NP)=0.                                                      C1320
      THET(NP)=0.                                                       C1330
      RN=SQRT(NY*NY+NZ*NZ)                                              C1340
      IF (L.EQ.0) GO TO 80                                              C1350
      SL=-1.0                                                           C1360
      IF (L.EQ.2) SL=1.0                                                C1370
      IF (NX.NE.0.) DELTA(NP)=ATAN2(SL*NX,RN)                           C1380
      SP=FLOAT(1-2*IP)                                                  C1390
      IF (NY.NE.0.) THET(NP)=ATAN2(SP*NY,-SP*NZ)                        C1400
      GO TO 90                                                          C1410
   80 IF (NX.NE.0.) DELTA(NP)=ATAN2(-NX,RN)                             C1420
      IF (NY.NE.0.) THET(NP)=ATAN2(-NY,NZ)                              C1430
   90 CONTINUE                                                          C1440
C                                                                       C1450
C     COMPUTE PANEL AREA                                                C1460
C                                                                       C1470
      AP=0.5*(XI(3)-XI(1))*ETACK                                        C1480
      IF (IP.EQ.1) AP=-AP                                               C1490
      RETURN                                                            C1500
      END                                                               C1510
                                                                        C1520-
```

```
      SUBROUTINE SCAMP4 (X,Y,N,NDA,NDB,DA,DB,C,S,M)
C
C     GIVEN A SET OF N POINTS WHOSE ABSCISSAE FORM A STRICTLY MONOTONIC
C     SEQUENCE, AND GIVEN A FIRST OR SECOND DERIVATIVE AT X(1) AND A
C     FIRST OR SECCND DERIVATIVE AT X(N), TO FIND THE SMOOTHEST POSSIBLE
C     CURVE PASSING RIGORCUSLY THROUGH THE GIVEN POINTS, SATISFYING THE
C     SPECIFIED BOUNCARY CONDITIONS, AND POSSESSING CONTINUOUS FIRST AND
C     SECOND DERIVATIVES. THE CRITERICN OF SMOOTHNESS IS THE
C     MINIMIZATION OF THE INTEGRAL OF THE SQUARE OF THE SECOND
C     DERIVATIVE, AND THE CUBIC FOUND IS ACCORDINGLY A CHAIN OF CUBICS,
C     I. E., A SEPARATE CUBIC ON EACH INTERVAL (X(I),X(I+1))
C
      DIMENSICN C(4,1), S(1), X(1), Y(1), Z(4)
      L=1
      KK=1
      D1=CA
      D2=CB
      IF (M-12) 20,10,20
   10 KK=2
   20 IF (NCA+1) 30,40,50
   30 D1=DERIV2(X,Y,X)
      GO TO 50
   40 D1=DERIV1(X,Y,1)
   50 NA=IABS(NCA)
      IF (NCB+1) 6C,70,80
   60 D2=DERIV2(X(N-3),Y(N-3),X(N))
      GO TO 80
   70 D2=DERIV1(X(N-2),Y(N-2),3)
   80 NB=IABS(NDB)
      CALL CCMCU (D1,D2,S,X,Y,L,M,N,NA,NB)
      IF (M) 160,90,160
   90 K=N-1
      DO 150 J=1,K
      CALL CUBIC2 (X(J),Y(J),S(J),Z,M)
      IF (M-1) 100,110,100
  100 M=10C*J+M
      GO TO 160
  110 GO TO (120,140), KK
  120 DO 130 I=1,4
  130 C(I,J)=Z(I)
      GO TO 150
  140 L=7*J
```

```
      C(L-6,1)=X(J)
      C(L-5,1)=X(J+1)
      C(L-4,1)=3.0
      C(L-3,1)=Z(1)
      C(L-2,1)=Z(2)
      C(L-1,1)=Z(3)
      C(L,1)=Z(4)
150   CONTINUE
      M=0
160   RETURN
      END
```

```
      SUBROUTINE DERIV (X,Y,N,NDA,DA,FD)
C
C     COMPANICN TO SUBROUTINE SCAMP4
C
C
C     FIT A CHAIN OF CUBIC CURVES THROUGH A SET OF N POINTS HAVING
C     CONTINUOUS FIRST AND SECOND DERIVATIVES AT THE INTERMEDIATE POINTS
C     AND SPECIFIED FIRST OR SECOND DERIVATIVE AT THE END POINTS
C
      COMMCN /COEF/ C(4,50),CC(4,50)
      DIMENSION X(1), Y(1), FC(1)
C
C     FIT CUBIC CHAIN AND GET FIRST DERIVATIVES
C
      CALL SCAMP4 (X,Y,N,NDA,-1,DA,0.,C,FD,0)
      RETURN
      END
```

```
      FUNCTION DERIV1 (X1,Y1,N)
C
C     COMPANICN TO SUBROUTINE SCAMP4
C
C
C     FIND THE FIRST CERIVATIVE OF THE QUADRATIC THROUGH THREE GIVEN
C     POINTS AT A SPECIFIED ONE OF THESE POINTS. THIS PROVIDES A GOOD
C     APPROXIMATION TO THE SLOPE OF A FUNCTION AT A POINT, PARTICULARLY
C     IF THE OTHER TWO POINTS USED ARE NEARBY.
C
      DIMENSION X(3), Y(3), X1(3), Y1(3)
      EQUIVALENCE (S,K)
      DO 10 I=1,3
      X(I)=X1(I)
10    Y(I)=Y1(I)
      K=N
C
C     FIND COEFFICIENTS OF THE X-SQUARED TERM AND THE X TERM. NO NEED TO
C     FIND CCNSTANT TERM, AS IT DISAPPEARS UNDER DIFFERENTIATION.
C
      E=Y(1)-Y(2)
      H=Y(1)-Y(3)
      A=X(1)-X(2)
      B=X(1)-X(3)
      C=A*(X(1)+X(2))
      DT=B*(X(1)+X(3))
      C3=(B*E-A*H)/(B*C-A*DT)
      C2=(E-C3*C)/A
C
C     TEST TO SEE WHETHER DERIVATIVE IS WANTED AT ONE OF THE INPUT
C     POINTS OR ELSEWHERE
C
      K1=IABS(K)
      DO 20 I=1,3
      IF (K1-I) 20,30,20
20    CONTINUE
      GO TO 40
30    S=X(K1)
40    DERIV1=C2+2.0*C3*S
      RETURN
      END
```

```
      FUNCTION DERIV2 (X,Y,XX)
C
C     COMPANION TO SUBROUTINE SCAMP4
C
C
C     FIND THE SECOND DERIVATIVE OF THE CUBIC THROUGH FOUR GIVEN POINTS
C     AT AN ARBITRARY POINT WHOSE X COORDINATE IS SPECIFIED
C
      DIMENSION X(4), Y(4)
      DERIV2=0.0
      IF (X(4)-X(3)) 10,70,10
10    IF (X(4)-X(2)) 20,70,20
20    IF (X(4)-X(1)) 30,70,30
30    IF (X(3)-X(2)) 40,70,40
40    IF (X(3)-X(1)) 50,70,50
50    IF (X(2)-X(1)) 60,70,60
60    Q41=(Y(4)-Y(1))/(X(4)-X(1))
      Q31=(Y(3)-Y(1))/(X(3)-X(1))
      Q21=(Y(2)-Y(1))/(X(2)-X(1))
      E=(Q31-Q21)/(X(3)-X(2))
      D=((Q41-Q21)/(X(4)-X(2))-E)/(X(4)-X(3))
      C=E-D*(X(3)+X(2)+X(1))
      DERIV2=2.0*(C+3.0*D*XX)
70    RETURN
      END
```

```
      SUBROUTINE CUBIC2 (X,Y,D,C,J)
C
C     COMPANICN TO SUBROUTINE SCAMP4
C
C
C     FIT A CUBIC TO TWO POINTS GIVEN THE SLOPE AT EACH POINT
C
      DIMENSION X(1), Y(1), D(1), C(1)
      X2=X(2)
      B=X(1)-X2
      IF (B) 20,10,20
   10 J=3
      GO TO 30
   20 CALL OVERFL (J)
      A=(Y(1)-Y(2))/B
      E=X(1)+X2
      C(4)=(D(1)+D(2)-A-A)/B/B
      C(3)=(A-D(2))/B-C(4)*(E+X2)
      C(2)=A-E*C(3)-C(4)*(E*X2+X(1)**2)
      C(1)=Y(2)-X2*(C(2)+X2*(C(3)+X2*C(4)))
      CALL OVERFL (J)
      J=3-J
   30 RETURN
      END
```

```
      SUBROUTINE COMCU (DA,DB,S,X,Y,L,M,N,NDA,NDB)
C
C     COMPANION TO SUBROUTINE SCAMP4
C
C
C     FIT A COMPOSITE CUBIC THROUGH N POINTS, I. E., A SEPARATE CUBIC
C     BETWEEN EACH PAIR OF ADJACENT POINTS, SUCH THAT N-1 CUBICS ARE SO
C     DETERMINED THAT EACH MATCHES ITS NEIGHBORS IN FUNCTION VALUE AND
C     IN THE FIRST AND SECOND DERIVATIVES.
C
      COMMON /COEF/ C(50),D(50),E(50),DUM(250)
      DIMENSION S(1), X(1), Y(1)
      K=N-1
      KUE=0
      IF (N-2) 10,20,60
10    M=-1
      GO TO 180
20    IF (NDA-1) 50,30,50
30    IF (NDB-1) 50,40,50
40    S(1)=DA
      S(2)=DB
      M=0
      GO TO 180
50    KUE=1
60    M=0
      E(1)=0.0
      C(N)=0.0
      IF (NDA-1) 70,70,80
70    D(1)=1.0
      C(1)=0.0
      S(1)=DA
      GO TO 90
80    D(1)=4.0
      C(1)=2.0
      S(1)=6.0*(Y(2)-Y(1))/(X(2)-X(1))-DA*(X(2)-X(1))
90    IF (KUE) 120,100,120
100   DO 110 I=2,K
      U=X(I)-X(I-1)
      V=X(I+1)-X(I)
      C(I)=U
      D(I)=2.0*(U+V)
      E(I)=V
```

```
110   S(I)=3.0/(U*V)*(U*U*(Y(I+1)-Y(I))+V*V*(Y(I)-Y(I-1)))
120   IF (NDB-1) 130,130,140
130   E(N)=0.0
      D(N)=1.0
      S(N)=DB
      GO TO 150
140   E(N)=2.0
      D(N)=4.0
      S(N)=6.0*(Y(N)-Y(N-1))/(X(N)-X(N-1))+DB*(X(N)-X(N-1))
150   C(1)=C(1)/D(1)
      S(1)=S(1)/D(1)
      DO 160 I=2,N
      F=D(I)-C(I-1)*E(I)
      C(I)=C(I)/F
160   S(I)=(S(I)-S(I-1)*E(I))/F
      DO 170 J=1,K
      I=N-J
170   S(I)=S(I)-S(I+1)*C(I)
180   RETURN
      END
```

```
      OVERLAY(LWB,1,1)
      PROGRAM CONFIG
C
C     INPUT AND INITIALIZE CCNFIGURATION DESCRIPTION (BASED ON PROGRAM
C     START OF NASA TMX-2074)
C
      COMMON ABC(8),J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,NRADX(4),NFORX
     1(4),NP,NPODOR,NF,NFINOR,NCAN,NCANOR,J2TEST,NW,NC,DUM(33)
      COMMCN /SCRAT/ BLOCK(7500)
C
      DIMENSICN ABCD(8), XAF(30), WAFORG(20,4), WAFORD(20,3,30), TZORD(2
     10,30), WAFOR(20,30), XFUS(30,4), ZFUS(30,4), FUSARD(30,4), FUSRAD(
     230,4), SFUS(30,30,8), PODORG(9,3), XPOD(9,30), PODORD(9,30), XPOD1
     3(9,30), FINORG(6,2,4), XFIN(6,10), FINORC(6,2,10), FINX2(6,2,10),
     4FINX3(6,2,10), FINOR(6,10), FINCR(6,10), CANORG(6,2,4), XCAN(6,10)
     5, CANORD(6,2,10), CANOR1(6,2,10), CANORX(6,2,10), CANOR(6,10), CAN
     6CR(6,10)
C
      EQUIVALENCE (BLOCK,XAF), (BLOCK(31),WAFORG), (BLOCK(111),WAFORD),
     1(BLOCK(1911),TZORD), (BLOCK(2511),WAFOR), (BLOCK,XFUS), (BLOCK(121
     2),ZFUS), (BLOCK(241),FUSARD), (BLOCK(361),FUSRAD), (BLOCK(241),SFU
     3S), (BLOCK,PODORG), (BLOCK(28),XPOD), (BLOCK(298),PODORD), (BLOCK(
     4568),XPOD1), (BLOCK,FINORG), (BLOCK(49),XFIN), (BLOCK(109),FINORD)
     5, (BLOCK(229),FINX2), (BLOCK(349),FINX3), (BLOCK(469),FINOR), (BLO
     6CK(529),FINCR), (BLOCK,CANORG), (BLOCK(49),XCAN), (BLOCK(109),CANO
     7RD), (BLOCK(229),CANOR1), (BLOCK(349),CANORX), (BLOCK(469),CANOR),
     8 (BLOCK(529),CANCR)
C
      INTEGER PLOT
      DATA NAN2/24/
      DATA PI/3.14159265/
C
      REWIND 9
C
C     REFERENCE AREA
C
      REFA=1.0
      IF (J0.EQ.0) GO TO 10
      READ (5,470) ABCD
      DECODE (7,480,ABCD) REFA
10    WRITE (9) REFA
C
```

```
C     WING
C
      IF (J1.EQ.0) GO TO 160
      N=IABS(NWAFOR)
      NREC=(N+9)/10
      I1=-9
      I2=0
      DO 20 NN=1,NREC
      READ (5,470) ABCD
      I1=I1+10
      I2=I2+10
      DECODE (70,480,ABCD) (XAF(I),I=I1,I2)
20    CONTINUE
      DO 30 I=1,NWAF
      READ (5,470) ABCD
      DECODE (28,480,ABCD) (WAFORG(I,J),J=1,4)
30    CONTINUE
C
C     J1 = -1 INDICATES UNCAMBERED WING DATA
C
      IF (J1.LT.0) GO TO 60
      DO 50 NN=1,NWAF
      I1=-9
      I2=0
      DO 40 N1=1,NREC
      READ (5,470) ABCD
      I1=I1+10
      I2=I2+10
      DECODE (70,480,ABCD) (TZORD(NN,I),I=I1,I2)
40    CONTINUE
50    CONTINUE
      GO TO 80
60    DO 70 I=1,NWAF
      DO 70 K=1,N
70    TZORD(I,K)=0.
80    L=1
C
C     NWAFOR POSITIVE INDICATES SYMMETRICAL ORDINATES
C     NWAFOR NEGATIVE INDICATES UPPER AND LOWER ORDINATES ARE GIVEN
C
      IF (NWAFOR.LT.0) L=2
      DO 100 NN=1,NWAF
      DO 100 K=1,L
```

```
      I1=-9
      I2=C
      DO 90 N1=1,NREC
      READ (5,470) ABCD
      I1=I1+10
      I2=I2+10
      DECODE (70,480,ABCD) (WAFORD(NN,K,I),I=I1,I2)
 90   CONTINUE
 100  CONTINUE
      DO 110 NN=1,NWAF
      DO 110 K=1,N
      WAFOR(NN,K)=WAFORD(NN,1,K)
      IF (L.EQ.1) GO TO 110
      WAFOR(NN,K)=(WAFORD(NN,1,K)-WAFORD(NN,2,K))/2.
      TZORD(NN,K)=(WAFORD(NN,1,K)+WAFORD(NN,2,K))/2.+TZORD(NN,K)
 110  CONTINUE
      IF (NWAFOR.LT.0) GO TO 130
      DO 120 NN=1,NWAF
      DO 120 K=1,N
 120  WAFORD(NN,2,K)=WAFORD(NN,1,K)
 130  CONTINUE
      NWAFOR=IABS(NWAFOR)
      NW=NWAFOR
      J1=IABS(J1)
C
C     CHANGE WING TO ACTUAL UNITS
C
      DO 150 I=1,NWAF
      E=.01*WAFORG(I,4)
      E3=WAFORG(I,3)
      DO 140 J=1,NWAFOR
      WAFORD(I,1,J)=E*WAFORD(I,1,J)+E3+TZORD(I,J)
      WAFORD(I,2,J)=-E*WAFORD(I,2,J)*E3+TZORD(I,J)
 140  WAFORD(I,3,J)=WAFORG(I,1)+E*XAF(J)
 150  CONTINUE
C
 160  WRITE (9) BLOCK
C
C     FUSELAGE (BODY)
C
      IF (J2.EQ.0) GO TO 290
      J2TEST=3
C
```

```
C      J2 = -1 AND J6 = -1 INDICATE CIRCULAR FUSELAGE SYMMETRICAL WITH
C      THE XY-PLANE
C
       IF (J2.EQ.-1.AND.J6.EQ.-1) J2TEST=1
C
C      J2 = -1 AND J6 = 0 INDICATE CIRCULAR CAMBERED FUSELAGE
C
       IF (J2.EQ.-1.AND.J6.EQ.0) J2TEST=2
C
C      J6 = 1 INDICATES COMPLETE CONFIGURATION SYMMETRICAL WITH THE
C      XY-PLANE
C
       IF (J6.EQ.1) J2TEST=1
       J2=1
       DO 280 NFU=1,NFUS
       NRAD=NRADX(NFU)
       NFUSOR=NFORX(NFU)
       N=NFUSOR
       NREC=(N+9)/10
       I1=-9
       I2=0
       DO 170 N1=1,NREC
       READ (5,470) ABCD
       I1=I1+10
       I2=I2+10
       DECODE (70,480,ABCD) (XFUS(I,NFU),I=I1,I2)
170    CONTINUE
C
C      J2TEST = 2 INDICATES CIRCULAR CAMBERED FUSELAGE
C
       IF (J2TEST.NE.2) GO TO 190
       I1=-9
       I2=0
       DO 180 N1=1,NREC
       READ (5,470) ABCD
       I1=I1+10
       I2=I2+10
       DECODE (70,480,ABCD) (ZFUS(I,NFU),I=I1,I2)
180    CONTINUE
       GO TO 210
190    DO 200 I=1,N
C
C      J2TEST = 3 INDICATES ARBITRARY FUSELAGE
```

```
C                                                                       J1730
200   ZFUS(I,NFU)=0.                                                    J1700
210   IF (J2TEST.NE.3) GO TO 250                                        J1740
      NCARD=(NRAD+9)/10                                                 J1750
      DO 240 LN=1,N                                                     J1760
      DO 230 K=1,2                                                      J1770
      KK=K+(NFU-1)*2                                                    J1780
      II=10                                                             J1790
      I1=-9                                                             J1800
      I2=0                                                              J1810
      DO 220 NN=1,NCARD                                                 J1820
      IF (NN.EQ.NCARD) II=MOD(NRAD,10)                                  J1830
      IF (II.EQ.0) II=10                                                J1840
      I1=I1+10                                                          J1850
      I2=I2+II                                                          J1860
      READ (5,470) ABCD                                                 J1870
      DECODE (70,480,ABCD) (SFUS(I,LN,KK),I=I1,I2)                      J1880
220   CONTINUE                                                          J1890
230   CONTINUE                                                          J1900
240   CONTINUE                                                          J1910
      GO TO 280                                                         J1920
250   I1=-9                                                             J1930
      I2=0                                                              J1940
      DO 260 N1=1,NREC                                                  J1950
      READ (5,470) ABCD                                                 J1960
      I1=I1+10                                                          J1970
      I2=I2+10                                                          J1980
      DECODE (70,480,ABCD) (FUSARD(I,NFU),I=I1,I2)                      J1990
260   CONTINUE                                                          J2000
      DO 270 I=1,N                                                      J2010
270   FUSRAD(I,NFU)=SQRT(FUSARD(I,NFU)/PI)                              J2020
280   CONTINUE                                                          J2030
290   WRITE (9) BLOCK                                                   J2040
C                                                                       J2050
C     POD GECMETRY DUMMY READ STATEMENTS                                J2060
C                                                                       J2070
      IF (J3.EQ.0) GO TO 330                                            J2080
      N=NPODOR                                                          J2090
      NREC=(N+9)/10                                                     J2100
      DO 320 NN=1,NP                                                    J2110
      READ (5,470) ABCD                                                 J2120
      DO 300 N1=1,NREC                                                  J2130
      READ (5,470) ABCD                                                 J2140
```

```
300   CONTINUE
      DO 310 N1=1,NREC
      READ (5,470) ABCD
310   CONTINUE
320   CONTINUE
330   CONTINUE
C
C     FINS (VERTICAL TAILS)
C
      IF (J4.EQ.0) GO TO 380
      N=NFINOR
      DO 350 NN=1,NF
      READ (5,470) ABCD
      DECODE (56,480,ABCD) ((FINORG(NN,I,J),J=1,4),I=1,2)
      READ (5,470) ABCD
      DECODE (70,480,ABCD) (XFIN(NN,I),I=1,N)
      READ (5,470) ABCD
      DECODE (70,480,ABCD) (FINORD(NN,1,J),J=1,N)
      DO 340 J=1,N
      FINCR(NN,J)=0.
340   FINOR(NN,J)=FINORD(NN,1,J)
350   CONTINUE
C
C     CHANGE FINS TO ACTUAL UNITS
C
      DO 370 LQ=1,NF
      DO 370 I=1,2
      J=3-I
      E=.01*FINORG(LQ,J,4)
      E2=FINORG(LQ,J,2)
      DO 360 K=1,NFINOR
      EE=FINORD(LQ,1,K)*E
      FINORD(LQ,J,K)=E2+EE
      FINX2(LQ,J,K)=E2-EE
360   FINX3(LQ,J,K)=FINORG(LQ,J,1)+E*XFIN(LQ,K)
370   CONTINUE
380   WRITE (9) BLOCK
C
C     CANARDS (HORIZONTAL TAILS)
C
      IF (J5.EQ.0) GO TO 460
      N=IABS(NCANOR)
      DO 420 NN=1,NCAN
```

```
      READ (5,470) ABCD
      DECODE (56,480,ABCD) ((CANORG(NN,I,J),J=1,4),I=1,2)
      READ (5,470) ABCD
      DECODE (70,480,ABCD) (XCAN(NN,I),I=1,N)
      READ (5,470) ABCD
      DECODE (70,480,ABCD) (CANORD(NN,1,J),J=1,N)
C
C     NCANOR POSITIVE INDICATES SYMMETRICAL ORDINATES
C     NCANOR NEGATIVE INDICATES UPPER AND LOWER ORDINATES ARE GIVEN
C
      IF (NCANOR.LT.0) GO TO 400
      DO 390 J=1,N
      CANCR(NN,J)=0.
      CANOR(NN,J)=CANORD(NN,1,J)
390   CANOR1(NN,1,J)=CANORD(NN,1,J)
      GO TO 420
400   READ (5,470) ABCD
      DECODE (70,480,ABCD) (CANOR1(NN,1,J),J=1,N)
      DO 410 J=1,N
      CANOR(NN,J)=(CANORD(NN,1,J)+CANOR1(NN,1,J))/2.
410   CANCR(NN,J)=(CANORD(NN,1,J)-CANOR1(NN,1,J))/2.
420   CONTINUE
C
C     CHANGE CANARD TO ACTUAL UNITS
C
      DO 450 NN=1,NCAN
      DO 440 K=1,2
      I=3-K
      E=.01*CANORG(NN,I,4)
      E3=CANORG(NN,I,3)
      DO 430 J=1,N
      CANORD(NN,I,J)=E*CANORD(NN,1,J)+E3
      CANOR1(NN,I,J)=-E*CANOR1(NN,1,J)+E3
430   CANORX(NN,I,J)=CANORG(NN,I,1)+E*XCAN(NN,J)
440   CONTINUE
450   CONTINUE
460   WRITE (9) BLOCK
C
      REWIND 9
      RETURN
C
C
470   FORMAT (8A10)
```

```
480   FORMAT (10F7.0)                                          J3010
      END                                                      J3020-
```

```
      OVERLAY(LWB,1,2)
      PROGRAM NEWORD
C
C     REVISE CHORDWISE PANEL SPACING ON WING AND COMPUTE NEW AIRFOIL
C     ORDINATES
C
      COMMCN ABC(8),J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,DUM(51)
      COMMCN /NEWCOM/ K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KRAD,MAX
      COMMCN /COEF/ C(4,50),CC(4,50)
      COMMCN /SCRAT/ BLOCK(7500)
C
      DIMENSION XAF(30), WAFORG(20,4), WAFORD(20,3,30), TZORD(20,30), TZ
     1ORK(20,30), WAFORK(20,30), DZCDX(20,30), DZTDX(20,30), DZCDXK(20,3
     20), WAFOR(20,30), DZTDXK(20,30), TORD(30), ZORD(30), DZC(30), DZT(
     330), RHO(20), A(20), B(20), R(20), XAT(30), XAFK(30)
C
      EQUIVALENCE (BLOCK,XAF), (BLOCK(31),WAFORG), (BLOCK(111),WAFORD),
     1(BLOCK(1911),TZORD), (BLOCK(2511),WAFOR), (BLOCK(3111),TZORK), (BL
     2OCK(3711),WAFORK), (BLOCK(4311),DZCDX), (BLOCK(4911),DZCDXK), (BLO
     3CK(5511),DZTDXK), (BLOCK(6111),XAFK), (BLOCK(6141),RHO), (BLOCK(61
     461),A), (BLOCK(6181),B), (BLOCK(6201),R), (BLOCK(6221),TORD), (BLO
     5CK(6251),ZORD), (BLOCK(6281),DZC), (BLOCK(6311),DZT), (BLOCK(6341)
     6,XAT), (BLOCK(6901),DZTDX)
C
      SLOP1(I,XI,C)=C(2,I)+XI*(2.*C(3,I)+3.*XI*C(4,I))
      SLOP2(I,XI,CC)=CC(2,I)+XI*(2.*CC(3,I)+3.*XI*CC(4,I))
      VALU1(I,XI,C)=C(1,I)+XI*(C(2,I)+XI*(C(3,I)+XI*C(4,I)))
      VALU2(I,XI,CC)=CC(1,I)+XI*(CC(2,I)+XI*(CC(3,I)+XI*CC(4,I)))
C
      IF (K1.EQ.3) READ (5,220) (RHO(N),N=1,NWAF)
      IF (KWAFOR.EQ.0) GO TO 10
      READ (5,220) (XAFK(K),K=1,KWAFOR)
      GO TO 30
10    KWAFCR=NWAFOR
      DO 20 K=1,NWAFOR
20    XAFK(K)=XAF(K)
30    CONTINUE
      NWAR=NWAFOR-1
C
C     CALCULATE CAMBER AND THICKNESS SLOPES
C
      DO 210 N=1,NWAF
```

```
      NDA=-1
      DA=0.
      DO 40 L=1,NWAFOR
      ZORD(L)=TZORD(N,L)
40    TORD(L)=WAFOR(N,L)
C
C     J1 = -1 INDICATES UNCAMBERED WING
C
      IF (J1.LT.0) GO TO 60
      CALL DERIV (XAF,ZORD,NWAFOR,NDA,DA,DZC)
      DO 50 L=1,NWAR
      DO 50 M=1,4
50    CC(M,L)=C(M,L)
      GO TO 80
60    DO 70 L=1,NWAR
      DZC(L)=0.
      DO 70 M=1,4
70    CC(M,L)=0.
80    NWA=NWAFOR
      IF (K1.LT.3) GO TO 100
C
C     CALCULATE INITIAL SLOPE FOR ROUND LEADING EDGE
C
      NWA=NWAR
      NDA=0
      R(N)=SQRT(2.*RHO(N))
      SAF2=SQRT(XAF(2))
      SAF3=SQRT(XAF(3))
      CON2=TORD(2)/XAF(2)-R(N)/SAF2
      CON3=TORD(3)/XAF(3)-R(N)/SAF3
      DX=XAF(3)-XAF(2)
      A(N)=(CON2*XAF(3)-CON3*XAF(2))/DX
      B(N)=(CCN3-CON2)/DX
      DA=R(N)/(2.*SAF2)+A(N)+2.*B(N)*XAF(2)
      DO 90 L=1,NWAR
      XAT(L)=XAF(L+1)
90    TORD(L)=TORD(L+1)
      GO TO 120
100   DO 110 L=1,NWA
110   XAT(L)=XAF(L)
120   CALL DERIV (XAT,TORD,NWA,NDA,DA,DZT)
      DO 130 L=1,NWAFOR
      DZCDX(N,L)=DZC(L)
```

```
130   DZTDX(N,L)=DZT(L)
      IF (K1.LT.3) GO TO 150
      DZTDX(N,1)=900.
      DO 140 L=2,NWAFOR
140   DZTDX(N,L)=DZT(L-1)
150   CONTINUE
      IF (KWAFOR.EQ.0) GO TO 210
C
C     INTERPOLATE FOR REVISEC CAMBER AND THICKNESS ORDINATES AND SLOPES
C
      TZORK(N,1)=TZORD(N,1)
      DZCDXK(N,1)=DZCDX(N,1)
      WAFORK(N,1)=WAFOR(N,1)
      DZTDXK(N,1)=DZTDX(N,1)
      KI=2
      DO 200 J=1,NWAR
      DO 180 K=KI,KWAFOR
      IF (XAFK(K).GT.XAF(J+1)) GO TO 190
      XJ=XAFK(K)
      TZCRK(N,K)=VALU2(J,XJ,CC)
      DZCDXK(N,K)=SLOP2(J,XJ,CC)
      L=J
      XL=XJ
      IF (K1.LT.3) GO TO 170
      IF (J.GT.1) GO TO 160
      SXJ=SQRT(XJ)
      DZTDXK(N,K)=R(N)/(2.*SXJ)+A(N)+2.*B(N)*XJ
      WAFORK(N,K)=R(N)*SXJ+XJ*(A(N)+B(N)*XJ)
      GO TO 180
160   XL=XJ-XAF(1)
      L=J-1
170   WAFORK(N,K)=VALU1(L,XL,C)
      DZTDXK(N,K)=SLOP1(L,XL,C)
180   CONTINUE
190   KI=K
200   CONTINUE
210   CONTINUE
      RETURN
C
C
220   FORMAT (10F7.0)
      END
```

```
      OVERLAY(LWB,1,3)
      PROGRAM WNGPAN
C
C     REVISE SPANWISE PANEL SPACING ON WING AND COMPUTE NEW PANEL
C     GEOMETRY
C
      COMMON ABC(8),J0,JL,J2,J3,J4,J5,J6,NWAF,NWAFOR,DUM(51)
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMON /NEWCOM/ KL,KWAF,KWAFOR,KRADX(4),KFORX(4),KRAD,MAX,KK(26),K
     1OL,NCPT,LOCPT,XCPT
      COMMON /SEG/ NSEG,NROW(20),NCOL(20),COSS(20),SINS(20),BTE(20),NWT(
     120),SPNW(20),XLEW(20),BLE(20),ZLEW(20),XS(20),YS(20),ZS(20)
      COMMON /SCRAT/ BLOCK(7500)
      COMMON /POINT/ ARRAY(6000)
      COMMON /VELCOM/ DUM1(6),PRINT,DUM2(53)
C
      DIMENSION XPT(600), YPT(600), ZPT(600), THET(600), DELTA(600), XC(
     130,20), YC(30,20), ZC(30,20), ZU(30,20), AREA(600), XE(600), XAF(3
     20), WAFORG(20,4), WAFORD(20,3,30), TZORK(20,30), WAFORK(20,30), DZ
     3CDX(20,30), DZTDX(20,30), DZCDXK(20,30), DZTDXK(20,30), SLOPE(600)
     4, XAFK(30), XK(20), YK(20), ZK(20), CK(20), CD(20), BL(20), TH(20)
     5, BT(20), CHORD(600)
C
      EQUIVALENCE (BLOCK,XAF), (BLOCK(31),WAFORG), (BLOCK(111),WAFORD),
     1(BLOCK(2511),DZTDX), (BLOCK(3111),TZORK), (BLOCK(3711),WAFORK), (B
     2LOCK(4311),DZCDX), (BLOCK(4911),DZCDXK), (BLOCK(5511),DZTDXK), (BL
     3OCK(6111),XAFK), (BLOCK(6141),XK), (BLOCK(6161),YK), (BLOCK(6181),
     4ZK), (BLOCK(6201),CK), (BLOCK(6221),BL), (BLOCK(6261),TH), (BLOCK(
     56281),BT), (BLOCK(6301),CHORD), (BLOCK(6901),SLOPE,ZU), (ARRAY,XPT
     6), (ARRAY(601),YPT), (ARRAY(1201),ZPT), (ARRAY(1801),THET), (ARRAY
     7(2401),DELTA), (ARRAY(3001),XC), (ARRAY(3601),YC), (ARRAY(4201),ZC
     8), (ARRAY(4801),AREA), (ARRAY(5401),XE)
C
      LOGICAL LBC,THK
      INTEGER PRINT
C
      XIN(X1,Y1,X2,Y2,Y)=X1+(X2-X1)*(Y-Y1)/(Y2-Y1)
C
      EPS=1.0E-6
      IF (KWAF.EQ.0) GO TO 10
C
C     READ INTERMEDIATE SPAN STATIONS
```

```
C                                                              L 430
      READ (5,280) (YK(K),K=1,KWAF)                            L 440
      GO TO 30                                                 L 450
10    KWAF=NWAF                                                L 460
      DO 20 K=1,KWAF                                           L 470
20    YK(K)=WAFORG(K,2)                                        L 480
30    CONTINUE                                                 L 490
      KU=2                                                     L 500
      KOL=KWAF                                                 L 510
      KI=1                                                     L 520
      NI=1                                                     L 530
      NW1=NWAF-1                                               L 540
      NSEG=1                                                   L 550
      NC=0                                                     L 560
      NJ=0                                                     L 570
      NP=0                                                     L 580
      IF (PRINT.GE.0) GO TO 40                                 L 590
      WRITE (6,290)                                            L 600
      WRITE (6,300)                                            L 610
40    DO 220 N=1,NW1                                           L 620
C                                                              L 640
C     CALCULATE WING SEGMENTS                                  L 650
C                                                              L 660
      M=N+1                                                    L 630
      DELY=WAFORG(N+1,2)-WAFORG(N,2)                           L 670
      IF (DELY.EQ.0.) GO TO 210                                L 680
      DELX=WAFORG(N+1,1)-WAFORG(N,1)                           L 690
      DELZ=WAFORG(N+1,3)-WAFORG(N,3)                           L 700
      DELC=WAFORG(N+1,4)-WAFORG(N,4)                           L 710
      DELYD=1./DELY                                            L 720
      BL(N)=DELX*DELYD                                         L 730
      BT(N)=(DELX+DELC)*DELYD                                  L 740
      TH(N)=ATAN2(DELZ,DELY)                                   L 750
      IF (N.EQ.1) GO TC 60                                     L 760
      IF (BL(N).NE.BL(N-1)) GO TO 50                           L 770
      IF (BT(N).NE.BT(N-1)) GO TO 50                           L 780
      IF (TH(N).NE.TH(N-1)) GO TO 50                           L 790
      GO TO 70                                                 L 800
50    NSEG=NSEG+1                                              L 810
60    CONTINUE                                                 L 820
      SINS(NSEG)=SIN(TH(N))                                    L 830
      COSS(NSEG)=COS(TH(N))                                    L 840
      BLE(NSEG)=BL(N)                                          L 850
```

```
      BTE(NSEG)=BT(N)
      NWT(NSEG)=0
70    CONTINUE
      DO 80 K=KC,KWAF
      IF (YK(K).GE.WAFORG(M,2)) GO TO 90
80    CONTINUE
90    KO=K
C
C     CALCULATE ORIGINS OF INTERMEDIATE CHORDS
C
      DO 200 K=KI,KO
      XK(K)=XIN(WAFORG(NI,1),WAFORG(NI,2),WAFORG(M,1),WAFORG(M,2),YK(K))
      ZK(K)=XIN(WAFORG(NI,3),WAFORG(NI,2),WAFORG(M,3),WAFORG(M,2),YK(K))
      CK(K)=XIN(WAFORG(NI,4),WAFORG(NI,2),WAFORG(M,4),WAFORG(M,2),YK(K))
      CL=CK(K)/100.
      L=1
      SJ=1.0
100   CONTINUE
C
C     CALCULATE COORDINATES OF PANEL CORNERS
C
      DO 150 J=1,KWAFOR
      XC(J,K)=XK(K)+CL*XAFK(J)
      YC(J,K)=YK(K)
      ZC(J,K)=ZK(K)
      IF (LBC) GO TO 110
      ZCAM=XIN(TZORK(NI,J),WAFORG(NI,2),TZORK(M,J),WAFORG(M,2),YK(K))
      ZTHK=XIN(WAFORK(NI,J),WAFORG(NI,2),WAFORK(M,J),WAFORG(M,2),YK(K))
      ZC(J,K)=ZK(K)+CL*(ZCAM+SJ*ZTHK)
      IF (L.EQ.1) ZU(J,K)=ZC(J,K)
110   IF (K.EQ.KI) GO TO 150
      K1=K-1
      NJ=NJ+1
      IF (J.EQ.1) GO TO 150
      J1=J-1
      NC=NC+1
      NP=NP+1
      IP=1
      IF (SJ.LT.0.) IP=0
      IQ=0
C
C     CALCULATE PANEL INCLINATIONS AND CENTROIDS ON WING SURFACE
C
```

```
      IF (.NOT.LBC) CALL PANEL (IP,IQ,J,K,L,NP,AP)
      AREA(NP)=AP
      CHORD(NP)=0.
      IF (PRINT.GE.0) GO TO 130
      IF (.NOT.LBC.AND.L.EQ.1) GO TO 120
      WRITE (6,310) NP,XC(J1,K1),YK(K1),ZC(J1,K1),XC(J,K1),YK(K1),ZC(J,K
     11),XC(J1,K),YK(K),ZC(J1,K),XC(J,K),YK(K),ZC(J,K)
      GO TO 130
  120 WRITE (6,310) NP,XC(J1,K1),YK(K1),ZU(J1,K1),XC(J,K1),YK(K1),ZU(J,K
     11),XC(J1,K),YK(K),ZU(J1,K),XC(J,K),YK(K),ZU(J,K)
  130 CONTINUE
C
C     CALCULATE PANEL CONTROL POINTS IN PLANE OF WING
C
      CR=XC(J,K1)-XC(J1,K1)
      CT=XC(J,K)-XC(J1,K)
      RI=(1.+CT/(CR+CT))/3.
      RO=1.-RI
      XLE=RI*XC(J1,K)+RO*XC(J1,K1)
      XTE=RI*XC(J,K)+RO*XC(J,K1)
      CHORD(NP)=XTE-XLE
      SPN=SQRT((YK(K)-YK(K1))*(YK(K)-YK(K1))+(ZK(K)-ZK(K1))*(ZK(K)-ZK(K1
     1)))
      SPNW(K1)=SPN
      IF (J.EQ.2) XLEW(K1)=XLE
      YLE=RI*YK(K)+RO*YK(K1)
      ZLE=RI*ZK(K)+RO*ZK(K1)
      IF (J.EQ.2) ZLEW(K1)=ZLE
      IF (LBC) GO TO 140
      IF (L.EQ.1.AND.J.EQ.KWAFOR) ZTU=ZPT(NP)
      IF (L.EQ.1.OR.J.NE.KWAFOR) GO TO 150
      XS(K1)=XPT(NP)
      YS(K1)=YPT(NP)
      ZS(K1)=(ZPT(NP)+ZTU)*.5
      XS(K1)=XTE
      YS(K1)=YLE
      ZTU=RI*ZU(J,K)+RO*ZU(J,K1)
      ZTL=RI*ZC(J,K)+RO*ZC(J,K1)
      ZS(K1)=(ZTU+ZTL)/2.
      GO TO 150
  140 CONTINUE
      XPT(NC)=XLE
      XE(NC)=XPT(NC)
```

```
      YPT(NC)=YLE
      ZPT(NC)=ZLE
C
C     CALCULATE PANEL AREAS, CHORDS, AND INCLINATION ANGLES
C
      AREA(NP)=.5*SPN*(CR+CT)
      THET(NC)=TH(N)
C
C     INTERPOLATE FOR WING CAMBER AND THICKNESS AT PANEL TRAILING EDGES
C
      DZCDX(K1,J)=XIN(DZCDXK(NI,J),WAFORG(NI,2),DZCDXK(M,J),WAFCRG(M,2),
     1YPT(NP))
      IF (J.EQ.2) DZCDX(K1,1)=XIN(DZCDXK(NI,1),WAFORG(NI,2),DZCDXK(M,1),
     1WAFORG(M,2),YPT(NP))
      DZTDX(K1,J)=XIN(DZTDXK(NI,J),WAFORG(NI,2),DZTDXK(M,J),WAFORG(M,2),
     1YPT(NP))
      SLOPE(NJ)=DZTDX(K1,J)
      DELTA(NC)=DZCDX(K1,J1)
      IF (J.NE.KWAFOR) GO TO 150
      NC=NC+1
      XPT(NC)=XTE-EPS
      XE(NC)=XPT(NC)
      YPT(NC)=YPT(NC-1)
      ZPT(NC)=ZPT(NC-1)
      ZTE=0.
      DELTA(NC)=DZCDX(K1,J)
      THET(NC)=TH(N)
150   CONTINUE
      IF (LBC) GO TO 160
      IF (SJ.LT.0.) GO TO 160
      SJ=-1.0
      L=2
      GO TO 100
160   CONTINUE
      IF (K.EQ.KI) GO TO 200
      IF (.NOT.LBC) GO TO 200
      IF (KL.EQ.3) GO TO 170
C
C     CALCULATE INITIAL SLOPE FOR SHARP LEADING EDGE AIRFOILS
C
      DZTDX(K1,1)=XIN(DZTDXK(NI,1),WAFORG(NI,2),DZTDXK(M,1),WAFORG(M,2),
     1YPT(NP))
      GO TO 190
```

