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Supersonic Second Order Analysis and Optimization Program User's Manual

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Los Angeles, California 90009

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FORWARD

This report was prepared by the Los Angeles Aerodynamics Group of Rockwell International, Los Angeles, California, for the Langley Research Center, National Aeronautics and Space Administration, Hampton, Virginia. The work was performed under Contract No. NAS1-15820, "Development of Second Order Potential Analysis/Design and Full Potential Analysis Aero Prediction Technology for Hypersonic Configuration Design." Mr. Noel Talcott and Mr. Kenneth M. Jones were the Project Monitors of this contract.

Mr. E. Bonner was the Program Manager and Dr. W. C. Clever was the principal investigator.

SUMMARY

Approximate nonlinear inviscid theoretical techniques for predicting aerodynamic characteristics and surface pressures for relatively slender vehicles at supersonic and moderate hypersonic speeds were developed. Emphasis was placed on approaches that would be responsive to conceptual design level of effort. Second order small disturbance and full potential theory was utilized to meet this objective.

Numerical codes were developed for relatively general three-dimensional geometries to evaluate the capability of the approximate equations of motion considered. This report represents a user's manual for the second order analysis and optimization codes. Contained herein for each program is a brief description, its input data, variables, and subprograms, a flow diagram, and a sample test case. Results from the computations indicate good agreement with experimental results for a variety of wing, body, and wing-body shapes. Case computation times of a minute on a CDC 176 were achieved for practical aircraft arrangements.

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INTRODUCTION

An examination of the literature for supersonic/hypersonic aircraft provides an indication of the flexiblilty and generality required for an analysis technique. Typical configuration development variables include wing section, incidence, height, dihedral, planform, effectiveness of longitudinal control surfaces for trim, effectiveness of empennage for directional stability, and propulsion system-airframe interactions.

Response to these requirements at the conceptual design level have been by the hypersonic impact methods and the linearized analysis and design algorithms. These approaches can treat complex geometries efficiently with minimum response time and cost. Shortcomings exist with both methods. The impact methods ignore component interference effects and crossflow interactions. The linearized approaches exclude shocks, vorticity and entropy wakes and layers.

A need exists for an improved analysis technique to optimize vehicles designed to travel at supersonic/hypersonic speeds. The technique should be more accurate than simple noninterfering panel methods and more computationally efficient than the current explicit finite-difference methods. Enough of the physics of the flow should be included to allow realistic optimization and permit considerations of component interaction. Nonlinear potential theoretical formulations hold the promise of meeting these objectives for preliminary vehicle definition efforts.

To satisfy the analysis needs, a program was undertaken to advance the aerodynamic prediction capabilities at the conceptual design level. Numerical second-order potential small disturbance analysis was developed as a first step up from the widely used linear theory. Such formulation incorporates nonlinear behavior by iteration of the Prandtl-Glauert approximation. This approach is known to extend the prediction success for airfoil and cone surface pressures to substantially higher values of the hypersonic similarity parameter than the first-order theory. References 3 and 4 contain the details of the theoretical development of the second order analysis and optimization method.

This report provides a user's manual for the second order analysis and optimization codes. Contained herein for each program is a brief description, its input data format, a complete list of variables and subprograms, flow diagrams, and sample test cases.

The computer program entitled "SOPA-Second Order Potential Analysis and Optimization Program" can be obtained for a fee from:

Computer Software Management and
Information Center (COSMIC)
112 Barrow Hall
University of Georgia
Athens, GA 30602
(404) 542-3265

Request the program packgage by the designation LAR 13314. The programs are written in FORTRAN V for use on the Control Data 6600 and the Cyber series of computers.

ANALYSIS PROGRAM WBODY

DISCUSSION

Computer program WBODY performs a linearized analysis of wing body combinations using axis and surface singularities. The solution satisfies the Prandtl-Glauert equation with boundary conditions as prescribed by the assumptions of thin wing theory. A second order solution may then be performed using the results of the first order (linearized) solution. The second order solution on the lifting surfaces is performed by using a modification of the exact result available for flow in two dimensions. On the body the second order solution combines an exact axisymmetric axial solution with the first order cross flow solution. The second order solution is not valid for transonic Mach numbers and should not be used for Mach numbers between 0.70 and 1.60. All output is placed in a dataset which may be used for computer graphics.

If a body is present and the use of axis singularities is indicated, isolated body axisymmetric axial and cross flow solutions will be performed first, using only the axis singularities. The axis singularities consist of linearly or quadratically varying line sources and quadratically or cubicly varying line doublets. The singularity and control point spacing are input by the program user. Either mass flux or velocity boundary conditions may be specified. A second order axial line source solution will be performed if indicated by the input.

The body panels are quadrilaterals of arbitrary shape having a constant source distribution. The lifting surface panels are quadrilaterals having two streamwise edges with a constant vortex distribution to simulate lift, and a constant or chordwise and spanwise linearly varying source distribution to simulate thickness.

The first order solution is performed by satisfying the condition of zero normal velocity, or zero mass flux if desired, at the panel control points of the body and lifting surfaces. The lifting surface boundary conditions are linearized and are satisfied on the mean camber line. The normal velocity or normal mass flux is composed of the sum of contributions from the free stream, angle of attack, and perturbations from the axis singularities, body panels, and lifting surface panels.

The complete first order solution is composed of a linear combination of four basic solutions:

1. The cross flow or add load solution. This solution contains no lifting surface thickness or camber.

2. The camber solution. This solution satisfies the boundary conditions for the lifting surface camber with zero free stream velocity and zero normal velocity (or mass flux) on the body panels.

3. The lift due to thickness solution. This solution represents the additional load due to the normal velocities induced by the thickness of the lifting surfaces.

4. The lift due to the body solution. This solution represents the additional load due to the normal velocities induced by the body in axial flow with no camber.

The second order solution, if desired, is performed using the results of the first order (linear) solution.

INPUT DATA

Data is input using subroutine DECRD1, described on page 19, and is stored in the array called "DATA". All locations are initially set equal to 0. Each case contains:

Miscellaneous data	locations	6 - 88
Body geometry data	locations	701 - 1900
Lifting surface geometry	locations	1 - 5, 89 - 700 and, 1201 - 1900

All of the data except the lifting surface geometry data must be input first, with the last card having a negative location number. This data must include any input for body panels and axial singularities.

The lifting surface geometry data follows with the last card for each lifting surface having a negative location number.

The last surface or last card for a given case is indicated by a positive value in location 1.

The body or surface geometry may be read from an APAS (Aerodynamic Preliminary Analysis System, references 5 and 6) file using data location 14.

The first card in each case may be a title card containing up to 72 characters. If the first card contains a blank or a minus sign in the first column and blanks in columns 2 thru 4, it is assumed the card contains numerical data, and is not a title card.

In addition the first card for each lifting surface may be a title card containing up to 16 characters, i.e. cols 1 - 16. This title will be used for the name of the surface.

The following is a description of the possible input for each case.