```
C
C      CALCULATE INITIAL SLOPE FOR ROUND LEADING EDGE AIRFOILS
C
170    NPJ=NP-J1
       SLE=-DZTDX(K1,2)
       DO 180 I=2,J1
180    SLE=SLE-(DZTDX(K1,I)+DZTDX(K1,I+1))*CHORD(NPJ+I)/CHORD(NPJ+1)
       DZTDX(K1,1)=SLE
190    NJJ=NJ-J1
       SLOPE(NJJ)=DZTDX(K1,1)
200    CONTINUE
C
C      COMPUTE NUMBER OF ROWS AND COLUMNS IN EACH WING SEGMENT
C
       NROW(NSEG)=J1
       NCOL(NSEG)=KO-KI
       NCPT=NC
       IF (NCPT.GT.600) GO TO 260
       NWING=NP
       NI=M
       KI=KO
       GO TO 220
210    KO=KO+1
       NI=NI+1
       BL(N)=0.
       BT(N)=0.
       TH(N)=0.
220    CONTINUE
       IF (PRINT.GE.0) GO TO 250
       WRITE (6,320)
       IF (LBC) WRITE (6,330)
       IF (.NOT.LBC) WRITE (6,340)
       DO 230 NP=1,NCPT
       IF (LBC) WRITE (6,350) NP,XPT(NP),YPT(NP),ZPT(NP),THET(NP),DELTA(N
      1P),SLOPE(NP)
       IF (.NOT.LBC) WRITE (6,350) NP,XPT(NP),YPT(NP),ZPT(NP),THET(NP),DE
      1LTA(NP)
230    CONTINUE
       WRITE (6,380)
       WRITE (6,360)
       DO 240 NP=1,NWING
240    WRITE (6,370) NP,AREA(NP),CHORD(NP)
250    CONTINUE
```

```
C
C     STORE WING GEOMETRY ON TAPE 7
C
      WRITE (7) ARRAY,CHORD,SLOPE
      GO TO 270
260   WRITE (6,390)
      CALL EXIT
270   RETURN
C
C
280   FORMAT (10F7.0)
290   FORMAT (1H1,9X,35HWING PANEL CORNER POINT COORDINATES/10X,86H1 AND
     1 3 INDICATE WING PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE TRAIL
     2ING-EDGE POINTS)
300   FORMAT (1H0,5X,5HPANEL,4(8X,1HX,8X,1HY,8X,1HZ)/20X,3(1H1,8X),3(1H2
     1,8X),3(1H3,8X),3(1H4,8X)//)
310   FORMAT (1H ,4X,I3,4X,12F9.5)
320   FORMAT (1H1,1X,48HWING PANEL CONTROL POINTS AND INCLINATION ANGLES
     1)
330   FORMAT (1H0,5HPOINT,8X,1HX,10X,1HY,10X,1HZ,10X,5HTHETA,6X,6HCAMBER
     1,5X,9HTHICKNESS/15X,3(2HCP,9X),10X,5HSLOPE,8X,5HSLOPE//)
340   FORMAT (1H0,5HPOINT,8X,1HX,10X,1HY,10X,1HZ,10X,5HTHETA,6X,5HDELTA/
     115X,3(2HCP,9X)//)
350   FORMAT (1H ,1X,I3,4X,6F11.5)
360   FORMAT (1H0,5HPANEL,6X,4HAREA,8X,5HCHORD)
370   FORMAT (1H ,1X,I3,4X,2F11.5)
380   FORMAT (1H1,9X,27HWING PANEL AREAS AND CHORDS)
390   FORMAT (51H  ERROR - NUMBER OF WING CONTROL POINTS EXCEEDS 600)
      END
```

```
      OVERLAY(LWB,1,4)
      PROGRAM NEWRAD
C
C     REVISE BODY (FUSELAGE) MERIDIAN LINE SPACING
C
      COMMON ABC(8),J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,NRADX(4),NFORX
     1(4),DUD(6),J2TEST,DUM(35)
      COMMON /NEWCOM/ KL,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX
      COMMCN /SCRAT/ BLOCK(7500)
      COMMCN /POINT/ ARRAY(4800)
C
      DIMENSION XFUS(30,4), ZFUS(30,4), FUSARD(30,4), FUSRAD(30,4), SFUS
     1(30,30,8), ANSIN(30), ANCOS(30), PHIN(30), PHIK(30), XB(30), YB(30
     2,30), ZB(30,30), YF(30), ZF(30)
C
      EQUIVALENCE (BLOCK,XFUS), (BLOCK(121),ZFUS), (BLOCK(241),FUSARD),
     1(BLOCK(361),FUSRAD), (BLOCK(241),SFUS), (ARRAY,YB), (ARRAY(1801),Z
     2B), (ARRAY(3601),XB), (ARRAY(3661),ANSIN), (ARRAY(3691),ANCOS), (A
     3RRAY(3721),PHIN), (ARRAY(3751),PHIK)
C
      LOGICAL NEWPHI
C
      XIN(X1,Y1,X2,Y2,Y)=X1+(X2-X1)*(Y-Y1)/(Y2-Y1)
C
      NEWPHI=.FALSE.
      M=1
      KFUS=NFUS
      KTEST=0
      RADD=1./57.2957795
      REWIND 10
      DO 110 NFU=1,NFUS
      NRAD=NRADX(NFU)
      KRAD=KRADX(NFU)
C
C     J2TEST IS SET IN PROGRAM CONFIG
C
C     J2TEST = 3 AND KRAD = 0 INDICATE AN ARBITRARY FUSELAGE WITH
C     MERIDIAN LINES DEFINED BY NRAD IN THE GEOMETRY INPUT
C
      IF (J2TEST.EQ.3.AND.KRAD.EQ.0) KTEST=1
      IF (KRAD.EQ.0.) KRAD=NRAD
      IF (KRAD.GT.20) GO TO 130
```

```
      IF (KRAD.LT.0) NEWPHI=.TRUE.
      KRAD=IABS(KRAD)
      KRADX(NFU)=KRAD
      NFUSOR=NFORX(NFU)
      FANG=FLOAT(2*(KRAD-1))
      DELE=6.2831853/FANG
C
C     READ NEW MERIDIAN ANGLES
C
      IF (NEWPHI) READ (5,160) (PHIK(K),K=1,KRAD)
      DO 30 K=1,KRAD
      E=FLOAT(K-1)
      IF (NEWPHI) GO TO 10
      PHIR=E*DELE
      GO TO 20
10    PHIR=PHIK(K)*RADD
20    PHIK(K)=PHIR
C
C     J2TEST = 3 INDICATES ARBITRARY FUSELAGE
C
      IF (J2TEST.EQ.3) GO TO 30
      PHIR4=PHIR+4.712389
      ANSIN(K)=SIN(PHIR4)
      ANCOS(K)=COS(PHIR4)
30    CONTINUE
      KK=1+(NFU-1)*2
      NF=NFU
      K2=KK+1
      DO 100 N=1,NFUSOR
      IF (N.GT.1) M=M+1
      IF (M.GT.60) GO TO 120
      XB(N)=XFUS(N,NF)
C
C     J2TEST = 3 INDICATES ARBITRARY FUSELAGE
C
      IF (J2TEST.EQ.3) GO TO 50
      RAD=FUSRAD(N,NF)
      CAM=ZFUS(N,NF)
C
C     COMPUTE SECTION Y AND Z COORDINATES FOR CIRCULAR BODY (FUSELAGE)
C
      DO 40 K=1,KRAD
      YB(N,K)=RAD*ANCOS(K)
```

```
40    ZB(N,K)=RAD*ANSIN(K)+CAM
      GO TO 100
50    CONTINUE
C
C     COMPUTE SECTION Y AND Z ORDINATES FOR NONCIRCULAR BODY (FUSELAGE)
C     BY LINEAR INTERPOLATION
C
      KI=2
      PHIN(1)=0.
      YB(N,1)=SFUS(1,N,KK)
      ZB(N,1)=SFUS(1,N,K2)
      YF(1)=YB(N,1)
      ZF(1)=ZB(N,1)
      ZC=(SFUS(1,N,K2)+SFUS(NRAD,N,K2))/2.
      DO 90 NN=2,NRAD
      IF (KTEST.EQ.1) GO TO 80
      YF(NN)=SFUS(NN,N,KK)
      ZF(NN)=SFUS(NN,N,K2)-ZC
      N1=NN-1
      IF (YF(NN).EQ.0..AND.ZF(NN).EQ.0.) GO TO 80
      PHIN(NN)=ATAN2(YF(NN),-ZF(NN))
      DO 60 K=KI,KRAD
      IF (PHIK(K).GT.PHIN(NN)) GO TO 70
      YB(N,K)=XIN(YF(N1),PHIN(N1),YF(NN),PHIN(NN),PHIK(K))
      ZB(N,K)=XIN(ZF(N1),PHIN(N1),ZF(NN),PHIN(NN),PHIK(K))+ZC
60    CONTINUE
70    KI=K
      GO TO 90
80    YB(N,NN)=SFUS(NN,N,KK)
      ZB(N,NN)=SFUS(NN,N,K2)
90    CONTINUE
100   CONTINUE
      MAX=M
      WRITE (10) XB,YB,ZB
110   CONTINUE
      GO TO 150
120   WRITE (6,180)
      GO TO 140
130   WRITE (6,170)
140   CALL EXIT
150   RETURN
C
C
```

```
160   FORMAT (10F7.0)                                                    M1290
170   FORMAT (1H ,39HERROR - BODY HAS MORE THAN 20 MERIDIANS)            M1300
180   FORMAT (1H ,44HERROR - BODY HAS MORE THAN 60 AXIAL STATIONS)       M1310
      END                                                                M1320-
```

```
      OVERLAY(LWB,1,5)
      PROGRAM BODPAN
C
C     REVISE AXIAL SPACING ON BODY (FUSELAGE) AND COMPUTE NEW PANEL
C     GEOMETRY
C
      COMMCN DUM(17),NFUS,NRADX(4),NFORX(4),DUD(42)
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMCN /NEWCOM/ KL,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX
      COMMON /SCRAT/ BLOCK(7500)
      COMMCN /POINT/ ARRAY(6000)
      COMMON /BTHET/ THETA(600)
      COMMON /VELCOM/ DUM1(6),PRINT,DUM2(53)
C
      DIMENSION XB(30), YB(30,30), ZB(30,30), XJ(60), AREA(600), XPT(600
     1), YPT(600), ZPT(600), THET(600), DELTA(600), XC(30,20), YC(30,20)
     2, ZC(30,20), XFUS(30,4)
C
      EQUIVALENCE (BLOCK,XFUS), (BLOCK(121),YB), (BLOCK(1921),ZB), (BLOC
     1K(3721),XB), (ARRAY,XPT), (ARRAY(601),YPT), (ARRAY(1201),ZPT), (AR
     2RAY(1801),THET), (ARRAY(2401),DELTA), (ARRAY(3001),XC), (ARRAY(360
     31),YC), (ARRAY(4201),ZC), (ARRAY(4801),AREA)
      INTEGER PRINT
C
      XIN(X1,Y1,X2,Y2,Y)=X1+(X2-X1)*(Y-Y1)/(Y2-Y1)
C
      REWIND 10
      IF (PRINT.GE.0) GO TO 10
      WRITE (6,180)
      WRITE (6,190)
10    CONTINUE
C
C     CALCULATE COORDINATES OF PANEL CORNERS
C
      IP=0
      IQ=0
      J=1
      L=0
      NP=0
      DO 100 NFU=1,NFUS
      JMAX=KFORX(NFU)
      NFUSOR=NFORX(NFU)
```

```
      KRAD=KRADX(NFU)
      KRAD=IABS(KRAD)
      IF (KRAD.EQ.0) KRAD=NRADX(NFU)
      READ (10) XB,YB,ZB
      IF (JMAX.EQ.0) GO TO 20
C
C     READ IN NEW AXIAL STATIONS FOR BODY (FUSELAGE)
C
      READ (5,170) (XJ(K),K=1,JMAX)
      GO TO 40
20    JMAX=NFORX(NFU)
      KFORX(NFU)=JMAX
      DO 30 K=1,JMAX
30    XJ(K)=XFUS(K,NFU)
40    CONTINUE
      DO 50 K=1,KRAD
      XC(J,K)=XB(1)
      YC(J,K)=YB(1,K)
50    ZC(J,K)=ZB(1,K)
      DO 90 JJ=2,JMAX
      J1=J
      J=J+1
      DO 80 M=2,NFUSOR
      M1=M-1
      IF (XB(M).LT.XJ(JJ)) GO TO 80
      DO 70 K=1,KRAD
      XC(J,K)=XJ(JJ)
      YC(J,K)=XIN(YB(M1,K),XB(M1),YB(M,K),XB(M),XJ(JJ))
      ZC(J,K)=XIN(ZB(M1,K),XB(M1),ZB(M,K),XB(M),XJ(JJ))
      IF (K.EQ.1) GO TO 70
      K1=K-1
      NP=NP+1
C
C     CALCULATE PANEL INCLINATION AND CENTROID
C
      CALL PANEL (IP,IQ,J,K,L,NP,AP)
C
      IF (PRINT.GE.0) GO TO 60
      WRITE (6,200) NP,XC(J1,K1),YC(J1,K1),ZC(J1,K1),XC(J,K1),YC(J,K1),Z
     1C(J,K1),XC(J1,K),YC(J1,K),ZC(J1,K),XC(J,K),YC(J,K),ZC(J,K)
60    AREA(NP)=AP
70    CONTINUE
      GO TO 90
```

```
80    CONTINUE                                                            N 860
90    CONTINUE                                                            N 870
100   CONTINUE                                                            N 880
      NBODY=NP                                                            N 890
      IF (NBODY.GT.600) GO TO 150                                         N 900
      IF (PRINT.GE.0) GO TO 130                                           N 910
      WRITE (6,210)                                                       N 920
      WRITE (6,220)                                                       N 930
      DO 110 NP=1,NBODY                                                   N 940
      WRITE (6,230) NP,XPT(NP),YPT(NP),ZPT(NP)                            N 950
110   CONTINUE                                                            N 960
      WRITE (6,240)                                                       N 970
      WRITE (6,250)                                                       N 980
      DO 120 NP=1,NBODY                                                   N 990
120   WRITE (6,230) NP,AREA(NP),DELTA(NP),THET(NP)                        N1000
130   CONTINUE                                                            N1010
      DO 140 NP=1,NBODY                                                   N1020
C                                                                         N1040
C     STORE BODY GEOMETRY ON TAPE 7                                       N1050
C                                                                         N1060
140   THETA(NP)=THET(NP)                                                  N1030
      WRITE (7) ARRAY                                                     N1070
      REWIND 10                                                           N1080
      GO TO 160                                                           N1090
150   WRITE (6,260)                                                       N1100
      CALL EXIT                                                           N1110
160   RETURN                                                              N1120
C                                                                         N1130
C                                                                         N1140
170   FORMAT (10F7.0)                                                     N1150
180   FORMAT (1H1,9X,35HBODY PANEL CORNER POINT COORDINATES/10X,86H1 AND  N1160
     1 3 INDICATE BODY PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE TRAIL  N1170
     2ING-EDGE POINTS)                                                    N1180
190   FORMAT (1H0,5X,5HPANEL,4(8X,1HX,8X,1HY,8X,1HZ)/20X,3(1H1,8X),3(1H2  N1190
     1,8X),3(1H3,8X),3(1H4,8X)//)                                         N1200
200   FORMAT (1H ,4X,I3,4X,12F9.5)                                        N1210
210   FORMAT (1H1,1X,36HBODY PANEL CONTROL POINT COORDINATES)             N1220
220   FORMAT (1H0,5HPOINT,6X,1HX,10X,1HY,10X,1HZ/15X,3(2HCP,9X)//)        N1230
230   FORMAT (1H ,1X,I3,4X,3F11.5)                                        N1240
240   FORMAT (1H1,4X,39HBODY PANEL AREAS AND INCLINATION ANGLES)          N1250
250   FORMAT (1H0,5HPANEL,6X,4HAREA,7X,5HDELTA,6X,5HTHETA//)              N1260
260   FORMAT (43H  ERROR - NUMBER OF BODY PANELS EXCEEDS 600)             N1270
      END                                                                 N1280-
```

```
      OVERLAY(LWB,1,6)
      PROGRAM NUTORD
C
C     REVISE CHORDWISE PANEL SPACING ON FIN (VERTICAL TAIL) OR CANARD
C     (HORIZONTAL TAIL) AND COMPUTE NEW AIRFOIL ORDINATES
C
      COMMON ABC(8),J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,DUNW(11),NF,NFINOR,
     1NC,NCANOR,DUM(36)
      COMMON /NEWCOM/ K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KRAD,MAX,K4,K5,KF
     1(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT,XCPT
      COMMCN /COEF/ C(4,50),CC(4,50)
      COMMON /SCRAT/ BLOCK(7500)
C
      DIMENSION TALORG(6,2,4), XT(6,10), TALORD(6,2,10), TALCR(6,10), TA
     1LOR(6,10), TORD(30), ZORD(30), DZC(30), DZT(30), XAF(30), TZORK(20
     2,30), WAFORK(20,30), DZCDX(20,30), DZTDX(20,30), DZCDXK(20,30), WA
     3FOR(20,30), DZTDXK(20,30), RHO(20), A(20), B(20), R(20), XAT(30),
     4XAFK(6,30)
C
      EQUIVALENCE (BLOCK,TALORG), (BLOCK(49),XT), (BLOCK(109),TALORD), (
     1BLOCK(469),TALOR), (BLOCK(529),TALCR), (BLOCK(589),WAFOR), (BLOCK(
     23111),TZORK), (BLOCK(3711),WAFORK), (BLOCK(4311),DZCDX), (BLOCK(49
     311),DZCDXK), (BLOCK(5511),DZTDXK), (BLOCK(6111),XAFK), (BLOCK(1189
     4),DZC), (BLOCK(1219),DZT), (BLOCK(1249),XAT), (BLOCK(1279),RHO), (
     5BLOCK(1299),R), (BLOCK(1309),A), (BLOCK(1329),B), (BLOCK(1349),TOR
     6D), (BLOCK(1379),ZORD), (BLOCK(2511),DZTDX)
C
      LOGICAL FIN
C
      SLOP1(I,XI,C)=C(2,I)+XI*(2.*C(3,I)+3.*XI*C(4,I))
      SLOP2(I,XI,CC)=CC(2,I)+XI*(2.*CC(3,I)+3.*XI*CC(4,I))
      VALU1(I,XI,C)=C(1,I)+XI*(C(2,I)+XI*(C(3,I)+XI*C(4,I)))
      VALU2(I,XI,CC)=CC(1,I)+XI*(CC(2,I)+XI*(CC(3,I)+XI*CC(4,I)))
C
C
C     NOTE THAT SOME WING VARIABLES ARE REDEFINED IN TERMS OF FIN OR
C     CANARD VARIABLES, THEREFORE CARE MUST BE EXERCISED IN FOLLOWING
C     THE LOGIC THROUGH THE TAIL SUBROUTINES. IN ESSENCE, THE PROGRAM
C     TREATS THE FINS AND CANARDS AS ADDITIONAL WING SEGMENTS.
C
C
      FIN=.FALSE.
```

```
      IF (K4.LE.0) GO TO 10
      FIN=.TRUE.
      NT=NF
      NWAFOR=NFINOR
      J1=-1
      JL=J4
      KL=K4
      GO TO 20
10    IF (K5.LE.0) RETURN
      NT=NC
      NWAFOR=IABS(NCANOR)
      J1=-1
C
C     NCANOR NEGATIVE INDICATES UPPER AND LOWER ORDINATES GIVEN
C
      IF (NCANOR.LT.0) J1=1
      JL=J5
      KL=K5
20    CONTINUE
      IF (KL.EQ.3) READ (5,240) (RHO(I),I=1,NT)
C
C     CALCULATE REVISED ORDINATES FOR EACH TAIL SEGMENT
C
      DO 230 N=1,NT
      KWAFOR=0
      IF (FIN.AND.KFINOR(N).GT.0) KWAFOR=KFINOR(N)
      IF (.NOT.FIN.AND.KANOR(N).GT.0) KWAFOR=KANOR(N)
      IF (KWAFOR.EQ.0) GO TO 30
      READ (5,240) (XAFK(N,K),K=1,KWAFOR)
      GO TO 50
30    KWAFOR=NWAFOR
      DO 40 K=1,NWAFOR
40    XAFK(N,K)=XT(N,K)
50    CONTINUE
      NWAR=NWAFOR-1
C
C     CALCULATE CAMBER AND THICKNESS SLOPES
C
      NDA=-1
      DA=0.
      DO 60 L=1,NWAFOR
      XAF(L)=XT(N,L)
      ZORD(L)=TALCR(N,L)
```

```
60    TORD(L)=TALOR(N,L)
      IF (J1.LT.0) GO TO 80
      CALL DERIV (XAF,ZORD,NWAFOR,NDA,DA,DZC)
      DO 70 L=1,NWAR
      DO 70 M=1,4
70    CC(M,L)=C(M,L)
      GO TO 100
80    DO 90 L=1,NWAR
      DZC(L)=0.
      DO 90 M=1,4
90    CC(M,L)=0.
      DZC(NWAFOR)=0.
100   NWA=NWAFOR
      IF (KL.LT.3.OR.RHO(N).EQ.0.) GO TO 120
C
C     CALCULATE INITIAL SLOPE FOR ROUND LEADING EDGE
C
      NWA=NWAR
      NDA=0
      R(N)=SQRT(2.*RHO(N))
      SAF2=SQRT(XAF(2))
      SAF3=SQRT(XAF(3))
      CON2=TORD(2)/XAF(2)-R(N)/SAF2
      CON3=TORD(3)/XAF(3)-R(N)/SAF3
      DX=XAF(3)-XAF(2)
      A(N)=(CON2*XAF(3)-CON3*XAF(2))/DX
      B(N)=(CON3-CON2)/DX
      DA=R(N)/(2.*SAF2)+A(N)+2.*B(N)*XAF(2)
      DO 110 L=1,NWAR
      XAT(L)=XAF(L+1)
110   TORD(L)=TORD(L+1)
      GO TO 140
120   DO 130 L=1,NWA
130   XAT(L)=XAF(L)
140   CALL DERIV (XAT,TORD,NWA,NDA,DA,DZT)
      DO 150 L=1,NWAFOR
      DZCDX(N,L)=DZC(L)
150   DZTDX(N,L)=DZT(L)
      IF (KL.LT.3.OR.RHO(N).EQ.0.) GO TO 170
      DZTDX(N,1)=900.
      DO 160 L=2,NWAFOR
160   DZTDX(N,L)=DZT(L-1)
170   CONTINUE
```

```
      IF (KWAFOR.EQ.0) GO TO 230
C
C     INTERPOLATE FOR REVISED CAMBER AND THICKNESS ORDINATES AND SLOPES
C
      TZORK(N,1)=TALCR(N,1)
      DZCDXK(N,1)=DZCDX(N,1)
      WAFORK(N,1)=TALOR(N,1)
      DZTDXK(N,1)=DZTDX(N,1)
      KI=2
      DO 220 J=1,NWAR
      DO 200 K=KI,KWAFOR
      IF (XAFK(N,K).GT.XAF(J+1)) GO TO 210
      XJ=XAFK(N,K)
      TZCRK(N,K)=VALU2(J,XJ,CC)
      DZCDXK(N,K)=SLOP2(J,XJ,CC)
      L=J
      XL=XJ
      IF (KL.LT.3.OR.RHO(N).EQ.0.) GO TO 190
      IF (J.GT.1) GO TO 180
      SXJ=SQRT(XJ)
      DZTDXK(N,K)=R(N)/(2.*SXJ)+A(N)+2.*B(N)*XJ
      WAFORK(N,K)=R(N)*SXJ+XJ*(A(N)+B(N)*XJ)
      GO TO 200
180   XL=XJ-XAF(1)
      L=J-1
190   WAFORK(N,K)=VALU1(L,XL,C)
      DZTDXK(N,K)=SLOP1(L,XL,C)
200   CONTINUE
210   KI=K
220   CONTINUE
230   CONTINUE
      RETURN
C
C
240   FORMAT (10F7.0)
      END
```

```
      OVERLAY(LWB,1,7)
      PROGRAM TALPAN
C
C     REVISE SPANWISE PANEL SPACING ON FIN (VERTICAL TAIL) OR CANARD
C     (HORIZONTAL TAIL) AND COMPUTE NEW PANEL GEOMETRY
C
      COMMON ABC(8),J0,JL,J2,J3,J4,J5,J6,NWAF,NWAFOR,DUNW(11),NF,NFINOR,
     1NK,NCANOR,DUM(36)
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMON /NEWCOM/ KL,KWAF,KWAFOR,KRADX(4),KFCRX(4),KRAD,MAX,K4,K5,KF
     1(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT,XCPT
      COMMON /SEG/ NSEG,NROW(20),NCOL(20),COSS(20),SINS(20),BTE(20),NWT(
     120),SPNW(20),XLEW(20),BLE(20),ZLEW(20),XS(20),YS(20),ZS(20)
      COMMON /SCRAT/ BLOCK(7500)
      COMMON /POINT/ ARRAY(6000)
      COMMON /VELCOM/ DUM1(6),PRINT,DUM2(53)
C
      DIMENSION XPT(600), YPT(600), ZPT(600), THET(600), DELTA(600), XC(
     130,20), YC(30,20), ZC(30,20), ZU(30,20), AREA(600), XE(600), TALOR
     2G(6,2,4), XT(6,10), TALORD(6,2,10), TALCR(6,10), TALOR(6,10), WAFO
     3RG(2,4), TZORK(20,30), WAFORK(20,30), DZCDX(20,30), DZTDX(20,30),
     4DZCDXK(20,30), DZTDXK(20,30), SLOPE(600), XAFK(6,30), XK(20), YK(2
     50), ZK(20), CK(20), CD(20), ZY(20), BL(20), TH(20), BT(20), CHORD(
     6600)
C
      EQUIVALENCE (BLOCK,TALORG), (BLOCK(49),XT), (BLOCK(109),TALORD), (
     1BLOCK(469),TALOR), (BLOCK(529),TALCR), (BLOCK(589),ZY), (BLOCK(609
     2),XK), (BLOCK(629),YK), (BLOCK(649),ZK), (BLOCK(669),CK), (BLOCK(6
     389),BL), (BLOCK(709),BT), (BLOCK(729),TH), (BLOCK(2511),DZTDX), (B
     4LOCK(3111),TZORK), (BLOCK(3711),WAFORK), (BLOCK(4311),DZCDX), (BLO
     5CK(4911),DZCDXK), (BLOCK(5511),DZTDXK), (BLOCK(6111),XAFK), (BLOCK
     6(6301),CHORD), (BLOCK(6901),SLOPE,ZU), (ARRAY,XPT), (ARRAY(601),YP
     7T), (ARRAY(1201),ZPT), (ARRAY(1801),THET), (ARRAY(2401),DELTA), (A
     8RRAY(3001),XC), (ARRAY(3601),YC), (ARRAY(4201),ZC), (ARRAY(4801),A
     9REA), (ARRAY(5401),XE)
C
      LOGICAL LBC,THK,FIN
      INTEGER PRINT
C
      XIN(X1,Y1,X2,Y2,Y)=X1+(X2-X1)*(Y-Y1)/(Y2-Y1)
C
C
```

```
C     NOTE THAT SOME WING VARIABLES ARE REDEFINED IN TERMS OF FIN OR
C     CANARD VARIABLES, THEREFORE CARE MUST BE EXERCISED IN FOLLOWING
C     THE LOGIC THROUGH THE TAIL SUBROUTINES. IN ESSENCE, THE PROGRAM
C     TREATS THE FINS AND CANARDS AS ADDITIONAL WING SEGMENTS.
C
C
      EPS=1.0E-6
      FIN=.FALSE.
      IF (K4.LE.0) GO TO 10
      FIN=.TRUE.
      IF (PRINT.LT.0) WRITE (6,270)
      NTAL=NF
      KK=K4
      KL=K4
      K4=0
      GO TO 20
10    IF (K5.LE.0) RETURN
      KK=0
      KL=K5
      NTAL=NK
      IF (PRINT.LT.0) WRITE (6,280)
20    CONTINUE
      IF (PRINT.LT.0) WRITE (6,290)
      REWIND 7
C
C     READ WING GEOMETRY FROM TAPE 7
C
      READ (7) ARRAY,CHORD,SLOPE
      REWIND 7
      KI=1
      NI=1
      NC=NCPT
      NJ=NCPT
      NINIT=NWING
      NP=NWING
      NC1=NC+1
      NP1=NP+1
C
C     CALCULATE PANEL GEOMETRY FOR EACH TAIL SEGMENT
C
      DO 200 NT=1,NTAL
      IF (FIN) KWAF=KF(NT)
      IF (.NOT.FIN) KWAF=KAN(NT)
```

```
      KWAF=IABS(KWAF)
      IF (KWAF.EQ.0) GO TO 30
C
C     READ INTERMEDIATE SPAN STATIONS
C
      READ (5,260) (YK(K),K=1,KWAF)
30    KWAFOR=NWAFOR
      IF (FIN.AND.KFINOR(NT).GT.0) KWAFOR=KFINOR(NT)
      IF (.NOT.FIN.AND.KANOR(NT).GT.0) KWAFOR=KANOR(NT)
      DO 50 N=1,2
      WAFORG(N,1)=TALORG(NT,N,1)
      IF (KK.GT.0) GO TO 40
      WAFORG(N,2)=TALORG(NT,N,2)
      WAFORG(N,3)=TALORG(NT,N,3)
      GO TO 50
40    WAFORG(N,2)=TALORG(NT,N,3)
      WAFORG(N,3)=TALORG(NT,N,2)
50    WAFORG(N,4)=TALORG(NT,N,4)
      IF (KWAF.NE.0) GO TO 70
      KWAF=2
      DO 60 K=1,2
60    YK(K)=WAFORG(K,2)
70    CONTINUE
      N=1
      M=2
      DELY=WAFORG(N+1,2)-WAFORG(N,2)
      IF (DELY.EQ.0.) GO TO 200
      DELX=WAFORG(N+1,1)-WAFORG(N,1)
      DELZ=WAFORG(N+1,3)-WAFORG(N,3)
      DELC=WAFORG(N+1,4)-WAFORG(N,4)
      BL(N)=DELX/DELY
      BT(N)=(DELX+DELC)/DELY
      CD(N)=WAFORG(N,4)
      IF (FIN) TH(N)=ATAN2(DELY,DELZ)
      IF (.NOT.FIN) TH(N)=ATAN2(DELZ,DELY)
      NSEG=NSEG+1
      SINS(NSEG)=SIN(TH(N))
      COSS(NSEG)=COS(TH(N))
      BLE(NSEG)=BL(N)
      BTE(NSEG)=BT(N)
      NWT(NSEG)=1
      IF (FIN) NWT(NSEG)=-1
      IF (.NOT.FIN.AND.KAN(NT).LT.0) NWT(NSEG)=-1
```

```
C
C     CALCULATE ORIGINS OF INTERMEDIATE CHORDS
C
      DO 190 K=KI,KWAF
      K1=K-1
      L=K+KOL
      L1=L-1
      XK(K)=XIN(WAFORG(NI,1),WAFORG(NI,2),WAFORG(M,1),WAFORG(M,2),YK(K))
      ZK(K)=XIN(WAFORG(NI,3),WAFORG(NI,2),WAFORG(M,3),WAFORG(M,2),YK(K))
      CK(K)=XIN(WAFORG(NI,4),WAFORG(NI,2),WAFORG(M,4),WAFORG(M,2),YK(K))
      CL=CK(K)/100.
      LP=1
      SJ=1.0
      ZY(K)=ZK(K)
      IF (FIN) ZK(K)=YK(K)
30    CONTINUE
C
C     CALCULATE COORDINATES OF PANEL CORNERS
C
      DO 140 J=1,KWAFOR
      XC(J,L)=XK(K)+CL*XAFK(NT,J)
      ZC(J,L)=ZK(K)
      IF (LBC) GO TO 90
      ZCAM=TZORK(NT,J)
      ZTHK=WAFORK(NT,J)
      ZC(J,L)=ZY(K)+CL*(ZCAM+SJ*ZTHK)
      IF (LP.EQ.1) ZU(J,L)=ZC(J,L)
90    IF (FIN) YK(K)=ZY(K)
      YC(J,L)=YK(K)
      IF (K.EQ.KI) GO TO 140
      NJ=NJ+1
      IF (J.EQ.1) GO TO 140
      J1=J-1
      NC=NC+1
      NP=NP+1
      IP=1
      IF (SJ.LT.0.) IP=0
      IQ=0
C
C     CALCULATE PANEL INCLINATIONS AND CENTROIDS ON TAIL SURFACE
C
      IF (.NOT.LBC) CALL PANEL (IP,IQ,J,L,LP,NP,AP)
      AREA(NP)=AP
```

```
      CHORD(NP)=0.
      IF (PRINT.GE.0) GO TO 110
      IF (.NOT.LBC.AND.LP.EQ.1) GO TO 100
      WRITE (6,300) NP,XC(J1,L1),YK(K1),ZC(J1,L1),XC(J,L1),YK(K1),ZC(J,L
     1 1),XC(J1,L),YK(K),ZC(J1,L),XC(J,L),YK(K),ZC(J,L)
      GO TO 110
100   WRITE (6,300) NP,XC(J1,L1),YK(K1),ZU(J1,L1),XC(J,L1),YK(K1),ZU(J,L
     1 1),XC(J1,L),YK(K),ZU(J1,L),XC(J,L),YK(K),ZU(J,L)
C
C     CALCULATE PANEL CONTROL POINTS IN PLANE OF TAIL
C
110   CONTINUE
      CR=XC(J,L1)-XC(J1,L1)
      CT=XC(J,L)-XC(J1,L)
      RI=(1.+CT/(CR+CT))/3.
      RO=1.-RI
      XLE=RI*XC(J1,L)+RO*XC(J1,L1)
      XTE=RI*XC(J,L)+RO*XC(J,L1)
      CHORD(NP)=XTE-XLE
      SPN=SQRT((YK(K)-YK(K1))*(YK(K)-YK(K1))+(ZK(K)-ZK(K1))*(ZK(K)-ZK(K1
     1 )))
      SPNW(L1)=SPN
      IF (J.EQ.2) XLEW(L1)=XLE
      YLE=RI*YK(K)+RO*YK(K1)
      ZLE=RI*ZK(K)+RO*ZK(K1)
      IF (J.EQ.2) ZLEW(K1)=ZLE
      IF (LBC) GO TO 120
      IF (LP.EQ.1.OR.J.NE.KWAFOR/2) GO TO 140
      XS(K1)=XTE
      YS(K1)=YLE
      ZTU=RI*ZU(J,L)+RO*ZU(J,L1)
      ZTL=RI*ZC(J,L)+RO*ZC(J,L1)
      ZS(K1)=(ZTU+ZTL)/2.
      GO TO 140
120   CONTINUE
      XPT(NC)=XLE
      XE(NC)=XPT(NC)
      YPT(NC)=YLE
      ZPT(NC)=ZLE
C
C     CALCULATE PANEL AREAS, CHORDS, AND INCLINATION ANGLES
C
      AREA(NP)=.5*SPN*(CR+CT)
```

```
      THET(NC)=TH(N)                                                    P2150
C                                                                       P2160
C     CALCULATE CAMBER AND THICKNESS SLOPES                             P2170
C                                                                       P2180
      KJ=KI+1                                                           P2190
      IF (K.GT.KJ) GO TO 130                                            P2200
      DZCDX(NT,J)=DZCDXK(NT,J)                                          P2210
      IF (J.EQ.2) DZCDX(NT,1)=DZCDXK(NT,1)                              P2220
      DZTDX(NT,J)=DZTDXK(NT,J)                                          P2230
  130 DELTA(NC)=DZCDX(NT,J1)                                            P2240
      SLOPE(NJ)=DZTDX(NT,J)                                             P2250
      IF (J.NE.KWAFOR) GO TO 140                                        P2260
      NC=NC+1                                                           P2270
      XPT(NC)=XTE-EPS                                                   P2280
      XE(NC)=XPT(NC)                                                    P2290
      YPT(NC)=YPT(NC-1)                                                 P2300
      ZPT(NC)=ZPT(NC-1)                                                 P2310
      ZTE=ZPT(NC)                                                       P2320
      DELTA(NC)=DZCDXK(NT,J)                                            P2330
      THET(NC)=TH(N)                                                    P2340
  140 CONTINUE                                                          P2350
      IF (LBC) GO TO 150                                                P2360
      IF (SJ.LT.0.) GO TO 150                                           P2370
      SJ=-1.0                                                           P2380
      LP=2                                                              P2390
      GO TO 80                                                          P2400
  150 CONTINUE                                                          P2410
      IF (K.EQ.KI) GO TO 190                                            P2420
      IF (K.GT.KJ) GO TO 190                                            P2430
      IF (.NOT.LBC) GO TO 190                                           P2440
      IF (KL.EQ.3) GO TO 160                                            P2450
C                                                                       P2460
C     CALCULATE INITIAL SLOPE FOR SHARP LEADING EDGE AIRFOILS           P2470
C                                                                       P2480
      DZTDX(NT,1)=DZTDXK(NT,1)                                          P2490
      GO TO 180                                                         P2500
C                                                                       P2510
C     CALCULATE INITIAL SLOPE FOR ROUND LEADING EDGE AIRFOIL            P2520
C                                                                       P2530
  160 NPJ=NP-J1                                                         P2540
      SLE=2.*ZTE/CHORD(NPJ+1)-DZTDX(NT,2)                               P2550
      DO 170 I=2,J1                                                     P2560
  170 SLE=SLE-(DZTDX(NT,I)+DZTDX(NT,I+1))*CHORD(NPJ+I)/CHORD(NPJ+1)     P2570
```

```
      DZTDX(NT,1)=SLE
180   NJJ=NJ-J1
      SLOPE(NJJ)=DZTDX(NT,1)
190   CONTINUE
C
C     COMPUTE NUMBER OF ROWS AND COLUMNS IN EACH TAIL SEGMENT
C
      NROW(NSEG)=J1
      NCOL(NSEG)=KWAF-KI
      NCPT=NC
      IF (NCPT.GT.600) GO TO 240
      NWING=NP
      NTAIL=NWING-NINIT
      KCL=KOL+KWAF
200   CONTINUE
      IF (PRINT.GE.0) GO TO 230
      IF (FIN) WRITE (6,310)
      IF (.NOT.FIN) WRITE (6,320)
      IF (LBC) WRITE (6,330)
      IF (.NOT.LBC) WRITE (6,340)
      DO 210 NP=NC1,NCPT
      IF (LBC) WRITE (6,350) NP,XPT(NP),YPT(NP),ZPT(NP),THET(NP),DELTA(N
     1P),SLOPE(NP)
      IF (.NOT.LBC) WRITE (6,350) NP,XPT(NP),YPT(NP),ZPT(NP),THET(NP),DE
     1LTA(NP)
210   CONTINUE
      IF (FIN) WRITE (6,390)
      IF (.NOT.FIN) WRITE (6,380)
      WRITE (6,360)
      DO 220 NP=NP1,NWING
220   WRITE (6,370) NP,AREA(NP),CHORD(NP)
230   CONTINUE
C
C     STORE WING AND TAIL GEOMETRY ON TAPE 7
C
      WRITE (7) ARRAY,CHORD,SLOPE
      GO TO 250
240   WRITE (6,400)
      CALL EXIT
250   RETURN
C
C
260   FORMAT (10F7.0)
```

```
270   FORMAT (1H1,9X,35H FIN PANEL CORNER POINT CCORDINATES/10X,86H 1 AN  P3010
     1D 3 INDICATE FIN PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE TRAIL  P3020
     2ING-EDGE PCINTS)                                                    P3030
280   FORMAT (1H1,9X,35HTAIL PANEL CORNER POINT CCORDINATES/10X,86H1 AND  P3040
     1 3 INDICATE TAIL PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE TRAIL  P3050
     2ING-EDGE POINTS)                                                    P3060
290   FORMAT (1H0,5X,5HPANEL,4(8X,1HX,8X,1HY,8X,1HZ)/20X,3(1H1,8X),3(1H2  P3070
     1,8X),3(1H3,8X),3(1H4,8X)//)                                         P3080
300   FORMAT (1H ,4X,I3,4X,12F9.5)                                        P3090
310   FORMAT (1H1,1X,48H FIN PANEL CONTRCL PCINTS ANC INCLINATICN ANGLES  P3100
     1)                                                                   P3110
320   FORMAT (1H1,1X,48HTAIL PANEL CONTRCL PCINTS ANC INCLINATION ANGLES  P3120
     1)                                                                   P3130
330   FORMAT (1H0,5HPOINT,8X,1HX,10X,1HY,10X,1HZ,10X,5HTHETA,6X,6HCAMBER  P3140
     1,5X,9HTHICKNESS/15X,3(2HCP,9X),10X,5HSLOPE,8X,5HSLOPE//)            P3150
340   FORMAT (1H0,5HPOINT,8X,1HX,10X,1HY,10X,1HZ,10X,5HTHETA,6X,5HDELTA/  P3160
     115X,3(2HCP,9X)//)                                                   P3170
350   FORMAT (1H ,1X,I3,4X,6F11.5)                                        P3180
360   FORMAT (1H0,5HPANEL,6X,4HAREA,8X,5HCHORD)                           P3190
370   FORMAT (1H ,1X,I3,4X,2F11.5)                                        P3200
380   FORMAT (1H1,9X,27HTAIL PANEL AREAS AND CHORDS)                      P3210
390   FORMAT (1H1,9X,27H FIN PANEL AREAS AND CHORCS)                      P3220
400   FORMAT (65H ERROR - NUMBER OF WING AND TAIL PANEL CONTRCL POINTS E  P3230
     1XCEEDS 600)                                                         P3240
      END                                                                 P3250-
```

```
      OVERLAY(LWB,2,0)
      PROGRAM VELCMP
C
C     COMPUTE THE VELOCITY COMPONENTS (U,V,W) AT THE PANEL CONTROL
C     POINTS AND FORM THE AERODYNAMIC INFLUENCE COEFFICIENT MATRICES
C
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,PRINT,NWTHK,NWBLOK,
     1NWROW(20),NBBLOK,NBROW(30)
      COMMON /NEWCOM/ K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,KDUM(28)
     1,LOCPT(20),XCPT(20)
      COMMON /SCRAT/ BLOCK(7500)
      COMMON /POINT/ ARRAY(6000)
      COMMON /SEG/ NSEG,NROW(20),NCOL(20),COSS(20),SINS(20),BT(20),DUM(6
     10),BL(20)
      COMMON /MATCOM/ MATIN
C
      DIMENSION XLE(600), XPT(600), DEL(600), COSTH(600)
      DIMENSION XBT(600), YBT(600), ZBT(600), YPT(600), ZPT(600)
      DIMENSION CHORD(600), DZTDX(600), IT(600), D(60,60), DELTA(600)
      DIMENSION DELTI(600)
C
      EQUIVALENCE (BLOCK,DEL), (BLOCK(601),COSTH)
      EQUIVALENCE (BLOCK(3901),XBT), (BLOCK(4501),YBT), (BLOCK(5101),ZBT
     1)
      EQUIVALENCE (BLOCK(5701),IT), (BLOCK(6301),CHORD), (BLOCK(6901),DZ
     1TDX), (ARRAY(2401),DELTA), (ARRAY(4801),DELTI)
      EQUIVALENCE (ARRAY,XPT), (ARRAY(1801),D), (ARRAY(5401),XLE)
      EQUIVALENCE (ARRAY(601),YPT), (ARRAY(1201),ZPT)
C
      REAL MACH
      LOGICAL LBC,SUB,SUPLE,SUPTE
      LWB=3LLWB
      MATIN=0
      NMAX=60
      EPS=1.0E-6
C
C     READ IN MACH NUMBER AND ANGLE OF ATTACK
C
      READ (5,240) MACH,ALPHA
      IF (MACH.LT.0..OR.MACH.EQ.EM) RETURN
      SUB=MACH.LT.1.0
```

```
      BETA=SQRT(ABS(MACH*MACH-1.0))
      BETAD=1./BETA
      REWIND 8
      REWIND 9
      REWIND 10
      NPOINT=NCPT
      NPANEL=NBODY+NWING
      IF (NPANEL.EQ.0) RETURN
      REWIND 7
      IF (NWING.EQ.0) GO TO 70
      NCPT=NWING
C
C     COMPUTE SIZES OF WING DIAGONAL BLOCKS
C
C
C     COMPUTE CHORDWISE CONTROL POINT LOCATIONS ON WING
C     (PLANAR BOUNDARY CONDITION OPTION ONLY)
C
      IF (.NOT.LBC) GO TO 10
      READ (7) ARRAY,CHORD,DZTDX
      IF (NBODY.EQ.0) GO TO 10
      READ (7) ARRAY
      WRITE (10) ARRAY
      REWIND 10
      REWIND 7
      READ (7) ARRAY,CHORD,DZTDX
10    REWIND 7
      I=0
      J=0
      K=0
      NWBLOK=0
      DO 50 N=1,NSEG
      NC=NCOL(N)
      NR=NROW(N)
      NR1=NR+1
      NWBLOK=NWBLOK+NC
      BLE=BL(N)*BETAD
      SUPLE=.FALSE.
      IF (.NOT.SUB.AND.ABS(BLE).LT.1.0) SUPLE=.TRUE.
      BTE=BT(N)*BETAD
      SUPTE=.FALSE.
      IF (.NOT.SUB.AND.ABS(BTE).LT.1.0) SUPTE=.TRUE.
      DO 50 M=1,NC
```

```
      K=K+1
      NK=NR
      IF (LBC.AND.SUPTE) NK=NR1
      IF (.NOT.LBC) NK=2*NR
      NWROW(K)=NK
      DO 50 L=1,NR1
      I=I+1
      IT(I)=0
      IF (L.LT.NR1) GO TO 30
      IF (LBC) XPT(I)=XLE(I)
      IF (SUPTE) GO TO 20
      IT(I)=I
   20 J=J+1
      IF (LBC) DEL(J)=DELTA(I)
      IF (LBC) COSTH(J)=COSS(N)
      GO TO 50
   30 IF (.NOT.LBC) GO TO 50
      J=J+1
      XF=.50
      XS=XF
      LOCPT(N)=0
      IF (.NOT.SUPTE) GO TO 40
      LOCPT(N)=1
      IF (SUPLE) XS=EPS
      XF=XS*FLOAT(NR1-L)/FLOAT(NR1-1)
   40 XPT(I)=XF*XLE(I+1)+(1.-XF)*XLE(I)
      DEL(J)=XF*DELTA(I+1)+(1.-XF)*DELTA(I)
      COSTH(J)=COSS(N)
      XCPT(N)=XS
   50 CONTINUE
      IF (LBC) NCPT=I
      IF (.NOT.LBC) GO TO 60
      REWIND 11
      WRITE (11) DEL,COSTH
      REWIND 11
      WRITE (7) ARRAY,CHORD,DZTDX
      IF (NBODY.EQ.0) GO TO 6C
      READ (10) ARRAY
      WRITE (7) ARRAY
   60 REWIND 7
      REWIND 10
      NPCINT=NCPT
   70 CONTINUE
```

```
      EM=MACH
      NPART=1
      CALL SECOND (TIME)
      WRITE (6,260) NPART,TIME
      IF (NWING.NE.0) READ (7) ARRAY,CHORD,DZTDX
      IF (NBODY.EQ.0) GO TO 100
      READ (7) ARRAY
      DO 80 N=1,NBODY
      XBT(N)=XPT(N)
      YBT(N)=YPT(N)
80    ZBT(N)=ZPT(N)
      NPOINT=NBODY
90    IF (NPART.EQ.1) WRITE (6,270)
C
C     COMPUTE VELOCITY COMPONENTS INDUCED BY BODY PANELS
C
      CALL OVERLAY (LWB,2,1)
      GO TO 110
100   IF (NPART.EQ.1.OR.NPART.EQ.4) WRITE (6,300)
C
C     COMPUTE VELOCITY COMPONENTS INDUCED BY WING PANELS
C
      IF (LBC) CALL OVERLAY (LWB,2,2)
      IF (.NOT.LBC) CALL OVERLAY (LWB,2,3)
      GO TO 110
110   CONTINUE
      IF (NWING.EQ.0.AND.NBODY.NE.0) GO TO 160
      IF (NBODY.EQ.0.AND.NWING.NE.0) GO TO 160
C
C     SET UP INDIQES FOR MATRIX PARTITIONS
C
      NPART=NPART+1
      IF (NPART.GT.4) GO TO 150
      CALL SECOND (TIME)
      WRITE (6,260) NPART,TIME
      IF (NPART.EQ.2) WRITE (6,280)
      IF (NPART.EQ.3) WRITE (6,290)
      REWIND 7
      REAC (7) ARRAY,CHORD,DZTDX
      IF (NPART.GT.2) GO TO 130
120   READ (7) (ARRAY(I),I=1,2400),(DELTI(I),I=1,600)
      IF (NPART.GT.2) GO TO 90
      NPOINT=NBODY
```

```
      GO TO 100                                                         Q1720
  130 NPOINT=NCPT                                                       Q1730
      IF (NPART.EQ.4) GO TO 100                                         Q1740
      READ (7) ARRAY                                                    Q1750
      DO 140 N=1,NBODY                                                  Q1760
      XBT(N)=XPT(N)                                                     Q1770
      YBT(N)=YPT(N)                                                     Q1780
  140 ZBT(N)=ZPT(N)                                                     Q1790
      REWIND 7                                                          Q1800
      GO TO 120                                                         Q1810
  150 READ (7) ARRAY                                                    Q1820
  160 REWIND 8                                                          Q1830
      REWIND 9                                                          Q1840
      REWIND 10                                                         Q1850
      MATIN=1                                                           Q1860
C                                                                       Q1870
C     WRITE DIAGONAL BLOCKS OF AERODYNAMIC MATRIX ON TAPE 7             Q1880
C                                                                       Q1890
      IF (NBODY.EQ.0) GO TO 190                                         Q1900
      NBBLOK=1                                                          Q1910
      NBROW(1)=NBODY                                                    Q1920
      IF (NBODY.LE.NMAX) GO TO 190                                      Q1930
      NBBLOK=0                                                          Q1940
      DO 180 KF=1,KFUS                                                  Q1950
      NR=KRADX(KF)-1                                                    Q1960
      NC=KFORX(KF)-1                                                    Q1970
      DO 180 NN=1,NC                                                    Q1980
      NBBLOK=NBBLOK+1                                                   Q1990
      NBROW(NBBLOK)=NR                                                  Q2000
      DO 170 M=1,NR                                                     Q2010
  170 READ (10) (D(M,N),N=1,NR)                                         Q2020
  180 WRITE (7) D                                                       Q2030
  190 IF (NWING.EQ.0) GO TO 220                                         Q2040
      IF (NWING.LE.NMAX) GO TO 220                                      Q2050
      DO 210 NW=1,NWBLOK                                                Q2060
      NR=NWROW(NW)                                                      Q2070
      DO 200 M=1,NR                                                     Q2080
  200 READ (10) (D(M,N),N=1,NR)                                         Q2090
  210 WRITE (7) D                                                       Q2100
      GO TO 230                                                         Q2110
  220 NWBLCK=1                                                          Q2120
      NWROW(1)=NWING                                                    Q2130
  230 REWIND 7                                                          Q2140
```

```
      REWIND 10
      CALL SECOND (TIME)
      WRITE (6,250) TIME
      RETURN
C
C
240   FORMAT (10F7.0)
250   FORMAT (1HO,6HTIME =F10.5)
260   FORMAT (1H1,11HPARTITION =I3,2X,6HTIME =F10.5)
270   FORMAT (1H ,25HINFLUENCE OF BODY ON BODY)
280   FORMAT (1H ,25HINFLUENCE OF WING ON BODY)
290   FORMAT (1H ,25HINFLUENCE OF BODY ON WING)
300   FORMAT (1H ,25HINFLUENCE OF WING ON WING)
      END
```

```
      SUBROUTINE TRAP (XT,YT,SUM,NT)
C
C     EVALUATE AN INTEGRAL BY THE TRAPEZOIDAL RULE.
C
      DIMENSION XT(1), YT(1)
      SUM=0.
      DO 10 I=2,NT
10    SUM=SUM+.5*(XT(I)-XT(I-1))*(YT(I)+YT(I-1))
      RETURN
      END
```

```
      OVERLAY(LWB,2,1)
      PROGRAM BODVEL
C
C     COMPUTE THE THREE COMPONENTS OF VELOCITY INDUCED AT SPECIFIED
C     CONTROL POINTS BY THE BODY PANELS
C     INDUCED AT SPECIFIED CONTROL POINTS BY THE BODY PANELS
C
      COMMON /PARAM/ NBODY,NWING,NPANEL,LBC,THK,MACH,ALPHA,REFA
      COMMON /VELCCM/ NPOINT,NPART,IMAX,JMAX,NMAX,EX,PRINT,NWTHK
      COMMON /NEWCOM/ K1,KWAF,KWAFUR,KRADX(4),KFORX(4),KFUS,MAX
      COMMON /SCRAT/ UB(600),VB(600),WB(600),VI(600),WI(600),AN(600),DN(
     160),DUM(240),XBT(600),YBT(6C0),ZBT(600),IT(600),CD(600)
      COMMON /POINT/ XPT(600),YPT(600),ZPT(600),THET(600),DELTA(600),XC(
     130,20),YC(30,20),ZC(30,20),DELTI(600)
      COMMON /BODCOM/ EM,DA,CX,XCOR(4),YCOR(4),ZCOR(4),XI,YI,ZI,XJ,ZJ
      COMMON /BTHET/ THETA(600)
C
      REAL MACH
      INTEGER PRINT
      EM=MACH
      JMAX=MAX
      II=0
C
C     I IS THE INDEX OF THE CENTROL POINT
C     J IS THE INDEX OF THE INFLUENCING PANEL
C
      DO 90 I=1,NPOINT
      ISKIP=IT(I)
      IF (LBC.AND.I.EQ.ISKIP.AND.NPART.EQ.3) GO TO 90
      II=II+1
      SINTI=SIN(THET(I))
      COSTI=COS(THET(I))
      XPTI=XPT(I)
      YPTI=YPT(I)
      ZPTI=ZPT(I)
      IF (NPART.EQ.1) DI=TAN(DELTA(I))
      IF (LBC.AND.NPART.EQ.3) DI=0.
      IF (.NOT.LBC.AND.NPART.EQ.3) DI=TAN(DELTI(I))
      DO 10 J=1,NBODY
      UB(J)=0.
      VI(J)=0.
   10 WI(J)=0.
```

```
      J=0
      J2=0
      L=0
      DO 50 KF=1,KFUS
      NROW=KRADX(KF)-1
      NCOL=KFORX(KF)-1
      DO 40 NC=1,NCOL
      L=L+1
      J1=1+J2
      J2=J1+NROW-1
      DO 30 N=1,NROW
      J=J+1
      DA=TAN(DELTA(J))
      COST=COS(THETA(J))
      SINT=SIN(THETA(J))
      XW=SINT*COSTI
      XX=COST*SINTI
      XY=COST*COSTI
      XZ=SINT*SINTI
      SINTR=XW-XX
      SINTL=XW+XX
      COSTR=XY+XZ
      COSTL=XY-XZ
      N1=N+1
      XC1=XC(L,N1)
      YC1=YC(L,N1)
      ZC1=ZC(L,N1)
C
C     CALCULATION OF PANEL CORNER POINTS IN PANEL COORDINATE SYSTEM
C
      XCOR(1)=0.
      YCOR(1)=0.
      ZCOR(1)=0.
      XCOR(2)=XC(L+1,N+1)-XC1
      XCOR(3)=0.
      XCOR(4)=XCOR(2)
      DO 20 K=2,4
      L1=L+1
      N1=N+1
      IF (K.GE.3) N1=N
      IF (K.EQ.3) L1=L
      DELY=YC(L1,N1)-YC1
      DELZ=ZC(L1,N1)-ZC1
```

```
      YCOR(K)=DELY*COST+DELZ*SINT
   20 ZCOR(K)=DELZ*COST-DELY*SINT
      CX=XCOR(2)
C
C     CALCULATION OF CONTROL POINT IN PANEL COORDINATE SYSTEM
C
      XI=XPTI-XC1
      DY=YPTI-YC1
      DZ=ZPTI-ZC1
      YI=DY*COST+DZ*SINT
      ZI=DZ*COST-DY*SINT
      XJ=XBT(J)-XC1
      DYJ=YBT(J)-YC1
      DZJ=ZBT(J)-ZC1
      ZJ=DZJ*COST-DYJ*SINT
C
C     CALCULATE VELOCITY COMPONENTS INDUCED BY CONSTANT SOURCE
C     DISTRIBUTION PANELS
C
      CALL SORPAN (UR,VR,WR)
      DY=-YPTI-YC1
      YI=DY*COST+DZ*SINT
      ZI=DZ*COST-DY*SINT
      CALL SORPAN (UL,VL,WL)
C
C     CALCULATE VELOCITY COMPONENTS IN ORIGINAL COORDINATE SYSTEM
C
      UB(J)=UL+UR+UB(J)
      VI(J)=VR*COSTR-WR*SINTR-VL*COSTL+WL*SINTL+VI(J)
      WI(J)=VR*SINTR+VL*SINTL+WR*COSTR+WL*COSTL+WI(J)
      VB(J)=VI(J)*COSTI-WI(J)*SINTI
      WB(J)=WI(J)*COSTI+VI(J)*SINTI
      AN(J)=WI(J)-UB(J)*DI
      IF (NPART.GT.1) GO TO 30
      IF (NBODY.LE.NMAX) GO TO 30
      IF (II.LT.J1.OR.II.GT.J2) GO TO 30
      JS1=J1
      JS2=J2
      NS=NROW
   30 CONTINUE
   40 CONTINUE
   50 CONTINUE
      JMAX=1
```

```
      IF (NBODY.LE.NMAX.OR.NPART.GT.1) GO TO 70
C
C     STORE DIAGONAL BLOCKS OF AERODYNAMIC MATRIX IN DN ARRAY
C
      DO 60 J=1,NBODY
      IF (J.LT.JS1.OR.J.GT.JS2) GO TO 60
      K=J-JS1+1
      DN(K)=AN(J)
      AN(J)=0.
60    CONTINUE
      WRITE (10) (DN(J),J=1,NS)
70    CONTINUE
      IF (IABS(PRINT).LT.4) GO TO 80
      WRITE (6,140) II
      WRITE (6,100) NBODY
      WRITE (6,130) (UB(J),J=1,NBODY)
C     WRITE(6,6) (VB(J),J=1,NBODY)
C     WRITE(6,6) (WB(J),J=1,NBODY)
      WRITE (6,110) NBODY
      WRITE (6,130) (AN(J),J=1,NBODY)
      IF (NBODY.GT.NMAX.AND.NPART.EQ.1) WRITE (6,120) NS
      IF (NBODY.GT.NMAX.AND.NPART.EQ.1) WRITE (6,130) (DN(J),J=1,NS)
80    WRITE (8) (UB(J),VB(J),WB(J),J=1,NBODY)
      WRITE (9) (AN(J),J=1,NBODY)
90    CONTINUE
      RETURN
C
C
100   FORMAT (2X,10HUB(J),J=1,,I3)
110   FORMAT (2X,10HAN(J),J=1,,I3)
120   FORMAT (2X,10HDN(J),J=1,,I3)
130   FORMAT (1H0,10F10.5)
140   FORMAT (1H0,22HAERODYNAMIC MATRIX, I=I3)
      END
```

```
      SUBROUTINE SORPAN (UPM,VPM,WPM)
C
C     COMPUTE THE THREE COMPONENTS OF VELOCITY INDUCED AT A SPECIFIED
C     CONTROL POINT BY A CONSTANT SOURCE DISTRIBUTION ON A
C     QUADRILATERAL PANEL HAVING LONGITUDINAL TAPER AND INCLINED AT AN
C     ANGLE DELTA TO THE FREE STREAM DIRECTION
C
C
      COMMON /BODCOM/ EM,SA,CX,XC(4),YC(4),ZC(4),XI,YI,ZI,XJ,ZJ
      DIMENSION B(4), SX(4), SM(4), DX(4), DY(4), DZ(4), D(4), E(4), F(4
     1), G(4), H(4), XPM(4), YMX(4), ZAX(4), AYM(4), RPM2(4)
      REAL NUM
C
      EPS=1.0E-5
      EP2=EPS*EPS
      PI=3.14159265
      BT2=1.-EM*EM
      BTA=SQRT(ABS(BT2))
      BA2=BT2*SA*SA
      TA=1.0+BA2
      IF (TA.LT.0.) GO TO 200
      SM(3)=0.0
      DO 190 I=1,4
      ZC(I)=ZJ-SA*(XJ-XC(I))
      IF (I.LE.2) SM(1)=(YC(2)-YC(1))/CX
      IF (I.GT.2) SM(3)=(YC(4)-YC(3))/CX
      SM(2)=SM(1)
      SM(4)=SM(3)
      SSM=SIGN(1.,SM(I))
      BM2=BT2*SM(I)*SM(I)
      TAM=TA+BM2
      IF (ABS(TAM).LE.EPS) TAM=0.
      SAM=SQRT(ABS(TAM))
      SAMD=1./SAM
      CPM=CX*SAM
      DX(I)=XI-XC(I)
      DY(I)=YI-YC(I)
      DZ(I)=ZI-ZC(I)
      IF (ABS(DX(I)).LE.EPS) DX(I)=0.
      IF (ABS(DY(I)).LE.EPS) DY(I)=0.
      IF (ABS(DZ(I)).LE.EPS) DZ(I)=0.
      RPM2(I)=0.
```

```
      DX2=DX(I)*DX(I)
      DY2=DY(I)*DY(I)
      DZ2=DZ(I)*DZ(I)
      DR2=DY2+DZ2
      IF (I.EQ.2) R22=DR2
      IF (I.EQ.4) R42=DR2
      D2=DX2+BT2*DR2
      D(I)=0.0
      IF (EM.GE.1.) DXZ=DX(I)-BTA*ABS(DZ(I))
      IF (EM.GE.1..AND.DXZ.LT.0.) GO TO 170
      IF (D2.GT.0.0) D(I)=SQRT(D2)
      XPM(I)=DX(I)+BT2*(SM(I)*DY(I)+SA*DZ(I))
      YMX(I)=DY(I)-SM(I)*DX(I)
      ZAX(I)=DZ(I)-SA*DX(I)
      AYM(I)=SA*DY(I)-SM(I)*DZ(I)
      IF (ABS(XPM(I)).LE.EPS) XPM(I)=0.
      IF (ABS(YMX(I)).LE.EPS) YMX(I)=0.
      IF (ABS(ZAX(I)).LE.EPS) ZAX(I)=0.
      IF (ABS(AYM(I)).LE.EPS) AYM(I)=0.
      IF (I.LE.2) RPM2(1)=YMX(1)*YMX(1)+ZAX(1)*ZAX(1)+BT2*(AYM(1)*AYM(1)
     1)
      RPM2(2)=RPM2(1)
      IF (I.GT.2) RPM2(3)=YMX(3)*YMX(3)+ZAX(3)*ZAX(3)+BT2*(AYM(3)*AYM(3)
     1)
      RPM2(4)=RPM2(3)
      IF (ABS(RPM2(I)).LE.EP2) RPM2(I)=0.
      RPM=SQRT(ABS(RPM2(I)))
      IF (RPM.LE.EPS) RPM=0.
      DPM=SAM*D(I)
      F(I)=0.
      DNOM=-DX(I)*YMX(I)-BT2*DZ(I)*AYM(I)
      FNUM=D(I)*ZAX(I)
      IF (FNUM.EQ.0..AND.DNOM.EQ.0.) GO TO 10
      F(I)=ATAN2(FNUM,DNOM)
      IF (D(I).EQ.0.) F(I)=F(I)*SIGN(1.,ZAX(I))
   10 IF (TAM) 100,90,20
   20 IF (EM.GT.1..AND.D(I).EQ.0.) GO TO 70
      IF (RPM-EPS) 40,40,30
   30 NUM=XPM(I)+DPM
      G(I)=ALOG(NUM/(BTA*RPM))*SAMD
      GO TO 150
   40 SX(I)=SIGN(1.,XPM(I))
      IF (EM.LT.1.0) GO TO 50
```

```
      IF (I.EQ.1.AND.XPM(1).LT.CPM) GO TO 130
      IF (I.EQ.3.AND.XPM(3).LT.CPM) GO TO 140
50    IF (I.EQ.2) SGN12=SX(1)*SX(2)
      IF (I.EQ.4) SGN34=SX(3)*SX(4)
      IF (XPM(I)) 60,70,80
60    IF (I.EQ.2.AND.SGN12.LT.0.) GO TO 130
      IF (I.EQ.4.AND.SGN34.LT.0.) GO TO 140
      G(I)=-ALOG(ABS(XPM(I)))*SAMD
      GO TO 150
70    G(I)=0.
      GO TO 150
80    G(I)=ALOG(XPM(I))*SAMD
      GO TO 150
90    G(I)=0.
      IF (XPM(I).GT.BTA*RPM) G(I)=D(I)/XPM(I)
      GO TO 150
100   G(I)=0.0
      ARG=SIGN(1.,XPM(I))
      IF (RPM.NE.0.) ARG=XPM(I)/(BTA*RPM)
      IF (ARG.GE.1.) GO TO 150
      IF (ARG.LE.-1.) GO TO 110
      IF (D(I).GT.0) G(I)=ACOS(ARG)*SAMD
      GO TO 150
110   AM2=SA*SA+SM(I)*SM(I)
      TRM1=(SM(I)*DY(I)+SA*DZ(I)+ABS(AYM(I))*SAM)/AM2
      IF (DX(I).GT.TRM1) GO TO 120
      F(I)=0.
      IF (SSM.GT.0.) F(I)=PI*SIGN(1.,ZAX(I))
      GO TO 150
120   IF (SSM*YMX(I).GE.0.) GO TO 150
      G(I)=PI*SAMD
      GO TO 150
130   G(1)=500.*SAMD
      IF (EM.LT.1.0) G(2)=-G(1)
      GO TO 160
140   G(3)=500.*SAMD
      IF (EM.LT.1.0) G(4)=-G(3)
150   CONTINUE
160   H(I)=0.
      HARG=-BTA*DY(I)
      IF (D(I).EQ.0.0.AND.HARG.EQ.0.0) GO TO 180
      IF (EM.LT.1.0) H(I)=BTA*.5*ALOG((D(I)+HARG)/(D(I)-HARG))
      IF (EM.GT.1.) H(I)=BTA*ATAN2(D(I),HARG)
```

```
      GO TO 180
170   F(I)=0.
      G(I)=0.
      H(I)=0.
      AYM(I)=0.
      YMX(I)=0.
      ZAX(I)=0.
      XPM(I)=0.
      DPM=0.
      RPM=0.
      RPM2(2)=RPM2(1)
      RPM2(4)=RPM2(3)
180   E(I)=H(I)+BT2*SM(I)*G(I)
190   CONTINUE
      TAD=1./TA
      E14=(E(1)-E(2)-E(3)+E(4))*TAD
      F14=(F(1)-F(2)-F(3)+F(4))*TAD
      G14=G(1)-G(2)-G(3)+G(4)
      R4PI=1.0/(4.*PI)
      IF (EM.GT.1.) R4PI=2.*R4PI
      UPM=R4PI*(E14/BT2-SA*F14)
      VPM=-R4PI*G14
      WPM=R4PI*(F14+SA*E14)
      RETURN
200   WRITE (6,210)
      CALL EXIT
C
C
210   FORMAT (1H0,35HBODY PANEL SLOPE EXCEEDS MACH ANGLE)
      END
```

```
      OVERLAY(LWB,2,2)
      PROGRAM LINVEL
C
C     COMPUTE THE THREE COMPONENTS OF VELOCITY INDUCED AT SPECIFIED
C     CONTROL POINTS BY SOURCE AND VORTEX DISTRIBUTIONS ON PANELS
C     LOCATED IN THE PLANE OF THE WING, FIN (VERTICAL TAIL), OR CANARD
C     (HORIZONTAL TAIL) SURFACE
C
C
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THIK,MACH,ALPHA,REFA
      COMMON /COMPS/ DX,DY,DZ,AL,BL,CL,SUB,BPOS,BCOS,BSIN,ML
      COMMON /SEG/ NSEG,NROW(20),NCOL(20),COSS(20),SINS(20),TT(20),NWT(2
     10)
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,PRINT,NWTHK
      COMMON /POINT/ ARRAY(6000)
      COMMON /SCRAT/ UCOR(30),VCOR(30),WCOR(30),ULOR(30),VLOR(30),WLOR(3
     10),UCOL(30),VCOL(30),WCOL(30),ULOL(30),VLOL(30),WLOL(30),UCIR(30),
     2VCIR(30),WCIR(30),ULIR(30),VLIR(30),WLIR(30),UCIL(30),VCIL(30),WCI
     3L(30),ULIL(30),VLIL(30),WLIL(30),RCOR(30),SCOR(30),TCOR(30),RLOR(3
     40),SLOR(30),TLOR(30),RCOL(30),SCOL(30),TCOL(30),RLOL(30),SLOL(30),
     5TLOL(30),RCIR(30),SCIR(30),TCIR(30),RLIR(30),SLIR(30),TLIR(30),RCI
     6L(30),SCIL(30),TCIL(30),RLIL(30),SLIL(30),TLIL(30),AC(600),UC(600)
     7,VC(600),WC(600),UT(600),VT(600),WT(600),DC(60),IT(600),CHORD(600)
     8,DZTDX(600)
C
      DIMENSION XPT(600), YPT(600), ZPT(600), THET(600), DELTA(600), XC(
     130,20), YC(30,20), ZC(30,20), BLE(30), UTOR(30), VTOR(30), WTOR(30
     2), UTOL(30), VTOL(30), WTOL(30), UTIR(30), VTIR(30), WTIR(30), UTI
     3L(30), VTIL(30), WTIL(30), ASAVE(30), USAVE(30), VSAVE(30), WSAVE(
     430)
C
      EQUIVALENCE (ARRAY,XPT), (ARRAY(601),YPT), (ARRAY(1201),ZPT), (ARR
     1AY(1801),THET), (ARRAY(3001),XC), (ARRAY(2401),UTOR), (ARRAY(2431)
     2,VTOR), (ARRAY(2461),WTOR), (ARRAY(2491),UTOL), (ARRAY(2521),VTOL)
     3, (ARRAY(2551),WTOL), (ARRAY(2581),UTIR), (ARRAY(2611),VTIR), (ARR
     4AY(2641),WTIR), (ARRAY(2671),UTIL), (ARRAY(2701),VTIL), (ARRAY(273
     51),WTIL), (ARRAY(3601),YC), (ARRAY(4201),ZC), (ARRAY(4801),DELTA),
     6 (ARRAY(2761),USAVE), (ARRAY(2791),VSAVE), (ARRAY(2821),WSAVE), (A
     7RRAY(2851),ASAVE)
C
      LOGICAL THK,THIK,LBC,SUB,BPOS,SUPTE,FLAG
      INTEGER PRINT
```

```
      REAL MACH.
      DATA PI/3.14159265/,EPS/1.0E-10/
      SUB=MACH.LT.1.0
      THK=THIK
      FLAG=.FALSE.
      EPS=1.0E-6
      NYC=1
      IF (ABS(YC(1,1)).LE.EPS) NYC=0
      BETA=SQRT(ABS(MACH*MACH-1.0))
      CON=1./(2.*PI)
      IF (SUB) CON=CON/2.
      CONT=2.*CON/BETA
      BCON=BETA*CON
      BCCNT=BETA*CCNT
C
C     I IS THE CONTROL POINT INDEX
C     J IS THE INFLUENCING PANEL INDEX
C     L IS THE PANEL ROW INDEX
C     M IS THE PANEL COLUMN INDEX
C     N IS THE WING SEGMENT INDEX
C
      II=0
      DO 350 I=1,NPOINT
      ISKIP=IT(I)
      IF (I.EQ.ISKIP.AND.NPART.NE.2) GO TO 350
      II=II+1
      SINTI=SIN(THET(I))
      COSTI=COS(THET(I))
      XI=XPT(I)
      YI=YPT(I)
      ZI=ZPT(I)
      DI=0.
      IF (NPART.EQ.2) DI=BETA*TAN(DELTA(I))
      J=0
      K=0
      J2=0
      M2=1
      NP=0
      DO 290 N=1,NSEG
      NR=NROW(N)
      NC=NCOL(N)
      NT=NWT(N)
      NR1=NR+1
```

```
      NC1=NC+1
      DO 10 L=1,NR1
      USAVE(L)=0.
      VSAVE(L)=0.
      WSAVE(L)=0.
   10 ASAVE(L)=0.
      M1=M2
      IF (N.GT.1.AND.NT.NE.0) M1=M2+1
C
C     IF FLAG IS TRUE, AN ADDITIONAL COLUMN OF VORTEX PANELS
C     EXTENDS FROM THE CENTER LINE TO THE INBOARD EDGE OF THE
C     WING, HORIZONTAL TAIL, OR CANARD
C
      IF (N.EQ.1.AND.NYC.NE.0) FLAG=.TRUE.
      MYC=1
      IF (ABS(YC(1,M1)).LE.EPS) MYC=0
      IF (N.GT.1.AND.NT.EQ.1.AND.MYC.NE.0) FLAG=.TRUE.
      IF (FLAG) THK=.FALSE.
   20 M2=M1+NC
      IF (FLAG) M2=M1
C
C     CALCULATE PANEL LEADING EDGE SLOPES
C
      DO 30 L=1,NR1
      IF (.NOT.FLAG) BLE(L)=(XC(L,M2)-XC(L,M1))/((YC(L,M2)-YC(L,M1))*BET
     1A)
      IF (FLAG) BLE(L)=0.
   30 CONTINUE
      BTE=BLE(NR1)
      SUPTE=.FALSE.
      IF (.NOT.SUB.AND.ABS(BTE).LT.1.0) SUPTE=.TRUE.
      COST=COSS(N)
      IF (FLAG) COST=1.0
      SINT=SINS(N)
      IF (FLAG) SINT=0.
      BCOS=BETA*COST
      BSIN=BETA*SINT
      XW=SINT*COSTI
      XX=COST*SINTI
      XY=COST*COSTI
      XZ=SINT*SINTI
      SINTR=XW-XX
      SINTL=XW+XX
```

```
      COSTR=XY+XZ
      COSTL=XY-XZ
C
C     CALCULATE INFLUENCE OF INBOARD CORNERS OF FIRST COLUMN OF PANELS
C
      DO 80 L=1,NR1
      DX=XI-XC(L,M1)
      DY=YI-YC(L,M1)
      IF (FLAG) DY=YI
      DZ=ZI-ZC(L,M1)
      AT=AL
      BL=BLE(L)
      CT=CL
      ML=1
      IF (L.EQ.NR1) GO TO 40
      BL1=BLE(L+1)
      AB=BL-BL1
      CC=XC(L+1,M1)-XC(L,M1)
40    CONTINUE
      BPOS=BL.GE.0.
      AL=AB
      BL=ABS(BL)
      CL=CC
      CALL VORVEL (UCOR(L),VCOR(L),WCOR(L),ULOR(L),VLOR(L),WLOR(L),UTOR(
     1L),VTOR(L),WTOR(L))
      IF (L.EQ.1) GO TO 50
      ABA=ABS(AL-AT)
      ACL=ABS(CL-CT)
      IF (ABA.LE.EPS.AND.ACL.LE.EPS) GO TO 50
      AL=AT
      CL=CT
      ML=2
      CALL VORVEL (X,X,X,X,X,X,UTOR(L),VTOR(L),WTOR(L))
      AL=AB
      CL=CC
      ML=1
50    IF (.NOT.THK) GO TO 60
      CALL SORVEL (RCOR(L),SCOR(L),TCOR(L),RLOR(L),SLOR(L),TLOR(L))
60    DY=-YI-YC(L,M1)
      IF (FLAG) DY=-YI
      CALL VORVEL (UCOL(L),VCOL(L),WCOL(L),ULOL(L),VLOL(L),WLOL(L),UTOL(
     1L),VTOL(L),WTOL(L))
      IF (L.EQ.1) GO TO 70
```

```
      IF (ABA.LE.EPS.AND.ACL.LE.EPS) GO TO 70
      AL=AT
      CL=CT
      ML=2
      CALL VORVEL (X,X,X,X,X,X,UTOL(L),VTOL(L),WTOL(L))
      AL=AB
      CL=CC
      ML=1
70    IF (.NOT.THK) GO TO 80
      CALL SORVEL (RCOL(L),SCOL(L),TCOL(L),RLOL(L),SLOL(L),TLOL(L))
80    CONTINUE
C
C     CALCULATE INFLUENCE OF CORNERS OF REMAINING COLUMNS OF PANELS
C
      IF (.NOT.FLAG) M1=M1+1
      DO 280 M=M1,M2
      NS=NR
      IF (SUPTE) NS=NR1
      IF (FLAG) GO TO 90
      J1=1+J2
      J2=J1+NS-1
90    DO 150 L=1,NR1
      UCIR(L)=UCOR(L)
      VCIR(L)=VCOR(L)
      WCIR(L)=WCOR(L)
      UCIL(L)=UCOL(L)
      VCIL(L)=VCOL(L)
      WCIL(L)=WCOL(L)
      ULIR(L)=ULOR(L)
      VLIR(L)=VLOR(L)
      WLIR(L)=WLOR(L)
      ULIL(L)=ULOL(L)
      VLIL(L)=VLOL(L)
      WLIL(L)=WLOL(L)
      UTIR(L)=UTOR(L)
      VTIR(L)=VTOR(L)
      WTIR(L)=WTOR(L)
      UTIL(L)=UTOL(L)
      VTIL(L)=VTOL(L)
      WTIL(L)=WTOL(L)
      IF (.NOT.THK) GO TO 100
      RCIR(L)=RCOR(L)
      SCIR(L)=SCOR(L)
```

```
      TCIR(L)=TGOR(L)                                                   U2150
      RCIL(L)=RCOL(L)                                                   U2160
      SCIL(L)=SCOL(L)                                                   U2170
      TCIL(L)=TCOL(L)                                                   U2180
      RLIR(L)=RLOR(L)                                                   U2190
      SLIR(L)=SLOR(L)                                                   U2200
      TLIR(L)=TLOR(L)                                                   U2210
      RLIL(L)=RLOL(L)                                                   U2220
      SLIL(L)=SLOL(L)                                                   U2230
      TLIL(L)=TLOL(L)                                                   U2240
  100 DX=XI-XC(L,M)                                                     U2250
      DY=YI-YC(L,M)                                                     U2260
      DZ=ZI-ZC(L,M)                                                     U2270
      AT=AL                                                             U2280
      BL=BLE(L)                                                         U2290
      CT=CL                                                             U2300
      IF (L.EQ.NR1) GO TO 110                                           U2310
      BL1=BLE(L+1)                                                      U2320
      AB=BL-BL1                                                         U2330
      CC=XC(L+1,M)-XC(L,M)                                              U2340
  110 CONTINUE                                                          U2350
      BPOS=BL.GE.0.                                                     U2360
      AL=AB                                                             U2370
      BL=ABS(BL)                                                        U2380
      CL=CC                                                             U2390
      CALL VORVEL (UCOR(L),VCOR(L),WCOR(L),ULOR(L),VLOR(L),WLOR(L),UTOR(U2400
     1L),VTOR(L),WTOR(L))                                               U2410
      IF (L.EQ.1) GO TO 120                                             U2420
      ABA=ABS(AL-AT)                                                    U2430
      ACL=ABS(CL-CT)                                                    U2440
      IF (ABA.LE.EPS.AND.ACL.LE.EPS) GO TO 120                          U2450
      AL=AT                                                             U2460
      CL=CT                                                             U2470
      ML=1                                                              U2480
      CALL VORVEL (X,X,X,X,X,X,UTOR(L),VTOR(L),WTOR(L))                 U2490
      AL=AB                                                             U2500
      CL=CC                                                             U2510
      ML=1                                                              U2520
  120 IF (.NOT.THK) GO TO 130                                           U2530
      CALL SORVEL (RCOR(L),SCOR(L),TCOR(L),RLOR(L),SLOR(L),TLOR(L))     U2540
  130 DY=-YI-YC(L,M)                                                    U2550
      CALL VORVEL (UCOL(L),VCOL(L),WCOL(L),ULOL(L),VLOL(L),WLOL(L),UTOL(U2560
     1L),VTOL(L),WTOL(L))                                               U2570
```

```
      IF (L.EQ.1) GO TO 140
      IF (ABA.LE.EPS.AND.ACL.LE.EPS) GO TO 140
      AL=AT
      CL=CT
      ML=2
      CALL VORVEL (X,X,X,X,X,X,UTOL(L),VTOL(L),WTOL(L))
      AL=AB
      CL=CC
      ML=1
  140 IF (.NOT.THK) GO TO 150
      CALL SORVEL (RCOL(L),SCOL(L),TCOL(L),RLOL(L),SLOL(L),TLOL(L))
  150 CONTINUE
C
C     COMBINE CORNER INFLUENCES TO OBTAIN PANEL VELOCITY CCMPONENTS
C
      DO 270 L=1,NR1
      IF (.NOT.FLAG.OR.L.GT.1) GO TO 160
      JSAVE=J
      KSAVE=K
      NPSAVE=NP
  160 K=K+1
      IF (SUPTE.OR.L.LT.NR1) GO TO 170
      IF (.NOT.THK) GO TO 270
      GO TO 210
  170 CONTINUE
      J=J+1
      IF (L.EQ.NR1) GO TO 200
      NP=NP+1
      AMP=1.0/CHORD(NP)
C
C     VELOCITY COMPONENTS INCUCED BY PANEL VORTEX DISTRIBUTIONS
C
      ULR=ULIR(L)-UTIR(L+1)-ULOR(L)+UTOR(L+1)
      ULL=ULIL(L)-UTIL(L+1)-ULOL(L)+UTOL(L+1)
      VLR=VLIR(L)-VTIR(L+1)-VLOR(L)+VTOR(L+1)
      VLL=VLIL(L)-VTIL(L+1)-VLOL(L)+VTOL(L+1)
      WLR=WLIR(L)-WTIR(L+1)-WLOR(L)+WTOR(L+1)
      WLL=WLIL(L)-WTIL(L+1)-WLOL(L)+WTOL(L+1)
      UCR=UCIR(L)-UCOR(L)-UCIR(L+1)+UCOR(L+1)-ULR
      UCL=UCIL(L)-UCOL(L)-UCIL(L+1)+UCOL(L+1)-ULL
      VCR=VCIR(L)-VCOR(L)-VCIR(L+1)+VCOR(L+1)-VLR
      VCL=VCIL(L)-VCOL(L)-VCIL(L+1)+VCOL(L+1)-VLL
      WCR=WCIR(L)-WCOR(L)-WCIR(L+1)+WCOR(L+1)-WLR
```