LOC	VARIABLE	DESCRIPTION
1	< 0.	The run will terminate.
	> 0.	Indicates the last surface has been read.
	> 1.1	The run will terminate after the slender body geometry (if any) has been printed.
2	N	The number of panels in the chordwise direction for this surface.
3	M	The number of panels in the spanwise direction for this surface.
7	ACALC	2. Compute the aerodynamic influence matricies and the quasi-inverse matrix and store on unit 11.
		1. Compute source influence matrix and store on unit 11. The vortex and quasi-inverse matricies are assumed to already exist.
		0. Compute new aerodynamic influence matrix.
		-1. Use aero influence matrix stored on unit 11.
		-2. Read aero and quasi-inverse matricies from unit 11
		(A second order solution always requires a quasi-inverse matrix).
8	x.y	If x.y < 0. a 2nd order solution is performed. If y > 6 d/dy of v terms are included.

10 ITYPE the type of source panels used.

If =-2. linearly varying source panels are used (spanwise and chordwise without leading or trailing edge panels).

If =-1. linearly varying source panels are used (chordwise varying only without leading or trailing edge panels).

If = 0. Constant source panels are used

If = 1. linearly varying source panels are used (chordwise varying only with leading and trailing edge panels).

If = 2. linearly varying source panels are used (spanwise and chordwise with leading and trailing edge panels).

12 If < 0. Only the geometry and the axial singularity solution will be calculated.

If < - 2. The program will stop after all of the geometry (including axial singularity geometry) is calculated.

13 CENT 1. Control point at panel centroid.
Control point at panel center otherwise.

14 < 1.0 Obtain body and aero surface geometry from input

1.0 Obtain body geometry from APAS (panels)
1.1 Obtain slender body geometry from APAS, create panels, and save after aero geometry.
1.2 Obtain slender body geometry from APAS, modify, create panels, and save after aero geometry.

2.0 Same as 1.0, 1.1, and, 1.2, but includes
2.1 aero surface panels and geometry.
2.2

2.0 Use twist and cambers from APAS and input data.
2.1 Use twist and cambers from input data only.
2.2 Use twist and cambers from APAS dataset only.

≥ 3.0 Obtain only aero surface panels and geometry from APAS (no body).

3.0 Use twist and cambers from APAS and input data.
3.1 Use twist and cambers from input data only.
3.2 Use twist and cambers from APAS dataset only.

15		1. Print source dz/dx and z/c matricies 2. Print both source and camber arrays 3. Print camber slope matrix
16	IPRNT	0. No printing of panel geometry. 1. Print body panel geometry (source panels). 2. Print vortex panel geometry 3. Print body panel and vortex panel geometry -1. Print body panel geometry from APAS dataset. -2. Print vortex panel geometry from APAS dataset. -3. Print body panel and vortex panel geometry (APAS)
18	0.K	K > 0 Print vn due to thickness. K > 1 Print u due to thickness. K > 2 Print v due to thickness. K > 3 Print w due to thickness. K > 4 Print phi due to thickness.
19	INTMED	Various orders of intermediate printout (-1. to 4.) -1. Least printout (no upper and lower surface Cp's) 2. More Printout Prints add load solution and v-normal (w-w), (w-b), (b-w), (b-b) 3. Above + 4. Above + 2nd order boundary condition solutions 5. Above + odd and even 2nd order velocities and Cp's.
20	DPLOT	0. No data is placed in a plot dataset. 1. Data is placed in an APAS dataset (geometry) 2. Data is placed in a UDP dataset (for plotting). > 2. Data is placed in a UDP dataset (extended) DPLOT > 2. is required if the dataset is to be used for a 2nd order optimization calculation.
21	XIJ.XKL	Detailed influence matrix calculation printout for vortex panels. From subroutine VORTEX. XIJ = 3 digit number for control point XKL = 3 digit number for panel number
22	XIJ.XKL	Detailed influence matrix calculation printout for source (thickness) panels. From subroutine PHIS11. XIJ = 3 digit number for control point XKL = 3 digit number for panel number

23 APRNT = IJ.KKK

.ne. 0. Print the aero influence matrix (vortex and body)
.gt. 0. Only normal velocities are printed.
.lt. 0. All velocities and phi are printed.

I or J = 0	nothing	
I or J = 1	vortex	I - influenced
I or J = 2	body	J - influencing
I or J = 3	both	

	11.KKK	vortex on vortex only
	12.KKK	body on vortex only
	21.KKK	vortex on body only
ABS(APRNT) =	22.KKK	body on body only
	13.KKK	all on vortex
	31.KKK	vortex on all
	23.KKK	all on body
	32.KKK	body on all
	32.KKK	all on all

The influence matrix printout will stop after KKK rows are Printed. If KKK = 000 all of the rows are printed.

24 SPRNT = IJ.KKK

.ne. 0. Print the source (thickness) influence matrix
> 0. Only normal velocities are printed.
< 0. All velocities and phi are printed.

I = 0	nothing	
I = 1	vortex	I - influenced panel
I = 2	body	
I = 3	both	

	1J.KKK	source on vortex only
ABS(APRNT) =	2J.KKK	source on body only
	3J.KKK	source on all

The influence matrix printout will stop after KKK rows are printed. If KKK = 000 all of the rows are printed.

25 > -1. Print perturbation velocities from axial singularities

= 0. Print velocities from sources and doublets
= 1. Print velocities from sources
= 3. Print velocities from sources (1st and 2nd) and doublets
= 4. Print velocities from sources (1st and 2nd)
> 4. Print velocities from sources (1st and 2nd) and doublets

26-28 S.K Surface to be extended to centerline.

If > 0 the surface will only be extended when the aero influence matrix is calculated.

S = surface number (in ascending order).

K = 0 Extend inboard panels with zero sweep.
K = 1 Extend inboard panels with same sweep.
K = 2 Extend inboard panels with negative sweep.

i.e. if DATA(26) = 2.0 the calculation of the aero influence matrix for surface # 2 will be performed by extending the inboard panels to y = 0. with zero sweep.

if < 0 the actual panel will be extended and locations 711-714 should be used.

29 < 0. beta * y / x is printed for each panel

30 MN Mach number used for order 2 solution CK2 array.

MN > 0. use MN as Mach number.
MN = 0. use freestream Mach number (generally used).
MN < 0. use normal Mach number.

if < 0. the maximum value of CK2 = - MN

31 X00 the x value of the pivot point for angle of attack. used for second order theory only.

32 XCG For computing Cm, Cr, Cw, Cy

33 YCG For non-symmetric rolling moment only

34 ZCG For non-symmetric rolling moment only

35	MACH	The Mach number
36	RD	The x/c fraction of each panel where the normal velocity is interpolated to calculate the zero suction drag. If 0. a value of 0.515 is used.
37	RS	The x/c fraction of each panel which is used to curvefit (Cp,x) in order to obtain an approximate value for the leading edge suction. (default = 0.250)
		Drag Polar (41 points calculated)
38		Delta CL for drag polar. Default = .05
39		Starting CL for drag polar. Default = 0.
40	CBAR	The reference chord length for computing Cm if 0. CBAR = CAVG is used.
41	CAVG	The reference chord length. If 0. CAVG = SREF/SPAN
42	SREF	The reference area. if 0. SREF = total area
43	SPAN	Span, any consistent set of units may be used. This value is used for reference purposes only. If 0. SPAN = 2. * Y-max
44	RATIO	The chordwise control point location. if 0. default is 0.875 for Mach > 1. 0.875 for Mach < 1.