```
      WCL=WCIL(L)-WCOL(L)-WCIL(L+1)+WCOL(L+1)-WLL
      IF (.NOT.THK) GO TO 180
C
C     VELOCITY COMPONENTS INCUCED BY PANEL SOURCE DISTRIBUTICNS
C
      RLR=(RLIR(L)-RLIR(L+1)-RLOR(L)+RLOR(L+1))*AMP
      RLL=(RLIL(L)-RLIL(L+1)-RLOL(L)+RLOL(L+1))*AMP
      SLR=(SLIR(L)-SLIR(L+1)-SLOR(L)+SLOR(L+1))*AMP
      SLL=(SLIL(L)-SLIL(L+1)-SLOL(L)+SLOL(L+1))*AMP
      TLR=(TLIR(L)-TLIR(L+1)-TLOR(L)+TLOR(L+1))*AMP
      TLL=(TLIL(L)-TLIL(L+1)-TLOL(L)+TLOL(L+1))*AMP
180   IF (L.EQ.1) GO TO 190
      UCR=RCR+UCR
      UCL=RCL+UCL
      VCR=SCR+VCR
      VCL=SCL+VCL
      WCR=TCR+WCR
      WCL=TCL+WCL
      IF (.NOT.THK) GO TO 220
      UTR=RTR-RLR
      UTL=RTL-RLL
      VTR=STR-SLR
      VTL=STL-SLL
      WTR=TTR-TLR
      WTL=TTL-TLL
      GO TO 220
C
C     SPECIAL CASE FOR LEADING EDGE PANELS
C
190   IF (.NOT.THK) GO TO 220
      UTR=RCIR(L)-RCOR(L)-RLR
      UTL=RCIL(L)-RCOL(L)-RLL
      VTR=SCIR(L)-SCOR(L)-SLR
      VTL=SCIL(L)-SCOL(L)-SLL
      WTR=TCIR(L)-TCOR(L)-TLR
      WTL=TCIL(L)-TCOL(L)-TLL
      GO TO 220
C
C     SPECIAL CASE FOR TRAILING EDGE PANELS
C
200   UCR=RCR
      UCL=RCL
      VCR=SCR
```

```
      VCL=SCL
      WCR=TCR
      WCL=TCL
      IF (.NOT.THK) GO TO 230
210   UTR=RLR-RCIR(L)+RCOR(L)
      UTL=RLL-RCIL(L)+RCOL(L)
      VTR=SLR-SCIR(L)+SCOR(L)
      VTL=SLL-SCIR(L)+SCOL(L)
      WTR=TLR-TCIR(L)+TCOR(L)
      WTL=TLL-TCIL(L)+TCOL(L)
      GO TO 230
220   RCR=ULR
      RCL=ULL
      SCR=VLR
      SCL=VLL
      TCR=WLR
      TCL=WLL
      IF (.NOT.THK) GO TO 230
      RTR=RLR
      RTL=RLL
      STR=SLR
      STL=SLL
      TTR=TLR
      TTL=TLL
C
C     COMBINE CONTRIBUTIONS OF LEFT AND RIGHT WING PANELS AND TRANSFORM
C     VELOCITY COMPONENTS BACK TO ORIGINAL COORDINATE SYSTEM
C
230   CONTINUE
      IF (.NOT.SUPTE.AND.L.EQ.NR1) GO TO 260
      UC(J)=(UCR+UCL)*CON
      AC(J)=(VCR*SINTR+VCL*SINTL+WCR*COSTR+WCL*COSTL)*BCON
      BC=(VCR*COSTR-WCR*SINTR-VCL*COSTL+WCL*SINTL)*BCON
      VC(J)=BC*COSTI-AC(J)*SINTI
      WC(J)=AC(J)*COSTI+BC*SINTI
      IF (NPART.EQ.2) AC(J)=AC(J)-DI*UC(J)
      IF (M.GT.M1) GO TO 250
      IF (.NOT.FLAG) GO TO 240
      USAVE(L)=UC(J)
      VSAVE(L)=VC(J)
      WSAVE(L)=WC(J)
      ASAVE(L)=AC(J)
      GO TO 270
```

```
240   UC(J)=UC(J)+USAVE(L)
      VC(J)=VC(J)+VSAVE(L)
      WC(J)=WC(J)+WSAVE(L)
      AC(J)=AC(J)+ASAVE(L)
250   IF (NWING.LE.NMAX) GO TO 260
      IF (NPART.EQ.2) GO TO 260
      IF (II.LT.J1.OR.II.GT.J2) GO TO 260
      JS1=J1
      JS2=J2
      NSS=NS
260   IF (.NOT.THK) GO TO 270
      UT(K)=(UTR+UTL)*CONT
      AT=(VTR*SINTR+VTL*SINTL+WTR*COSTR+WTL*COSTL)*BCONT
      BT=(VTR*COSTR-WTR*SINTR-VTL*COSTL+WTL*SINTL)*BCONT
      VT(K)=BT*COSTI-AT*SINTI
      WT(K)=AT*COSTI+BT*SINTI
270   CONTINUE
280   CONTINUE
      IF (.NOT.FLAG) GO TO 290
      FLAG=.FALSE.
      THK=THIK
      J=JSAVE
      K=KSAVE
      NP=NPSAVE
      GO TO 20
290   CONTINUE
      NWING=J
      NWTHK=K
      IF (NWING.LE.NMAX.OR.NPART.EQ.2) GO TO 310
C
C     STORE DIAGONAL BLOCKS OF AERODYNAMIC MATRIX IN DC ARRAY
C
      DO 300 J=1,NWING
      IF (J.LT.JS1.OR.J.GT.JS2) GO TO 300
      K=J-JS1+1
      DC(K)=AC(J)
      AC(J)=0.
300   CONTINUE
      WRITE (10) (DC(J),J=1,NSS)
310   CONTINUE
      IF (IABS(PRINT).LT.4) GO TO 330
      WRITE (6,370) II
      WRITE (6,380) NWING
```

```
      WRITE (6,360) (UC(J),J=1,NWING)
      WRITE (6,390) NWING
      WRITE (6,360) (AC(J),J=1,NWING)
      IF (.NOT.THK) GO TO 320
      WRITE (6,400) NWTHK
      WRITE (6,360) (UT(K),K=1,NWTHK)
      WRITE (6,410) NWTHK
      WRITE (6,360) (WT(K),K=1,NWTHK)
  320 CONTINUE
      IF (NWING.GT.NMAX.AND.NPART.NE.2) WRITE (6,420) NSS
      IF (NWING.GT.NMAX.AND.NPART.NE.2) WRITE (6,360) (DC(J),J=1,NSS)
  330 IF (.NOT.THK) GO TO 340
      WRITE (8) (UT(K),VT(K),WT(K),K=1,NWTHK)
  340 WRITE (8) (UC(J),VC(J),WC(J),J=1,NWING)
      WRITE (9) (AC(J),J=1,NWING)
  350 CONTINUE
      RETURN
C
C
  360 FORMAT (1H0,10F10.5)
  370 FORMAT (1H0,22HAERODYNAMIC MATRIX, I=I3)
  380 FORMAT (2X,10HUC(J),J=1,,I3)
  390 FORMAT (2X,10HAC(J),J=1,,I3)
  400 FORMAT (2X,10HUT(K),K=1,,I3)
  410 FORMAT (2X,10HWT(K),K=1,,I3)
  420 FORMAT (2X,10HDC(J),J=1,,I3)
      END
```

```
      SUBROUTINE SORVEL (UC,VC,WC,UL,VL,WL)
C
C     COMPUTE THE THREE COMPONENTS OF VELOCITY INDUCED AT A SPECIFIED
C     CONTROL POINT BY CONSTANT AND LINEARLY VARYING SOURCE
C     DISTRIBUTIONS ON A SWEPT QUADRILATERAL PANEL. SORVEL CALCULATES
C     THE VELOCITY INDUCED BY ONE CORNER OF THE PANEL.
C
C     UC, VC, WC ARE VELOCITY COMPONENTS INDUCED BY CONSTANT SOURCE
C     DISTRIBUTION
C
C     UL, VL, WL ARE VELOCITY COMPONENTS INDUCED BY LINEAR CHORDWISE,
C     LINEAR SPANWISE SOURCE DISTRIBUTION
C
      COMMON /COMPS/ X,DELTAY,DELTAZ,A,B,C,SUB,BPOS,COST,SINT
      LOGICAL SUB,SUP,BPOS,BNEG,SUPLE
C
      DATA EPS/1.0E-6/,PI/3.14159265/
      SUP=.NOT.SUB
      SUPLE=.FALSE.
      BNEG=.NOT.BPOS
      IF (ABS(B).LE.EPS) B=0.
      SGN=1.0
      IF (SUP) SGN=-1.0
      BT1=SGN+B*B
      BTERM=SQRT(ABS(BT1))
      BTERMD=1./BTERM
      Y=DELTAY*COST+DELTAZ*SINT
      IF (BNEG) Y=-Y
      Z=DELTAZ*COST-DELTAY*SINT
      IF (ABS(Y).LE.EPS) Y=0.
      IF (ABS(Z).LE.EPS) Z=0.
      X2=X*X
      Y2=Y*Y
      Z2=Z*Z
      R2=Y2+Z2
      R=SQRT(R2)
      IF (SUB) GO TO 10
      IF (B.LT.1.0) SUPLE=.TRUE.
      IF (X.LE.0.) GO TO 170
      D=0.
      IF (X2.GT.R2) D=SQRT(X2-R2)
      GO TO 20
```

```
10    D=SQRT(X2+R2)
20    CONTINUE
      T2=B*X+SGN*Y
      T3=X-B*Y
      AT3=ABS(T3)
      IF (AT3.LE.EPS) AT3=0.
      UC=-PI*BTERMD
C
C     SPECIAL CASE FOR SUPERSUNIC LEADING EDGE
C
      IF (D.GT.0.) GO TO 30
      IF (Y.LE.B*X) GO TO 170
      IF (T3.LE.0.) GO TO 170
      IF (X.LE.(B*Y+BTERM*ABS(Z))) GO TO 170
      SZ=SIGN(1.0,Z)
      UC=-PI/BTERM
      VC=-B*UC
      WC=SZ*PI
      UL=-PI*(T3*BTERMD-Z*SZ)
      VL=-B*UL
      WL=-SZ*BTERM*UL
      GO TO 160
30    IF (SUP.AND.X2.LE.R2) GO TO 170
      IF (Z.EQ.0.) GO TO 80
C
C     GENERAL EQUATIONS
C
      DENOM=B*R2-X*Y
      F1=ATAN2(Z*D,DENOM)
      IF (SUB) F1=F1-ATAN2(Z,Y)
      G1=0.
      IF (BTERM.EQ.0.) GO TO 60
      ARG=T2
      IF (SUB) GO TO 40
      TZ=T3*T3+BT1*Z2
      IF (TZ.GT.0.) ST3=SQRT(TZ)
      IF (SUPLE) GO TO 50
40    ARG=ARG+D*BTERM
      IF (SUP) ARG=ARG/ST3
      IF (ARG.GT.0.) G1=ALOG(ARG)*BTERMD
      GO TO 70
50    G1=ACOS(ARG/ST3)*BTERMD
      GO TO 70
```

```
60    IF (T2.NE.0.) G1=D/T2
70    G2=ALOG((X+D)/R)
      G3=0.
      IF (SUB) G3=ALOG(R)
      C1=D
      IF (SUB) C1=X+D
      G=BT1*G1-B*G2
      H=B*G1-G2+G3
      UC=-G1
      VC=H
      WC=F1
      UL=Z*F1-T3*G1-Y*G2
      VL=T3*H+C1-B*Z*F1
      WL=T3*F1+Z*G
      GO TO 160
C
C     SPECIAL EQUATIONS FOR Z=0
C
80    CONTINUE
      F1=C.
      DENOM=-Y*T3
      IF (DENOM.NE.0.) F1=ATAN2(0.,DENOM)
      IF (SUB.AND.Y.NE.0.) F1=F1-ATAN2(0.,Y)
      IF (SUPLE) GO TO 100
      G1=0.
      IF (BTERM.EQ.0.) GO TO 110
      IF (AT3.GT.0.) GO TO 90
      G1=(100.+ALOG(2.*BT1*ABS(Y)))*BTERMD
      IF (SUB.AND.Y.LT.0.) G1=-G1
      GO TO 120
90    ARG=T2+D*BTERM
      IF (SUP) ARG=ARG/AT3
      IF (ARG.GT.0.) G1=ALOG(ARG)*BTERMD
      GO TO 120
100   G1=ACOS(T2/AT3)*BTERMD
      GO TO 120
110   IF (T2.NE.0.) G1=D/T2
120   G2=100.
      IF (Y.EQ.0.) GO TO 130
      G2=ALOG((X+D)/ABS(Y))
      GO TO 140
130   IF (X.NE.0.) G2=G2+ALOG(2.*ABS(X))
      IF (X.LT.0.) G2=-G2
```

```
 140  C1=D
      G3=0.
      IF (.NOT.SUB) GO TO 150
      C1=X+D
      IF (Y.NE.0.) G3=ALOG(ABS(Y))
      IF (Y.EQ.0.) G3=-100.
 150  H=B*G1-G2+G3
      UC=-G1
      VC=H
      WC=F1
      UL=-T3*G1-Y*G2
      VL=T3*H+C1
      WL=T3*F1
C
 160  IF (BPOS) RETURN
      UC=-UC
      WC=-WC
      UL=-UL
      WL=-WL
      RETURN
 170  UC=0.
      VC=0.
      WC=0.
      UL=0.
      VL=0.
      WL=0.
      RETURN
      END
```

```
      SUBROUTINE VORVEL (UC,VC,WC,UL,VL,WL,ULT,VLT,WLT)
C
C     COMPUTE THE THREE COMPONENTS OF VELOCITY INDUCED AT A SPECIFIED
C     CONTROL POINT BY CONSTANT AND LINEARLY VARYING VORTEX
C     DISTRIBUTIONS ON A SWEPT QUADRILATERAL PANEL. VORVEL CALCULATES
C     THE VELOCITY INCUCED BY THE LEADING AND TRAILING CORNERS OF ONE
C     EDGE OF THE PANEL.
C
C     UC, VC, WC ARE VELOCITY COMPONENTS INDUCED BY CONSTANT CHORDWISE
C     AND SPANWISE VORTEX DISTRIBUTION
C
C     UL, VL, WL, ARE VELOCITY COMPCNENTS INDUCED BY LEADING EDGE OF
C     LINEAR CHORDWISE, CONSTANT SPANWISE VORTEX DISTRIBUTION
C
C     ULT, VLT, WLT ARE VELOCITY COMPONENTS INDUCED BY TRAILING EDGE OF
C     LINEAR CHORDWISE, CONSTANT SPANWISE VORTEX DISTRIBUTION
C
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMCN /COMPS/ X,DELTAY,DELTAZ,A,B,C,SUB,BPOS,COST,SINT,ML
      DIMENSION Q(51), XI(51), QX(51)
      LOGICAL SUB,SUP,BPOS,SUPLE,LBC
C
      DATA EPS/1.0E-6/,PI/3.14159265/
      IF (ABS(C).LE.EPS) C=0.
      CC=C*C
      SUP=.NOT.SUB
      SUPLE=.FALSE.
      IF (ABS(B).LE.EPS) B=0.
      AB=A+B
      SGN=1.0
      IF (SUP) SGN=-1.0
      B1=SGN+B*B
      SB1=SQRT(ABS(B1))
      Y=DELTAY*COST+DELTAZ*SINT
      Z=DELTAZ*COST-DELTAY*SINT
      IF (ABS(Y).LE.EPS) Y=0.
      IF (ABS(Z).LE.EPS) Z=0.
      X2=X*X
      Y2=Y*Y
      Z2=Z*Z
      R2=Y2+Z2
      R=SQRT(R2)
```

```
      IF (SUB) GO TO 10
      IF (ABS(B).LT.1.0) SUPLE=.TRUE.
      IF (X.LT.0.) GO TO 320
   10 D=0.
      D2=X2+SGN*R2
      IF (D2.GT.0.) D=SQRT(D2)
      AZ=A*Z
      T1=C-A*Y
      IF (ABS(T1).LE.EPS) T1=0.
      T2=T1*T1
      T3=X-B*Y
      AT3=ABS(T3)
      IF (AT3.LE.EPS) AT3=0.
      T4=AZ*AZ
      T5=T2+T4
      IF (T5.NE.0.) T5=1./T5
      T6=B*C-A*X
      T7=T6*T6
      T8=T7+SGN*(T2+T4)
      T9=T1*T3+A*B*Z2
      E=SQRT(ABS(T8))
      B2=SGN*(C*Y-A*R2)
      B3=B*X+SGN*Y
      B4=T5*T6
      TZ=T3*T3+B1*Z2
      IF (TZ.GT.0.) ST3=SQRT(TZ)
      WQ=0.
C
C     EVALUATION OF DOWNWASH INDUCED BY TRAILING VORTEX SHEET
C
      IF (A.EQ.0..OR.ML.EQ.2) GO TO 80
      MAX=11
      XI(1)=0.
      EL=1.0
      IF (SUP.AND.X.LT.C) EL=X/C
      DXI=EL/FLOAT(MAX-1)
      XO=0.
      IF (T1.NE.0.) XO=T3/T1
      DO 70 M=1,MAX
      Q(M)=0.
      IF (M.GT.1) XI(M)=XI(M-1)+DXI
      DX=X-XI(M)*C
      IF (SUP.AND.DX.LT.0.) GC TO 60
```

```
      IF (Y.LE.B*X) GO TO 320
      IF (X.LT.(B*Y+SB1*ABS(Z))) GO TO 320
      SZ=SIGN(1.0,Z)
      PZ=PI*SZ
      UC=PZ
      VC=-B*PZ
      WC=-SZ*SB1*PZ
      IF (T8.GT.0.) E=0.
      SL=PI*T5*(SZ*T9-Z*E)
      TL=SZ*E*T5*SL
      IF (T8.GT.0.) TL=PI*T5*T5*T8*ABS(Z)
      IF (ML.EQ.2) GO TO 90
      UL=SL
      VL=-((B+T1*B4)*SL-AZ*TL)/2.
      WL=AZ*B4*SL-T1*TL+A*WQ
      IF (.NOT.LBC.AND.ML.EQ.1) GO TO 310
90    ULS=SL+PZ
      ULT=ULS
      TT=SZ*E*T5*ULS
      IF (T8.GT.0.) TT=TL
      VLT=(A*PZ-(AB+T1*B4)*ULS+AZ*TT)/2.
      WLT=AZ*B4*ULS-T1*TT
      GO TO 310
100   IF (SUP.AND.D.EQ.0.) GO TO 320
      IF (Z.EQ.0.) GO TO 180
C
C     GENERAL EQUATIONS
C
      DENOM=B*R2-X*Y
      F1=ATAN2(Z*D,DENOM)
      IF (SUB) F1=F1-ATAN2(Z,Y)
      G1=0.
      IF (T8.EQ.0.) GO TO 130
      IF (C.EQ.0.) GO TO 110
      ARG=X*T6+B2
      IF (T8.LT.0.) GO TO 120
      ARG=(ARG+D*E)/(ST3*C)
      IF (SUP) ARG=ABS(ARG)
      IF (ARG.GT.0.) G1=ALOG(ARG)
      GO TO 130
110   IF (ST3.NE.0.) G1=ALOG(ST3)
      GO TO 130
120   ARG=ARG/(ST3*C)
```

```
      DX2=DX*DX
      BX=B-A*XI(M)
      BX2=BX*BX
      BX1=SGN+BX2
      SBX=SQRT(ABS(BX1))
      SDX=0.
      DXR=DX2+SGN*R2
      IF (DXR.GT.0.) SDX=SQRT(DXR)
      IF (SDX.EQ.0.) GO TO 20
      ARG=SGN*Y+BX*DX
      IF (SBX.EQ.0.) GO TO 40
      TZI=(T3-XI(M)*T1)**2+BX1*Z2
      IF (TZI.EQ.0.) GO TO 50
      STZ=SQRT(TZI)
      IF (SUP.AND.BX.LT.1.0) GO TO 30
      ARG=(ARG+SBX*SDX)/STZ
      IF (SUP) ARG=ABS(ARG)
      IF (ARG.GT.0.) Q(M)=ALOG(ARG)*BX/SBX
      GO TO 60
   20 IF (T1.LT.BX*T6.AND.T8.LT.0.) GO TO 60
      IF (Y.LE.BX*DX) GO TO 60
      IF (DX.LT.(BX*Y+SBX*ABS(Z))) GO TO 60
      Q(M)=PI*BX/SBX
      GO TO 60
   30 ARG=ARG/STZ
      IF (ARG.GT.1.0) GO TO 60
      IF (ARG.LE.-1.0) GO TO 20
      Q(M)=ACOS(ARG)*BX/SBX
      GO TO 60
   40 Q(M)=SDX*BX/ARG
      GO TO 60
   50 Q(M)=100.
      IF (Y.LT.0.) Q(M)=-ALOG(ABS(Y))*BX/SBX
   60 CONTINUE
      QX(M)=Q(M)*XI(M)
   70 CONTINUE
      CALL TRAP (XI,QX,WQ,MAX)
   80 CONTINUE
      IF (.NOT.SUPLE) GO TO 100
C
C     SPECIAL EQUATIONS FOR SUPERSONIC LEADING EDGE
C
      IF (D.GT.0.) GO TO 100
```

```
      IF (ABS(ARG).GT.1.0) GO TO 130
      G1=-ACOS(ARG)
  130 H1=0.
      IF (LBC.AND.ML.EQ.2) GO TO 150
      IF (SB1.EQ.0.) GO TO 150
      ARH=B3
      IF (SUPLE) GO TO 140
      ARH=(ARH+D*SB1)/ST3
      IF (ARH.GT.0.) H1=ALOG(ARH)
      GO TO 150
  140 H1=-ACOS(ARH/ST3)
  150 G2=ALOG((X+D)/R)
      G3=0.
      IF (SUB) G3=ALOG(R)
      C1=D
      IF (SUB) C1=X+C1
      C2=C1/R2
      H=SB1*H1-B*(G2-G3)
      IF (SB1.EQ.0.) H2=B*D/B3-G2+G3
      IF (SB1.NE.0.) H2=B*H1/SB1-G2+G3
      UC=F1
      VS=-B*F1+Z*C2
      WS=H-Y*C2
      VC=VS
      WC=WS
      IF (C.EQ.0.) C2=0.
      C3=0.
      C4=0.
      C5=G2/2.
      C6=0.
      IF (C.EQ.0.) GO TO 160
      C3=(X*C2+SGN*G2)/(2.*C)
      C4=((X2-SGN*R2/2.)*G2-1.5*X*D)/(2.*CC)
      C5=(D-X*G2)/C
  160 CONTINUE
      WQ=WQ-C4
      G=E*G1-T6*G2
      SL=T5*(T9*F1+Z*G)
      TL=-B*D
      IF (C.NE.0.) TL=(B2*G2+T6*D)/C
      TL=-T5*(T5*(G*T9-Z*T8*F1)+TL)
      IF (ML.EQ.2) GO TO 170
      UL=SL
```

```
      VL=-((B+T1*B4)*SL-AZ*TL)/2.+Z*C3
      WL=AZ*B4*SL-T1*TL-Y*C3+A*WQ
      IF (.NOT.LBC.AND.ML.EQ.1) GO TO 310
  170 ULS=SL+F1
      ULT=ULS
      TLT=TL-T5*G
      WQT=C5-C4-G3/2.
      VLS=(A*F1-(AB+T1*B4)*ULS+AZ*TLT)/2.+Z*(C2+C3)
      VLT=VLS
      WLS=AZ*B4*ULS-T1*TLT-Y*(C2+C3)+A*WQT
      WLT=WLS
      GO TO 310
C
C     SPECIAL EQUATIONS FOR Z=0
C
  180 CONTINUE
      F1=0.
      DENCM=-Y*T3
      IF (DENCM.NE.0.) F1=ATAN2(0.,DENOM)
      IF (SUB.AND.Y.NE.0.) F1=F1-ATAN2(0.,Y)
      G1=0.
      IF (T8.EQ.0.) GO TO 220
      IF (C.EQ.0.) GO TO 200
      IF (T8.LT.0.) GO TO 210
      IF (AT3.GT.0.) GO TO 190
      IF (Y.EQ.0..OR.T1.LE.0.) GO TO 220
      G1=ALOG(T1*ABS(Y))
      IF (SUB.AND.Y.LT.0.) G1=-G1
      IF (Y.GT.0.) G1=100.+G1
      GO TO 220
  190 ARG=(X*T6+SGN*Y*T1+D*E)/(AT3*C)
      IF (SUP) ARG=ABS(ARG)
      IF (ARG.GT.0.) G1=ALOG(ARG)
      GO TO 220
  200 IF (AT3.NE.0.) G1=ALOG(AT3)
      GO TO 220
  210 ARG=(X*T6-Y*T1)/(AT3*C)
      IF (ABS(ARG).GT.1.0) GO TO 220
      G1=-ACOS(ARG)
  220 H1=0.
      IF (LBC.AND.ML.EQ.2) GO TO 250
      IF (SB1.EQ.0.) GO TO 250
      IF (SUPLE) GO TO 240
```

```
      IF (AT3.GT.0.) GO TO 230
      IF (Y.EQ.0.) GO TO 250
      H1=ALOG(ABS(Y))
      IF (SUB.AND.Y.LT.0.) H1=-H1
      IF (Y.GT.0.) H1=100.+H1
      GO TO 250
  230 CONTINUE
      ARH=(B3+D*SB1)/AT3
      IF (ARH.GT.0.) H1=ALOG(ARH)
      GO TO 250
  240 H1=-ACOS(B3/AT3)
  250 G2=100.
      IF (Y.NE.0.) GO TO 260
      IF (X.NE.0.) G2=G2+ALOG(2.*ABS(X))
      IF (X.LT.0.) G2=-G2
      GO TO 270
  260 G2=ALOG((X+D)/ABS(Y))
  270 G3=0.
      C1=D
      IF (.NOT.SUB) GO TO 280
      C1=X+D
      G3=-100.
      IF (Y.NE.0.) G3=ALOG(ABS(Y))
  280 C2=0.
      IF (Y.NE.0.) C2=C1/Y2
      H=SB1*H1-B*(G2-G3)
      IF (SB1.EQ.0.) H2=B*D/B3-G2+G3
      IF (SB1.NE.0.) H2=B*H1/SB1-G2+G3
      UC=F1
      VS=-B*F1
      WS=H-Y*C2
      VC=VS
      WC=WS
      IF (C.EQ.0.) C2=0.
      C4=0.
      C5=G2/2.
      C6=0.
      IF (C.EQ.0.) GO TO 290
      C3=(X*C2+SGN*G2)/2.
      C4=((X2-SGN*Y2/2.)*G2-1.5*X*D)/(2.*CC)
      C5=(D-X*G2)/C
  290 CONTINUE
      WQ=WQ-C4
```

```
      WQT=C5-C4-G3/2.
      IF (T1.NE.0.) GO TO 300
      WL=A*WQ
      WLS=A*WQT
      WLT=WLS
      GO TO 330
300   SL=T3*F1/T1
      UL=SL
      VL=-(B+T6/T1)*SL/2.
      G=E*G1-T6*G2
      TL=T3*T5*G
      IF (C.EQ.0.) TL=TL-B*D/T1
      IF (C.NE.0.) TL=TL+(T6*D/T1+Y*(SGN*G2-C3))/C
      WL=TL+A*WQ
      IF (.NOT.LBC.AND.ML.EQ.1) GO TO 310
      ULS=SL+F1
      VLS=(A*F1-(AB+T6/T1)*ULS)/2.
      WLS=TL+G/T1-Y*C2+A*WQT
      ULT=ULS
      VLT=VLS
      WLT=WLS
310   RETURN
320   UC=0.
      VC=0.
      WC=0.
      WL=0.
      WLT=0.
330   UL=0.
      VL=0.
      ULT=0.
      VLT=0.
      IF (C.EQ.0.) GO TO 310
      RETURN
      END
```

```
      OVERLAY(LWB,2,3)
      PROGRAM WNGVEL
C
C     COMPUTE THE THREE COMPONENTS OF VELOCITY INCUCED AT SPECIFIED
C     CONTROL POINTS BY VORTEX PANELS LOCATED ON WING, FIN (VERTICAL
C     TAIL), OR CANARC (HORIZONTAL TAIL) SURFACES.
C
C
      COMMON /PARAM/ NBODY,NWING,NPANEL,LBC,THK,MACH,ALPHA,REFA
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,PRINT,NWTHK
      COMMON /SEG/ NSEG,NROW(20),NCOL(20),COSS(20),SINS(20),TT(20),NWT(2
     10),SPNW(20),XLEW(20),BLE(20),ZLEW(20),XS(20),YS(20),ZS(20)
      COMMCN /COMPS/ XJ,YJ,ZJ,AL,BL,CL,SUB,BPCS,M,NSIDE
      COMMON /POINT/ ARRAY(6000)
      COMMON /SCRAT/ DUMMY(1440),A(30),CI(30),CO(30),AC(600),UC(600),VC(
     1600),WC(600),COSBD(600),SINBD(600),TANBD(600),DC(60),DUM(990),UL(3
     20),VL(30),WL(30),AN(30),ZU(30,20)
      COMMON /TRAN/ SIND,COSD,TAND,SINT,CCST,CCNTC,SINTI,COSTI,CCN,BCON,
     1DI
      COMMON /BTHET/ THETI(600)
C
      DIMENSION XPT(600), YPT(600), ZPT(600), THET(600), DELTA(600), XC(
     130,20), YC(30,20), ZC(30,20), DELTI(600)
C
      EQUIVALENCE (ARRAY,XPT), (ARRAY(601),YPT), (ARRAY(1201),ZPT), (ARR
     1AY(1801),THET), (ARRAY(2401),DELTA), (ARRAY(3001),XC), (ARRAY(3601
     2),YC), (ARRAY(4201),ZC), (ARRAY(4801),DELTI)
C
      LOGICAL THK,LBC,SUB,BPCS
      INTEGER PRINT
      REAL MACH
      DATA PI/3.14159265/
      SUB=MACH.LT.1.0
      SGN=-1.0
      IF (SUB) SGN=1.0
      BETA=SQRT(ABS(MACH*MACH-1.0))
      CON=1./(2.*PI)
      IF (SUB) CCN=CCN/2.
      BCON=BETA*CCN
      IF (NPART.NE.2) GO TO 10
      REWIND 7
      READ (7) (DUMMY(N),N=1,1800),(THET(N),N=1,600),(DELTA(N),N=1,600)
```

```
      REWIND 7
 10   CONTINUE
      DO 20 N=1,NWING
      BD=BETA*TAN(DELTA(N))
      TANBD(N)=BD
      ARG=1.+SGN*BD*BD
      IF (ARG.LT.0.) GO TO 320
      COSBD(N)=1./SQRT(ARG)
 20   SINBD(N)=BD*COSBD(N)
C
C     I IS THE INDEX OF THE CONTROL POINT
C     J IS THE INDEX OF THE INFLUENCING PANEL
C
      DO 310 I=1,NPOINT
      IF (NPART.EQ.2) GO TO 30
      SINTI=SIN(THET(I))
      COSTI=COS(THET(I))
      DI=TANBD(I)
      GO TO 40
 30   SINTI=SIN(THETI(I))
      COSTI=COS(THETI(I))
      DI=BETA*TAN(DELTI(I))
 40   XI=XPT(I)
      YI=YPT(I)
      ZI=ZPT(I)
      J=0
      JJ=0
      J2=0
      N2=0
C
C     COMPUTE INFLUENCE OF EACH WING SEGMENT
C
      DO 270 NS=1,NSEG
      NR=NROW(NS)
      NC=NCOL(NS)
      NR1=NR+1
      NR2=2*NR
      NC1=NC+1
      NT=NWT(NS)
      NI=N2+1
      IF (NS.GT.1.AND.NT.NE.0) NI=NI+1
      N2=NI+NC-1
C
```

```
C     COMPUTE INFLUENCE OF EACH COLUMN OF PANELS
C
      DO 270 N=NI,N2
      J1=1+J2
      J2=J1+NR2-1
      JL=J1
      JT=J1+NR
      I1=JT-1
      I2=I1+NR
C
C     COMPUTE VELOCITIES INDUCED BY POINT SOURCE
C
      DXS=XI-XS(N)
      DYS=(YI-YS(N))*BETA
      DZS=(ZI-ZS(N))*BETA
      S2=DXS**2+DYS**2+DZS**2
      IF (S2.GT.0.) S=SQRT(S2)
      S3=0.
      IF (S2.GT.0.) S3=1./(S*S2)
      US=CCN*DXS*S3
      VS=BCON*DYS*S3*SGN
      WS=BCON*DZS*S3*SGN
      AS=WS*COSTI-VS*SINTI-US*DI
C
C     COMPUTE INFLUENCE OF UPPER AND LOWER SURFACES
C
      DO 260 NSIDE=1,2
C
C     COMPUTE INFLUENCE OF EACH PANEL
C
      DO 260 L=1,NR1
      J=J+1
      IF (L.EQ.NR1) GO TO 140
      JJ=JJ+1
      SIND=SINBD(JJ)
      COSD=COSBD(JJ)
      TAND=TANBD(JJ)
      THETA=THET(JJ)
      COST=COS(THETA)
      SINT=SIN(THETA)
      COSTD=COST*COSD
      CONTD=SQRT(SGN*TAND*TAND+COST*COST)
      COSDTD=1./(COSD*CCNTD)
```

```
      CONTDD=1./CONTD                                                   X1290
C                                                                       X1300
C     COMPUTE PANEL LEADING AND TRAILING EDGE SLOPES                    X1310
C                                                                       X1320
      DO 50 M=1,2                                                       X1330
      M1=L+M-1                                                          X1340
      DXC=XC(M1,N+1)-XC(M1,N)                                           X1350
      DYC=YC(M1,N+1)-YC(M1,N)                                           X1360
      IF (NSIDE.EQ.1) DZC=ZU(M1,N+1)-ZU(M1,N)                           X1370
      IF (NSIDE.EQ.2) DZC=ZC(M1,N+1)-ZC(M1,N)                           X1380
      DYC=BETA*DYC                                                      X1390
      DZC=BETA*DZC                                                      X1400
      DZL=DZC*COSTD-DXC*SIND                                            X1410
      DYL=DYC*COSD*CONTD+SINT*DZL*CONTDD                                X1420
      DXL=(DXC*COSTD+DZC*SIND*SGN)*COSDTD                               X1430
      BL=DXL/DYL                                                        X1440
      IF (M.EQ.1) BLE=BL                                                X1450
      IF (M.EQ.2) BTE=BL                                                X1460
50    CONTINUE                                                          X1470
      AL=BLE-BTE                                                        X1480
      A(L)=AL                                                           X1490
C                                                                       X1500
C     COMPUTE PANEL CHORD LENGTHS                                       X1510
C                                                                       X1520
      DO 130 K=1,2                                                      X1530
      N1=N+K-1                                                          X1540
      DXC=XC(L+1,N1)-XC(L,N1)                                           X1550
      DYC=YC(L+1,N1)-YC(L,N1)                                           X1560
      IF (NSIDE.EQ.1) DZC=ZU(L+1,N1)-ZU(L,N1)                           X1570
      IF (NSIDE.EQ.2) DZC=ZC(L+1,N1)-ZC(L,N1)                           X1580
      CL=(DXC*COSTD+BETA*DZC*SIND*SGN)*COSDTD                           X1590
      IF (K.EQ.1) CI(L)=CL                                              X1600
      IF (K.EQ.2) CO(L)=CL                                              X1610
C                                                                       X1620
C     COMPUTE INFLUENCE OF PANEL CORNERS                                X1630
C                                                                       X1640
      DO 130 M=1,2                                                      X1650
      M1=L+M-1                                                          X1660
C                                                                       X1670
C     COMPUTE CONTROL POINT IN PANEL COORDINATE SYSTEM                  X1680
C                                                                       X1690
      DX=XI-XC(M1,N1)                                                   X1700
      DY=YI-YC(M1,N1)                                                   X1710
```

```
      IF (NSIDE.EQ.1) DZ=ZI-ZU(M1,N1)
      IF (NSIDE.EQ.2) DZ=ZI-ZC(M1,N1)
      DY=BETA*DY
      DZ=BETA*DZ
      XJ=(DX*COSTD+DZ*SIND*SGN)*COSDTD
      ZJ=DZ*COSTD-DX*SIND
      YJ=DY*COSD*CONTD+SINT*ZJ*CONTDD
      ZJ=ZJ-DY*COSD*SINT
      IF (M.EQ.1) BL=BLE
      IF (M.EQ.2) BL=BTE
      IF (K.EQ.2) GO TO 90
      IF (M.EQ.2) GO TO 60
      CALL VORPAN (UCIR,VCIR,WCIR,ULIR,VLIR,WLIR,X,X,X,VEIR,WEIR,VAIR,WA
     1IR)
      GO TO 70
60    CALL VORPAN (RCIR,SCIR,TCIR,X,X,X,RLIR,SLIR,TLIR,SEIR,TEIR,SAIR,TA
     1IR)
70    DY=-YI-YC(M1,N1)
      DY=BETA*DY
      ZJ=DZ*COSTD-DX*SIND
      YJ=DY*COSD*CONTD+SINT*ZJ*CONTDD
      ZJ=ZJ-DY*COSD*SINT
      IF (M.EQ.2) GO TO 80
      CALL VORPAN (UCIL,VCIL,WCIL,ULIL,VLIL,WLIL,X,X,X,VEIL,WEIL,VAIL,WA
     1IL)
      GO TO 130
80    CALL VORPAN (RCIL,SCIL,TCIL,X,X,X,RLIL,SLIL,TLIL,SEIL,TEIL,SAIL,TA
     1IL)
      GO TO 130
90    IF (M.EQ.2) GO TO 100
      CALL VORPAN (UCOR,VCOR,WCOR,ULOR,VLOR,WLOR,X,X,X,VEOR,WEOR,VAOR,WA
     1OR)
      GO TO 110
100   CALL VORPAN (RCOR,SCOR,TCOR,X,X,X,RLOR,SLOR,TLOR,SEOR,TEOR,SAOR,TA
     1OR)
110   DY=-YI-YC(M1,N1)
      DY=BETA*DY
      ZJ=DZ*COSTD-DX*SIND
      YJ=DY*COSD*CONTD+SINT*ZJ*CONTDD
      ZJ=ZJ-DY*COSD*SINT
      IF (M.EQ.2) GO TO 120
      CALL VORPAN (UCOL,VCOL,WCOL,ULOL,VLOL,WLOL,X,X,X,VEOL,WEOL,VAOL,WA
     1OL)
```

```
      GO TO 130
  120 CALL VORPAN (RCOL,SCOL,TCOL,X,X,X,RLOL,SLOL,TLOL,SEOL,TEOL,SAOL,TA
     1OL)
  130 CONTINUE
      GO TO 170
C
C     COMPUTE INFLUENCE OF WAKE- NOTE- PLANAR WAKE ASSUMED
C
  140 SINT=SINS(NS)
      COST=COSS(NS)
      CONTD=CCSD
      COSDTD=1./(COSD*CONTD)
      CONTDD=1./CONTD
      TAND=0.
      SIND=0.
      COSD=1.0
      BCOS=BETA*COST
      BSIN=BETA*SINT
      DXC=XC(NR1,N+1)-XC(NR1,N)
      DYC=YC(NR1,N+1)-YC(NR1,N)
      DZC=ZC(NR1,N+1)-ZC(NR1,N)
      DYL=DYL*COST+DZC*SINT
      BL=DXC/(BETA*DYL)
      AL=0.
      CL=1.0
      M=1
      DO 160 K=1,2
      N1=N+K-1
      XJ=XI-XC(NR1,N1)
      DY=YI-YC(NR1,N1)
      DZ=ZI-ZC(NR1,N1)
      YJ=DY*BCOS+DZ*BSIN
      ZJ=DZ*BCCS-DY*BSIN
      IF (K.EQ.2) GO TC 150
      CALL VORPAN (X,X,X,X,X,X,X,X,X,VEIR,WEIR,VAIR,WAIR)
      DY=-YI-YC(NR1,N1)
      YJ=DY*BCOS+DZ*BSIN
      ZJ=DZ*BCOS-DY*BSIN
      CALL VORPAN (X,X,X,X,X,X,X,X,X,VEIL,WEIL,VAIL,WAIL)
      GO TO 160
  150 CALL VORPAN (X,X,X,X,X,X,X,X,X,VEOR,WEGR,VACR,WAOR)
      DY=-YI-YC(NR1,N1)
      YJ=DY*BCOS+DZ*BSIN
```

```
      ZJ=DZ*BCOS-DY*BSIN
      CALL VORPAN (X,X,X,X,X,X,X,X,X,VEOL,WECL,VACL,WAOL)
      SEIR=0.
      SEIL=0.
      SEOL=0.
      SEOR=0.
      SAIR=0.
      SAIL=0.
      SAOL=0.
      SAOR=0.
      TAIR=0.
      TAIL=0.
      TAOL=0.
      TAOR=0.
      TEIR=0.
      TEIL=0.
      TEOR=0.
      TEOL=0.
160   CONTINUE
170   CONTINUE
C
C     COMBINE CORNER INFLUENCES TO OBTAIN PANEL VELOCITY COMPONENTS
C
      UAR=0.
      VAR=VAIR-VAOR-SAIR+SAOR
      WAR=WAIR-WAOR-TAIR+TAOR
      UAL=0.
      VAL=VAIL-VAOL-SAIL+SAOL
      WAL=WAIL-WAOL-TAIL+TAOL
      UIR=0.
      VIR=VEIR-SEIR
      WIR=WEIR-TEIR
      UIL=0.
      VIL=VEIL-SEIL
      WIL=WEIL-TEIL
      UOR=0.
      VOR=VEOR-SEOR
      WOR=WEOR-TEOR
      UOL=0.
      VCL=VEOL-SEOL
      WOL=WEOL-TECL
      IF (L.EQ.NR1) GO TO 180
      ULR=ULIR-ULOR-RLIR+RLOR
```