Data locations 45 - 47 apply to 2nd order solutions only.

45 IJK Printing of odd and even symmetry u,v,w velocities.

if DATA(45) = LMN. I = L, J = M, K = N

I		J		K	
= 0	No velocities printed	= 0	none	= 0	none
= 1	u velocities printed	= 1	odd	= 1	add load
= 2	v velocities printed	= 2	even	= 2	twist and camber
> 2	All velocities printed	> 2	all	= 3	thickness
				= 4	axial
				> 4	

e.g. To print odd and even symmetry thickness v velocities.

use DATA(45) = 231. I = 2, J = 3, K = 1

46 IJK Printing of odd and even symmetry d/dx of u,v,w

47 IJK Printing of odd and even symmetry d/dy of v

I > 0 is required

48 J Printing of d/dx of camber and thickness normal velocities.

J = 1 Camber only.
J = 2 Thickness only.
J > 2 Both

50 ALPHAO The angle of attack of the surfaces with respect to the x,y plane (degrees). Used for second order theory only. ALPHAD is made up of ALPHAO and the angle of attack of the freestream with respect to the x-axis, ALPHAI.

i.e. ALPHAI = ALPHAD - ALPHAO

For a first order solution only ALPHAD matters.

51 ALPHAD(1) The angle of attack of the configuration with respect to the freestream (degrees).

52 ALPHAD(2)
58 ALPHAD(8) (maximum number of angles of attack = 8)

If ALPHAD(K) > 90. an add load solution is perfomed.

i.e. (ALPHAD = 1.0) - (ALPHAD = 0.0)

61 CAMTHK(1) Input in form OB-OV.CAM-THK, and used with ALPHAD(1)

OB = The order of the Cp on the body (one digit).
OV = The order of the Cp on the lifting surfaces)
CAM > 1 Camber included.
THK > 1 Thickness included.
CAM = 0 No Camber included.
THK = 0 No thickness included.

OB, OV, CAM, THK are each one digit.

If = 0. OB = 4, is used for the body Cp,
OV, is determined by DATA(8), and camber and thickness are included

OV = 1, unless DATA(8) < 0.
If OV > 2, OV = 2 will be used, and also the difference between the 1st and 2nd order delta-Cp's will be printed.

If < 0. Same as above except the 2nd order axial solution (if performed) is used to calculate u,v,w.

The body pressure formula is
determined by the value of OB.

OB	Cp
1	Cp = - 2 * u
2	Cp = - 2 * u - beta2 * u*u - v*v - w*w
3	Cp = - 2 * u - u*u - v*v - w*w
4	Cp = Isentropic pressure formula
5	Cp = Isentropic for alpha = 0. + isentropic add load

u,v,w use 1st order axial contributions if CAMTHK > 0
u,v,w use 2nd order axial contributions if CAMTHK < 0

e.g. CAMTHK = - 31.02

\- indicates, 2nd order u,v,w from axial solution (if performed).
3 indicates, pressure formula #3 on body.
1 indicates, 1st order Cp on lifting surfaces.
0 indicates, camber is not included.
2 indicates, thickness is included.

62 CAMTHK(2) used with ALPHAD(2)
68 CAMTHK(8) used with ALPHAD(8)

The following data (89-700) are read for each lifting surface.

89 TC The t/c due to thickness for this lifting surface

If < 0. a thickness influence matrix is calculated although TC = 0 is used. A second order solution will always calculate a thickness influence matrix.

Locations 90-94 are the thickness coefficients

If 90-94 are all 0. a NACA 4 digit airfoil is used.
If C0 < 0. a biconvex airfoil is used.

90	C0	The coefficient of the SQRT(x) term for thickness
91	C1	The coefficient of the x term for thickness
92	C2	The coefficient of the x**2 term for thickness
93	C3	The coefficient of the x**3 term for thickness
94	C4	The coefficient of the x**4 term for thickness

101	SWEEPL	The leading edge sweep in degrees. This value is ignored if 103 is .lt. 0., which means a planform shape is to be read in.
102	SWEEPT	The trailing edge sweep in degrees
103	ROOT	Root dimension or chord length along the symmetry axis
		<0. the planform shape is read in from 241-320
		>0. this value is used to calculate the geometry
104	ROOTX0	The x value at the start of the root.
105	ROOTZ0	The z value for the root. This value will be used with 109 or will be added to values from 121-160.
106	SPAN0	The value of the SPAN. Used with even spacing.
107	XSP	If < 0. the chordwise panel spacing is even
		If = 0. the chordwise panel spacing is cosine
		If > 0. the chordwise panel spacing is half cosine
108	FLAP	The x/c for the flap hinge
109	DIHDRL	The dihedral angle in degrees. (used with 105)
110	RATIOY	The spanwise control point location. If 0., the centroid is used unless location 201 is nonzero.
111	SYM	= 0. Symmetry about y=0. is assumed
		≠ 0. No symmetry
112	ND	The number of chordwise locations of camber input.
113	MD	The number of spanwise locations of camber input. if MD < 3 only the first value will be used. i.e. all span stations will have the same camber.

Planform Shape

121	Z(J)	z values at the y coordinates
161	Y(J)	y coordinates. (if ((Y(2)-Y(1))**2+(Z(2)-Z(1))**2) is 0. The semi span is broken into M equal segments) there must be M+1 values input
201	YC(J)	y coordinates for the control points. Nonzero values will be used to override values based on location 110.
241	XLE(J)	The leading edge coordinates at Y(J)
		These values are considered only if 103 is < 0
		XLE(1) Corresponds to the coordinate on the axis
		XLE(m+1) corresponds to the coordinate at the tip
		any values which are exactly 0. will be changed to make the edge straight between the two surrounding nonzero values.
281	XTE(J)	The trailing edge coordinates. Same format as 241-280

```
321    XD(I)     The x/c values where the camber is input.  See 112
341    YD(J)     The y   values where the camber is input.  See 113
361    ZD(J)     The z   values where the camber is input.
381    TWIST(J)  The twist in degrees at the above values of (y,z)

401              The values of dz/dx for the camber.
                   401     to 400+ND    are for YD(1) at XD(1) to XD(ND)
                   401+ND to 400+ND*2  are for YD(2) at XD(1) to XD(ND)
                 These values are interpolated to obtain the boundary
                   conditions at the control points.
```

Body Geometry

```
702    NY        The number of panels around the body (half).
703    NX        The number of panels in the x direction on the body.
704    NX        The number of singularity segments on the slender
                   body.  If < 0 the singularity segments will be
                   shifted along the Mach lines (supersonic only)
705    NC        The number of control points   on the slender body.

706     IJ.K     I = the order of the source  singularities (1,2).
                 J = the order of the doublet singularities (2,3).

                 If  I = 0     I = 1  is used.
                 If  I > 2     I = 2  is used.

                 If  J = 0     J = 2  is used.
                 If  J > 3     J = 3  is used.

                 There is always a 1st order line source  at the nose.
                 There is always a 2nd order line doublet at the nose.

               IJ < 0   exact conical solution desired at nose.

               IJ > 30  the nose 1st order line source  strength = 0.
                        the nose 2nd order line doublet strength = 0.

                K > 0   a second order axial solution is performed.

                K = 1   no r*phir**3 term included in order 2 solution.
                K = 2      r*phir**3 term included in order 2 solution.

707    ECC       The eccentricity of the body cross sections.
                 Area = pi * r(I)**2 for body cross sections.

708     = 0.     Velocity  boundary conditions on body  (beta2x = 1.0)
        > 0.     Mass flux boundary conditions on body. (beta2x = beta2)
```

709	M.N	> 0	Print source and doublet solutions.
		M > 1	Print shifted singularity points and loads.
		> 2	Print source and doublet coefficients.
		= 1	Print source influence matrix
		N = 2	Print doublet influence matrix
		> 2	Print both influence matricies

710 IU unit number for placing axial loads in a plot dataset (use unit 12)

711 WBI(1) = 0. the body and 1st surface intersection is computed.
712 WBI(2) = 0. the body and 2nd surface intersection is computed.
713 WBI(3) = 0. the body and 3rd surface intersection is computed.
714 WBI(4) = 0. the body and 4th surface intersection is computed.

715 DELTA Used to calculate the maximum allowable slope of bodies. For the axial singularity calculation a conical nose extension is constructed tangent to the body such that:

dr/dx = 1.0 / beta - DELTA if delta > 0.

This operation is performed only for Mach > 1.0 . on the region of the actual body where,

dr/dx > 1.0 / beta - DELTA

Tangent cone formulas are used to calculate Cp's.

The type of pressure coefficient calculation, and the angle of attack, for 721-726, are determined from locations 51-58 and 61-68.

721 THETA - 1 the 1st theta for Cp computation on body.
722 THETA - 2 the 2nd theta for Cp computation on body.
723 THETA - 3 the 3rd theta for Cp computation on body.
724 THETA - 4 the 4th theta for Cp computation on body.
725 THETA - 5 the 5th theta for Cp computation on body.
726 THETA - 6 the 6th theta for Cp computation on body.

741 VSHELL(ISF)
= 1. the surface is a shell composed of vortex panels only the upper surface is considered.
= 0. the surface is a normal lifting surface.

751 XINLET(I) If .ne. 0. The x station is assumed to have an inlet the mass flow is (1.-XINLET(I)).

801 XG(I) The x coordinates of the body geometry sections.

851 XX(I) The x coordinates of the body panel cross sections. if XX(I) = 0., and DATA(703) > 0., XX(I) = XG(I) is assumed.

901 RR(I) The r values of the body geometry sections.

1001 X(I) The x coordinates of the slender body singularities.
1101 XC(I) The x coordinates of the slender body control points.

1201 CAM(IJ) The camber for each panel. Input as dz/dx at the control point (each surface input separately), unless the input is being read through an APAS dataset. For an APAS input all camber values are input at one time and the value of DATA(14) must be considered.

i.e. If the data is not being input through an APAS dataset, DATA(1200+I) is the initial camber dz/dx for the I'th panel of the surface being input.

1801 TWIST(J) The twist for each span station. This is for APAS dataset inputs only, and the twist values for all span stations are input at one time. See DATA(14) for additional information on twist input.

1996 FLOW(1) Mass flow coefficient for inlet # 1
1997 FLOW(2) Mass flow coefficient for inlet # 2
1998 FLOW(3) Mass flow coefficient for inlet # 3
1999 FLOW(4) Mass flow coefficient for inlet # 4
2000 FLOW(5) Mass flow coefficient for inlet # 5

FLOW(I) = Average value of (1.-beta2x*u) for all field point of inlet I (see location 708).

maximum of 200 field points

2001	x, y, z, inlet #	for field point #1
2006	x, y, z, inlet #	for field point #2
2011	x, y, z, inlet #	for field point #3
2016	x, y, z, inlet #	for field point #4
2021	x, y, z, inlet #	for field point #5
2026	x, y, z, inlet #	for field point #6

inlet # = 0 means the point is not an inlet point.

SUBROUTINE DECRD1

Subroutine DECRD1 is used to read input data from a fixed block dataset. The input data which is read is placed in floating point format into locations of the array "DATA" which appears in the argument list. The subroutine will also read a single title card of up to 72 characters and place the literal data in the array "TITLE" which also appears in the argument list. Subroutine DECRD1 allows input in two different formats, called decrd format and free format. A description of these input formats will follow.

The first time DECRD1 is entered, the first record is assumed to be in decrd format with LRECL = 72. LRECL is the length of each record which is read (maximum LRECL = 132).

If the characters "C","D", or "F" appear in column 1, the card will not be read for any data (except for LRECL).

A 'C' indicates a comment card.
A 'D' indicates the following cards are to be read using decrd format.
An 'F' indicates the following cards are to be read using free format.

The value of LRECL appears in the card with an F in column 1 in the form LRECL(KLM), where KLM is a three digit integer. It will remain constant each time DECRD1 is entered, unless it is reset.

Unless the first card containing data in each entry to DECRD1 has a blank or a minus sign appearing in column 1, with blanks in columns 2-4, the first card is assumed to be a title card containing 72 characters of literal data. However, cards with the characters "C", "D", or "F" in column 1 do not count as data cards and may appear before the title card. When using free format, the first data card of an entry to DECRD1 should be checked carefully to see that the first four columns are of the correct form, to avoid confusion between a card containing title data and a card with numerical data.

DECRD FORMAT

In Decrd format each data card has the format I12,5E12.5. The first number on each card is an integer giving a location in the input array; the following numbers on the card specify the values to be input into that and the four immediately succeeding locations. These numbers can be input either in F format, which must include a decimal point or in E12.5 format. Locations left blank will remain unchanged. The last card to be read for each call to DECRD1 is signaled by having a negative location number.

FREE FORMAT

Data may be written in I, F, E, or D format separated by blanks, commas, or semicolons. The data will be placed in consecutive locations of the array "DATA" in the program. Data locations may be skipped by writing an X or using consecutive commas with nothing other than blanks between. When data locations are skipped, the previous values remain unchanged.