```
      ULL=ULIL-ULOL-RLIL+RLOL
      VLR=VLIR-VLOR-SLIR+SLOR
      VLL=VLIL-VLOL-SLIL+SLOL
      WLR=WLIR-WLOR-TLIR+TLOR
      WLL=WLIL-WLOL-TLIL+TLOL
      UCR=UCIR-UCOR-RCIR+RCOR-ULR
      UCL=UCIL-UCOL-RCIL+RCOL-ULL
      VCR=VCIR-VCOR-SCIR+SCOR-VLR
      VCL=VCIL-VCOL-SCIL+SCCL-VLL
      WCR=WCIR-WCOR-TCIR+TCOR-WLR
      WCL=WCIL-WCOL-TCIL+TCCL-WLL
C
C     COMBINE CONTRIBUTICNS OF LEFT AND RIGHT WING PANELS AND TRANSFORM
C     VELOCITY COMPONENTS BACK TO ORIGINAL CCORDINATE SYSTEM
C
      CALL TRANS (UCR,VCR,WCR,UCL,VCL,WCL,UC(J),VC(J),WC(J),AC(J))
      CALL TRANS (ULR,VLR,WLR,ULL,VLL,WLL,UL(L+1),VL(L+1),WL(L+1),AN(L+1
     1))
      IF (L.EQ.1) GO TO 220
180   CALL TRANS (UIR,VIR,WIR,UIL,VIL,WIL,UI,VI,WI,AI)
      CALL TRANS (UOR,VOR,WOR,UOL,VCL,WOL,UO,VO,WC,AO)
      CALL TRANS (UAR,VAR,WAR,UAL,VAL,WAL,UA,VA,WA,BA)
      IF (L.EQ.NR1) GO TO 190
      UC(J)=UC(J)+UL(L)
      VC(J)=VC(J)+VL(L)
      WC(J)=WC(J)+WL(L)
      AC(J)=AC(J)+AN(L)
      GO TO 200
190   UC(J)=UL(L)
      VC(J)=VL(L)
      WC(J)=WL(L)
      AC(J)=AN(L)
200   CONTINUE
C
C     ADD CONTRIBUTICN OF THE WAKE
C
      DO 210 K=2,L
      K1=K-1
      UW=UI*CI(K1)-UO*CO(K1)+UA*A(K1)
      VW=VI*CI(K1)-VO*CO(K1)+VA*A(K1)
      WW=WI*CI(K1)-WC*CO(K1)+WA*A(K1)
      AW=AI*CI(K1)-AC*CO(K1)+BA*A(K1)
      JK=JL+K-2
```

```
      IF (NSIDE.EQ.2.AND.K.GT.2) JK=JK+NR
      UC(JK)=UC(JK)+UW
      VC(JK)=VC(JK)+VW
      WC(JK)=WC(JK)+WW
      AC(JK)=AC(JK)+AW
      IF (L.EQ.NR1) GO TO 210
      JM=JK+1
      IF (NSIDE.EQ.2.AND.K.EQ.2) JM=JM+NR
      UC(JM)=UC(JM)+UW
      VC(JM)=VC(JM)+VW
      WC(JM)=WC(JM)+WW
      AC(JM)=AC(JM)+AW
210   CONTINUE
220   CONTINUE
      IF (NSIDE.EQ.1) GO TO 240
      IF (L.NE.1) GO TO 230
C
C     SPECIAL CASE FOR LEADING EDGE PANELS
C
      UC(JL)=UC(JL)+UC(J)
      VC(JL)=VC(JL)+VC(J)
      WC(JL)=WC(JL)+WC(J)
      AC(JL)=AC(JL)+AC(J)
      J=J-1
230   IF (L.NE.NR1) GO TO 240
      J=J-1
240   IF (NWING.LE.NMAX) GO TO 250
      IF (NPART.EQ.2) GO TO 250
      IF (I.LT.J1.OR.I.GT.J2) GO TO 250
      JS1=J1
      JS2=J2
      NRS=NR2
250   CONTINUE
260   CONTINUE
      UC(JT)=US
      VC(JT)=VS
      WC(JT)=WS
      AC(JT)=AS
270   CONTINUE
      NWING=J
      NWTHK=NWING
      IF (NWING.LE.NMAX) GO TO 290
      IF (NPART.EQ.2) GO TO 290
```

```
C
C     STORE DIAGONAL BLOCKS OF AERODYNAMIC MATRIX IN DC ARRAY
C
      DO 280 J=1,NWING
      IF (J.LT.JS1.OR.J.GT.JS2) GO TO 280
      M=J-JS1+1
      DC(M)=AC(J)
      AC(J)=0.
  280 CONTINUE
      WRITE (10) (DC(J),J=1,NRS)
  290 CONTINUE
      IF (IABS(PRINT).LT.4) GO TO 300
      WRITE (6,370) I
      WRITE (6,330) NWING
      WRITE (6,360) (UC(J),J=1,NWING)
C     WRITE(6,6) (VC(J),J=1,NWING)
C     WRITE(6,6) (WC(J),J=1,NWING)
      WRITE (6,340) NWING
      WRITE (6,360) (AC(J),J=1,NWING)
      IF (NWING.GT.NMAX) WRITE (6,350) NR
      IF (NWING.GT.NMAX) WRITE (6,360) (DC(J),J=1,NRS)
  300 WRITE (8) (UC(J),VC(J),WC(J),J=1,NWING)
      WRITE (9) (AC(J),J=1,NWING)
  310 CONTINUE
      RETURN
  320 WRITE (6,380)
      CALL EXIT
C
C
  330 FORMAT (2X,10HUC(J),J=1,,I3)
  340 FORMAT (2X,10HAC(J),J=1,,I3)
  350 FORMAT (2X,10HDC(J),J=1,,I3)
  360 FORMAT (1H0,10F10.5)
  370 FORMAT (1H0,22HAERODYNAMIC MATRIX, I=I3)
  380 FORMAT (1H0,43HERROR - WING PANEL SLOPE EXCEEDS MACH ANGLE)
      END
```

```
      SUBROUTINE VORPAN (UC,VC,WC,UL,VL,WL,ULT,VLT,WLT,VE,WE,VA,WA)
C
C     COMPUTE THE THREE COMPONENTS OF VELOCITY INDUCED AT A SPECIFIED
C     CONTROL POINT BY CONSTANT AND LINEARLY VARYING VORTEX
C     DISTRIBUTIONS ON A SWEPT QUADRILATERAL PANEL. ALSO COMPUTE THE
C     THREE COMPONENTS OF VELOCITY INDUCED BY THE CONCENTRATED VORTEX
C     LYING ALONG THE DOWNSTREAM EXTENSION OF THE INBOARD EDGE AS WELL
C     AS THE VORTEX SHEET LOCATED DOWNSTREAM OF THE TRAILING EDGE
C     BETWEEN THE INBOARD EDGE AND THE INTERSECTION OF THE LEADING AND
C     TRAILING EDGES OF THE PANEL.
C
C     UC, VC, WC ARE VELOCITY COMPONENTS INDUCED BY CONSTANT CHORDWISE
C     AND SPANWISE VORTEX DISTRIBUTION
C
C     UL, VL, WL, ARE VELOCITY COMPONENTS INDUCED BY LEADING EDGE OF
C     LINEAR CHORDWISE, CONSTANT SPANWISE VORTEX DISTRIBUTION
C
C     ULT, VLT, WLT ARE VELOCITY COMPONENTS INDUCED BY TRAILING EDGE OF
C     LINEAR CHORDWISE, CONSTANT SPANWISE VORTEX DISTRIBUTICN
C
C     VE, WE ARE VELOCITY COMPONENTS INDUCED BY CONCENTRATED VORTICES
C     IN THE WAKE
C
C     VA, WA ARE VELOCITY COMPONENTS INDUCED BY VORTEX SHEET IN THE
C     WAKE
C
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMON /COMPS/ X,Y,Z,A,B,C,SUB,BPOS,ML,NS
      DIMENSION Q(51), XI(51), QX(51)
      LOGICAL SUB,SUP,BPOS,SUPLE,LBC
C
      DATA EPS/1.0E-6/,PI/3.14159265/
      IF (ABS(C).LE.EPS) C=0.
      CC=C*C
      SUP=.NOT.SUB
      SUPLE=.FALSE.
      IF (ABS(B).LE.EPS) B=0.
      AB=A+B
      SGN=1.0
      IF (SUP) SGN=-1.0
      B1=SGN+B*B
      SB1=SQRT(ABS(B1))
```

```
      IF (ABS(Y).LE.EPS) Y=0.
      IF (ABS(Z).LE.EPS) Z=0.
      X2=X*X
      Y2=Y*Y
      Z2=Z*Z
      R2=Y2+Z2
      R=SQRT(R2)
      VA=0.
      VE=0.
      WA=0.
      WE=0.
      IF (SUB) GO TO 10
      IF (ABS(B).LT.1.0) SUPLE=.TRUE.
      IF (X.LT.0.) GO TO 340
   10 D=0.
      D2=X2+SGN*R2
      IF (D2.GT.0.) D=SQRT(D2)
      AZ=A*Z
      T1=C-A*Y
      IF (ABS(T1).LE.EPS) T1=0.
      T2=T1*T1
      T3=X-B*Y
      AT3=ABS(T3)
      IF (AT3.LE.EPS) AT3=0.
      T4=AZ*AZ
      T5=T2+T4
      IF (T5.NE.0.) T5=1./T5
      T6=B*C-A*X
      T7=T6*T6
      T8=T7+SGN*(T2+T4)
      T9=T1*T3+A*B*Z2
      E=SQRT(ABS(T8))
      B2=SGN*(C*Y-A*R2)
      B3=B*X+SGN*Y
      B4=T5*T6
      TZ=T3*T3+B1*Z2
      IF (TZ.GT.0.) ST3=SQRT(TZ)
      WQ=0.
C
C     EVALUATION OF DOWNWASH INDUCED BY TRAILING VORTEX SHEET
C
      IF (A.EQ.0..OR.ML.EQ.2) GO TO 80
      MAX=11
```

```
      XI(1)=0.
      EL=1.0
      IF (SUP.AND.X.LT.C) EL=X/C
      DXI=EL/FLOAT(MAX-1)
      XO=0.
      IF (T1.NE.0.) XO=T3/T1
      DO 70 M=1,MAX
      Q(M)=0.
      IF (M.GT.1) XI(M)=XI(M-1)+DXI
      DX=X-XI(M)*C
      IF (SUP.AND.DX.LT.0.) GO TO 60
      DX2=DX*DX
      BX=B-A*XI(M)
      BX2=BX*BX
      BX1=SGN+BX2
      SBX=SQRT(ABS(BX1))
      SDX=0.
      DXR=DX2+SGN*R2
      IF (DXR.GT.0.) SDX=SQRT(DXR)
      IF (SDX.EQ.0.) GO TO 20
      ARG=SGN*Y+BX*DX
      IF (SBX.EQ.0.) GO TO 40
      TZI=(T3-XI(M)*T1)**2+BX1*Z2
      IF (TZI.EQ.0.) GO TO 50
      STZ=SQRT(TZI)
      IF (SUP.AND.BX.LT.1.0) GO TO 30
      ARG=(ARG+SBX*SDX)/STZ
      IF (SUP) ARG=ABS(ARG)
      IF (ARG.GT.0.) Q(M)=ALOG(ARG)*BX/SBX
      GO TO 60
20    IF (T1.LT.BX*T6.AND.T8.LT.0.) GO TO 60
      IF (Y.LE.BX*DX) GO TO 60
      IF (DX.LT.(BX*Y+SBX*ABS(Z))) GO TO 60
      Q(M)=PI*BX/SBX
      GO TO 60
30    ARG=ARG/STZ
      IF (ARG.GT.1.0) GO TO 60
      IF (ARG.LE.-1.0) GO TO 20
      Q(M)=ACOS(ARG)*BX/SBX
      GO TO 60
40    Q(M)=SDX*BX/ARG
      GO TO 60
50    Q(M)=100.
```

```
      IF (Y.LT.0.) Q(M)=-ALOG(ABS(Y))*BX/SBX                            Y1290
   60 CONTINUE                                                          Y1300
      QX(M)=Q(M)*XI(M)                                                  Y1310
   70 CONTINUE                                                          Y1320
      CALL TRAP (XI,QX,WQ,MAX)                                          Y1330
   80 CONTINUE                                                          Y1340
      IF (.NOT.SUPLE) GO TO 100                                         Y1350
C                                                                       Y1360
C     SPECIAL EQUATIONS FOR SUPERSONIC LEADING EDGE                     Y1370
C                                                                       Y1380
      IF (D.GT.0.) GO TO 100                                            Y1390
      IF (Y.LE.B*X) GO TO 340                                           Y1400
      IF (X.LT.(B*Y+SB1*ABS(Z))) GO TO 340                              Y1410
      SZ=SIGN(1.0,Z)                                                    Y1420
      PZ=PI*SZ                                                          Y1430
      UC=PZ                                                             Y1440
      VC=-B*PZ                                                          Y1450
      WC=-SZ*SB1*PZ                                                     Y1460
      IF (T8.GT.0.) E=0.                                                Y1470
      SL=PI*T5*(SZ*T9-Z*E)                                              Y1480
      TL=SZ*E*T5*SL                                                     Y1490
      IF (T8.GT.0.) TL=PI*T5*T5*T8*ABS(Z)                               Y1500
      IF (ML.EQ.2) GO TO 90                                             Y1510
      UL=SL                                                             Y1520
      VL=-((B+T1*B4)*SL-AZ*TL)*0.5                                      Y1530
      WL=AZ*B4*SL-T1*TL+A*WQ                                            Y1540
      IF (.NOT.LBC.AND.ML.EQ.1) GO TO 330                               Y1550
   90 ULS=SL+PZ                                                         Y1560
      ULT=ULS                                                           Y1570
      TT=SZ*E*T5*ULS                                                    Y1580
      IF (T8.GT.0.) TT=TL                                               Y1590
      VLT=(A*PZ-(AB+T1*B4)*ULS+AZ*TT)*0.5                               Y1600
      WLT=AZ*B4*ULS-T1*TT                                               Y1610
      GO TO 330                                                         Y1620
  100 IF (SUP.AND.D.EQ.0.) GO TO 340                                    Y1630
      IF (Z.EQ.0.) GO TO 190                                            Y1640
C                                                                       Y1650
C     GENERAL EQUATIONS                                                 Y1660
C                                                                       Y1670
      DENOM=B*R2-X*Y                                                    Y1680
      F1=ATAN2(Z*D,DENOM)                                               Y1690
      IF (SUB) F1=F1-ATAN2(Z,Y)                                         Y1700
      G1=0.                                                             Y1710
```

```
      IF (T8.EQ.0.) GO TO 130
      IF (C.EQ.0.) GO TO 110
      ARG=X*T6+B2
      IF (T8.LT.0.) GO TO 120
      ARG=(ARG+D*E)/(ST3*C)
      IF (SUP) ARG=ABS(ARG)
      IF (ARG.GT.0.) G1=ALOG(ARG)
      GO TO 130
110   IF (ST3.NE.0.) G1=ALOG(ST3)
      GO TO 130
120   ARG=ARG/(ST3*C)
      IF (ABS(ARG).GT.1.0) GO TO 130
      G1=-ACOS(ARG)
130   H1=C.
      IF (LBC.AND.ML.EQ.2) GO TO 150
      IF (SB1.EQ.0.) GO TO 150
      ARH=B3
      IF (SUPLE) GO TO 140
      ARH=(ARH+D*SB1)/ST3
      IF (ARH.GT.0.) H1=ALOG(ARH)
      GO TO 150
140   H1=-ACOS(ARH/ST3)
150   G2=ALOG((X+D)/R)
      G3=0.
      IF (SUB) G3=ALOG(R)
      C1=D
      IF (SUB) C1=X+C1
      C2=C1/R2
      H=SB1*H1-B*(G2-G3)
      IF (SB1.EQ.0.) H2=B*D/B3-G2+G3
      IF (SB1.NE.0.) H2=B*H1/SB1-G2+G3
      UC=F1
      VS=-B*F1+Z*C2
      WS=H-Y*C2
      VC=VS
      WC=WS
      IF (C.EQ.0.) C2=0.
      C3=0.
      C4=0.
      C5=G2/2.
      IF (C.EQ.0.) GO TO 160
      C3=(X*C2+SGN*G2)/(2.*C)
      C4=((X2-SGN*R2*0.5)*G2-1.5*X*D)/(2.*CC)
```

```
      C5=(D-X*G2)/C                                                     Y2150
  160 IF (LBG) GO TO 170                                                Y2160
      C6=.50/R2                                                         Y2170
      IF (SUB) C6=C6*C1/D                                               Y2180
      C2=C2+C6*C                                                        Y2190
      VB=-F1*0.5                                                        Y2200
      WB=H2*0.5                                                         Y2210
      VD=Z*C6                                                           Y2220
      WD=-Y*C6                                                          Y2230
      VA=VB                                                             Y2240
      WA=WB                                                             Y2250
      VE=VD                                                             Y2260
      WE=WD                                                             Y2270
      IF (ML.EQ.1) GO TO 170                                            Y2280
      VC=VS+C*VD+A*VB                                                   Y2290
      WC=WS+C*WD+A*WB                                                   Y2300
  170 WQ=WQ-C4                                                          Y2310
      G=E*G1-T6*G2                                                      Y2320
      SL=T5*(T9*F1+Z*G)                                                 Y2330
      TL=-B*D                                                           Y2340
      IF (C.NE.O.) TL=(B2*G2+T6*D)/C                                    Y2350
      TL=-T5*(T5*(G*T9-Z*T8*F1)+TL)                                     Y2360
      IF (ML.EQ.2) GO TO 180                                            Y2370
      UL=SL                                                             Y2380
      VL=-((B+T1*B4)*SL-AZ*TL)*0.5+Z*C3                                 Y2390
      WL=AZ*B4*SL-T1*TL-Y*C3+A*WQ                                       Y2400
      IF (.NOT.LBC.AND.ML.EQ.1) GO TO 330                               Y2410
  180 ULS=SL+F1                                                         Y2420
      ULT=ULS                                                           Y2430
      TLT=TL-T5*G                                                       Y2440
      WQT=C5-C4-G3*0.5                                                  Y2450
      VLS=(A*F1-(AB+T1*B4)*ULS+AZ*TLT)*0.5+Z*(C2+C3)                    Y2460
      VLT=VLS                                                           Y2470
      WLS=AZ*B4*ULS-T1*TLT-Y*(C2+C3)+A*WQT                              Y2480
      WLT=WLS                                                           Y2490
      IF (LBC) GO TO 330                                                Y2500
      VLT=VLS+A*VB                                                      Y2510
      WLT=WLS+A*WB                                                      Y2520
      GO TO 330                                                         Y2530
C                                                                       Y2540
C     SPECIAL EQUATIONS FOR Z=0                                         Y2550
C                                                                       Y2560
  190 CONTINUE                                                          Y2570
```

```
      F1=0.                                                             Y2580
      DENOM=-Y*T3                                                       Y2590
      IF (DENOM.NE.0.) F1=ATAN2(0.,DENOM)                               Y2600
      IF (SUB.AND.Y.NE.0.) F1=F1-ATAN2(0.,Y)                            Y2610
      IF (NS.EQ.2) F1=-F1                                               Y2620
      G1=0.                                                             Y2630
      IF (T8.EQ.0.) GO TO 230                                           Y2640
      IF (C.EQ.0.) GO TO 210                                            Y2650
      IF (T8.LT.0.) GO TO 220                                           Y2660
      IF (AT3.GT.0.) GO TO 200                                          Y2670
      IF (Y.EQ.0..OR.T1.LE.0.) GO TO 230                                Y2680
      G1=ALOG(T1*ABS(Y))                                                Y2690
      IF (SUB.AND.Y.LT.0.) G1=-G1                                       Y2700
      IF (Y.GT.0.) G1=100.+G1                                           Y2710
      GO TO 230                                                         Y2720
  200 ARG=(X*T6+SGN*Y*T1+D*E)/(AT3*C)                                   Y2730
      IF (SUP) ARG=ABS(ARG)                                             Y2740
      IF (ARG.GT.0.) G1=ALOG(ARG)                                       Y2750
      GO TO 230                                                         Y2760
  210 IF (AT3.NE.0.) G1=ALOG(AT3)                                       Y2770
      GO TO 230                                                         Y2780
  220 ARG=(X*T6-Y*T1)/(AT3*C)                                           Y2790
      IF (ABS(ARG).GT.1.0) GO TO 230                                    Y2800
      G1=-ACOS(ARG)                                                     Y2810
  230 H1=0.                                                             Y2820
      IF (LBC.AND.ML.EQ.2) GO TO 260                                    Y2830
      IF (SB1.EQ.0.) GO TO 260                                          Y2840
      IF (SUPLE) GO TO 250                                              Y2850
      IF (AT3.GT.0.) GO TO 240                                          Y2860
      IF (Y.EQ.0.) GO TO 260                                            Y2870
      H1=ALOG(ABS(Y))                                                   Y2880
      IF (SUB.AND.Y.LT.0.) H1=-H1                                       Y2890
      IF (Y.GT.0.) H1=100.+H1                                           Y2900
      GO TO 260                                                         Y2910
  240 CONTINUE                                                          Y2920
      ARH=(B3+D*SB1)/AT3                                                Y2930
      IF (ARH.GT.0.) H1=ALOG(ARH)                                       Y2940
      GO TO 260                                                         Y2950
  250 H1=-ACOS(B3/AT3)                                                  Y2960
  260 G2=100.                                                           Y2970
      IF (Y.NE.0.) GO TO 270                                            Y2980
      IF (X.NE.0.) G2=G2+ALOG(2.*ABS(X))                                Y2990
      IF (X.LT.0.) G2=-G2                                               Y3000
```

```
      GO TO 280                                                         Y3010
270   G2=ALOG((X+D)/ABS(Y))                                             Y3020
280   G3=0.                                                             Y3030
      C1=D                                                              Y3040
      IF (.NOT.SUB) GO TO 290                                           Y3050
      C1=X+D                                                            Y3060
      G3=-100.                                                          Y3070
      IF (Y.NE.0.) G3=ALOG(ABS(Y))                                      Y3080
290   C2=0.                                                             Y3090
      IF (Y.NE.0.) C2=C1/Y2                                             Y3100
      H=SB1*H1-B*(G2-G3)                                                Y3110
      IF (SB1.EQ.0.) H2=B*D/B3-G2+G3                                    Y3120
      IF (SB1.NE.0.) H2=B*H1/SB1-G2+G3                                  Y3130
      UC=F1                                                             Y3140
      VS=-B*F1                                                          Y3150
      WS=H-Y*C2                                                         Y3160
      VC=VS                                                             Y3170
      WC=WS                                                             Y3180
      IF (C.EQ.0.) C2=0.                                                Y3190
      C4=0.                                                             Y3200
      C5=G2*0.5                                                         Y3210
      IF (C.EQ.0.) GO TO 300                                            Y3220
      C3=(X*C2+SGN*G2)*0.5                                              Y3230
      C4=((X2-SGN*Y2*0.5)*G2-1.5*X*D)/(2.*CC)                           Y3240
      C5=(D-X*G2)/C                                                     Y3250
300   IF (LBC) GO TO 310                                                Y3260
      C6=0.                                                             Y3270
      IF (Y.NE.0.) C6=.50/Y2                                            Y3280
      IF (SUB.AND.D.NE.0.) C6=C6*C1/D                                   Y3290
      C2=C2+C6*C                                                        Y3300
      VB=-F1*0.5                                                        Y3310
      WB=H2*0.5                                                         Y3320
      WD=-Y*C6                                                          Y3330
      VA=VB                                                             Y3340
      WA=WB                                                             Y3350
      WE=WD                                                             Y3360
      IF (ML.EQ.1) GO TO 310                                            Y3370
      VC=VS+A*VB                                                        Y3380
      WC=WS+A*WB+C*WD                                                   Y3390
310   WQ=WQ-C4                                                          Y3400
      WQT=C5-C4-G3*0.5                                                  Y3410
      IF (T1.NE.0.) GO TO 320                                           Y3420
      WL=A*WQ                                                           Y3430
```

```
      WLS=A*WQT
      WLT=WLS
      IF (.NOT.LBC) WLT=WLS+A*WB
      GO TO 350
320   SL=T3*F1/T1
      UL=SL
      VL=-(B+T6/T1)*SL*0.5
      G=E*G1-T6*G2
      TL=T3*T5*G
      IF (C.EQ.0.) TL=TL-B*D/T1
      IF (C.NE.0.) TL=TL+(T6*D/T1+Y*(SGN*G2-C3))/C
      WL=TL+A*WQ
      IF (.NOT.LBC.AND.ML.EQ.1) GC TO 330
      ULS=SL+F1
      VLS=(A*F1-(AB+T6/T1)*ULS)*0.5
      WLS=TL+G/T1-Y*C2+A*WQT
      ULT=ULS
      VLT=VLS
      WLT=WLS
      IF (LBC) GO TO 330
      VLT=VLS+A*VB
      WLT=WLS+A*WB
330   RETURN
340   UC=0.
      VC=0.
      WC=0.
      WL=0.
      WLT=0.
350   UL=0.
      VL=0.
      ULT=0.
      VLT=0.
      IF (C.EQ.0.) GO TO 330
      RETURN
      END
```

```
      SUBROUTINE TRANS (UR,VR,WR,UL,VL,WL,U,V,W,A)
C
C     TRANSFORM THE THREE COMPONENTS OF VELOCITY FROM THE PANEL
C     COORDINATE SYSTEM TO THE REFERENCE COORDINATE SYSTEM. ALSO COMBINE
C     THE CONTRIBUTIONS OF THE LEFT AND RIGHT WING PANELS AND CALCULATE
C     THE NORMAL VELOCITY AT THE CONTROL POINT.
C
      COMMON /TRAN/ SIND,COSD,TAND,SINT,COST,CONTD,SINTI,COSTI,CON,BCON,
     1DI
C
      VW=SINT*(VR+VL)+CONTD*(WR+WL)
      U=CON*(COST*(UR+UL)-SINC*VW)/CONTD
      V=BCCN*COSD*(CONTD*(VR-VL)-SINT*(WR-WL))
      W=BCON*(TAND*(UR+UL)+COST*COSD*VW)/CONTD
      A=COSTI*W-SINTI*V-DI*U
      RETURN
      END
```

```
      OVERLAY(LWB,3,0)
      PROGRAM SOLVE
C
C     SOLVE FOR THE STRENGTHS OF THE BODY SOURCES AND WING VORTICES
C     WHICH SATISFY THE BOUNDARY CONDITION OF TANGENTIAL FLOW AT THE
C     PANEL CONTROL POINTS. ALSO DETERMINE THE CORRESPONDING PRESSURE
C     DISTRIBUTION AND THE FORCES AND MOMENTS ON THE CONFIGURATION.
C
C
C     THE PROGRAM MUST SOLVE A SYSTEM OF LINEAR EQUATIONS OF MAXIMUM
C     ORDER 1200. THE SOLUTION TECHNIQUE SELECTED CAN BE DESCRIBED AS A
C     BLOCKED JACOBI ITERATIVE METHOD. THE 1200 BY 1200 MATRIX IS
C     NATURALLY PARTITIONED INTO FOUR 600 BY 600 BLOCKS. EACH PARTITION
C     IS FURTHER SUBDIVIDED INTO BLOCKS OF MAXIMUM SIZE 60 BY 60. THE
C     MATRIX ELEMENTS IN EACH BLOCK ARE CAREFULLY CHOSEN TO REPRESENT
C     SOME WELL DEFINED FEATURE OF THE ORIGINAL CONFIGURATION. FOR
C     EXAMPLE, A BODY BLOCK REPRESENTS THE INFLUENCE OF ONE RING OF
C     PANELS AROUND THE BODY, WHILE A WING BLOCK REPRESENTS THE
C     INFLUENCE OF ONE CHORDWISE COLUMN OF WING PANELS. FOR WINGS USING
C     THE NON-PLANAR BOUNDARY CONDITION OPTION, THE BLOCK SIZE
C     CORRESPONDS TO THE TOTAL NUMBER OF PANELS ON THE UPPER AND LOWER
C     SURFACES OF THE COLUMN.
C
C     THE INITIAL ITERATION CALCULATES THE SINGULARITY STRENGTHS
C     CORRESPONDING TO EACH BLOCK IN ISOLATION. FOR THIS STEP, ONLY THE
C     DIAGONAL BLOCKS ARE PRESENT IN THE AERODYNAMIC MATRIX. ONCE THE
C     INITIAL APPROXIMATION TO THE SINGULARITY STRENGTHS IS DETERMINED,
C     THE INTERFERENCE EFFECT OF EACH BLOCK ON ALL THE OTHERS IS
C     CALCULATED BY MATRIX MULTIPLICATION. THE INCREMENTAL NORMAL
C     VELOCITIES OBTAINED ARE SUBTRACTED FROM THE NORMAL VELOCITIES
C     SPECIFIED BY THE BOUNDARY CONDITIONS. THIS PROCESS IS ITERATED A
C     FIXED NUMBER OF TIMES AT PRESENT. THE NUMBER OF ITERATIONS IS SET
C     IN SUBROUTINE ITRATE.
C
C
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMON /POINT/ ARRAY(6000)
      COMMON /SCRAT/ U(600),V(600),W(600),A(60,60),DUD(300),GW(600),GB(6
     100),DZTDX(600)
      COMMON /SEG/ NSEG,NR(20),NC(20),DUM(60)
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EX,PRINT,NWTHK
      COMMON /FORM/ CN,CT,CM,CNB,CTB,CMB,CNS(20),CTS(20),CMS(20)
```

```
      COMMON /MATCCM/ MATIN
C
      DIMENSION UA(600), VA(600), WA(600), CP(600), NS(600), CHORD(600),
     1 THET(600), DELTA(600), NB(600), NW(600), NT(600), DEL(600), COSTH
     2(600)
C
      EQUIVALENCE (UA,A), (VA,A(601)), (WA,A(1201)), (CP,A(1801)), (NS,A
     1(2401)), (ARRAY(1801),THET), (ARRAY(2401),DELTA), (NW,U), (NB,V),
     2(NT,W), (ARRAY(3601),CHORD), (GW,DEL), (GB,COSTH)
C
      REAL MACH,NB,NW,NT,NS
      INTEGER CCMPT,PRINT
      LOGICAL LBC,THK,LOWER
C
      EM=MACH
      NPASS=0
      REWIND 7
      REWIND 8
      ALP=ALPHA/57.2957795
      SINAL=SIN(ALP)
      COSAL=COS(ALP)
C
C     CALCULATE NORMAL VELOCITIES REQUIRED TO SATISFY BOUNDARY
C     CONDITIONS AT WING AND BCDY CONTROL POINTS
C
      IF (NWING.EQ.0) GO TO 20
      READ (7) ARRAY,CHORD,DZTDX
      IF (LBC) READ (11) DEL,CCSTH
      REWIND 11
      DO 10 I=1,NWING
      IF (LBC) TANDEL=DEL(I)
      IF (.NOT.LBC) TANDEL=TAN(DELTA(I))
      IF (LBC) CCST=COSTH(I)
      IF (.NOT.LBC) COST=COS(THET(I))
10    NW(I)=COSAL*TANDEL-SINAL*COST
20    IF (NBODY.EQ.0) GO TO 70
      READ (7) ARRAY
      DO 30 I=1,NBODY
      TANDEL=TAN(DELTA(I))
30    NB(I)=COSAL*TANDEL-SINAL*COS(THET(I))
      IF (.NOT.LBC.OR.NWING.EQ.0) GO TO 70
      IF (.NOT.THK) GO TO 70
C
```

```
C     CALCULATE NORMAL VELOCITIES ON BODY PANELS DUE TO
C     WING THICKNESS (PLANAR BOUNDARY CONDITION OPTION)
C
      DO 40 I=1,NBODY
      READ (8) (UA(J),VA(J),WA(J),J=1,NBODY)
40    CONTINUE
      DO 60 I=1,NBODY
      READ (8) (UA(J),VA(J),WA(J),J=1,NWTHK)
      READ (8) (UADUM,VADUM,WADUM,J=1,NWING)
      US=0.
      VS=0.
      WS=0.
      SINT=SIN(THET(I))
      COST=COS(THET(I))
      DO 50 J=1,NWTHK
      US=US+UA(J)*DZTDX(J)
      VS=VS+VA(J)*DZTDX(J)
50    WS=WS+WA(J)*DZTDX(J)
      NS(I)=WS*COST-VS*SINT-US*TAN(DELTA(I))
60    NB(I)=NB(I)-NS(I)*COSAL
      REWIND 8
70    CONTINUE
C
C     SOLVE MATRIX EQUATIONS - DIRECT SOLUTION IF MATRICES
C     LESS THAN 60 BY 60, ITERATIVE SOLUTION OTHERWISE
C
      IF (NBODY.LE.NMAX.AND.NWING.LE.NMAX) GO TO 80
      IF (MATIN.EQ.1) CALL DIAGIN
      REWIND 10
      GO TO 90
80    CALL PARTIN
      IF (NBODY.EQ.0.OR.NWING.EQ.0) GO TO 100
90    CALL ITRATE
100   CONTINUE
      REWIND 7
      IF (NWING.EQ.0) GO TO 110
      READ (7) ARRAY,CHORD,DZTDX
110   CONTINUE
      NPASS=NPASS+1
      IF (NBODY.EQ.0) GO TO 210
C
C     CALCULATE VELOCITY COMPONENTS ON BODY PANELS
C
```

```
      DO 120 I=1,NBODY
      U(I)=0.
      V(I)=0.
      W(I)=0.
  120 CONTINUE
      DO 130 I=1,NBODY
      READ (8) (UA(J),VA(J),WA(J),J=1,NBODY)
      IF (NPASS.EQ.2) GO TO 130
      DO 130 J=1,NBODY
      U(I)=U(I)+UA(J)*GB(J)
      V(I)=V(I)+VA(J)*GB(J)
      W(I)=W(I)+WA(J)*GB(J)
  130 CONTINUE
      IF (NPASS.EQ.1) READ (7) ARRAY
      DO 180 I=1,NBODY
      IF (NWING.EQ.0) GO TO 170
      IF (.NOT.THK) GO TO 150
      READ (8) (UA(J),VA(J),WA(J),J=1,NWTHK)
      IF (NPASS.EQ.2) GO TO 150
      DO 140 J=1,NWTHK
      U(I)=U(I)+UA(J)*DZTDX(J)
      V(I)=V(I)+VA(J)*DZTDX(J)
      W(I)=W(I)+WA(J)*DZTDX(J)
  140 CONTINUE
  150 READ (8) (UA(J),VA(J),WA(J),J=1,NWING)
      IF (NPASS.EQ.2) GO TO 180
      DO 160 J=1,NWING
      U(I)=U(I)+UA(J)*GW(J)
      V(I)=V(I)+VA(J)*GW(J)
      W(I)=W(I)+WA(J)*GW(J)
  160 CONTINUE
  170 CONTINUE
      NS(I)=W(I)*COS(THET(I))-V(I)*SIN(THET(I))-U(I)*TAN(DELTA(I))
  180 CONTINUE
      IF (NPASS.EQ.2) GO TO 210
      IF (IABS(PRINT).LT.2) GO TO 200
      WRITE (6,340) EM,ALPHA
      WRITE (6,390)
      DO 190 N=1,NBODY
  190 WRITE (6,410) N,GB(N),U(N),V(N),W(N),NS(N)
  200 CONTINUE
C
C     CALCULATE PRESSURES ON BODY PANELS
```

```
C
      CALL PRESS (NBODY,EM,ALP,U,V,W,CP,CPSTAG,CPCRIT,CPVAC)
C
C     CALCULATE FORCES AND MOMENT ON BODY
C
      COMPT=1
      CALL FORMOM (NBODY,NPASS,ALP,COMPT)
210   IF (NWING.EQ.0) GO TO 330
C
C     CALCULATE VELOCITY COMPONENTS ON WING PANELS
C
      DO 220 I=1,NWING
      U(I)=0.
      V(I)=0.
220   W(I)=0.
      IF (NBODY.EQ.0) GO TO 240
      DO 230 I=1,NWING
      READ (8) (UA(J),VA(J),WA(J),J=1,NBODY)
      DO 230 J=1,NBODY
      U(I)=U(I)+UA(J)*GB(J)
      V(I)=V(I)+VA(J)*GB(J)
      W(I)=W(I)+WA(J)*GB(J)
230   CONTINUE
240   SGN=1.0
      IF (LBC.AND.NPASS.EQ.2) SGN=-1.0
      DO 270 I=1,NWING
      IF (.NOT.THK) GO TO 260
      READ (8) (UA(J),VA(J),WA(J),J=1,NWTHK)
      DO 250 J=1,NWTHK
      U(I)=U(I)+UA(J)*DZTDX(J)
      V(I)=V(I)+VA(J)*DZTDX(J)
250   W(I)=W(I)+WA(J)*DZTDX(J)*SGN
260   READ (8) (UA(J),VA(J),WA(J),J=1,NWING)
      DO 270 J=1,NWING
      U(I)=U(I)+UA(J)*GW(J)*SGN
      V(I)=V(I)+VA(J)*GW(J)*SGN
      W(I)=W(I)+WA(J)*GW(J)
270   CONTINUE
      IF (IABS(PRINT).LT.2) GO TO 310
      IF (.NOT.LBC) GO TO 280
      IF (NPASS.EQ.1) WRITE (6,360) EM,ALPHA
      IF (NPASS.EQ.2) WRITE (6,370) EM,ALPHA
      GO TO 290
```

```
280   WRITE (6,350) EM,ALPHA                                              AA2150
290   WRITE (6,400)                                                       AA2160
      DO 300 N=1,NWING                                                    AA2170
300   WRITE (6,410) N,GW(N),U(N),V(N),W(N)                                AA2180
310   CONTINUE                                                            AA2190
C                                                                         AA2200
C     CALCULATE PRESSURES ON WING PANELS                                  AA2210
C                                                                         AA2220
      CALL PRESS (NWING,EM,ALP,U,V,W,CP,CPSTAG,CPCRIT,CPVAC)              AA2230
C                                                                         AA2240
C     CALCULATE FORCES AND MOMENT ON WING AND TAIL                        AA2250
C                                                                         AA2260
      COMPT=2                                                             AA2270
      CALL FORMOM (NWING,NPASS,ALP,COMPT)                                 AA2280
      IF (LBC.AND.NPASS.EQ.1) GO TO 320                                   AA2290
      GO TO 330                                                           AA2300
320   REWIND 8                                                            AA2310
      GO TO 110                                                           AA2320
330   CONTINUE                                                            AA2330
      WRITE (6,380) CPSTAG,CPCRIT,CPVAC                                   AA2340
      REWIND 7                                                            AA2350
      REWIND 8                                                            AA2360
      CALL SECOND (TIME)                                                  AA2370
      WRITE (6,420) TIME                                                  AA2380
      RETURN                                                              AA2390
C                                                                         AA2400
C                                                                         AA2410
340   FORMAT (1H1,25HVELOCITIES ON BODY, MACH=,F5.3,3X,6HALPHA=,F7.3//)   AA2420
350   FORMAT (1H1,25HVELOCITIES ON WING, MACH=,F5.3,3X,6HALPHA=,F7.3//)   AA2430
360   FORMAT (1H1,39HVELOCITIES ON WING UPPER SURFACE, MACH=,F5.3,3X,6HA AA2440
     1LPHA=,F7.3//)                                                       AA2450
370   FORMAT (1H1,39HVELOCITIES ON WING LOWER SURFACE, MACH=,F5.3,3X,6HA AA2460
     1LPHA=,F7.3//)                                                       AA2470
380   FORMAT (1H0,8HCPSTAG =F10.5,3X,8HCPCRIT =F10.5,3X,7HCPVAC =,F10.5) AA2480
390   FORMAT (1X,5HPANEL,10X,6HSOURCE,10X,5HAXIAL,10X,7HLATERAL,10X,8HVE AA2490
     1RTICAL,10X,6HNORMAL/2X,3HNO.,10X,8HSTRENGTH,7X,8HVELOCITY,9X,8HVEL AA2500
     2OCITY,9X,8HVELOCITY,9X,8HVELOCITY)                                  AA2510
400   FORMAT (1X,5HPANEL,10X,6HVORTEX,10X,5HAXIAL,10X,7HLATERAL,10X,8HVE AA2520
     1RTICAL/2X,3HNO.,10X,8HSTRENGTH,7X,8HVELOCITY,9X,8HVELOCITY,9X,8HVE AA2530
     2LOCITY//)                                                           AA2540
410   FORMAT (1H ,I4,7X,F10.5,5X,F10.5,3(7X,F10.5))                       AA2550
420   FORMAT (1H0,6HTIME =F10.5)                                          AA2560
      END                                                                 AA2570-
```

```
      SUBROUTINE INVERT (A,IA,NROWS)
C
C     SIMPLE MATRIX INVERSION ROUTINE BASED ON GAUSS-JORDAN ELIMINATION
C     WITHOUT PIVOTING
C
      REAL A(NROWS,NROWS),PIVCT,T
      INTEGER IPIVOT(115),INDXR(115),INDXC(115)
      N=IA
      DO 10 J=1,N
10    IPIVOT(J)=0
      DO 100 I=1,N
      T=0.0
      DO 30 J=1,N
      IF (IPIVOT(J).EQ.1) GO TO 30
      DO 20 K=1,N
      IF (IPIVOT(K).EQ.1) GO TO 20
      IF (.NOT.(ABS(A(J,K))-ABS(T).GT.0.0)) GO TO 20
      IROW=J
      ICOL=K
      T=A(J,K)
20    CONTINUE
30    CONTINUE
      IPIVOT(ICOL)=IPIVOT(ICOL)+1
      IF (IROW.EQ.ICOL) GO TO 50
      DO 40 L=1,N
      T=A(IROW,L)
      A(IROW,L)=A(ICOL,L)
40    A(ICOL,L)=T
50    INDXR(I)=IROW
      INDXC(I)=ICOL
      PIVOT=A(ICOL,ICOL)
      IF (PIVOT) 60,130,60
60    A(ICOL,ICOL)=1.0
      DO 70 L=1,N
70    A(ICOL,L)=A(ICOL,L)/PIVOT
      DO 90 L=1,N
      IF (L.EQ.ICOL) GO TO 90
      T=A(L,ICOL)
      A(L,ICOL)=0.0
      DO 80 M=1,N
80    A(L,M)=A(L,M)-A(ICOL,M)*T
90    CONTINUE
```