If the first piece of data on a card is a positive or negative integer, which is not a multiplying factor to be described below, it will be assumed to be the location number of the next piece of data on the card. If this integer is negative this card will be the last card read until subroutine DECRD1 is called again. This means the last card must have a negative location number as the first piece of data on the card. If the piece of data is not an integer, or if it is a multiplying factor, the data will be placed in consecutive locations continuing from the previous card.

A semicolon can be used to designate the end of one card and the start of a new card. This means that the next piece of data will be treated as if it were the first piece of data on a new card. For this new card everything in the previous paragraph applies.

An integer followed by '=' will cause the subsequent data to be placed in consecutive locations beginning with the integer. Blanks may be placed before or after the '='.

A * preceeded by an integer is used to designate a multiplying factor, and will cause subsequent data to be repeated the integer number of times. E.g. 5 * 4.4 will result in the value 4.4 being placed in 5 consecutive data locations starting with the appropriate data location. Writing 10*X will result in 10 data locations being skipped. Spaces before and after a * are ignored. A multiplier must be an integer (I format), and it must be > 1.

Everything within ( ) will be ignored, unless it is preceeded by a multiplying factor which is greater than one. E.g. 5*(3.2 4.6 x 5) will cause the sequence of data (3.2 4.6 x 5) to be repeated 5 times. Nested parentheses are not allowed.

LIST OF VARIABLES

GENERAL VARIABLES

CHORD(J)	The chord value at the centroid of span station J
IJS(IS)	The value of IJ where section IS begins
IJ0(J)	The number of the first panel at span station J
IS0(ISF)	The section number where surface ISF begins.
JS(IS)	The span station where section IS begins
MS(IS)	The number of span stations in section IS
NB	The number of basic solutions.
NCHORD(J)	The number of panels at span station J
NS	The total number of sections
NSF	The total number of surfaces
NSPAN(ISF)	The number of span stations on surface ISF
NSL	The number of vortex shell sections
NST	The total number of span stations on all lifting surfaces.
NSTS	The number of source span stations
NTB	The number of body panels.
NTL	The number of vortex shell panels.
NTP	The total number of panels.
NTS	The number of source parameters.
NTSL	The total number of vortex shell span stations
NTV	The number of vortex panels.

LIFTING SURFACE PANELS

CAM(IJ)	The normal velocity at the control point due to
COSZ(IJ)	The cosine of the normal of panel IJ
CX(I,IS)	x/c values for the control points of section IS
DS(J)	Width of span station J
DWDX(IJ)	The local dw/dx at thickness control point IJ
DX(I,IS)	Delta (x/c) for the panels of section IS
ETA(J)	Fraction of span running distance for (YCC(J),ZCC(J)) camber.
PA(IJ)	The area of panel IJ
SINZ(IJ)	The sine of the normal of panel IJ
TWIST(J)	Twist of span station J
WTHK(IJ)	The local dz/dx at thickness control point IJ
X(KL,IC)	x values of the corners of vortex panel KL (4)
XC(IJ,1)	x value of the centroid for vortex panel IJ
XC(IJ,2)	x value of the control point for vortex panel IJ
XLE(1,J)	x value at the leading left edge of span station J.
XLE(2,J)	x value at the leading right edge of span station J.
XM(I,IS)	x/c values for the midpoints of panels of section IS
XTE(1,J)	x value at the trailing left edge of span station J.

```
XTE(2,J)      x value at the trailing right edge of span station J.
XX(I,IS)      x/c values for the panels of section IS
Y(KL,IC)      y values of the corners of vortex panel KL  (2)
YC(IJ)        y value of the control point for vortex panel IJ
YCC(J)        y value at the control point of span station J
 YO(1,J)      y value at the left  edge of span station J.
 YO(2,J)      y value at the right edge of span station J.
Z(KL,IC)      z values of the corners of vortex panel KL  (2)
ZC(IJ)        z value of the control point for vortex panel IJ
ZCC(J)        z value at the control point of span station J
ZTHK(IJ)      The local  z/c at thickness control point IJ
 ZO(1,J)      z value at the left  edge of span station J.
 ZO(2,J)      z value at the right edge of span station J.
```

BODY PANELS

```
 B(I) = SQRT(DY(I)**2 + BETA2*DX(I)**2)      I = 1,4
BT(IC,IJ)     tans**2 + beta2  for each side of body panel IJ
              = 1.- Mach**2  mass flux boundary conditions.

   i.e.   (1. + beta2x * u ) * XN + v * YN + ( w + alpha ) * ZN = 0.

 BETA2X       = 1.            velocity boundary conditions.
  IBB(K)      The body station number of the first station in body
                section K.
  IJB(K)      The panel number of the first body panel in section K.
   NX(K)      The number of x body stations for body section K
   NY(K)      The number of panels at each body station (half) for
                body section K.

XB(IC,KL)     x values of the corners of body panel KL   (4)
XINLET(IJ)    mass flow coefficient of body panel IJ; 0. = impermeable
 XN(1,IJ) = x - component of body panel IJ normal
 XN(2,IJ) = y - component of body panel IJ normal
 XN(3,IJ) = z - component of body panel IJ normal

 XN(4) = XN(1) / XN(8)
 XN(5) = XN(2) / SQRT(XN(2)**2 + XN(3)**2)
 XN(6) = XN(3) / SQRT(XN(2)**2 + XN(3)**2)

 XN(7) = SQRT(XN(2)**2 + XN(3)**2) / XN(8)
 XN(8) = SQRT(beta2*XN(1)**2 + XN(2)**2 + XN(3)**2)
 XN(9) = SQRT(      XN(1)**2 + XN(2)**2 + XN(3)**2)  =  2. * area
XP(IC,KL)     x values of the corners of body panel KL   (4)  planar
  XBO(I)      The x value of the center of body station I.
XO(1,IJ)      x value of the centroid of body panel IJ
XO(2,IJ)      y value of the centroid of body panel IJ
```

XO(3,IJ)	z value of the centroid of body panel IJ		
YB(IC,KL)	x values of the corners of body panel KL	(4)	
YP(IC,KL)	x values of the corners of body panel KL	(4)	planar
ZB(IC,KL)	x values of the corners of body panel KL	(4)	
ZP(IC,KL)	x values of the corners of body panel KL	(4)	planar

COMPUTED VARIABLES

Cp(IJ,K) The delta-Cp across panel IJ from basic solution K.

UK(IJ,K) The control point upper surface x velocity.
VK(IJ,K) The control point upper surface binormal velocity.
WK(IJ,K) The control point upper surface normal velocity.
PK(IJ,K) The control point upper surface velocity potential.

US(IJ) The thickness induced upper surface x velocity.
VS(IJ) The thickness induced upper surface binormal velocity.
WS(IJ) The thickness induced upper surface normal velocity.
PS(IJ) The thickness induced upper surface velocity potential.

The following variables are required for 2nd order solutions only.

WSX(IJ) d/dx of WS(IJ) source normal velocity.
WCX(IJ) d/dx of WK(IJ,2) camber normal velocity.

KKX The number of 2nd order boundary condition solutions.

= 6 if there is no body.
= 9 if there is a body.

UBE(IJ,K) The even symmetry u velocities due to 2nd order b.c.
UBO(IJ,K) The odd symmetry u velocities due to 2nd order b.c.

SUBPROGRAMS

	FUNCTION
MAIN	Sets the main array size for the program.
ABMAIN	Reads input data, computes geometry, and sets array sizes.
ACMAIN	Controls the flow of the program.
AERO2	Controls the program flow for the computation of 1st or 2nd order pressures and loads.
AERO2B	Computes the u velocities due to 2nd order boundary Conditions.
AERO2P	Computes the 1st or 2nd order pressures from the induced velocities.
AERO2V	Computes the odd and even symmetry velocities induced by the basic solutions.
AMINMX	Finds the largest, smallest or largest absolute value of the elements of an array.
APAS	Reads geometry from APAS output.
APASB	Modifies APAS body geometry coordinates to form desired panel coordinates.
AXXABA	Checks if an axis singularity solution is desired.
AXXAIJ	Computes axis singularity source and doublet influence coefficients.
AXXBDY	Computes body geometry for axis singularity solution.
AXXBXR	Prints axisymmetric body geometry and coefficients of source and doublet coefficients.
AXXCSD	Computes coefficients of semi-infinite source and doublet line singularities.
AXXLIN	Computes x and r for axisymmetric body geometry.
AXXLOD	Computes Cp's and forces on isolated body from axis singularity solution.
AXXNCP	Integrates forces on body nose using Cp's from a tangent cone solution.
AXXNF0	Function for body nose curve fit.
AXXNF1	Function for body nose curve fit.
AXXNOS	Finds the point where a conical nose extension is added to the body in order to avoid body slopes in excess of the Mach angle.
AXXSLX	Controls program flow for axis singularity solution.
AXXTCN	Computes tangent cone Cp's on the body.
AXXUVW	Computes velocities from axis singularities.
AXXVEL	Computes velocities at panel control points from axis singularities.
AXXXIS	Computes influence coefficients for source and doublet semi-infinite line singularities.
BDYAIJ	Computes influence coefficients for body panels.
BDYSCE	Calculates u,v,w,phi influence coefficients for a

unit strength source panel.

BODYDS	Prints arrays of characteristics at body panel control points.
BODYG	Computes body panel geometric characteristics.
BODYGM	Computes and prints body geometry from input data.
BODYRD	Reads body panel geometry from APAS dataset.
BODYW	Finds the intersection of the body and the aerodynmaic surfaces.
CLCM	Computes the lift drag and moment characteristics of aerodynamic surfaces.
DECRD1	Reads the input data.
DISPLY	Prints arrays of characteristics at the panel control points of the aerodynmaic surfaces.
DMXMVE	Moves the elements of a double precision array.
DSSPLY	Prints arrays of characteristics at the panel corner points of the aerodynamic surfaces.
ENDREC	Used with errset to check for APAS type influence matrix.
FIELD	Computes first order field point properties using previously calculated influence coefficients and the first order solution.
FXDX3	Integrates data using a third order curve fit through the nearest four points.
GEOM	Computes the geometric characteristics of the aerodynamic surfaces and panels.
GOMTRY	Computes the panel geometry for the aerodynamic surfaces.
HSHLDR	Solves sets of linear simultaneous equations in a least square sense.
INLET	Performs solution while satisfying boundary conditions at a set of inlet points.
INTRP3	Interpolates or differentiates data using a third order curve fit through the nearest four points.
INTRP4	Interpolates or differentiates data using a third or fourth order curve fit through the nearest four points.
INTRPX	Interpolates or differentiates properties chordwise on an aerodynamic surface using subroutine INTRP4.
INTRPY	Interpolates or differentiates properties spanwise on an aerodynamic surface using subroutine INTRP4.
INTSCT	Finds the intersection of two lines.
LINEAR	Fills in aerodynamic surface geometry not input, and Calculates geometry.
MATRIX	Computes aerodynamic influence coefficients for source and vortex panels on aerodynamic surfaces.
MATRXF	Displays arrays of data.
MATRXT	Displays arrays of data.
MTXADD	Adds multiples of two arrays.
MTXMLT	Multiplies two arrays.
MTXMVE	Moves the elements of an array.

NOTZRO	Checks to see if an array has any nonzero elements.
ORTHO	Solves sets of linear simultaneous equations using the method of succesive orthogonalizations. A quasi-inverse matrix may be computed or, if previously computed, used to perform the solution.
PHIS11	Calculates u,v,w,phi influence coefficients for aero surface source panel edges on control points.
PHIXY	Calculates v (binormal) velocities on aerodynamic surfaces from phi (for 2nd order solution).
PLOT	Writes geometry and aerodynamic data on a disk unit for computer graphics.
POLAR	Calculates first order drag polar and aerodynamic cofficients.
QUADPL	Computes body source panel geometric characteristics.
SQFIT	Calculates leading edge suction using a least square Curve fit of Cp to cot(x/c).
THICK	Computes wing thickness z/c, dz/dx, d2z/dx2 from input.
VORTEX	Calculates u,v,w,phi influence coefficients for aero surface vortex panel edges on control points.
VTXAIJ	Controls program flow for aerodynamic influence Coefficient calculation.
VTXDRG	Calculates vortex drag in the Trefftz plane.
VTXDR2	Calculates coefficients for VTXDRG.
VTXLFT	Calculates vortex lift from leading edge suction.
WBINF	Prints source or vortex influence matricies for aerodynamic surfaces.
WBSOL	Controls the matrix solution using subroutine ortho.
WBUVW	Calculates boundary conditions for solution.
WBVEL	Calculates u,v,w,phi at panel control points.
WINTRP	Interplolates velocities to various points on panels.

file	use
5	input data
6	Print output
8	scratch file
9	scratch file
10	scratch file
11	storage of influence matricies and quasi-inverse
12	plot output file
13	APAS geometry input file