```
100   CONTINUE
      DO 120 I=1,N
      L=N+1-I
      IF (INDXR(L).EQ.INDXC(L)) GO TO 120
      IROW=INDXR(L)
      ICOL=INDXC(L)
      DO 110 K=1,N
      T=A(K,IROW)
      A(K,IROW)=A(K,ICOL)
110   A(K,ICOL)=T
120   CONTINUE
C
C     SUCCESSFUL SOLUTION
C
      RETURN
C
130   CONTINUE
C
C     SINGULAR MATRIX
C
      WRITE (6,140)
      CALL EXIT
C
C
140   FORMAT (29H ERROR THE MATRIX IS SINGULAR)
      END
```

```
      SUBROUTINE PARTIN
C
C     FOR WING-BODY COMBINATIONS, INVERT THE MATRIX PATITIONS (PROVIDED
C     THE ORDER DOES NOT EXCEED 60).
C
C     FOR ISOLATED WINGS OR BODIES, ALSO SOLVE THE BOUNDARY CONDITION
C     EQUATIONS AND DETERMINE THE WING VORTEX STRENGTHS OR BODY SOURCE
C     STRENGTHS.
C
C
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMCN /SEG/ NSEG,NR(20),DUD(80)
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EX,PRINT,NWTHK
      COMMCN /POINT/ ARRAY(4800)
      COMMON /SCRAT/ NW(600),NB(600),NT(600),A(60,60),DUM(300),GW(600),G
     1B(600),GT(600)
      DIMENSION D(60,60)
      EQUIVALENCE (D,ARRAY)
      REAL NW,NB,NT
      CALL SECOND (TIME)
      NDIM=60
      WRITE (6,110) TIME
      REWIND 9
      NPANEL=NBODY+NWING
      IF (NWING.EQ.0.OR.NBODY.EQ.0) GO TO 50
      IP=0
      REWIND 10
      DO 10 I=1,NBODY
10    READ (9) (D(I,J),J=1,NBODY)
      CALL INVERT (D,NBODY,NDIM)
      WRITE (10) D
      DO 20 I=1,NBODY
20    READ (9) (D(I,J),J=1,NWING)
      DO 30 I=1,NWING
30    READ (9) (D(I,J),J=1,NBODY)
      DO 40 I=1,NWING
40    READ (9) (D(I,J),J=1,NWING)
      CALL INVERT (D,NWING,NDIM)
      WRITE (10) D
      REWIND 9
      REWIND 10
      GO TO 100
```

```
50    CONTINUE
      DO 60 I=1,NPANEL
60    READ (9) (A(I,J),J=1,NPANEL)
      REWIND 9
      CALL INVERT (A,NPANEL,NDIM)
      IF (NWING.EQ.0) GO TO 80
      DO 70 I=1,NWING
      GW(I)=0.
      DO 70 J=1,NWING
      GW(I)=GW(I)+A(I,J)*NW(J)
70    CONTINUE
      GO TO 100
80    DO 90 I=1,NBODY
      GB(I)=0.
      DO 90 J=1,NBODY
      GB(I)=GB(I)+A(I,J)*NB(J)
90    CONTINUE
100   CALL SECOND (TIME)
      WRITE (6,110) TIME
      REWIND 9
      RETURN
C
C
110   FORMAT (1H0,6HTIME =F10.5)
      END
```

```
      SUBROUTINE DIAGIN
C
C     INVERT THE DIAGONAL BLOCKS OF THE MATRIX.
C
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMCN /SEG/ NSEG,NR(20),DUD(80)
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,PRINT,NWTHK,NWBLOK,
     1NWROW(20),NBBLOK,NBROW(30)
      COMMCN /POINT/ ARRAY(4800)
      DIMENSICN D(60,60)
      EQUIVALENCE (D,ARRAY)
      REWIND 9
      REWIND 10
      NDIM=60
      IF (NBODY.EQ.0) GO TO 50
      DO 40 NB=1,NBBLOK
      NROW=NBROW(NB)
      NCOL=NROW
      IF (NBODY.GT.NMAX) GO TO 20
      DO 10 I=1,NBODY
10    READ (9) (D(I,J),J=1,NBODY)
      GO TO 30
20    READ (7) D
30    CALL INVERT (D,NCOL,NDIM)
      WRITE (10) D
40    CONTINUE
50    IF (NWING.EQ.0) GO TO 140
      DO 130 NW=1,NWBLOK
      NROW=NWROW(NW)
      NCOL=NROW
      IF (NWING.GT.NMAX) GO TO 110
      IF (NBODY.EQ.0) GO TO 90
      DO 60 I=1,NBODY
60    READ (9) (D(I,J),J=1,NBODY)
      DO 70 I=1,NBODY
70    READ (9) (D(I,J),J=1,NWING)
      DO 80 I=1,NWING
80    READ (9) (D(I,J),J=1,NBODY)
90    DO 100 I=1,NWING
100   READ (9) (D(I,J),J=1,NWING)
      GO TO 120
110   READ (7) D
```

```
120   CALL INVERT (D,NCOL,NDIM)
      WRITE (10) D
130   CONTINUE
140   REWIND 10
      REWIND 9
      REWIND 7
      RETURN
      END
```

```
      SUBROUTINE ITRATE
C
C     SOLVE THE BOUNDARY CONDITION EQUATIONS BY AN ITERATIVE METHOD AND
C     DETERMINE THE STRENGTHS OF THE BODY SOURCES AND THE WING, FIN
C     (VERTICAL TAIL), AND CANARD (HORIZONTAL TAIL) VORTICES.
C
C     NOTE THAT THE NUMBER OF ITERATIONS IS FIXED AT PRESENT
C
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA
      COMMCN /SEG/ NSEG,NR(20),DUD(80)
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,PRINT,NWTHK,NWBLOK,
     1NWROW(20),NBBLOK,NBROW(30)
      COMMON /POINT/ D(60,60),DNB(600),DNW(600)
      COMMON /SCRAT/ NW(600),NB(600),NT(600),A(600),RW(600),RB(600),DUM(
     12100),GW(600),GB(600),GT(600)
C
      REAL NB,NW,NT
      INTEGER PRINT
C
C     SET MAXIMUM NUMBER OF ITERATIONS - IMAX
C
      IMAX=15
C
      IT=0
      REWIND 9
      IF (NBODY.EQ.0) GO TO 20
      DO 10 N=1,NBODY
10    RB(N)=NB(N)
20    IF (NWING.EQ.0) GO TO 40
      DO 30 N=1,NWING
30    RW(N)=NW(N)
40    IT=IT+1
      CALL SECOND (TIME)
      WRITE (6,240) TIME
      IB=0
      IW=0
      IF (NBODY.EQ.0) GO TO 70
      JS=0
      NBLOK=NBBLOK
      DO 60 NN=1,NBLOK
      NROW=NBROW(NN)
      NCOL=NROW
```

```
      READ (10) D
      DO 50 I=1,NROW
      IB=IB+1
      GB(IB)=0.
      DO 50 J=1,NCOL
      JJ=J+JS
50    GB(IB)=GB(IB)+D(I,J)*RB(JJ)
      JS=JS+NROW
60    CONTINUE
70    IF (NWING.EQ.0) GO TO 100
      JS=0
      NBLOK=NWBLCK
      DO 90 NN=1,NBLOK
      NROW=NWRCW(NN)
      NCOL=NROW
      READ (10) D
      DO 80 I=1,NROW
      IW=IW+1
      GW(IW)=0.
      DO 80 J=1,NCOL
      JJ=J+JS
80    GW(IW)=GW(IW)+D(I,J)*RW(JJ)
      JS=JS+NROW
90    CONTINUE
100   CONTINUE
      REWIND 10
      IF (IABS(PRINT).LT.3) GO TO 110
      WRITE (6,250) IT
      IF (NBODY.GT.0) WRITE (6,260) (GB(N),N=1,NBODY)
      IF (NWING.GT.0) WRITE (6,260) (GW(N),N=1,NWING)
110   IF (IT.EQ.IMAX) GO TO 230
      IF (NBODY.EQ.0) GO TO 170
      DO 130 I=1,NBODY
      DNB(I)=0.
      READ (9) (A(J),J=1,NBODY)
      IF (NBODY.LE.NMAX) GO TO 130
      DO 120 J=1,NBODY
120   DNB(I)=DNB(I)+A(J)*GB(J)
130   RB(I)=NB(I)-DNB(I)
      IF (NWING.EQ.0) GO TO 160
      DO 150 I=1,NBODY
      READ (9) (A(J),J=1,NWING)
      DO 140 J=1,NWING
```

```
140   DNB(I)=CNB(I)+A(J)*GW(J)
150   RB(I)=NB(I)-DNB(I)
160   CONTINUE
170   IF (NWING.EQ.0) GO TO 220
      DO 190 I=1,NWING
      DNW(I)=0.
      IF (NBODY.EQ.0) GO TO 190
      READ (9) (A(J),J=1,NBODY)
      DO 180 J=1,NBODY
180   DNW(I)=DNW(I)+A(J)*GB(J)
190   RW(I)=NW(I)-DNW(I)
      IF (NWING.LE.NMAX) GO TO 220
      DO 210 I=1,NWING
      READ (9) (A(J),J=1,NWING)
      DO 200 J=1,NWING
200   DNW(I)=DNW(I)+A(J)*GW(J)
210   RW(I)=NW(I)-DNW(I)
220   CONTINUE
      REWIND 9
      IF (IT.LT.IMAX) GO TO 40
230   RETURN
C
C
240   FORMAT (1H0,6HTIME =F10.5)
250   FORMAT (1H0,3I3)
260   FORMAT (1H ,10F10.5)
      END
```

```
      SUBROUTINE PRESS (NP,XMACH,ARA,U,V,W,CPP,CPSTAG,CPCRIT,CPVAC)
C
C     COMPUTE THE PRESSURE COEFFICIENT USING THE EXACT ISENTROPIC
C     FORMULA. ALSO COMPUTE THE STAGNATION PRESSURE COEFFICIENT,
C     CRITICAL PRESSURE COEFFICIENT, AND VACUUM PRESSURE COEFFICIENT.
C
      DIMENSION U(1), V(1), W(1), CPP(1)
      XM2=XMACH*XMACH
      BT2=XM2-1.
      CPCRIT=0.
      CPSTAG=1.
      CPVAC=0.
      COSARA=COS(ARA)
      SINARA=SIN(ARA)
      IF (XM2.EQ.0.) GO TO 10
      CON=1.42857/XM2
      CON1=.2*XM2
   10 DO 30 J=1,NP
      UWPM=U(J)*COSARA+W(J)*SINARA
      UWIND=1.+UWPM
      VWIND=V(J)
      WWIND=W(J)*COSARA-U(J)*SINARA
      VW2=VWIND*VWIND+WWIND*WWIND
      Q2=UWIND*UWIND+VW2
      IF (XMACH.EQ.0.) GO TO 20
      ARG=1.+CON1*(1.-Q2)
      IF (ARG.LT.0.) ARG=0.
      CPP(J)=CON*(ARG**3.5-1.)
      GO TO 30
   20 CPP(J)=1.-Q2
   30 CONTINUE
      IF (XMACH.EQ.0.) GO TO 40
      CPSTAG=CON*((1.+CON1)**3.5-1.)
      CPCRIT=CON*((5./6.+XM2/6.)**3.5-1.)
      CPVAC=-CON
   40 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE FORMCM (NPAN,NPASS,ALFA,COMPT)
C
C     CALCULATE THE FORCE AND MOMENT COEFFICIENTS ON THE BODY, WING,
C     FIN (VERTICAL TAIL) AND CANARD (HORIZONTAL TAIL)
C
      COMMON /PARAM/ NBODY,NWING,NTAIL,LBC,THK,MACH,ALPHA,REFA,REFB,REFC
     1,REFD,REFL,REFX,REFZ
      COMMON /HEAD/ TITLE1(8),TITLE2(8)
      COMMON /SEG/ NSEG,NROW(20),NCOL(20),COSS(20),SINS(20),BTE(20),NWT(
     120),SPNW(20),XLEW(20),BLE(20),ZLEW(20)
      COMMON /PCINT/ ARRAY(6000)
      COMMON /SCRAT/ DCN(600),DCM(600),DCT(600),II(600),SIND(600),COSD(6
     100),CP(600),DUD(300),SINT(600),COST(600),GW(600),GB(600),DZTDX(600
     2)
      COMMCN /NEWCOM/ KDUM(41),LOCPT(20),XCPT(20)
      COMMON /VELCCM/ NPOINT,NDUM(5),PRINT,NDUN(22)
      COMMON /FORM/ CNW,CTW,CMW,CNB,CTB,CMB,CNS(20),CTS(20),CMS(20)
C
      DIMENSION XPT(600), YPT(600), ZPT(600), THET(600), DELTA(600), SGN
     1(600), AREA(600), CHORD(600), CHD(20), XLE(600), ZLE(600), XC(30,2
     20)
C
      EQUIVALENCE (ARRAY,XPT), (ARRAY(601),YPT), (ARRAY(1201),ZPT), (ARR
     1AY(1801),THET), (ARRAY(2401),DELTA), (ARRAY(3001),XC,SGN), (ARRAY(
     24801),AREA), (ARRAY(3601),CHORD), (ARRAY(5401),XLE), (CHD,DUD)
      INTEGER COMPT,TEST,PRINT
      REAL MACH
      LOGICAL LBC
C
C
C     NOTE THAT THE WING, CANARD, AND TAIL ARE ALL SEGMENTS OF THE WING
C     IN THIS SUBROUTINE
C
      EPS=1.0E-6
      NP=NPAN
C
C     COMPT=1 INDICATES BODY FORCE AND MOMENT CALCULATION
C     COMPT=2 INDICATES WING FORCE AND MOMENT CALCULATION
C
C     NPASS=1 FOR THE BODY
C     NPASS=1 FOR THE WING UPPER AND LOWER SURFACES IF THE NON-PLANAR
C             BOUNDARY CONDITION OPTION IS SELECTED
```

```
C     NPASS=1 FOR THE WING UPPER SURFACE IF THE PLANAR BOUNDARY
C             CONDITICN OPTION IS SELECTED
C     NPASS=2 FOR THE WING LOWER SURFACE IF THE PLANAR BOUNDARY
C             CONDITICN OPTION IS SELECTED
C
      IF (COMPT.EQ.1) XON=XC(1,1)
      IF (COMPT.EQ.2.AND.NBODY.GT.0) GO TO 10
      CNB=0.
      CTB=0.
      CMB=0.
10    CONTINUE
      IF (NBODY.EQ.0.OR.NWING.EQ.0.OR.NPASS.EQ.2) GO TO 20
      REWIND 7
      IF (COMPT.EQ.2) READ (7) ARRAY,CHORD,DZTDX
20    CONTINUE
      SIAL=SIN(ALFA)
      COAL=COS(ALFA)
      WRITE (6,300)
      WRITE (6,320) TITLE1,TITLE2
      WRITE (6,310)
      IF (COMPT.EQ.1) WRITE (6,440)
      IF (.NOT.LBC) GO TO 30
      IF (COMPT.EQ.2.AND.NPASS.EQ.1) WRITE (6,470)
      IF (COMPT.EQ.2.AND.NPASS.EQ.2) WRITE (6,480)
      GO TO 40
30    IF (COMPT.EQ.2) WRITE (6,450)
40    CONTINUE
      WRITE (6,330) MACH,ALPHA
      WRITE (6,340)
      IF (LBC.AND.COMPT.GT.1) GO TO 60
      DO 50 I=1,NPAN
      SGN(I)=1.0
      SIND(I)=SIN(DELTA(I))
      COSD(I)=COS(DELTA(I))
      SINT(I)=SIN(THET(I))
50    COST(I)=COS(THET(I))
      GO TO 80
60    CONTINUE
C
C     FOR THE PLANAR BOUNDARY CONDITION OPTION CALCULATE THE WING CAMBER
C     AND THICKNESS SLOPES AT CENTER OF PANELS, AND (X,Y,Z) COORDINATES
C     OF CENTRAL POINT
C
```

```
      I=0
      J=0
      DO 70 N=1,NSEG
      NC=NCOL(N)
      NR=NROW(N)
      NR1=NR+1
      DO 70 M=1,NC
      DO 70 L=1,NR1
      J=J+1
      IF (L.EQ.NR1) GO TO 70
      I=I+1
      SGN(I)=1.0
      IF (NPASS.EQ.2) SGN(I)=-1.0
      DELC=(DELTA(J)+DELTA(J+1))*0.5
      DELZ=(DZTDX(J)+DZTDX(J+1))*0.5
      IF (NPASS.EQ.1) TAND=DELC+DELZ
      IF (NPASS.EQ.2) TAND=DELC-DELZ
      SIND(I)=TAND/SQRT(1.+TAND*TAND)
      COSD(I)=SQRT(1.-SIND(I)*SIND(I))
      SINT(I)=SINS(N)
      COST(I)=COSS(N)
      XS=XCPT(N)
      PT=XS
      IF (LOCPT(N).NE.0) PT=XS*FLOAT(NR-L)/FLOAT(NR-1)
      RL=.5+PT
      RT=.5-PT
      IF (LOCPT(N).NE.0) CP(I)=CP(J)*RL+CP(J+1)*RT
      IF (NPASS.EQ.2) GO TO 70
      XPT(I)=(XLE(J)+XLE(J+1))*0.5
      YPT(I)=YPT(J)
      ZPT(I)=ZPT(J)
70    CONTINUE
      IF (COMPT.EQ.2) NP=I
80    CONTINUE
      IF (NPASS.EQ.2.OR.COMPT.EQ.1) GO TO 110
C
C     CALCULATE CHORD LENGTH OF EACH COLUMN OF PANELS ON WING
C
      I=0
      J=0
      DO 90 N=1,NSEG
      NC=NCOL(N)
      NR=NROW(N)
```

```
      DO 90 M=1,NC                                                      AG1290
      J=J+1                                                             AG1300
      CHD(J)=0.                                                         AG1310
      KS=2                                                              AG1320
      IF (LBC) KS=1                                                     AG1330
      DO 90 K=1,KS                                                      AG1340
      DO 90 L=1,NR                                                      AG1350
      I=I+1                                                             AG1360
      IF (K.EQ.1) CHC(J)=CHD(J)+CHORD(I)                                AG1370
      IF (K.EQ.2) SGN(I)=-1.0                                           AG1380
90    CONTINUE                                                          AG1390
      I=0                                                               AG1400
      J=0                                                               AG1410
C                                                                       AG1420
C     ASSOCIATE THE LEADING EDGE COORDINATES AND CHORD LENGTHS OF EACH  AG1430
C     COLUMN OF PANELS WITH THE INDIVIDUAL PANELS IN THE COLUMN         AG1440
C                                                                       AG1450
      DO 100 N=1,NSEG                                                   AG1460
      NC=NCOL(N)                                                        AG1470
      NR=NROW(N)                                                        AG1480
      DO 100 M=1,NC                                                     AG1490
      J=J+1                                                             AG1500
      KS=2                                                              AG1510
      IF (LBC) KS=1                                                     AG1520
      DO 100 K=1,KS                                                     AG1530
      DO 100 L=1,NR                                                     AG1540
      I=I+1                                                             AG1550
      ZLE(I)=ZLEW(J)                                                    AG1560
      XLE(I)=XLEW(J)                                                    AG1570
      CHORD(I)=CHD(J)                                                   AG1580
100   CONTINUE                                                          AG1590
110   CONTINUE                                                          AG1600
      IF (NPASS.EQ.2) GO TO 120                                         AG1610
      CN=0.                                                             AG1620
      CT=0.                                                             AG1630
      CM=0.                                                             AG1640
      GO TO 130                                                         AG1650
120   CN=CNW                                                            AG1660
      CT=CTW                                                            AG1670
      CM=CMW                                                            AG1680
130   IP=0                                                              AG1690
C                                                                       AG1700
C     CALCULATE THE FORCES AND MCMENT ACTING CN EACH PANEL AND SUM OVER AG1710
```

```
C     THE ENTIRE COMPCNENT
C
      DO 160 I=1,NP
      IP=IP+1
      XP=XPT(I)
      YP=YPT(I)
      ZP=ZPT(I)
      F1=COSD(I)*COST(I)
      F2=SIND(I)
      FAK=AREA(I)*SGN(I)
      IF (LBC.AND.COMPT.GT.1.AND.COSD(I).NE.0.) FAK=FAK/COSD(I)
      IF (ABS(YP).LT.EPS) FAK=0.5*FAK
      DCN(I)=-CP(I)*F1*FAK
      DCT(I)=CP(I)*F2*FAK
      DCM(I)=DCN(I)*(REFX-XP)-DCT(I)*(REFZ-ZP)
      XQ=XP
      YQ=YP
      ZQ=ZP
      IF (COMPT.EQ.2) GO TO 140
C
C     NONDIMENSIONALIZE BODY PANEL CONTRCL PCINT COORDINATES
C     X COORDINATES ARE DIVIDED BY THE BODY REFERENCE LENGTH
C     Y AND Z CCORDINATES ARE DIVIDED BY THE BODY REFERENCE DIAMETER
C
      XQ=(XP-XCN)/REFL
      YQ=YP/REFD
      ZQ=ZP/REFD
      GO TO 150
C
C     NONDIMENSICNALIZE WING PANEL CONTRCL PCINT COORDINATES
C     X AND Z COORDINATES ARE DIVIDED BY THE REFERENCE CHORD
C     Y COORDINATES ARE DIVIDED BY THE REFERENCE SEMISPAN
C
140   IF (CHORD(I).NE.0.) XQ=(XP-XLE(I))/CHORD(I)
      IF (REFB.NE.0.) YQ=YP/REFB
      IF (CHORD(I).NE.0.) ZQ=(ZP-ZLE(I))/CHORD(I)
150   CONTINUE
      WRITE (6,350) IP,XP,YP,ZP,XQ,YQ,ZQ,CP(I),DCN(I),DCT(I),DCM(I),IP
      CN=CN+DCN(I)
      CT=CT+DCT(I)
      CM=CM+DCM(I)
160   CONTINUE
      IF (COMPT.GT.1) GO TO 170
```

```
C
C      STORE BODY FORCES AND MOMENT
C
       CNB=CN
       CTB=CT
       CMB=CM
       GO TO 180
170    CONTINUE
C
C      STORE WING FORCES AND MOMENT
C
       CNW=CN
       CTW=CT
       CMW=CM
       IF (LBC.AND.NPASS.EQ.1) GO TO 200
180    CONTINUE
       WRITE (6,300)
       WRITE (6,360)
       IF (COMPT.EQ.1) WRITE (6,440)
       IF (COMPT.EQ.2) WRITE (6,450)
C
C      COMPUTE NORMAL AND TANGENTIAL (AXIAL) FORCE COEFFICIENTS, PITCHING
C        MOMENT COEFFICIENT, LIFT AND DRAG COEFFICIENT, AND CENTER OF
C      PRESSURE OF COMPONENT
C
       IT=0
190    CN=2.*CN/REFA
       CT=2.*CT/REFA
       CM=2.*CM/(REFA*REFC)
       CL=CN*COAL-CT*SIAL
       CD=CN*SIAL+CT*COAL
       DXN=0.
       IF (CL.NE.0.) DXN=CM/CL
       IF (COMPT.EQ.1) WRITE (6,380) REFA,REFB,REFL
       IF (COMPT.EQ.2) WRITE (6,370) REFA,REFB,REFC
       WRITE (6,390) REFX,REFZ
       WRITE (6,400) CN,CT,CM,CL,CD,DXN
200    CONTINUE
       IF (COMPT.EQ.1) GO TO 290
       IF (LBC.AND.NPASS.EQ.1) GO TO 210
       IF (NBODY.EQ.0.OR.IT.GT.0) GO TO 210
       IT=IT+1
       CN=CNB+CNW
```

```
      CT=CTB+CTW                                                        AG2580
      CM=CMB+CMW                                                        AG2590
      WRITE (6,300)                                                     AG2600
      WRITE (6,360)                                                     AG2610
      WRITE (6,460)                                                     AG2620
      GO TO 190                                                         AG2630
  210 IF (PRINT.EQ.0) GO TO 290                                         AG2640
      IF (LBC.AND.NPASS.EQ.1) GO TO 220                                 AG2650
      WRITE (6,300)                                                     AG2660
      WRITE (6,420)                                                     AG2670
      WRITE (6,450)                                                     AG2680
  220 CONTINUE                                                          AG2690
      J=0                                                               AG2700
      K=0                                                               AG2710
      I2=0                                                              AG2720
      IZ=0                                                              AG2730
C                                                                       AG2740
C     COMPUTE SECTION FORCES AND MOMENT FOR WING IF THE PRINT OPTION IS AG2750
C     NONZERO                                                           AG2760
C                                                                       AG2770
      DO 280 N=1,NSEG                                                   AG2780
      NR=NROW(N)                                                        AG2790
      NR2=NR*2                                                          AG2800
      NC=NCOL(N)                                                        AG2810
      DO 280 M=1,NC                                                     AG2820
      J=J+1                                                             AG2830
      K=K+1                                                             AG2840
      I1=I2+1                                                           AG2850
      IF (LBC) I2=I2+NR                                                 AG2860
      IF (.NOT.LBC) I2=I2+NR2                                           AG2870
      IZ=IZ+1                                                           AG2880
      IF (IZ.LT.4) GO TO 230                                            AG2890
      IF (LBC.AND.NPASS.EQ.1) GO TO 230                                 AG2900
      IZ=1                                                              AG2910
      WRITE (6,300)                                                     AG2920
      WRITE (6,420)                                                     AG2930
      WRITE (6,450)                                                     AG2940
  230 CONTINUE                                                          AG2950
      DELY=SPNW(J)                                                      AG2960
      XL=XLEW(J)                                                        AG2970
      IF (LBC.AND.NPASS.EQ.1) GO TO 240                                 AG2980
      WRITE (6,410)                                                     AG2990
      WRITE (6,430) DELY,REFC,XL                                        AG3000
```

```
240   CONTINUE                                                          AG3010
      IF (LBC.AND.NPASS.EQ.2) GO TO 250                                 AG3020
      CN=0.                                                             AG3030
      CT=0.                                                             AG3040
      CM=0.                                                             AG3050
      GO TO 260                                                         AG3060
250   CN=CNS(K)                                                         AG3070
      CT=CTS(K)                                                         AG3080
      CM=CMS(K)                                                         AG3090
260   CONTINUE                                                          AG3100
C                                                                       AG3110
C     SUM THE FORCES AND MOMENT ACTING ON EACH PANEL AND SECTION, AND   AG3120
C     STORE RESULTS                                                     AG3130
C                                                                       AG3140
      DO 270 I=I1,I2                                                    AG3150
      CN=CN+DCN(I)                                                      AG3160
      CT=CT+DCT(I)                                                      AG3170
      CM=CM+DCM(I)                                                      AG3180
270   CONTINUE                                                          AG3190
      CNS(K)=CN                                                         AG3200
      CTS(K)=CT                                                         AG3210
      CMS(K)=CM                                                         AG3220
      IF (LBC.AND.NPASS.EQ.1) GO TO 280                                 AG3230
C                                                                       AG3240
C     COMPUTE NORMAL AND TANGENTIAL (AXIAL) FORCE COEFFICIENTS, PITCHING AG3250
C     MOMENT COEFFICIENT, LIFT AND DRAG COEFFICIENT, AND CENTER OF      AG3260
C     PRESSURE OF SECTION                                               AG3270
C                                                                       AG3280
      H1=1./(DELY*CHD(J))                                               AG3290
      H2=H1/REFC                                                        AG3300
      CN=CN*H1                                                          AG3310
      CT=CT*H1                                                          AG3320
      CM=CM*H2                                                          AG3330
      CL=CN*COAL-CT*SIAL                                                AG3340
      CD=CN*SIAL+CT*COAL                                                AG3350
      DXN=0.                                                            AG3360
      IF (CL.NE.0.) DXN=CM/CL                                           AG3370
      WRITE (6,400) CN,CT,CM,CL,CD,DXN                                  AG3380
280   CONTINUE                                                          AG3390
290   CONTINUE                                                          AG3400
      RETURN                                                            AG3410
C                                                                       AG3420
C                                                                       AG3430
```

```
300   FORMAT (1H1)                                                                          AG3440
310   FORMAT (//,10X,40HINTEGRATION OF THE PRESSURE DISTRIBUTION,/)                         AG3450
320   FORMAT (10X,8A10/10X,8A10)                                                            AG3460
330   FORMAT (//,10X,6HMACH= ,F8.4,/,10X,6HALPHA= ,F8.4)                                    AG3470
340   FORMAT (1X,5HPOINT,9X,1HX,9X,1HY,9X,1HZ,9X,3HX/C,9X,4H2Y/B,9X,3HZ/                    AG3480
     1C,9X,2HCP,9X,2HCN,9X,2HCT,9X,2HCM,5X,5HPOINT/)                                        AG3490
350   FORMAT (1X,I6,10F11.5,I6)                                                             AG3500
360   FORMAT (///,10X,18HTOTAL COEFFICIENTS,/,10X,18(1H-))                                  AG3510
370   FORMAT (10X,5HREFA=,F14.4,3X,5HREFB=,F14.4,3X,5HREFC=,F14.4)                          AG3520
380   FORMAT (10X,5HREFA=,F14.4,3X,5HREFD=,F14.4,3X,5HREFL=,F14.4)                          AG3530
390   FORMAT (/,10X,5HREFX=,F14.4,3X,5HREFZ=,F14.4)                                         AG3540
400   FORMAT (/,10X,3HCN=,F14.4,/,10X,3HCT=,F14.4,/,10X,3HCM=,F14.4,/,10                    AG3550
     1X,3HCL=,F14.4,/,10X,3HCD=,F14.4,/,9X,4HXCP=,F14.4)                                    AG3560
410   FORMAT (//)                                                                           AG3570
420   FORMAT (10X,20HSECTION COEFFICIENTS,/,10X,20(1H-))                                    AG3580
430   FORMAT (10X,5HCELY=,F14.4,3X,5HREFL=,F14.4,3X,4HXLE=,F14.4)                           AG3590
440   FORMAT (10X,11HON THE BODY,//)                                                        AG3600
450   FORMAT (10X,11HON THE WING,//)                                                        AG3610
460   FORMAT (10X,29HON THE COMPLETE CONFIGURATION,//)                                      AG3620
470   FORMAT (10X,25HON THE WING UPPER SURFACE,//)                                          AG3630
480   FORMAT (10X,25HON THE WING LOWER SURFACE,//)                                          AG3640
      END                                                                                   AG3650
```

APPENDIX III

SAMPLE CASE

UNIFIED SUBSONIC-SUPERSONIC AERODYNAMICS PROGRAM   VERSION A00

LIST OF INPUT CARDS

```
00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890

      OGIVE CYLINDER BODY WITH 45 DEGREE SWEEP NACA 65A004 MID-WING
 0 -1 -1            -1  2 26  1  5 28
0.      .5      .75     1.25    2.5     5.      7.5     10.     15.     20.      XAF1
25.     30.     35.     40.     45.     50.     55.     60.     65.     70.      XAF2
75.     80.     85.     90.     95.     100.                                     XAF3
13.65   0.      0.      10.                                                      WAFORG1
27.65   12.     0.      2.                                                       WAFORG2
0.      .3075   .373    .4755   .6515   .8745   1.06    1.216   1.463   1.6505   WAFORD1
1.7925  1.8955  1.964   1.9975  1.994   1.9475  1.857   1.728   1.5675  1.3815   WAFORD2
1.174   .949    .715    .480    .2445   .009                                     WAFORD3
0.      .3075   .373    .4755   .6515   .8745   1.06    1.216   1.463   1.6505   WAFORD1
1.7925  1.8955  1.964   1.9975  1.994   1.9475  1.657   1.728   1.5675  1.3815   WAFORD2
1.174   .949    .715    .480    .2445   .009                                     WAFORD3
0.      .5833   1.1667  1.75    2.3333  2.9167  3.5     4.0833  4.6667  5.25     XFUS1
5.8333  6.4167  7.0     7.5833  8.1667  8.75    9.3333  9.9167  10.5    11.0833  XFUS2
11.666715.2     18.75   22.3    25.85   29.4    32.95   36.5                     XFUS3
0.      .08605  .32573  .69221  1.160951.709202.315422.960803.627134.29759       FUSARD1
4.958345.595676.197176.752697.252617.689558.055558.345878.556108.68411           FUSARD2
8.727   8.727   8.727   8.727   8.727   8.727   8.727   8.727                    FUSARD3
      SINGULARITY PANELING FOR SAMPLE CASE
  1  1 -2
  1  3  1               6 11  1  5 16
144.    12.     6.89    3.33    36.5    20.813  0.                               REFL
.204    .204                                                                     RHO2
0.      10.     20.     30.     40.     50.     60.     70.     80.     90.      XAFK10
100.                                                                             XAFK11
1.667   2.97    5.37    7.73    10.1    12.0                                     YK6
0.      1.5     4.5     7.5     10.5    11.667  15.594817.372619.150320.928      XFUSK10
22.705824.483526.28     29.4    33.     36.5                                     XFUSK16
2.01    0.                                                                       MALPHA
2.01    5.                                                                       MALPHA
-1.                                                                              MALPHA

00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

OGIVE CYLINDER BODY WITH 45 DEGREE SWEEP NACA 65A004 MID-WING

WING PANEL CORNER POINT COORDINATES
1 AND 3 INDICATE WING PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE TRAILING-EDGE POINTS

PANEL	X_1	Y_1	Z_1	X_2	Y_2	Z_2	X_3	Y_3	Z_3	X_4	Y_4	Z_4
1	15.59483	1.66700	0.00000	16.48370	1.66700	0.00000	17.11500	2.97000	0.00000	17.91700	2.97000	0.00000
2	16.48370	1.66700	0.00000	17.37257	1.66700	0.00000	17.91700	2.97000	0.00000	18.71900	2.97000	0.00000
3	17.37257	1.66700	0.00000	18.26143	1.66700	0.00000	18.71900	2.97000	0.00000	19.52100	2.97000	0.00000
4	18.26143	1.66700	0.00000	19.15030	1.66700	0.00000	19.52100	2.97000	0.00000	20.32300	2.97000	0.00000
5	19.15030	1.66700	0.00000	20.03917	1.66700	0.00000	20.32300	2.97000	0.00000	21.12500	2.97000	0.00000
6	20.03917	1.66700	0.00000	20.92803	1.66700	0.00000	21.12500	2.97000	0.00000	21.92700	2.97000	0.00000
7	20.92803	1.66700	0.00000	21.81690	1.66700	0.00000	21.92700	2.97000	0.00000	22.72900	2.97000	0.00000
8	21.81690	1.66700	0.00000	22.70577	1.66700	0.00000	22.72900	2.97000	0.00000	23.53100	2.97000	0.00000
9	22.70577	1.66700	0.00000	23.59463	1.66700	0.00000	23.53100	2.97000	0.00000	24.33300	2.97000	0.00000
10	23.59463	1.66700	0.00000	24.48350	1.66700	0.00000	24.33300	2.97000	0.00000	25.13500	2.97000	0.00000
11	17.11500	2.97000	0.00000	17.91700	2.97000	0.00000	19.91500	5.37000	0.00000	20.55700	5.37000	0.00000
12	17.91700	2.97000	0.00000	18.71900	2.97000	0.00000	20.55700	5.37000	0.00000	21.19900	5.37000	0.00000
13	18.71900	2.97000	0.00000	19.52100	2.97000	0.00000	21.19900	5.37000	0.00000	21.84100	5.37000	0.00000
14	19.52100	2.97000	0.00000	20.32300	2.97000	0.00000	21.84100	5.37000	0.00000	22.48300	5.37000	0.00000
15	20.32300	2.97000	0.00000	21.12500	2.97000	0.00000	22.48300	5.37000	0.00000	23.12500	5.37000	0.00000
16	21.12500	2.97000	0.00000	21.92700	2.97000	0.00000	23.12500	5.37000	0.00000	23.76700	5.37000	0.00000
17	21.92700	2.97000	0.00000	22.72900	2.97000	0.00000	23.76700	5.37000	0.00000	24.40900	5.37000	0.00000
18	22.72900	2.97000	0.00000	23.53100	2.97000	0.00000	24.40900	5.37000	0.00000	25.05100	5.37000	0.00000
19	23.53100	2.97000	0.00000	24.33300	2.97000	0.00000	25.05100	5.37000	0.00000	25.69300	5.37000	0.00000
20	24.33300	2.97000	0.00000	25.13500	2.97000	0.00000	25.69300	5.37000	0.00000	26.33500	5.37000	0.00000
21	19.91500	5.37000	0.00000	20.55700	5.37000	0.00000	22.66833	7.73000	0.00000	23.15300	7.73000	0.00000
22	20.55700	5.37000	0.00000	21.19900	5.37000	0.00000	23.15300	7.73000	0.00000	23.63767	7.73000	0.00000
23	21.19900	5.37000	0.00000	21.84100	5.37000	0.00000	23.63767	7.73000	0.00000	24.12233	7.73000	0.00000
24	21.84100	5.37000	0.00000	22.48300	5.37000	0.00000	24.12233	7.73000	0.00000	24.60700	7.73000	0.00000
25	22.48300	5.37000	0.00000	23.12500	5.37000	0.00000	24.60700	7.73000	0.00000	25.09167	7.73000	0.00000
26	23.12500	5.37000	0.00000	23.76700	5.37000	0.00000	25.09167	7.73000	0.00000	25.57633	7.73000	0.00000
27	23.76700	5.37000	0.00000	24.40900	5.37000	0.00000	25.57633	7.73000	0.00000	26.06100	7.73000	0.00000
28	24.40900	5.37000	0.00000	25.05100	5.37000	0.00000	26.06100	7.73000	0.00000	26.54567	7.73000	0.00000
29	25.05100	5.37000	0.00000	25.69300	5.37000	0.00000	26.54567	7.73000	0.00000	27.03033	7.73000	0.00000
30	25.69300	5.37000	0.00000	26.33500	5.37000	0.00000	27.03033	7.73000	0.00000	27.51500	7.73000	0.00000
31	22.66833	7.73000	0.00000	23.15300	7.73000	0.00000	25.43333	10.10000	0.00000	25.76000	10.10000	0.00000
32	23.15300	7.73000	0.00000	23.63767	7.73000	0.00000	25.76000	10.10000	0.00000	26.08667	10.10000	0.00000
33	23.63767	7.73000	0.00000	24.12233	7.73000	0.00000	26.08667	10.10000	0.00000	26.41333	10.10000	0.00000
34	24.12233	7.73000	0.00000	24.60700	7.73000	0.00000	26.41333	10.10000	0.00000	26.74000	10.10000	0.00000
35	24.60700	7.73000	0.00000	25.09167	7.73000	0.00000	26.74000	10.10000	0.00000	27.06667	10.10000	0.00000
36	25.09167	7.73000	0.00000	25.57633	7.73000	0.00000	27.06667	10.10000	0.00000	27.39333	10.10000	0.00000
37	25.57633	7.73000	0.00000	26.06100	7.73000	0.00000	27.39333	10.10000	0.00000	27.72000	10.10000	0.00000
38	26.06100	7.73000	0.00000	26.54567	7.73000	0.00000	27.72000	10.10000	0.00000	28.04667	10.10000	0.00000
39	26.54567	7.73000	0.00000	27.03033	7.73000	0.00000	28.04667	10.10000	0.00000	28.37333	10.10000	0.00000
40	27.03033	7.73000	0.00000	27.51500	7.73000	0.00000	28.37333	10.10000	0.00000	28.70000	10.10000	0.00000
41	25.43333	10.10000	0.00000	25.76000	10.10000	0.00000	27.65000	12.00000	0.00000	27.85000	12.00000	0.00000
42	25.76000	10.10000	0.00000	26.08667	10.10000	0.00000	27.85000	12.00000	0.00000	28.05000	12.00000	0.00000
43	26.08667	10.10000	0.00000	26.41333	10.10000	0.00000	28.05000	12.00000	0.00000	28.25000	12.00000	0.00000
44	26.41333	10.10000	0.00000	26.74000	10.10000	0.00000	28.25000	12.00000	0.00000	28.45000	12.00000	0.00000
45	26.74000	10.10000	0.00000	27.06667	10.10000	0.00000	28.45000	12.00000	0.00000	28.65000	12.00000	0.00000
46	27.06667	10.10000	0.00000	27.39333	10.10000	0.00000	28.65000	12.00000	0.00000	28.85000	12.00000	0.00000
47	27.39333	10.10000	0.00000	27.72000	10.10000	0.00000	28.85000	12.00000	0.00000	29.05000	12.00000	0.00000
48	27.72000	10.10000	0.00000	28.04667	10.10000	0.00000	29.05000	12.00000	0.00000	29.25000	12.00000	0.00000
49	28.04667	10.10000	0.00000	28.37333	10.10000	0.00000	29.25000	12.00000	0.00000	29.45000	12.00000	0.00000
50	28.37333	10.10000	0.00000	28.70000	10.10000	0.00000	29.45000	12.00000	0.00000	29.65000	12.00000	0.00000