FLOW DIAGRAM

```
**********
* AAMAIN *
**********
    |
    V
**********          **********
* ABMAIN *<==>|<==>* DECRD1 *
**********    |     **********
    |         V
    |         |     **********         **********
    |         |<==>*  APAS   *<=======>* APASB   *
    |         |     **********         **********
    |         V
    |         |     **********
    |         |<==>* LINEAR *
    |         |     **********
    |         V
    |         |     **********
    |         |<==>* GOMTRY *
    |         |     **********
    |         V
    |         |     **********
    |         |<==>* THICK   *
    |               **********
    |
    |
    |
    |
    V
```

```
      |
      |
      |
      V
**********
* ACMAIN *<==>|<==>*  GEOM  *
**********    |    **********
              V
              |    **********          **********
              |<==>* BODYG  *<==>|<==>* BODYRD *
              |    **********    |     **********
              V                  V
              |                  |     **********
              |                  |<==>* AXXLIN *
              |                  |     **********
              |                  V
              |                  |     **********
              |                  |<==>* QUADPL *
              |                  |     **********
              |                  V
              |                  |     **********
              |                  |<==>* BODYGM *
              |                  |     **********
              |                  V
              |                  |     **********
              |                  |<==>* BODYW  *
              |                        **********
              |    **********
              |<==>* AXXABA *<==> see Slender Body Flow diagram
              |    **********
              V
              |    **********          **********          **********
              |<==>* VTXAIJ *<=======>* MATRIX *<==>|<==>* VORTEX *
              |    **********          **********   |     **********
              V                                     V
              |                                     |     **********
              |                                     |<==>* PHIS11 *
              |                                           **********
              |
              |
              V
```

```
|
|
|
|
|
|
|        **********          **********
|<==>*  BDYAIJ  *<=======>*  BDYSCE  *
|        **********          **********
V
|        **********
|<==>*  WBUVW    *
|        **********
V
|        **********          **********
|<==>*  WBSOL    *<=======>*  ORTHO    *
|        **********          **********
V
|        **********
|<==>*  WBVEL    *
|        **********
V
|        **********
|<==>*  WBINF    *
|        **********
V
|        **********          **********
|<==>*  VTXDRG  *<=======>*  VTXDR2  *
|        **********          **********
V
```

```
|
|
|
|
|
|     **********           **********
|<==>* AERO2  *<==>|<==>* PHIXY  *
|     **********   |     **********
V                  V
|                  |     **********
|                  |<==>* AERO2V *
|                  |     **********
V                  V
|                  |     **********        **********
|                  |<==>* AERO2B *<======>* WBSOL  *
|                  |     **********        **********
V                  V                           |
|                  |     **********        **********
|                  |<==>* AERO2P *        * ORTHO  *
|                  |     **********        **********
V                  V
|                  |     **********       **********
|                  |<==>*  CLCM  *<=>|<=>* SQFIT  *
|                  |     **********  |    **********
V                  V                 V
|                  |     **********  |    **********
|                  |<==>*  PLOT  *   |<=>* VTXLFT *
|                        **********       **********
|
|
V
|     **********
|<==>* POLAR  *
      **********
```

SLENDER BODY CALCULATION

```
***********
* AXXABA *
***********
     |
     |
     V
***********          ***********
* AXXBDY *<==>|<==>* AXXLIN *
***********   |      ***********
              V
              |      ***********            ***********      ***********
              |<==>* AXXNOS *<========>* AXXNCP *<===>* AXXTCN *
              |      ***********            ***********      ***********
              V
              |      ***********            ***********
              |<==>* AXXSLX *<==>|<==>* AXXCSD *
              |      ***********      |     ***********
              V                       V
              |                       |     ***********
              |                       |<==>* AXXBXR *
              |                       |     ***********
              V                       V
              |                       |     ***********        ***********
              |                       |<==>* AXXAIJ *<=====>* AXXXIS *
              |                       |     ***********        ***********
              V                       V
              |                       |     ***********
              |                       |<==>* HSHLDR *
              |                       |     ***********
              V                       V
              |                       |     ***********
              |                       |<==>* AXXUVW *
              |                       |     ***********
              V                       V
              |                       |     ***********
              |                       |<==>* AXXLOD *
              |                             ***********
              V
              |      ***********            ***********         ***********
              |<==>* AXXVEL *<========>* AXXAIJ *<=>|<=>* AXXXIS *
                     ***********            ***********  |      ***********
                                                         |
                                                         |      ***********
                                                         |<=>* AXXCOR *
                                                                ***********
```

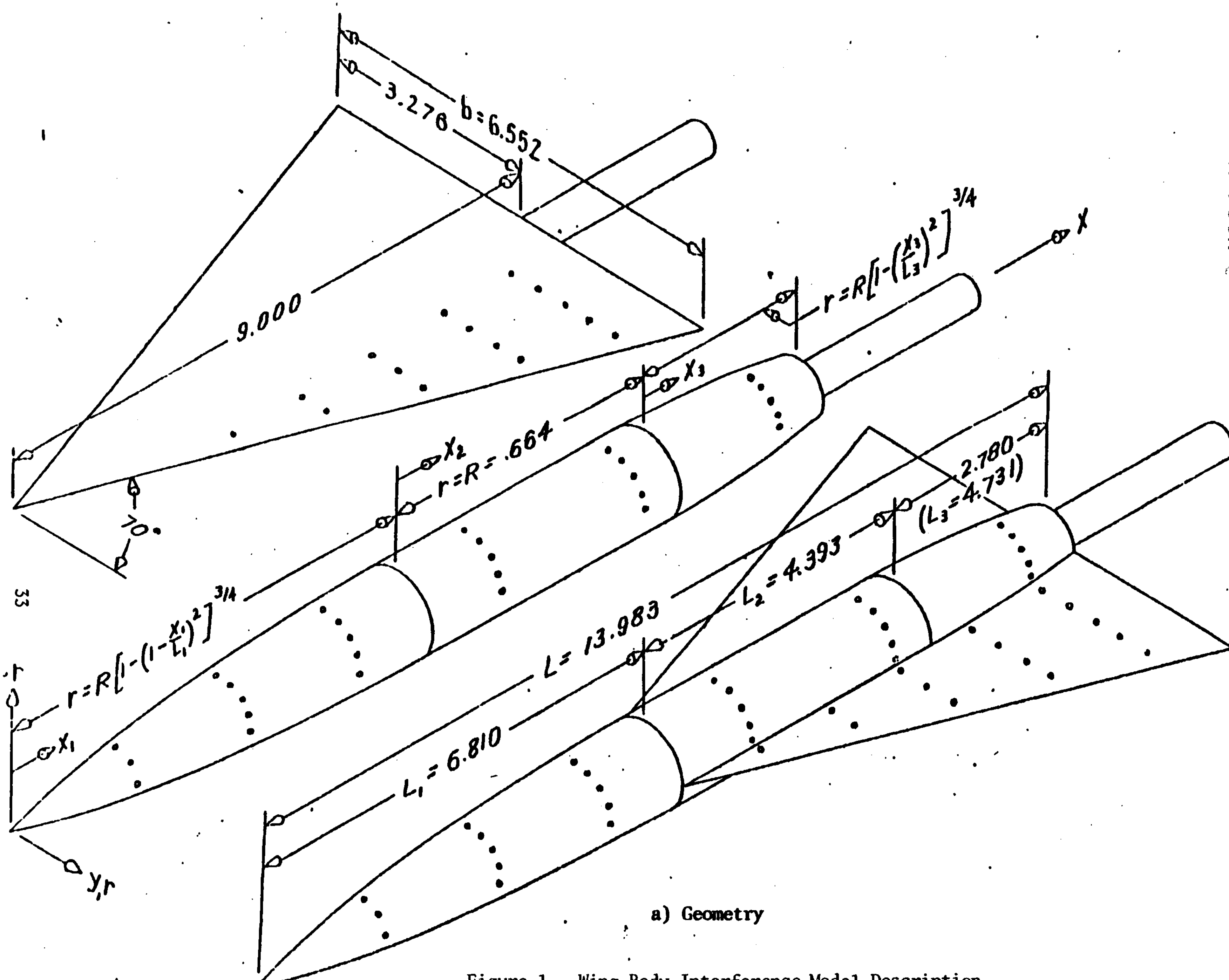
TEST CASE

Results for the seventy degree delta wing-body arrangement of figure 1 are presented in this section.