WING PANEL CONTROL POINTS AND INCLINATION ANGLES

POINT	X_{CP}	Y_{CP}	Z_{CP}	THETA	CAMBER SLOPE	THICKNESS SLOPE
1	16.34190	2.30734	0.00000	0.00000	0.00000	.17879
2	17.18808	2.30734	0.00000	0.00000	0.00000	.05696
3	18.03425	2.30734	0.00000	0.00000	0.00000	.03265
4	18.88043	2.30734	0.00000	0.00000	0.00000	.01709
5	19.72661	2.30734	0.00000	0.00000	0.00000	.00315
6	20.57279	2.30734	0.00000	0.00000	0.00000	-.01379
7	21.41896	2.30734	0.00000	0.00000	0.00000	-.02918
8	22.26514	2.30734	0.00000	0.00000	0.00000	-.03946
9	23.11132	2.30734	0.00000	0.00000	0.00000	-.04623
10	23.95749	2.30734	0.00000	0.00000	0.00000	-.04704
11	24.80367	2.30734	0.00000	0.00000	0.00000	-.04710
12	18.46329	4.12568	0.00000	0.00000	0.00000	.17879
13	19.18825	4.12568	0.00000	0.00000	0.00000	.05696
14	19.91320	4.12568	0.00000	0.00000	0.00000	.03265
15	20.63816	4.12568	0.00000	0.00000	0.00000	.01709
16	21.36311	4.12568	0.00000	0.00000	0.00000	.00315
17	22.08807	4.12568	0.00000	0.00000	0.00000	-.01379
18	22.81302	4.12568	0.00000	0.00000	0.00000	-.02918
19	23.53798	4.12568	0.00000	0.00000	0.00000	-.03946
20	24.26293	4.12568	0.00000	0.00000	0.00000	-.04623
21	24.98788	4.12568	0.00000	0.00000	0.00000	-.04704
22	25.71284	4.12568	0.00000	0.00000	0.00000	-.04710
23	21.22759	6.49507	0.00000	0.00000	0.00000	.17879
24	21.79458	6.49507	0.00000	0.00000	0.00000	.05696
25	22.36158	6.49507	0.00000	0.00000	0.00000	.03265
26	22.92857	6.49507	0.00000	0.00000	0.00000	.01709
27	23.49557	6.49507	0.00000	0.00000	0.00000	.00315
28	24.06256	6.49507	0.00000	0.00000	0.00000	-.01379
29	24.62956	6.49507	0.00000	0.00000	0.00000	-.02918
30	25.19655	6.49507	0.00000	0.00000	0.00000	-.03946
31	25.76355	6.49507	0.00000	0.00000	0.00000	-.04623
32	26.33054	6.49507	0.00000	0.00000	0.00000	-.04704
33	26.89754	6.49507	0.00000	0.00000	0.00000	-.04710
34	23.96109	8.83808	0.00000	0.00000	0.00000	.17879
35	24.37188	8.83808	0.00000	0.00000	0.00000	.05696
36	24.78268	8.83808	0.00000	0.00000	0.00000	.03265
37	25.19347	8.83808	0.00000	0.00000	0.00000	.01709
38	25.60427	8.83808	0.00000	0.00000	0.00000	.00315
39	26.01506	8.83808	0.00000	0.00000	0.00000	-.01379
40	26.42586	8.83808	0.00000	0.00000	0.00000	-.02918
41	26.83665	8.83808	0.00000	0.00000	0.00000	-.03946
42	27.24745	8.83808	0.00000	0.00000	0.00000	-.04623
43	27.65824	8.83808	0.00000	0.00000	0.00000	-.04704
44	28.06904	8.83808	0.00000	0.00000	0.00000	-.04710
45	26.45281	10.97384	0.00000	0.00000	0.00000	.17879
46	26.72122	10.97384	0.00000	0.00000	0.00000	.05696
47	26.98963	10.97384	0.00000	0.00000	0.00000	.03265
48	27.25805	10.97384	0.00000	0.00000	0.00000	.01709
49	27.52646	10.97384	0.00000	0.00000	0.00000	.00315
50	27.79487	10.97384	0.00000	0.00000	0.00000	-.01379
51	28.06328	10.97384	0.00000	0.00000	0.00000	-.02918
52	28.33169	10.97384	0.00000	0.00000	0.00000	-.03946
53	28.60010	10.97384	0.00000	0.00000	0.00000	-.04623
54	28.86851	10.97384	0.00000	0.00000	0.00000	-.04704
55	29.13692	10.97384	0.00000	0.00000	0.00000	-.04710

WING PANEL AREAS AND CHORDS

PANEL	AREA	CHORD
1	1.10160	.84618
2	1.10160	.84618
3	1.10160	.84618
4	1.10160	.84618
5	1.10160	.84618
6	1.10160	.84618
7	1.10160	.84618
8	1.10160	.84618
9	1.10160	.84618
10	1.10160	.84618
11	1.73280	.72495
12	1.73280	.72495
13	1.73280	.72495
14	1.73280	.72495
15	1.73280	.72495
16	1.73280	.72495
17	1.73280	.72495
18	1.73280	.72495
19	1.73280	.72495
20	1.73280	.72495
21	1.32947	.56700
22	1.32947	.56700
23	1.32947	.56700
24	1.32947	.56700
25	1.32947	.56700
26	1.32947	.56700
27	1.32947	.56700
28	1.32947	.56700
29	1.32947	.56700
30	1.32947	.56700
31	.96143	.41079
32	.96143	.41079
33	.96143	.41079
34	.96143	.41079
35	.96143	.41079
36	.96143	.41079
37	.96143	.41079
38	.96143	.41079
39	.96143	.41079
40	.96143	.41079
41	.50033	.26841
42	.50033	.26841
43	.50033	.26841
44	.50033	.26841
45	.50033	.26841
46	.50033	.26841
47	.50033	.26841
48	.50033	.26841
49	.50033	.26841
50	.50033	.26841

BODY PANEL CORNER POINT COORDINATES
1 AND 3 INDICATE BODY PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE TRAILING-EDGE POINTS

PANEL	X_1	Y_1	Z_1	X_2	Y_2	Z_2	X_3	Y_3	Z_3	X_4	Y_4	Z_4
1	0.00000	0.00000	0.00000	1.50000	.00000	-.40622	0.00000	0.00000	0.00000	1.50000	.28724	-.28724
2	0.00000	0.00000	0.00000	1.50000	.28724	-.28724	0.00000	0.00000	0.00000	1.50000	.40622	.00000
3	0.00000	0.00000	0.00000	1.50000	.40622	.00000	0.00000	0.00000	0.00000	1.50000	.28724	.28724
4	0.00000	0.00000	0.00000	1.50000	.28724	.28724	0.00000	0.00000	0.00000	1.50000	-.00000	.40622
5	1.50000	.00000	-.40622	4.50000	.00000	-1.04487	1.50000	.28724	-.28724	4.50000	.73883	-.73883
6	1.50000	.28724	-.28724	4.50000	.73883	-.73883	1.50000	.40622	.00000	4.50000	1.04487	.00000
7	1.50000	.40622	.00000	4.50000	1.04487	.00000	1.50000	.28724	.28724	4.50000	.73883	.73883
8	1.50000	.28724	.28724	4.50000	.73883	.73883	1.50000	-.00000	.40622	4.50000	-.00000	1.04487
9	4.50000	.00000	-1.04487	7.50000	.00000	-1.45730	4.50000	.73883	-.73883	7.50000	1.03047	-1.03047
10	4.50000	.73883	-.73883	7.50000	1.03047	-1.03047	4.50000	1.04487	.00000	7.50000	1.45730	.00000
11	4.50000	1.04487	.00000	7.50000	1.45730	.00000	4.50000	.73883	.73883	7.50000	1.03047	1.03047
12	4.50000	.73883	.73883	7.50000	1.03047	1.03047	4.50000	-.00000	1.04487	7.50000	-.00000	1.45730
13	7.50000	.00000	-1.45730	10.50000	.00000	-1.65030	7.50000	1.03047	-1.03047	10.50000	1.16694	-1.16694
14	7.50000	1.03047	-1.03047	10.50000	1.16694	-1.16694	7.50000	1.45730	.00000	10.50000	1.65030	.00000
15	7.50000	1.45730	.00000	10.50000	1.65030	.00000	7.50000	1.03047	1.03047	10.50000	1.16694	1.16694
16	7.50000	1.03047	1.03047	10.50000	1.16694	1.16694	7.50000	-.00000	1.45730	10.50000	-.00000	1.65030
17	10.50000	.00000	-1.65030	11.66700	.00000	-1.66670	10.50000	1.16694	-1.16694	11.66700	1.17854	-1.17854
18	10.50000	1.16694	-1.16694	11.66700	1.17854	-1.17854	10.50000	1.65030	.00000	11.66700	1.66670	.00000
19	10.50000	1.65030	.00000	11.66700	1.66670	.00000	10.50000	1.16694	1.16694	11.66700	1.17854	1.17854
20	10.50000	1.16694	1.16694	11.66700	1.17854	1.17854	10.50000	-.00000	1.65030	11.66700	-.00000	1.66670
21	11.66700	.00000	-1.66670	15.59480	.00000	-1.66670	11.66700	1.17854	-1.17854	15.59480	1.17854	-1.17854
22	11.66700	1.17854	-1.17854	15.59480	1.17854	-1.17854	11.66700	1.66670	.00000	15.59480	1.66670	.00000
23	11.66700	1.66670	.00000	15.59480	1.66670	.00000	11.66700	1.17854	1.17854	15.59480	1.17854	1.17854
24	11.66700	1.17854	1.17854	15.59480	1.17854	1.17854	11.66700	-.00000	1.66670	15.59480	-.00000	1.66670
25	15.59480	.00000	-1.66670	17.37260	.00000	-1.66670	15.59480	1.17854	-1.17854	17.37260	1.17854	-1.17854
26	15.59480	1.17854	-1.17854	17.37260	1.17854	-1.17854	15.59480	1.66670	.00000	17.37260	1.66670	.00000
27	15.59480	1.66670	.00000	17.37260	1.66670	.00000	15.59480	1.17854	1.17854	17.37260	1.17854	1.17854
28	15.59480	1.17854	1.17854	17.37260	1.17854	1.17854	15.59480	-.00000	1.66670	17.37260	-.00000	1.66670
29	17.37260	.00000	-1.66670	19.15030	.00000	-1.66670	17.37260	1.17854	-1.17854	19.15030	1.17854	-1.17854
30	17.37260	1.17854	-1.17854	19.15030	1.17854	-1.17854	17.37260	1.66670	.00000	19.15030	1.66670	.00000
31	17.37260	1.66670	.00000	19.15030	1.66670	.00000	17.37260	1.17854	1.17854	19.15030	1.17854	1.17854
32	17.37260	1.17854	1.17854	19.15030	1.17854	1.17854	17.37260	-.00000	1.66670	19.15030	-.00000	1.66670
33	19.15030	.00000	-1.66670	20.92800	.00000	-1.66670	19.15030	1.17854	-1.17854	20.92800	1.17854	-1.17854
34	19.15030	1.17854	-1.17854	20.92800	1.17854	-1.17854	19.15030	1.66670	.00000	20.92800	1.66670	.00000
35	19.15030	1.66670	.00000	20.92800	1.66670	.00000	19.15030	1.17854	1.17854	20.92800	1.17854	1.17854
36	19.15030	1.17854	1.17854	20.92800	1.17854	1.17854	19.15030	-.00000	1.66670	20.92800	-.00000	1.66670
37	20.92800	.00000	-1.66670	22.70580	.00000	-1.66670	20.92800	1.17854	-1.17854	22.70580	1.17854	-1.17854
38	20.92800	1.17854	-1.17854	22.70580	1.17854	-1.17854	20.92800	1.66670	.00000	22.70580	1.66670	.00000
39	20.92800	1.66670	.00000	22.70580	1.66670	.00000	20.92800	1.17854	1.17854	22.70580	1.17854	1.17854
40	20.92800	1.17854	1.17854	22.70580	1.17854	1.17854	20.92800	-.00000	1.66670	22.70580	-.00000	1.66670
41	22.70580	.00000	-1.66670	24.48350	.00000	-1.66670	22.70580	1.17854	-1.17854	24.48350	1.17854	-1.17854
42	22.70580	1.17854	-1.17854	24.48350	1.17854	-1.17854	22.70580	1.66670	.00000	24.48350	1.66670	.00000
43	22.70580	1.66670	.00000	24.48350	1.66670	.00000	22.70580	1.17854	1.17854	24.48350	1.17854	1.17854
44	22.70580	1.17854	1.17854	24.48350	1.17854	1.17854	22.70580	-.00000	1.66670	24.48350	-.00000	1.66670
45	24.48350	.00000	-1.66670	26.28000	.00000	-1.66670	24.48350	1.17854	-1.17854	26.28000	1.17854	-1.17854
46	24.48350	1.17854	-1.17854	26.28000	1.17854	-1.17854	24.48350	1.66670	.00000	26.28000	1.66670	.00000
47	24.48350	1.66670	.00000	26.28000	1.66670	.00000	24.48350	1.17854	1.17854	26.28000	1.17854	1.17854
48	24.48350	1.17854	1.17854	26.28000	1.17854	1.17854	24.48350	-.00000	1.66670	26.28000	-.00000	1.66670
49	26.28000	.00000	-1.66670	29.40000	.00000	-1.66670	26.28000	1.17854	-1.17854	29.40000	1.17854	-1.17854
50	26.28000	1.17854	-1.17854	29.40000	1.17854	-1.17854	26.28000	1.66670	.00000	29.40000	1.66670	.00000
51	26.28000	1.66670	.00000	29.40000	1.66670	.00000	26.28000	1.17854	1.17854	29.40000	1.17854	1.17854
52	26.28000	1.17854	1.17854	29.40000	1.17854	1.17854	26.28000	-.00000	1.66670	29.40000	-.00000	1.66670
53	29.40000	.00000	-1.66670	33.00000	.00000	-1.66670	29.40000	1.17854	-1.17854	33.00000	1.17854	-1.17854
54	29.40000	1.17854	-1.17854	33.00000	1.17854	-1.17854	29.40000	1.66670	.00000	33.00000	1.66670	.00000
55	29.40000	1.66670	.00000	33.00000	1.66670	.00000	29.40000	1.17854	1.17854	33.00000	1.17854	1.17854
56	29.40000	1.17854	1.17854	33.00000	1.17854	1.17854	29.40000	-.00000	1.66670	33.00000	-.00000	1.66670
57	33.00000	.00000	-1.66670	36.50000	.00000	-1.66670	33.00000	1.17854	-1.17854	36.50000	1.17854	-1.17854
58	33.00000	1.17854	-1.17854	36.50000	1.17854	-1.17854	33.00000	1.66670	.00000	36.50000	1.66670	.00000
59	33.00000	1.66670	.00000	36.50000	1.66670	.00000	33.00000	1.17854	1.17854	36.50000	1.17854	1.17854
60	33.00000	1.17854	1.17854	36.50000	1.17854	1.17854	33.00000	-.00000	1.66670	36.50000	-.00000	1.66670

BODY PANEL CONTROL POINT COORDINATES

POINT	X_{CP}	Y_{CP}	Z_{CP}
1	1.00000	.09575	-.23116
2	1.00000	.23116	-.09575
3	1.00000	.23116	.09575
4	1.00000	.09575	.23116
5	3.22006	.27308	-.65928
6	3.22006	.65928	-.27308
7	3.22006	.65928	.27308
8	3.22006	.27308	.65928
9	6.08242	.44633	-1.07754
10	6.08242	1.07754	-.44633
11	6.08242	1.07754	.44633
12	6.08242	.44633	1.07754
13	9.03105	.55006	-1.32796
14	9.03105	1.32796	-.55006
15	9.03105	1.32796	.55006
16	9.03105	.55006	1.32796
17	11.08446	.58637	-1.41563
18	11.08446	1.41563	-.58637
19	11.08446	1.41563	.58637
20	11.08446	.58637	1.41563
21	13.63090	.58927	-1.42262
22	13.63090	1.42262	-.58927
23	13.63090	1.42262	.58927
24	13.63090	.58927	1.42262
25	16.48370	.58927	-1.42262
26	16.48370	1.42262	-.58927
27	16.48370	1.42262	.58927
28	16.48370	.58927	1.42262
29	18.26145	.58927	-1.42262
30	18.26145	1.42262	-.58927
31	18.26145	1.42262	.58927
32	18.26145	.58927	1.42262
33	20.03915	.58927	-1.42262
34	20.03915	1.42262	-.58927
35	20.03915	1.42262	.58927
36	20.03915	.58927	1.42262
37	21.81690	.58927	-1.42262
38	21.81690	1.42262	-.58927
39	21.81690	1.42262	.58927
40	21.81690	.58927	1.42262
41	23.59465	.58927	-1.42262
42	23.59465	1.42262	-.58927
43	23.59465	1.42262	.58927
44	23.59465	.58927	1.42262
45	25.38175	.58927	-1.42262
46	25.38175	1.42262	-.58927
47	25.38175	1.42262	.58927
48	25.38175	.58927	1.42262
49	27.84000	.58927	-1.42262
50	27.84000	1.42262	-.58927
51	27.84000	1.42262	.58927
52	27.84000	.58927	1.42262
53	31.20000	.58927	-1.42262
54	31.20000	1.42262	-.58927
55	31.20000	1.42262	.58927
56	31.20000	.58927	1.42262
57	34.75000	.58927	-1.42262
58	34.75000	1.42262	-.58927
59	34.75000	1.42262	.58927
60	34.75000	.58927	1.42262

BODY PANEL AREAS AND INCLINATION ANGLES

PANEL	AREA	DELTA	THETA
1	.24037	.24517	-2.74889
2	.24037	.24517	-1.96350
3	.24037	.24517	-1.17810
4	.24037	.24517	-.39270
5	1.69784	.19420	-2.74889
6	1.69784	.19420	-1.96350
7	1.69784	.19420	-1.17810
8	1.69784	.19420	-.39270
9	2.89570	.12634	-2.74889
10	2.89570	.12634	-1.96350
11	2.89570	.12634	-1.17810
12	2.89570	.12634	-.39270
13	3.57398	.05937	-2.74889
14	3.57398	.05937	-1.96350
15	3.57398	.05937	-1.17810
16	3.57398	.05937	-.39270
17	1.48147	.01298	-2.74889
18	1.48147	.01298	-1.96350
19	1.48147	.01298	-1.17810
20	1.48147	.01298	-.39270
21	5.01045	0.00000	-2.74889
22	5.01045	0.00000	-1.96350
23	5.01045	0.00000	-1.17810
24	5.01045	0.00000	-.39270
25	2.26783	0.00000	-2.74889
26	2.26783	0.00000	-1.96350
27	2.26783	0.00000	-1.17810
28	2.26783	0.00000	-.39270
29	2.26770	0.00000	-2.74889
30	2.26770	0.00000	-1.96350
31	2.26770	0.00000	-1.17810
32	2.26770	0.00000	-.39270
33	2.26770	0.00000	-2.74889
34	2.26770	0.00000	-1.96350
35	2.26770	0.00000	-1.17810
36	2.26770	0.00000	-.39270
37	2.26783	0.00000	-2.74889
38	2.26783	0.00000	-1.96350
39	2.26783	0.00000	-1.17810
40	2.26783	0.00000	-.39270
41	2.26770	0.00000	-2.74889
42	2.26770	0.00000	-1.96350
43	2.26770	0.00000	-1.17810
44	2.26770	0.00000	-.39270
45	2.29168	0.00000	-2.74889
46	2.29168	0.00000	-1.96350
47	2.29168	0.00000	-1.17810
48	2.29168	0.00000	-.39270
49	3.97999	0.00000	-2.74889
50	3.97999	0.00000	-1.96350
51	3.97999	0.00000	-1.17810
52	3.97999	0.00000	-.39270
53	4.59229	0.00000	-2.74889
54	4.59229	0.00000	-1.96350
55	4.59229	0.00000	-1.17810
56	4.59229	0.00000	-.39270
57	4.46473	0.00000	-2.74889
58	4.46473	0.00000	-1.96350
59	4.46473	0.00000	-1.17810
60	4.46473	0.00000	-.39270

PARTITION = 1 TIME = 86.64100
INFLUENCE OF BODY ON BODY

PARTITION = 2 TIME = 116.86700
INFLUENCE OF WING ON BODY

PARTITION = 3 TIME = 146.28100
INFLUENCE OF BODY ON WING

PARTITION = 4 TIME = 173.92100
INFLUENCE OF WING ON WING

TIME = 204.25900

TIME = 206.69900

TIME = 224.44500

VELOCITIES ON BODY, MACH=2.010   ALPHA= 0.000

PANEL NO.	SOURCE STRENGTH	AXIAL VELOCITY	LATERAL VELOCITY	VERTICAL VELOCITY	NORMAL VELOCITY
1	.19642	-.09678	.08648	-.20879	.25020
2	.19642	-.09678	.20879	-.08648	.25020
3	.19642	-.09678	.20879	.08648	.25020
4	.19642	-.09678	.08648	.20879	.25020
5	.17261	-.07016	.06998	-.16896	.19668
6	.17261	-.07016	.16896	-.06998	.19668
7	.17261	-.07016	.16896	.06998	.19668
8	.17261	-.07016	.06998	.16896	.19668
9	.11296	-.03539	.04689	-.11319	.12701
10	.11296	-.03539	.11319	-.04689	.12701
11	.11296	-.03539	.11319	.04689	.12701
12	.11296	-.03539	.04689	.11319	.12701
13	.05198	-.00181	.02270	-.05481	.05944
14	.05198	-.00181	.05481	-.02270	.05944
15	.05198	-.00181	.05481	.02270	.05944
16	.05198	-.00181	.02270	.05481	.05944
17	-.02286	.02050	.00507	-.01224	.01298
18	-.02286	.02050	.01224	-.00507	.01298
19	-.02286	.02050	.01224	.00507	.01298
20	-.02286	.02050	.00507	.01224	.01298
21	-.00277	.01807	.00000	.00000	-.00000
22	-.00277	.01807	.00000	.00000	-.00000
23	-.00277	.01807	-.00000	.00000	-.00000
24	-.00277	.01807	-.00000	.00000	-.00000
25	.02891	.00714	.00000	.00000	-.00000
26	.02891	.00714	-.00000	-.00000	.00000
27	.02891	.00714	.00000	-.00000	-.00000
28	.02891	.00714	-.00000	.00000	-.00000
29	-.00208	.00751	-.00000	-.00000	-.00000
30	.02371	-.00814	-.00807	-.01949	-.00000
31	.02371	-.00814	-.00807	.01949	-.00000
32	-.00208	.00751	.00000	-.00000	.00000
33	-.02323	.00037	-.01946	-.00806	.00000
34	.01089	.00055	-.00635	-.01534	-.00000
35	.01089	.00055	-.00635	.01534	-.00000
36	-.02323	.00037	-.01946	.00806	.00000
37	-.04014	-.00101	-.01001	-.00415	.00000
38	-.01999	.01434	.00025	.00060	.00000
39	-.01999	.01434	.00025	-.00060	.00000
40	-.04014	-.00101	-.01001	.00415	.00000
41	.00854	-.00006	.00244	.00101	-.00000
42	-.00627	.01918	.00711	.01716	.00000
43	-.00627	.01918	.00711	-.01716	.00000
44	.00854	-.00006	.00244	-.00101	.00000
45	.03622	.00587	.01490	.00617	-.00000
46	-.01324	.01811	.01223	.02952	.00000
47	-.01324	.01811	.01223	-.02952	.00000
48	.03622	.00587	.01490	-.00617	-.00000
49	.01694	.01450	.02036	.00843	-.00000
50	-.06066	.00777	.00965	.02329	.00000
51	-.06066	.00777	.00965	-.02329	.00000
52	.01694	.01450	.02036	-.00843	-.00000
53	.03094	.01317	.02397	.00993	.00000
54	-.05393	.01141	.01118	.02698	.00000
55	-.05393	.01141	.01118	-.02698	.00000
56	.03094	.01317	.02397	-.00993	.00000
57	.01268	.00842	.02074	.00859	.00000
58	-.07801	.00925	.01240	.02993	.00000
59	-.07801	.00925	.01240	-.02993	.00000
60	.01268	.00842	.02074	-.00859	.00000

OGIVE CYLINDER BODY WITH 45 DEGREE SWEEP NACA 65A004 MID-WING
SINGULARITY PANELING FOR SAMPLE CASE

INTEGRATION OF THE PRESSURE DISTRIBUTION

ON THE BODY

MACH= 2.0100
ALPHA= 0.0000

POINT	X	Y	Z	X/C	2Y/B	Z/C	CP	CN	CT	CM	POINT
1	1.00000	.09575	-.23116	.02740	.02875	-.06942	.15199	.03274	.00887	.64669	1
2	1.00000	.23116	-.09575	.02740	.06942	-.02875	.15199	.01356	.00887	.26787	2
3	1.00000	.23116	.09575	.02740	.06942	.02875	.15199	-.01356	.00887	-.26787	3
4	1.00000	.09575	.23116	.02740	.02875	.06942	.15199	-.03274	.00887	-.64669	4
5	3.22006	.27308	-.65928	.08822	.08201	-.19798	.11288	.17374	.03699	3.03221	5
6	3.22006	.65928	-.27308	.08822	.19798	-.08201	.11288	.07197	.03699	1.25598	6
7	3.22006	.65928	.27308	.08822	.19798	.08201	.11288	-.07197	.03699	-1.25598	7
8	3.22006	.27308	.65928	.08822	.08201	.19798	.11288	-.17374	.03699	-3.03222	8
9	6.08242	.44633	-1.07754	.16664	.13403	-.32359	.05759	.15283	.02101	2.22865	9
10	6.08242	1.07754	-.44633	.16664	.32359	-.13403	.05759	.06330	.02101	.92314	10
11	6.08242	1.07754	.44633	.16664	.32359	.13403	.05759	-.06330	.02101	-.92314	11
12	6.08242	.44633	1.07754	.16664	.13403	.32359	.05759	-.15283	.02101	-2.22865	12
13	9.03105	.55006	-1.32796	.24743	.16518	-.39879	.00010	.00034	.00002	.00392	13
14	9.03105	1.32796	-.55006	.24743	.39879	-.16518	.00010	.00014	.00002	.00163	14
15	9.03105	1.32796	.55006	.24743	.39879	.16518	.00010	-.00014	.00002	-.00163	15
16	9.03105	.55006	1.32796	.24743	.16518	.39879	.00010	-.00034	.00002	-.00392	16
17	11.08446	.58637	-1.41563	.30368	.17609	-.42511	-.03988	-.05458	-.00077	-.52986	17
18	11.08446	1.41563	-.58637	.30368	.42511	-.17609	-.03988	-.02261	-.00077	-.21948	18
19	11.08446	1.41563	.58637	.30368	.42511	.17609	-.03988	.02261	-.00077	.21948	19
20	11.08446	.58637	1.41563	.30368	.17609	.42511	-.03988	.05458	-.00077	.52986	20
21	13.63090	.58927	-1.42262	.37345	.17696	-.42721	-.03515	-.16270	0.00000	-1.16854	21
22	13.63090	1.42262	-.58927	.37345	.42721	-.17696	-.03515	-.06739	0.00000	-.48402	22
23	13.63090	1.42262	.58927	.37345	.42721	.17696	-.03515	.06739	0.00000	.48402	23
24	13.63090	.58927	1.42262	.37345	.17696	.42721	-.03515	.16270	0.00000	1.16854	24
25	16.48370	.58927	-1.42262	.45161	.17696	-.42721	-.01413	-.02960	0.00000	-.12817	25
26	16.48370	1.42262	-.58927	.45161	.42721	-.17696	-.01413	-.01226	0.00000	-.05309	26
27	16.48370	1.42262	.58927	.45161	.42721	.17696	-.01413	.01226	0.00000	.05309	27
28	16.48370	.58927	1.42262	.45161	.17696	.42721	-.01413	.02960	0.00000	.12817	28
29	18.26145	.58927	-1.42262	.50031	.17696	-.42721	-.01486	-.03112	0.00000	-.07942	29
30	18.26145	1.42262	-.58927	.50031	.42721	-.17696	.01602	.01390	0.00000	.03547	30
31	18.26145	1.42262	.58927	.50031	.42721	.17696	.01602	-.01390	0.00000	-.03547	31
32	18.26145	.58927	1.42262	.50031	.17696	.42721	-.01486	.03112	0.00000	.07942	32
33	20.03915	.58927	-1.42262	.54902	.17696	-.42721	-.00118	-.00248	0.00000	-.00192	33
34	20.03915	1.42262	-.58927	.54902	.42721	-.17696	-.00137	-.00119	0.00000	-.00092	34
35	20.03915	1.42262	.58927	.54902	.42721	.17696	-.00137	.00119	0.00000	.00092	35
36	20.03915	.58927	1.42262	.54902	.17696	.42721	-.00118	.00248	0.00000	.00192	36
37	21.81690	.58927	-1.42262	.59772	.17696	-.42721	.00191	.00400	0.00000	-.00401	37
38	21.81690	1.42262	-.58927	.59772	.42721	-.17696	-.02805	-.02434	0.00000	.02443	38
39	21.81690	1.42262	.58927	.59772	.42721	.17696	-.02805	.02434	0.00000	-.02443	39
40	21.81690	.58927	1.42262	.59772	.17696	.42721	.00191	-.00400	0.00000	.00401	40
41	23.59465	.58927	-1.42262	.64643	.17696	-.42721	.00010	.00022	0.00000	-.00061	41
42	23.59465	1.42262	-.58927	.64643	.42721	-.17696	-.03756	-.03259	0.00000	.09066	42
43	23.59465	1.42262	.58927	.64643	.42721	.17696	-.03756	.03259	0.00000	-.09066	43
44	23.59465	.58927	1.42262	.64643	.17696	.42721	.00010	-.00022	0.00000	.00061	44
45	25.38175	.58927	-1.42262	.69539	.17696	-.42721	-.01188	-.02515	0.00000	.11491	45
46	25.38175	1.42262	-.58927	.69539	.42721	-.17696	-.03616	-.03171	0.00000	.14490	46
47	25.38175	1.42262	.58927	.69539	.42721	.17696	-.03616	.03171	0.00000	-.14490	47
48	25.38175	.58927	1.42262	.69539	.17696	.42721	-.01188	.02515	0.00000	-.11491	48
49	27.84000	.58927	-1.42262	.76274	.17696	-.42721	-.02881	-.10593	0.00000	.74438	49
50	27.84000	1.42262	-.58927	.76274	.42721	-.17696	-.01596	-.02431	0.00000	.17085	50
51	27.84000	1.42262	.58927	.76274	.42721	.17696	-.01596	.02431	0.00000	-.17085	51
52	27.84000	.58927	1.42262	.76274	.17696	.42721	-.02881	.10593	0.00000	-.74438	52
53	31.20000	.58927	-1.42262	.85479	.17696	-.42721	-.02645	-.11222	0.00000	1.16565	53
54	31.20000	1.42262	-.58927	.85479	.42721	-.17696	-.02323	-.04083	0.00000	.42408	54
55	31.20000	1.42262	.58927	.85479	.42721	.17696	-.02323	.04083	0.00000	-.42408	55
56	31.20000	.58927	1.42262	.85479	.17696	.42721	-.02645	.11222	0.00000	-1.16565	56
57	34.75000	.58927	-1.42262	.95205	.17696	-.42721	-.01712	-.07061	0.00000	.98404	57
58	34.75000	1.42262	-.58927	.95205	.42721	-.17696	-.01924	-.03288	0.00000	.45826	58
59	34.75000	1.42262	.58927	.95205	.42721	.17696	-.01924	.03288	0.00000	-.45826	59
60	34.75000	.58927	1.42262	.95205	.17696	.42721	-.01712	.07061	0.00000	-.98404	60

TOTAL COEFFICIENTS

ON THE BODY

REFA= 144.0000 REFD= 3.3300 REFL= 36.5000

REFX= 20.8130 REFZ= 0.0000

CN= .0000
CT= .0037
CM= -.0000
CL= .0000
CD= .0037
XCP= -1.5870

VELOCITIES ON WING UPPER SURFACE, MACH=2.010 ALPHA= 0.000

PANEL NO.	VORTEX STRENGTH	AXIAL VELOCITY	LATERAL VELOCITY	VERTICAL VELOCITY
1	-.00000	-.12191	.14872	.17879
2	-.00000	.02325	-.06309	.05696
3	.00000	.00695	-.03468	.03265
4	.00000	.00518	-.02358	.01709
5	.00000	.00868	-.01760	.00315
6	-.00000	.01821	-.02061	-.01379
7	-.00000	.02206	-.01522	-.02918
8	.00000	.02414	-.00917	-.03946
9	.00000	.02864	-.01025	-.04623
10	.00000	.02582	-.00434	-.04704
11	-.00000	.02247	.00144	-.04710
12	.00000	-.12687	.15178	.17879
13	-.00000	-.03264	.04060	.05696
14	-.00000	-.00618	.00164	.03265
15	-.00000	.02367	-.05002	.01709
16	-.00000	.01651	-.03580	.00315
17	.00000	.02284	-.04163	-.01379
18	.00000	.02992	-.04226	-.02918
19	-.00000	.03571	-.04406	-.03946
20	-.00000	.03733	-.04154	-.04623
21	-.00000	.03439	-.03595	-.04704
22	-.00000	.03269	-.03250	-.04710
23	-.00000	-.12591	.14680	.17879
24	-.00000	-.03502	.04206	.05696
25	.00000	-.01856	.02123	.03265
26	-.00000	-.00934	.00966	.01709
27	-.00000	.00056	-.00363	.00315
28	-.00000	.02291	-.03670	-.01379
29	-.00000	.04714	-.07500	-.02918
30	-.00000	.04349	-.06282	-.03946
31	-.00000	.04270	-.05353	-.04623
32	-.00000	.04277	-.05200	-.04704
33	-.00000	.04111	-.04856	-.04710
34	-.00000	-.12906	.15068	.17879
35	.00000	-.03764	.04531	.05696
36	-.00000	-.01850	.01967	.03265
37	-.00000	-.00791	.00540	.01709
38	-.00000	-.00023	-.00397	.00315
39	-.00000	.01061	-.01688	-.01379
40	.00000	.01939	-.02695	-.02918
41	-.00000	.02434	-.03331	-.03946
42	-.00000	.02815	-.03980	-.04623
43	-.00000	.02809	-.04334	-.04704
44	.00000	.03065	-.04243	-.04710
45	-.00000	-.14159	.17134	.17879
46	-.00000	-.04752	.06159	.05696
47	.00000	-.01946	.02050	.03265
48	.00000	-.01057	.00896	.01709
49	-.00000	-.00287	-.00036	.00315
50	.00000	.00763	-.01249	-.01379
51	.00000	.01648	-.02250	-.02918
52	-.00000	.02364	-.03263	-.03946
53	-.00000	.02826	-.04052	-.04623
54	-.00000	.02754	-.04298	-.04704
55	-.00000	.02755	-.04707	-.04710

OGIVE CYLINDER BODY WITH 45 DEGREE SWEEP NACA 65A004 MID-WING
SINGULARITY PANELING FOR SAMPLE CASE

INTEGRATION OF THE PRESSURE DISTRIBUTION

ON THE WING UPPER SURFACE

MACH= 2.0100
ALPHA= 0.0000

POINT	X	Y	Z	X/C	2Y/B	Z/C	CP	CN	CT	CM	POINT
1	16.76499	2.30734	0.00000	.05000	.19228	0.00000	.07831	-.08627	.01017	-.34921	1
2	17.61117	2.30734	0.00000	.15000	.19228	0.00000	-.03365	.03707	-.00166	.11869	2
3	18.45734	2.30734	0.00000	.25000	.19228	0.00000	-.01353	.01490	-.00037	.03511	3
4	19.30352	2.30734	0.00000	.35000	.19228	0.00000	-.01427	.01572	-.00016	.02373	4
5	20.14970	2.30734	0.00000	.45000	.19228	0.00000	-.02670	.02941	.00016	.01951	5
6	20.99587	2.30734	0.00000	.55000	.19228	0.00000	-.03980	.04384	.00094	-.00802	6
7	21.84205	2.30734	0.00000	.65000	.19228	0.00000	-.04580	.05046	.00173	-.05192	7
8	22.68823	2.30734	0.00000	.75000	.19228	0.00000	-.05237	.05769	.00247	-.10819	8
9	23.53441	2.30734	0.00000	.85000	.19228	0.00000	-.05418	.05969	.00278	-.16243	9
10	24.38058	2.30734	0.00000	.95000	.19228	0.00000	-.04851	.05343	.00252	-.19063	10
11	18.82577	4.12568	0.00000	.05000	.34381	0.00000	.14091	-.24418	.02878	-.48523	11
12	19.55072	4.12568	0.00000	.15000	.34381	0.00000	.03717	-.06441	.00289	-.08131	12
13	20.27568	4.12568	0.00000	.25000	.34381	0.00000	-.01839	.03187	-.00079	.01712	13
14	21.00063	4.12568	0.00000	.35000	.34381	0.00000	-.04077	.07065	-.00071	-.01326	14
15	21.72559	4.12568	0.00000	.45000	.34381	0.00000	-.03961	.06864	.00037	-.06264	15
16	22.45054	4.12568	0.00000	.55000	.34381	0.00000	-.05263	.09119	.00196	-.14933	16
17	23.17550	4.12568	0.00000	.65000	.34381	0.00000	-.06497	.11258	.00386	-.26596	17
18	23.90045	4.12568	0.00000	.75000	.34381	0.00000	-.07210	.12494	.00535	-.38575	18
19	24.62541	4.12568	0.00000	.85000	.34381	0.00000	-.07093	.12292	.00573	-.46861	19
20	25.35036	4.12568	0.00000	.95000	.34381	0.00000	-.06657	.11534	.00543	-.52336	20
21	21.51108	6.49507	0.00000	.05000	.54126	0.00000	.14331	-.19052	.02246	.13300	21
22	22.07808	6.49507	0.00000	.15000	.54126	0.00000	.05227	-.06950	.00311	.08792	22
23	22.64507	6.49507	0.00000	.25000	.54126	0.00000	.02754	-.03662	.00091	.06708	23
24	23.21207	6.49507	0.00000	.35000	.54126	0.00000	.00870	-.01157	.00012	.02776	24
25	23.77906	6.49507	0.00000	.45000	.54126	0.00000	-.02337	.03107	.00017	-.09215	25
26	24.34606	6.49507	0.00000	.55000	.54126	0.00000	-.06915	.09194	.00198	-.32482	26
27	24.91305	6.49507	0.00000	.65000	.54126	0.00000	-.08921	.11860	.00407	-.48628	27
28	25.48005	6.49507	0.00000	.75000	.54126	0.00000	-.08484	.11279	.00483	-.52638	28
29	26.04704	6.49507	0.00000	.85000	.54126	0.00000	-.08398	.11164	.00521	-.58435	29
30	26.61404	6.49507	0.00000	.95000	.54126	0.00000	-.08242	.10958	.00516	-.63568	30
31	24.16649	8.83808	0.00000	.05000	.73651	0.00000	.14910	-.14335	.01690	.48071	31
32	24.57728	8.83808	0.00000	.15000	.73651	0.00000	.05497	-.05285	.00237	.19893	32
33	24.98808	8.83808	0.00000	.25000	.73651	0.00000	.02608	-.02507	.00062	.10468	33
34	25.39887	8.83808	0.00000	.35000	.73651	0.00000	.00806	-.00775	.00008	.03552	34
35	25.80967	8.83808	0.00000	.45000	.73651	0.00000	-.01044	.01004	.00005	-.05018	35
36	26.22046	8.83808	0.00000	.55000	.73651	0.00000	-.03020	.02904	.00062	-.15701	36
37	26.63126	8.83808	0.00000	.65000	.73651	0.00000	-.04417	.04247	.00146	-.24711	37
38	27.04205	8.83808	0.00000	.75000	.73651	0.00000	-.05322	.05117	.00219	-.31873	38
39	27.45285	8.83808	0.00000	.85000	.73651	0.00000	-.05728	.05507	.00257	-.36568	39
40	27.86364	8.83808	0.00000	.95000	.73651	0.00000	-.05967	.05737	.00270	-.40449	40
41	26.58702	10.97384	0.00000	.05000	.91449	0.00000	.16990	-.08500	.01002	.49082	41
42	26.85543	10.97384	0.00000	.15000	.91449	0.00000	.06594	-.03299	.00148	.19936	42
43	27.12384	10.97384	0.00000	.25000	.91449	0.00000	.02978	-.01490	.00037	.09402	43
44	27.39225	10.97384	0.00000	.35000	.91449	0.00000	.01342	-.00672	.00007	.04419	44
45	27.66066	10.97384	0.00000	.45000	.91449	0.00000	-.00483	.00242	.00001	-.01656	45
46	27.92907	10.97384	0.00000	.55000	.91449	0.00000	-.02441	.01221	.00026	-.08692	46
47	28.19748	10.97384	0.00000	.65000	.91449	0.00000	-.04067	.02035	.00070	-.15026	47
48	28.46589	10.97384	0.00000	.75000	.91449	0.00000	-.05268	.02636	.00113	-.20172	48
49	28.73430	10.97384	0.00000	.85000	.91449	0.00000	-.05689	.02847	.00133	-.22549	49
50	29.00271	10.97384	0.00000	.95000	.91449	0.00000	-.05653	.02828	.00133	-.23164	50

VELOCITIES ON WING LOWER SURFACE, MACH=2.010   ALPHA= 0.000

PANEL NO.	VORTEX STRENGTH	AXIAL VELOCITY	LATERAL VELOCITY	VERTICAL VELOCITY
1	-.00000	-.12191	.14872	-.17879
2	-.00000	.02325	-.06309	-.05696
3	.00000	.C0695	-.03468	-.03265
4	.00000	.00518	-.02358	-.01709
5	.00000	.00868	-.01760	-.00315
6	-.00000	.01821	-.02061	.01379
7	-.00000	.02206	-.01522	.02918
8	.00000	.02414	-.00917	.03946
9	.00000	.02864	-.01025	.04623
10	.00000	.02582	-.00434	.04704
11	-.00000	.02247	.00144	.04710
12	.00000	-.12687	.15178	-.17879
13	-.00000	-.03264	.04060	-.05696
14	-.00000	-.00618	.00164	-.03265
15	-.00000	.02367	-.05002	-.01709
16	-.00000	.01651	-.03580	-.00315
17	.00000	.02284	-.04163	.01379
18	.00000	.02992	-.04226	.02918
19	-.00000	.03571	-.04406	.03946
20	-.00000	.03733	-.04194	.04623
21	-.00000	.03439	-.03595	.04704
22	-.00000	.03269	-.03250	.04710
23	-.C0000	-.12591	.14680	-.17879
24	-.00000	-.03502	.04206	-.05696
25	.00000	-.01856	.02123	-.03265
26	-.00000	-.00934	.00966	-.01709
27	-.00000	.00056	-.00363	-.00315
28	-.00000	.02291	-.03670	.01379
29	-.00000	.04714	-.07500	.02918
30	-.00000	.04349	-.06282	.03946
31	-.00000	.04270	-.05353	.04623
32	-.00000	.04277	-.05200	.04704
33	-.00000	.04111	-.04856	.04710
34	-.00000	-.12906	.15068	-.17879
35	.00000	-.03764	.04531	-.05696
36	-.00000	-.01850	.01967	-.03265
37	-.00000	-.00791	.00540	-.01709
38	-.00000	-.00023	-.00397	-.00315
39	-.00000	.01061	-.01688	.01379
40	.00000	.01939	-.02695	.02918
41	-.00000	.02434	-.03331	.03946
42	-.00000	.02815	-.03980	.04623
43	-.00000	.02809	-.04334	.04704
44	.00000	.03065	-.04243	.04710
45	-.00000	-.14159	.17134	-.17879
46	-.00000	-.04752	.06159	-.05696
47	.00000	-.01946	.02050	-.03265
48	.00000	-.01057	.00896	-.01709
49	-.00000	-.00287	-.00036	-.00315
50	.00000	.00763	-.01249	.01379
51	.00000	.01648	-.02250	.02918
52	-.00000	.02364	-.03263	.03946
53	-.00000	.02826	-.04052	.04623
54	-.00000	.02754	-.04298	.04704
55	-.00000	.02755	-.04707	.04710

OGIVE CYLINDER BODY WITH 45 DEGREE SWEEP NACA 65A004 MID-WING
SINGULARITY PANELING FOR SAMPLE CASE

INTEGRATION OF THE PRESSURE DISTRIBUTION

ON THE WING LOWER SURFACE

MACH= 2.0100
ALPHA= 0.0000

POINT	X	Y	Z	X/C	2Y/B	Z/C	CP	CN	CT	CM	POINT
1	16.76499	2.30734	0.00000	.05000	.19228	0.00000	.07831	.08627	.01017	.34921	1
2	17.61117	2.30734	0.00000	.15000	.19228	0.00000	-.03365	-.03707	-.00166	-.11869	2
3	18.45734	2.30734	0.00000	.25000	.19228	0.00000	-.01353	-.01490	-.00037	-.03511	3
4	19.30352	2.30734	0.00000	.35000	.19228	0.00000	-.01427	-.01572	-.00016	-.02373	4
5	20.14970	2.30734	0.00000	.45000	.19228	0.00000	-.02670	-.02941	.00016	-.01951	5
6	20.99587	2.30734	0.00000	.55000	.19228	0.00000	-.03980	-.04384	.00094	.00802	6
7	21.84205	2.30734	0.00000	.65000	.19228	0.00000	-.04580	-.05046	.00173	.05192	7
8	22.68823	2.30734	0.00000	.75000	.19228	0.00000	-.05237	-.05769	.00247	.10819	8
9	23.53441	2.30734	0.00000	.85000	.19228	0.00000	-.05418	-.05969	.00278	.16243	9
10	24.38058	2.30734	0.00000	.95000	.19228	0.00000	-.04851	-.05343	.00252	.19063	10
11	18.82577	4.12568	0.00000	.05000	.34381	0.00000	.14091	.24418	.02878	.48523	11
12	19.55072	4.12568	0.00000	.15000	.34381	0.00000	.03717	.06441	.00289	.08131	12
13	20.27568	4.12568	0.00000	.25000	.34381	0.00000	-.01839	-.03187	-.00079	-.01712	13
14	21.00063	4.12568	0.00000	.35000	.34381	0.00000	-.04077	-.07065	-.00071	.01326	14
15	21.72559	4.12568	0.00000	.45000	.34381	0.00000	-.03961	-.06864	.00037	.06264	15
16	22.45054	4.12568	0.00000	.55000	.34381	0.00000	-.05263	-.09119	.00196	.14933	16
17	23.17550	4.12568	0.00000	.65000	.34381	0.00000	-.06497	-.11258	.00386	.26596	17
18	23.90045	4.12568	0.00000	.75000	.34381	0.00000	-.07210	-.12494	.00535	.38575	18
19	24.62541	4.12568	0.00000	.85000	.34381	0.00000	-.07093	-.12292	.00573	.46661	19
20	25.35036	4.12568	0.00000	.95000	.34381	0.00000	-.06657	-.11534	.00543	.52336	20
21	21.51108	6.49507	0.00000	.05000	.54126	0.00000	.14331	.19052	.02246	-.13300	21
22	22.07808	6.49507	0.00000	.15000	.54126	0.00000	.05227	.06950	.00311	-.08792	22
23	22.64507	6.49507	0.00000	.25000	.54126	0.00000	.02754	.03662	.00091	-.06708	23
24	23.21207	6.49507	0.00000	.35000	.54126	0.00000	.00870	.01157	.00012	-.02776	24
25	23.77906	6.49507	0.00000	.45000	.54126	0.00000	-.02337	-.03107	.00017	.09215	25
26	24.34606	6.49507	0.00000	.55000	.54126	0.00000	-.06915	-.09194	.00198	.32482	26
27	24.91305	6.49507	0.00000	.65000	.54126	0.00000	-.08921	-.11860	.00407	.48628	27
28	25.48005	6.49507	0.00000	.75000	.54126	0.00000	-.08484	-.11279	.00483	.52638	28
29	26.04704	6.49507	0.00000	.85000	.54126	0.00000	-.08398	-.11164	.00521	.58435	29
30	26.61404	6.49507	0.00000	.95000	.54126	0.00000	-.08242	-.10958	.00516	.63568	30
31	24.16649	8.83808	0.00000	.05000	.73651	0.00000	.14910	.14335	.01690	-.48071	31
32	24.57728	8.83808	0.00000	.15000	.73651	0.00000	.05497	.05285	.00237	-.19893	32
33	24.98808	8.83808	0.00000	.25000	.73651	0.00000	.02608	.02507	.00062	-.10468	33
34	25.39887	8.83808	0.00000	.35000	.73651	0.00000	.00806	.00775	.00008	-.03552	34
35	25.80967	8.83808	0.00000	.45000	.73651	0.00000	-.01044	-.01004	.00005	.05018	35
36	26.22046	8.83808	0.00000	.55000	.73651	0.00000	-.03020	-.02904	.00062	.15701	36
37	26.63126	8.83808	0.00000	.65000	.73651	0.00000	-.04417	-.04247	.00146	.24711	37
38	27.04205	8.83808	0.00000	.75000	.73651	0.00000	-.05322	-.05117	.00219	.31873	38
39	27.45285	8.83808	0.00000	.85000	.73651	0.00000	-.05728	-.05507	.00257	.36568	39
40	27.86364	8.83808	0.00000	.95000	.73651	0.00000	-.05967	-.05737	.00270	.40449	40
41	26.58702	10.97384	0.00000	.05000	.91449	0.00000	.16990	.08500	.01002	-.49082	41
42	26.85543	10.97384	0.00000	.15000	.91449	0.00000	.06594	.03299	.00148	-.19936	42
43	27.12384	10.97384	0.00000	.25000	.91449	0.00000	.02978	.01490	.00037	-.09402	43
44	27.39225	10.97384	0.00000	.35000	.91449	0.00000	.01342	.00672	.00007	-.04419	44
45	27.66066	10.97384	0.00000	.45000	.91449	0.00000	-.00483	-.00242	.00001	.01656	45
46	27.92907	10.97384	0.00000	.55000	.91449	0.00000	-.02441	-.01221	.00026	.08692	46
47	28.19748	10.97384	0.00000	.65000	.91449	0.00000	-.04067	-.02035	.00070	.15026	47
48	28.46589	10.97384	0.00000	.75000	.91449	0.00000	-.05268	-.02636	.00113	.20172	48
49	28.73430	10.97384	0.00000	.85000	.91449	0.00000	-.05689	-.02847	.00133	.22549	49
50	29.00271	10.97384	0.00000	.95000	.91449	0.00000	-.05653	-.02828	.00133	.23164	50

TOTAL COEFFICIENTS

ON THE WING

REFA=	144.0000	REFB=	12.0000	REFC=	6.8900
REFX=	20.8130	REFZ=	0.0000		

CN=	-.0000
CT=	.0046
CM=	.0000
CL=	-.0000
CD=	.0046
XCP=	-.1056

TOTAL COEFFICIENTS

ON THE COMPLETE CONFIGURATION

REFA=	144.0000	REFB=	12.0000	REFC=	6.8900
REFX=	20.8130	REFZ=	0.0000		

CN=	.0000
CT=	.0083
CM=	-.0000
CL=	.0000
CD=	.0083
XCP=	-3.5710

SECTION COEFFICIENTS

ON THE WING

DELY=	1.3030	REFL=	6.8900	XLE=	16.3419

CN=	-.0000
CT=	.0034
CM=	-.0000
CL=	-.0000
CD=	.0034
XCP=	.3338

DELY=	2.4000	REFL=	6.8900	XLE=	18.4633

CN=	-.0000
CT=	.0061
CM=	.0000
CL=	-.0000
CD=	.0061
XCP=	-.1551

DELY=	2.3600	REFL=	6.8900	XLE=	21.2276

CN=	-.0000
CT=	.0072
CM=	.0000
CL=	-.0000
CD=	.0072
XCP=	-.4477

SECTION COEFFICIENTS

ON THE WING

DELY=	2.3700	REFL=	6.8900	XLE=	23.9611

CN=	-.0000
CT=	.0061
CM=	.0000
CL=	-.0000
CD=	.0061
XCP=	-.6329

DELY=	1.9000	REFL=	6.8900	XLE=	26.4528

CN=	.0000
CT=	.0065
CM=	.0000
CL=	.0000
CD=	.0065
XCP=	3.0337

CPSTAG = 2.45650 CPCRIT = 1.13092 CPVAC = -.35360

TIME = 253.82300

TIME = 256.24700

TIME = 274.05300

VELOCITIES ON BODY, MACH=2.010 ALPHA= 5.000

PANEL NO.	SOURCE STRENGTH	AXIAL VELOCITY	LATERAL VELOCITY	VERTICAL VELOCITY	NORMAL VELOCITY
1	.29821	-.12592	.12742	-.27006	.32977
2	.23814	-.10863	.24926	-.06568	.28260
3	.15320	-.08418	.16672	.10663	.21590
4	.09313	-.06689	.04488	.14592	.16873
5	.29647	-.09585	.11639	-.23061	.27645
6	.22353	-.08065	.21498	-.03868	.22928
7	.12038	-.05914	.12165	.10076	.16258
8	.04744	-.04393	.02305	.10602	.11541
9	.25703	-.05884	.09712	-.17579	.20705
10	.17238	-.04502	.16318	-.00891	.15988
11	.05267	-.02549	.06234	.08451	.09318
12	-.03198	-.01167	-.00371	.04973	.04601
13	.22872	-.01979	.07956	-.11702	.13973
14	.12507	-.00925	.11155	.02886	.09256
15	-.02150	.00564	-.00234	.07409	.02586
16	-.12515	.01618	-.03433	-.00781	-.02131
17	.16034	.00840	.06631	-.07381	.09346
18	.05307	.01544	.07345	.05586	.04629
19	-.09862	.02540	-.04907	.06596	-.02042
20	-.20589	.03245	-.05621	-.04942	-.06759
21	.19295	.01318	.06479	-.06032	.08052
22	.07831	.01601	.06479	.06925	.03335
23	-.08383	.02000	-.06479	.06925	-.03335
24	-.19848	.02282	-.06479	-.06032	-.08052
25	.23512	.00731	.06566	-.05996	.08052
26	.11426	.00720	.06566	.07137	.03335
27	-.05666	.00703	-.06566	.07137	-.03335
28	-.17752	.00692	-.06566	-.05996	-.08052
29	-.15629	.00058	-.00204	-.08800	.08052
30	-.07665	-.03603	.00504	-.07486	.03330
31	.12388	.01975	-.02128	-.03592	-.03340
32	.15214	.01440	.00204	-.08800	-.08052
33	.00748	-.03345	-.02645	-.09813	.08054
34	.00491	-.03148	-.02400	-.14499	.03331
35	.01679	.03255	.01123	-.11439	-.03340
36	-.05376	.03414	-.01240	-.08200	-.08050
37	.05941	-.04515	-.01938	-.09522	.08056
38	-.00215	-.00961	-.00666	-.10331	.03338
39	-.03768	.03816	.00723	-.10454	-.03333
40	-.13940	.04306	-.00056	-.08689	-.08049
41	-.10269	-.01962	.03603	-.07224	.08053
42	-.09683	-.01116	.01946	-.04030	.03340
43	.08433	.04942	-.00515	-.07459	-.03330
44	.11970	.01950	-.03113	-.07425	-.08051
45	.09772	-.03097	.01107	-.08255	.08050
46	-.03546	-.03552	-.01010	-.11170	.03342
47	.00907	.07167	.03465	-.17065	-.03329
48	-.02556	.04271	.01866	-.09491	-.08054
49	.04061	-.02359	.04121	-.07005	.08049
50	-.06008	-.00391	.03051	-.01369	.03343
51	-.06077	.01942	-.01112	-.06012	-.03328
52	-.00687	.05255	-.00061	-.08694	-.08055
53	.16144	-.00624	.06860	-.05875	.08053
54	-.03317	-.00266	.04641	.02451	.03349
55	-.07429	.02541	-.02383	-.02926	-.03321
56	-.09979	.03250	-.02073	-.07855	-.08051
57	.16721	.00258	.06929	-.05847	.08053
58	-.01301	.01136	.06502	.06939	.03351
59	-.14241	.00707	-.03996	.00974	-.03319
60	-.14195	.01420	-.02790	-.07559	-.08051

OGIVE CYLINDER BODY WITH 45 DEGREE SWEEP NACA 65A004 MID-WING
SINGULARITY PANELING FOR SAMPLE CASE

INTEGRATION OF THE PRESSURE DISTRIBUTION

ON THE BODY

MACH= 2.0100
ALPHA= 5.0000

POINT	X	Y	Z	X/C	2Y/B	Z/C	CP	CN	CT	CM	POINT
1	1.00000	.09575	-.23116	.02740	.02875	-.06942	.23352	.05031	.01362	.99362	1
2	1.00000	.23116	-.09575	.02740	.06942	-.02875	.17365	.01550	.01013	.30604	2
3	1.00000	.23116	.09575	.02740	.06942	.02875	.11402	-.01017	.00665	-.20096	3
4	1.00000	.09575	.23116	.02740	.02875	.06942	.08674	-.01869	.00506	-.36905	4
5	3.22006	.27308	-.65928	.08822	.08201	-.19798	.18116	.27883	.05936	4.86624	5
6	3.22006	.65928	-.27308	.08822	.19798	-.08201	.12674	.08080	.04153	1.41019	6
7	3.22006	.65928	.27308	.08822	.19798	.08201	.07717	-.04920	.02529	-.85865	7
8	3.22006	.27308	.65928	.08822	.08201	.19798	.05850	-.09004	.01917	-1.57145	8
9	6.08242	.44633	-1.07754	.16664	.13403	-.32359	.11548	.30647	.04213	4.46908	9
10	6.08242	1.07754	-.44633	.16664	.32359	-.13403	.06657	.07318	.02429	1.06719	10
11	6.08242	1.07754	.44633	.16664	.32359	.13403	.02498	-.02746	.00911	-.40042	11
12	6.08242	.44633	1.07754	.16664	.13403	.32359	.01211	-.03215	.00442	-.46878	12
13	9.03105	.55006	-1.32796	.24743	.16518	-.39879	.04100	.13514	.00869	1.58062	13
14	9.03105	1.32796	-.55006	.24743	.39879	-.16518	.00005	.00006	.00001	.00073	14
15	9.03105	1.32796	.55006	.24743	.39879	.16518	-.02880	.03933	-.00611	.45998	15
16	9.03105	.55006	1.32796	.24743	.16518	.39879	-.03132	.10324	-.00664	1.20759	16
17	11.08446	.58637	-1.41563	.30368	.17609	-.42511	-.01359	-.01860	-.00026	-.18057	17
18	11.08446	1.41563	-.58637	.30368	.42511	-.17609	-.04685	-.02656	-.00090	-.25787	18
19	11.08446	1.41563	.58637	.30368	.42511	.17609	-.06477	.03672	-.00125	.35647	19
20	11.08446	.58637	1.41563	.30368	.17609	.42511	-.05882	.08050	-.00113	.78153	20
21	13.63090	.58927	-1.42262	.37345	.17696	-.42721	-.02320	-.10738	0.00000	-.77118	21
22	13.63090	1.42262	-.58927	.37345	.42721	-.17696	-.05041	-.09667	0.00000	-.69426	22
23	13.63090	1.42262	.58927	.37345	.42721	.17696	-.05761	.11046	0.00000	.79336	23
24	13.63090	.58927	1.42262	.37345	.17696	.42721	-.04146	.19190	0.00000	1.37824	24
25	16.48370	.58927	-1.42262	.45161	.17696	-.42721	-.01193	-.02500	0.00000	-.10824	25
26	16.48370	1.42262	-.58927	.45161	.42721	-.17696	-.03493	-.03031	0.00000	-.13124	26
27	16.48370	1.42262	.58927	.45161	.42721	.17696	-.03462	.03005	0.00000	.13009	27
28	16.48370	.58927	1.42262	.45161	.17696	.42721	-.01116	.02338	0.00000	.10121	28
29	18.26145	.58927	-1.42262	.50031	.17696	-.42721	.00649	.01359	0.00000	.03468	29
30	18.26145	1.42262	-.58927	.50031	.42721	-.17696	.08422	.07309	0.00000	.18649	30
31	18.26145	1.42262	.58927	.50031	.42721	.17696	-.03398	.02949	0.00000	.07524	31
32	18.26145	.58927	1.42262	.50031	.17696	.42721	-.02084	.04367	0.00000	.11142	32
33	20.03915	.58927	-1.42262	.54902	.17696	-.42721	.07774	.16288	0.00000	.12604	33
34	20.03915	1.42262	-.58927	.54902	.42721	-.17696	.06984	.06061	0.00000	.04690	34
35	20.03915	1.42262	.58927	.54902	.42721	.17696	-.05572	.04836	0.00000	.03742	35
36	20.03915	.58927	1.42262	.54902	.17696	.42721	-.05800	.12152	0.00000	.09404	36
37	21.81690	.58927	-1.42262	.59772	.17696	-.42721	.10455	.21906	0.00000	-.21991	37
38	21.81690	1.42262	-.58927	.59772	.42721	-.17696	.02705	.02348	0.00000	-.02357	38
39	21.81690	1.42262	.58927	.59772	.42721	.17696	-.06541	.05676	0.00000	-.05698	39
40	21.81690	.58927	1.42262	.59772	.17696	.42721	-.07379	.15461	0.00000	-.15522	40
41	23.59465	.58927	-1.42262	.64643	.17696	-.42721	.04685	.09816	0.00000	-.27305	41
42	23.59465	1.42262	-.58927	.64643	.42721	-.17696	.02789	.02420	0.00000	-.06733	42
43	23.59465	1.42262	.58927	.64643	.42721	.17696	-.08500	.07377	0.00000	-.20520	43
44	23.59465	.58927	1.42262	.64643	.17696	.42721	-.03171	.06643	0.00000	-.18478	44
45	25.38175	.58927	-1.42262	.69539	.17696	-.42721	.07302	.15461	0.00000	-.70637	45
46	25.38175	1.42262	-.58927	.69539	.42721	-.17696	.08247	.07233	0.00000	-.33046	46
47	25.38175	1.42262	.58927	.69539	.42721	.17696	-.12755	.11186	0.00000	-.51105	47
48	25.38175	.58927	1.42262	.69539	.17696	.42721	-.07352	.15565	0.00000	-.71114	48
49	27.84000	.58927	-1.42262	.76274	.17696	-.42721	.05484	.20165	0.00000	-1.41697	49
50	27.84000	1.42262	-.58927	.76274	.42721	-.17696	.00912	.01390	0.00000	-.09766	50
51	27.84000	1.42262	.58927	.76274	.42721	.17696	-.03128	.04764	0.00000	-.33476	51
52	27.84000	.58927	1.42262	.76274	.17696	.42721	-.09019	.33164	0.00000	-2.33045	52
53	31.20000	.58927	-1.42262	.85479	.17696	-.42721	.01468	.06230	0.00000	-.64709	53
54	31.20000	1.42262	-.58927	.85479	.42721	-.17696	-.00172	-.00303	0.00000	.03142	54
55	31.20000	1.42262	.58927	.85479	.42721	.17696	-.04535	.07970	0.00000	-.82789	55
56	31.20000	.58927	1.42262	.85479	.17696	.42721	-.05531	.23467	0.00000	-2.43756	56
57	34.75000	.58927	-1.42262	.95205	.17696	-.42721	-.00317	-.01308	0.00000	.18229	57
58	34.75000	1.42262	-.58927	.95205	.42721	-.17696	-.04199	-.07174	0.00000	.99979	58
59	34.75000	1.42262	.58927	.95205	.42721	.17696	-.01723	.02943	0.00000	-.41022	59
60	34.75000	.58927	1.42262	.95205	.17696	.42721	-.02134	.08802	0.00000	-1.22679	60

TOTAL COEFFICIENTS

ON THE BODY

REFA= 144.0000 REFD= 3.3300 REFL= 36.5000

REFX= 20.8130 REFZ= 0.0000

CN= .0526
CT= .0035
CM= .0053
CL= .0521
CD= .0081
XCP= .1021

VELOCITIES ON WING UPPER SURFACE, MACH=2.010   ALPHA= 5.000

PANEL NO.	VORTEX STRENGTH	AXIAL VELOCITY	LATERAL VELOCITY	VERTICAL VELOCITY
1	.22408	-.00993	.01805	.09163
2	.20022	.12328	-.18020	-.03020
3	.16902	.09144	-.13524	-.05450
4	.12030	.06533	-.09981	-.07007
5	.07135	.04435	-.07099	-.08401
6	.03408	.03523	-.05783	-.10095
7	.03636	.04023	-.05336	-.11633
8	.06207	.05516	-.05672	-.12661
9	.07180	.06449	-.06097	-.13338
10	.08669	.06911	-.05953	-.13419
11	.11014	.07749	-.06001	-.13426
12	.16587	-.04398	.05506	.09163
13	.16609	.05036	-.05625	-.03020
14	.17415	.08086	-.09951	-.05450
15	.16984	.10855	-.14900	-.07007
16	.15922	.09612	-.12989	-.08401
17	.13547	.09057	-.12543	-.10095
18	.10343	.08163	-.11324	-.11633
19	.06977	.07059	-.10269	-.12661
20	.05319	.06391	-.09504	-.13338
21	.04661	.05768	-.08707	-.13419
22	.04233	.05383	-.08245	-.13426
23	.14925	-.05133	.05979	.09163
24	.14901	.03945	-.04483	-.03020
25	.15071	.05676	-.06657	-.05450
26	.15332	.06729	-.07945	-.07007
27	.15678	.07891	-.09435	-.08401
28	.16070	.10322	-.12910	-.10095
29	.16040	.12730	-.16727	-.11633
30	.15640	.12167	-.15367	-.12661
31	.14848	.11695	-.14177	-.13338
32	.13225	.10889	-.13537	-.13419
33	.11211	.09716	-.12656	-.13426
34	.14331	-.05743	.06712	.09163
35	.14342	.03404	-.03833	-.03020
36	.14370	.05333	-.06412	-.05450
37	.14424	.06417	-.07864	-.07007
38	.14474	.07211	-.08825	-.08401
39	.14546	.08331	-.10147	-.10095
40	.14666	.09269	-.11202	-.11633
41	.14815	.09839	-.11893	-.12661
42	.14990	.10307	-.12600	-.13338
43	.15198	.10406	-.13016	-.13419
44	.15398	.10761	-.12978	-.13426
45	.14022	-.07147	.08551	.09163
46	.14038	.02268	-.02033	-.03020
47	.14054	.05080	-.06147	-.05450
48	.14085	.05984	-.07314	-.07007
49	.14119	.06769	-.08261	-.08401
50	.14151	.07836	-.09488	-.10095
51	.14182	.08737	-.10503	-.11633
52	.14215	.09469	-.11528	-.12661
53	.14254	.09951	-.12328	-.13338
54	.14289	.09895	-.12564	-.13419
55	.14325	.09913	-.13002	-.13426

OGIVE CYLINDER BODY WITH 45 DEGREE SWEEP NACA 65A004 MID-WING
SINGULARITY PANELING FOR SAMPLE CASE

INTEGRATION OF THE PRESSURE DISTRIBUTION

ON THE WING UPPER SURFACE

MACH= 2.0100
ALPHA= 5.0000

POINT	X	Y	Z	X/C	2Y/B	Z/C	CP	CN	CT	CM	POINT
1	16.76499	2.30734	0.00000	.05000	.19228	0.00000	-.10958	.12071	-.01423	.48864	1
2	17.61117	2.30734	0.00000	.15000	.19228	0.00000	-.18922	.20844	-.00934	.66740	2
3	18.45734	2.30734	0.00000	.25000	.19228	0.00000	-.14170	.15610	-.00388	.36772	3
4	19.30352	2.30734	0.00000	.35000	.19228	0.00000	-.09971	.10984	-.00111	.16580	4
5	20.14970	2.30734	0.00000	.45000	.19228	0.00000	-.07159	.07887	.00042	.05231	5
6	20.99587	2.30734	0.00000	.55000	.19228	0.00000	-.06742	.07427	.00160	-.01358	6
7	21.84205	2.30734	0.00000	.65000	.19228	0.00000	-.08517	.09383	.00322	-.09655	7
8	22.68823	2.30734	0.00000	.75000	.19228	0.00000	-.10645	.11727	.00502	-.21991	8
9	23.53441	2.30734	0.00000	.85000	.19228	0.00000	-.11814	.13014	.00607	-.35417	9
10	24.38058	2.30734	0.00000	.95000	.19228	0.00000	-.12830	.14133	.00665	-.50421	10
11	18.82577	4.12568	0.00000	.05000	.34381	0.00000	-.01494	.02588	-.00305	.05143	11
12	19.55072	4.12568	0.00000	.15000	.34381	0.00000	-.11757	.20373	-.00913	.25717	12
13	20.27568	4.12568	0.00000	.25000	.34381	0.00000	-.16626	.28810	-.00716	.15480	13
14	21.00063	4.12568	0.00000	.35000	.34381	0.00000	-.17911	.31036	-.00314	-.05823	14
15	21.72559	4.12568	0.00000	.45000	.34381	0.00000	-.16501	.28593	.00152	-.26094	15
16	22.45054	4.12568	0.00000	.55000	.34381	0.00000	-.15367	.26627	.00572	-.43603	16
17	23.17550	4.12568	0.00000	.65000	.34381	0.00000	-.13760	.23844	.00818	-.56330	17
18	23.90045	4.12568	0.00000	.75000	.34381	0.00000	-.12315	.21339	.00914	-.65883	18
19	24.62541	4.12568	0.00000	.85000	.34381	0.00000	-.11204	.19414	.00905	-.74012	19
20	25.35036	4.12568	0.00000	.95000	.34381	0.00000	-.10303	.17853	.00840	-.81004	20
21	21.51108	6.49507	0.00000	.05000	.54126	0.00000	.00257	-.00342	.00040	.00239	21
22	22.07808	6.49507	0.00000	.15000	.54126	0.00000	-.08677	.11535	-.00517	-.14593	22
23	22.64507	6.49507	0.00000	.25000	.54126	0.00000	-.11058	.14701	-.00366	-.26934	23
24	23.21207	6.49507	0.00000	.35000	.54126	0.00000	-.12933	.17194	-.00174	-.41251	24
25	23.77906	6.49507	0.00000	.45000	.54126	0.00000	-.15894	.21131	.00112	-.62676	25
26	24.34606	6.49507	0.00000	.55000	.54126	0.00000	-.19700	.26191	.00563	-.92533	26
27	24.91305	6.49507	0.00000	.65000	.54126	0.00000	-.21101	.28052	.00963	-1.15017	27
28	25.48005	6.49507	0.00000	.75000	.54126	0.00000	-.20309	.27001	.01157	-1.26013	28
29	26.04704	6.49507	0.00000	.85000	.54126	0.00000	-.19389	.25777	.01202	-1.34916	29
30	26.61404	6.49507	0.00000	.95000	.54126	0.00000	-.17989	.23916	.01126	-1.38737	30
31	24.16649	8.83808	0.00000	.05000	.73651	0.00000	.01376	-.01323	.00156	.04436	31
32	24.57728	8.83808	0.00000	.15000	.73651	0.00000	-.07874	.07570	-.00339	-.28496	32
33	24.98808	8.83808	0.00000	.25000	.73651	0.00000	-.10507	.10102	-.00251	-.42175	33
34	25.39887	8.83808	0.00000	.35000	.73651	0.00000	-.12121	.11654	-.00118	-.53442	34
35	25.80967	8.83808	0.00000	.45000	.73651	0.00000	-.13736	.13206	.00070	-.65988	35
36	26.22046	8.83808	0.00000	.55000	.73651	0.00000	-.15448	.14852	.00319	-.80313	36
37	26.63126	8.83808	0.00000	.65000	.73651	0.00000	-.16686	.16043	.00551	-.93341	37
38	27.04205	8.83808	0.00000	.75000	.73651	0.00000	-.17540	.16863	.00722	-1.05041	38
39	27.45285	8.83808	0.00000	.85000	.73651	0.00000	-.18025	.17330	.00808	-1.15065	39
40	27.86364	8.83808	0.00000	.95000	.73651	0.00000	-.18353	.17646	.00831	-1.24413	40
41	26.58702	10.97384	0.00000	.05000	.91449	0.00000	.03823	-.01913	.00225	.11044	41
42	26.85543	10.97384	0.00000	.15000	.91449	0.00000	-.06559	.03282	-.00147	-.19831	42
43	27.12384	10.97384	0.00000	.25000	.91449	0.00000	-.09898	.04952	-.00123	-.31252	43
44	27.39225	10.97384	0.00000	.35000	.91449	0.00000	-.11357	.05682	-.00057	-.37386	44
45	27.66066	10.97384	0.00000	.45000	.91449	0.00000	-.12942	.06475	.00034	-.44341	45
46	27.92907	10.97384	0.00000	.55000	.91449	0.00000	-.14607	.07308	.00157	-.52006	46
47	28.19748	10.97384	0.00000	.65000	.91449	0.00000	-.15978	.07994	.00274	-.59032	47
48	28.46589	10.97384	0.00000	.75000	.91449	0.00000	-.17000	.08505	.00364	-.65091	48
49	28.73430	10.97384	0.00000	.85000	.91449	0.00000	-.17392	.08702	.00406	-.68928	49
50	29.00271	10.97384	0.00000	.95000	.91449	0.00000	-.17421	.08716	.00410	-.71385	50

VELOCITIES ON WING LOWER SURFACE, MACH=2.010 ALPHA= 5.000

PANEL NO.	VORTEX STRENGTH	AXIAL VELOCITY	LATERAL VELOCITY	VERTICAL VELOCITY
1	.22408	-.23401	.27548	-.26595
2	.20022	-.07694	.05418	-.14412
3	.16902	-.07758	.06587	-.11981
4	.12030	-.05497	.05258	-.10424
5	.07135	-.02700	.03570	-.09031
6	.03408	.00115	.01657	-.07336
7	.03636	.00387	.02286	-.05798
8	.06207	-.00691	.03836	-.04770
9	.07180	-.00731	.04059	-.04093
10	.08669	-.01757	.05057	-.04012
11	.11014	-.03265	.06299	-.04006
12	.16587	-.20584	.24857	-.26595
13	.16609	-.11573	.13752	-.14412
14	.17415	-.09329	.10285	-.11981
15	.16984	-.06128	.04905	-.10424
16	.15922	-.06311	.05825	-.09031
17	.13547	-.04490	.04213	-.07336
18	.10343	-.02179	.02868	-.05798
19	.06977	.00082	.01455	-.04770
20	.05319	.01072	.01115	-.04093
21	.04661	.01107	.01517	-.04012
22	.04233	.01151	.01750	-.04006
23	.14925	-.20058	.23392	-.26595
24	.14901	-.10955	.12903	-.14412
25	.15071	-.09395	.10910	-.11981
26	.15332	-.08603	.09883	-.10424
27	.15678	-.07786	.08716	-.09031
28	.16070	-.05748	.05580	-.07336
29	.16040	-.03310	.01739	-.05798
30	.15640	-.03473	.02806	-.04770
31	.14848	-.03154	.03468	-.04093
32	.13225	-.02336	.03135	-.04012
33	.11211	-.01495	.02941	-.04006
34	.14331	-.20075	.23432	-.26595
35	.14342	-.10938	.12899	-.14412
36	.14370	-.09038	.10350	-.11981
37	.14424	-.08007	.08952	-.10424
38	.14474	-.07263	.08038	-.09031
39	.14546	-.06215	.06778	-.07336
40	.14666	-.05397	.05819	-.05798
41	.14815	-.04976	.05237	-.04770
42	.14990	-.04683	.04647	-.04093
43	.15198	-.04792	.04356	-.04012
44	.15398	-.04636	.04500	-.04006
45	.14022	-.21168	.25309	-.26595
46	.14038	-.11769	.14344	-.14412
47	.14054	-.08974	.10248	-.11981
48	.14085	-.08102	.09111	-.10424
49	.14119	-.07349	.08196	-.09031
50	.14151	-.06315	.06996	-.07336
51	.14182	-.05445	.06007	-.05798
52	.14215	-.04746	.05006	-.04770
53	.14254	-.04303	.04231	-.04093
54	.14289	-.04393	.03996	-.04012
55	.14325	-.04412	.03598	-.04006

OGIVE CYLINDER BODY WITH 45 DEGREE SWEEP NACA 65A004 MID-WING
SINGULARITY PANELING FOR SAMPLE CASE

INTEGRATION OF THE PRESSURE DISTRIBUTION

ON THE WING LOWER SURFACE

MACH= 2.0100
ALPHA= 5.0000

POINT	X	Y	Z	X/C	2Y/B	Z/C	CP	CN	CT	CM	POINT
1	16.76499	2.30734	0.00000	.05000	.19228	0.00000	.29517	.32516	.03833	1.31626	1
2	17.61117	2.30734	0.00000	.15000	.19228	0.00000	.17381	.19147	.00858	.61305	2
3	18.45734	2.30734	0.00000	.25000	.19228	0.00000	.14959	.16478	.00410	.38817	3
4	19.30352	2.30734	0.00000	.35000	.19228	0.00000	.09354	.10304	.00104	.15554	4
5	20.14970	2.30734	0.00000	.45000	.19228	0.00000	.03394	.03738	-.00020	.02480	5
6	20.99587	2.30734	0.00000	.55000	.19228	0.00000	.00168	.00185	-.00004	-.00034	6
7	21.84205	2.30734	0.00000	.65000	.19228	0.00000	.00857	.00944	-.00032	-.00971	7
8	22.68823	2.30734	0.00000	.75000	.19228	0.00000	.01865	.02054	-.00088	-.03852	8
9	23.53441	2.30734	0.00000	.85000	.19228	0.00000	.02880	.03172	-.00148	-.08633	9
10	24.38058	2.30734	0.00000	.95000	.19228	0.00000	.05438	.05990	-.00282	-.21371	10
11	16.82577	4.12568	0.00000	.05000	.34381	0.00000	.31460	.54513	.06426	1.08331	11
12	19.55072	4.12568	0.00000	.15000	.34381	0.00000	.22655	.39257	.01759	.49553	12
13	20.27568	4.12568	0.00000	.25000	.34381	0.00000	.17245	.29882	.00743	.16056	13
14	21.00063	4.12568	0.00000	.35000	.34381	0.00000	.14107	.24445	.00247	-.04587	14
15	21.72559	4.12568	0.00000	.45000	.34381	0.00000	.12247	.21221	-.00113	-.19366	15
16	22.45054	4.12568	0.00000	.55000	.34381	0.00000	.07674	.13297	-.00286	-.21774	16
17	23.17550	4.12568	0.00000	.65000	.34381	0.00000	.02777	.04812	-.00165	-.11367	17
18	23.90045	4.12568	0.00000	.75000	.34381	0.00000	-.00584	-.01011	.00043	.03122	18
19	24.62541	4.12568	0.00000	.85000	.34381	0.00000	-.01631	-.02825	.00132	.10772	19
20	25.35036	4.12568	0.00000	.95000	.34381	0.00000	-.01720	-.02980	.00140	.13520	20
21	21.51108	6.49507	0.00000	.05000	.54126	0.00000	.30197	.40146	.04732	-.28025	21
22	22.07808	6.49507	0.00000	.15000	.54126	0.00000	.22019	.29274	.01312	-.37033	22
23	22.64507	6.49507	0.00000	.25000	.54126	0.00000	.15751	.26258	.00653	-.48107	23
24	23.21207	6.49507	0.00000	.35000	.54126	0.00000	.18127	.24099	.00244	-.57815	24
25	23.77906	6.49507	0.00000	.45000	.54126	0.00000	.15125	.20109	-.00107	-.59643	25
26	24.34606	6.49507	0.00000	.55000	.54126	0.00000	.10311	.13708	-.00295	-.48431	26
27	24.91305	6.49507	0.00000	.65000	.54126	0.00000	.07770	.10330	-.00354	-.42354	27
28	25.48005	6.49507	0.00000	.75000	.54126	0.00000	.07472	.09934	-.00426	-.46362	28
29	26.04704	6.49507	0.00000	.85000	.54126	0.00000	.06182	.08219	-.00383	-.43018	29
30	26.61404	6.49507	0.00000	.95000	.54126	0.00000	.04414	.05868	-.00276	-.34040	30
31	24.16649	8.83808	0.00000	.05000	.73651	0.00000	.30182	.29018	.03420	-.97310	31
32	24.57728	8.83808	0.00000	.15000	.73651	0.00000	.21633	.20799	.00932	-.78293	32
33	24.98808	8.83808	0.00000	.25000	.73651	0.00000	.18771	.18047	.00449	-.75347	33
34	25.39887	8.83808	0.00000	.35000	.73651	0.00000	.16950	.16296	.00165	-.74733	34
35	25.80967	8.83808	0.00000	.45000	.73651	0.00000	.15022	.14442	-.00077	-.72164	35
36	26.22046	8.83808	0.00000	.55000	.73651	0.00000	.12952	.12452	-.00268	-.67336	36
37	26.63126	8.83808	0.00000	.65000	.73651	0.00000	.11537	.11092	-.00381	-.64536	37
38	27.04205	8.83808	0.00000	.75000	.73651	0.00000	.10711	.10298	-.00441	-.64146	38
39	27.45285	8.83808	0.00000	.85000	.73651	0.00000	.10512	.10106	-.00471	-.67103	39
40	27.86364	8.83808	0.00000	.95000	.73651	0.00000	.10462	.10059	-.00473	-.70920	40
41	26.58702	10.97384	0.00000	.05000	.91449	0.00000	.31643	.15832	.01866	-.91414	41
42	26.85543	10.97384	0.00000	.15000	.91449	0.00000	.22349	.11182	.00501	-.67565	42
43	27.12384	10.97384	0.00000	.25000	.91449	0.00000	.18804	.09408	.00234	-.59373	43
44	27.39225	10.97384	0.00000	.35000	.91449	0.00000	.17134	.08573	.00087	-.56403	44
45	27.66066	10.97384	0.00000	.45000	.91449	0.00000	.15208	.07609	-.00041	-.52104	45
46	27.92907	10.97384	0.00000	.55000	.91449	0.00000	.13093	.06551	-.00141	-.46617	46
47	28.19748	10.97384	0.00000	.65000	.91449	0.00000	.11329	.05668	-.00195	-.41859	47
48	28.46589	10.97384	0.00000	.75000	.91449	0.00000	.10052	.05029	-.00215	-.38490	48
49	28.73430	10.97384	0.00000	.85000	.91449	0.00000	.09666	.04836	-.00226	-.38310	49
50	29.00271	10.97384	0.00000	.95000	.91449	0.00000	.09814	.04910	-.00231	-.40212	50

TOTAL COEFFICIENTS

ON THE WING

REFA=	144.0000	REFB=	12.0000	REFC=	6.8900
REFX=	20.8130	REFZ=	0.0000		

CN=	.1969
CT=	.0046
CM=	-.0705
CL=	.1957
CD=	.0217
XCP=	-.3600

TOTAL COEFFICIENTS

ON THE COMPLETE CONFIGURATION

REFA=	144.0000	REFB=	12.0000	REFC=	6.8900
REFX=	20.8130	REFZ=	0.0000		

CN=	.2495
CT=	.0081
CM=	-.0651
CL=	.2479
CD=	.0298
XCP=	-.2628

SECTION COEFFICIENTS

ON THE WING

DELY= 1.3030 REFL= 6.8900 XLE= 16.3419

CN=	.1974
CT=	.0037
CM=	.0356
CL=	.1963
CD=	.0209
XCP=	.1812

DELY= 2.4000 REFL= 6.8900 XLE= 18.4633

CN=	.2305
CT=	.0063
CM=	-.0135
CL=	.2291
CD=	.0263
XCP=	-.0590

DELY= 2.3600 REFL= 6.8900 XLE= 21.2276

CN=	.2863
CT=	.0069
CM=	-.1299
CL=	.2846
CD=	.0318
XCP=	-.4563

SECTION COEFFICIENTS

ON THE WING

DELY= 2.3700 REFL= 6.8900 XLE= 23.9611

CN=	.2841
CT=	.0058
CM=	-.2140
CL=	.2825
CD=	.0305
XCP=	-.7577

DELY= 1.9000 REFL= 6.8900 XLE= 26.4528

CN=	.2732
CT=	.0062
CM=	-.2762
CL=	.2716
CD=	.0300
XCP=	-1.0171

CPSTAG = 2.45650 CPCRIT = 1.13092 CPVAC = -.35360

TIME = 303.80100

REFERENCES

1. Craidon, C. B.; Description of a Digital Computer Program for Aircraft Configuration Plots. NASA TM X-2074, September, 1970.

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