The aerodynamic paneling representation used in the analysis is presented on figure 2 and is typical of the program geometrical graphics output.

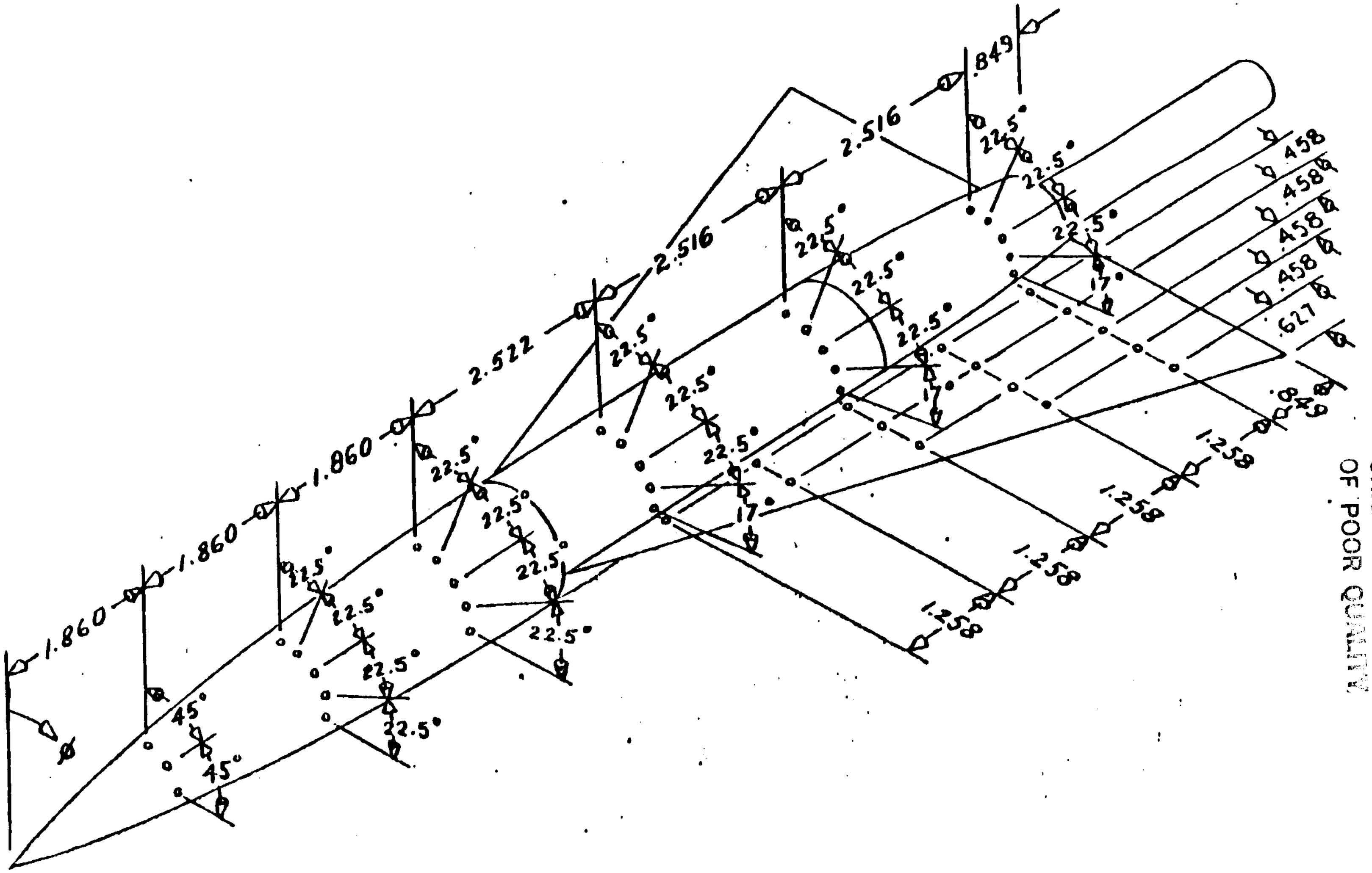
Comparison of first and second order results with experiments for a Mach number of 6 and an angle of attack of 8 degrees are presented, on figure 3. Improved wing surface pressure coefficient predictions are systematically obtained for the second order analysis with the exception of the root section on the compression side and are in reasonably good agreement with measurements. Additional results are presented in references 2 and 3.

Test case input is presented on pages 41 through 43, and detailed program printed output is presented on pages 44 through 98. Typical aerodynamic data graphics output is presented on pages 99 through 109.



a) Geometry

Figure 1. Wing-Body Interference Model Description



b) Pressure Tap Locations

Figure 1. Completed

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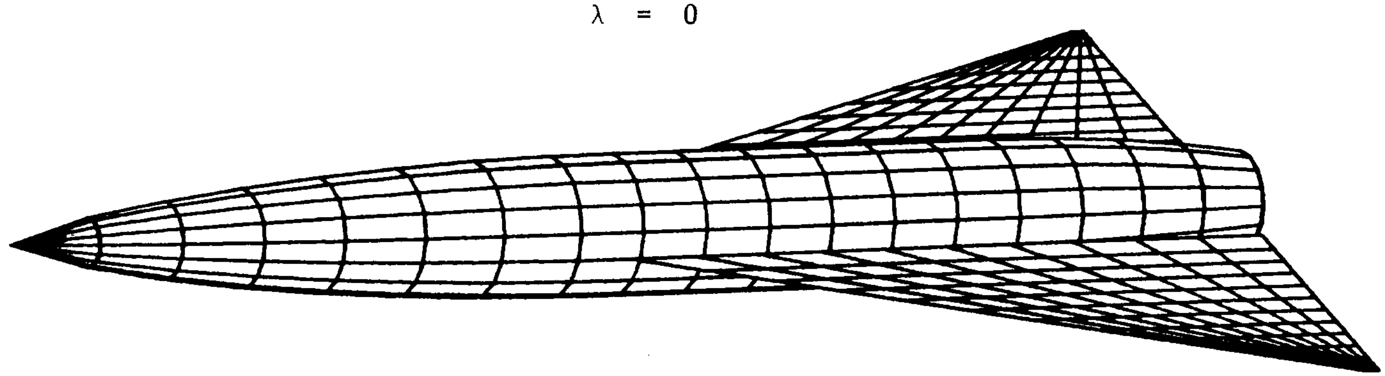
$AR = 1.46$

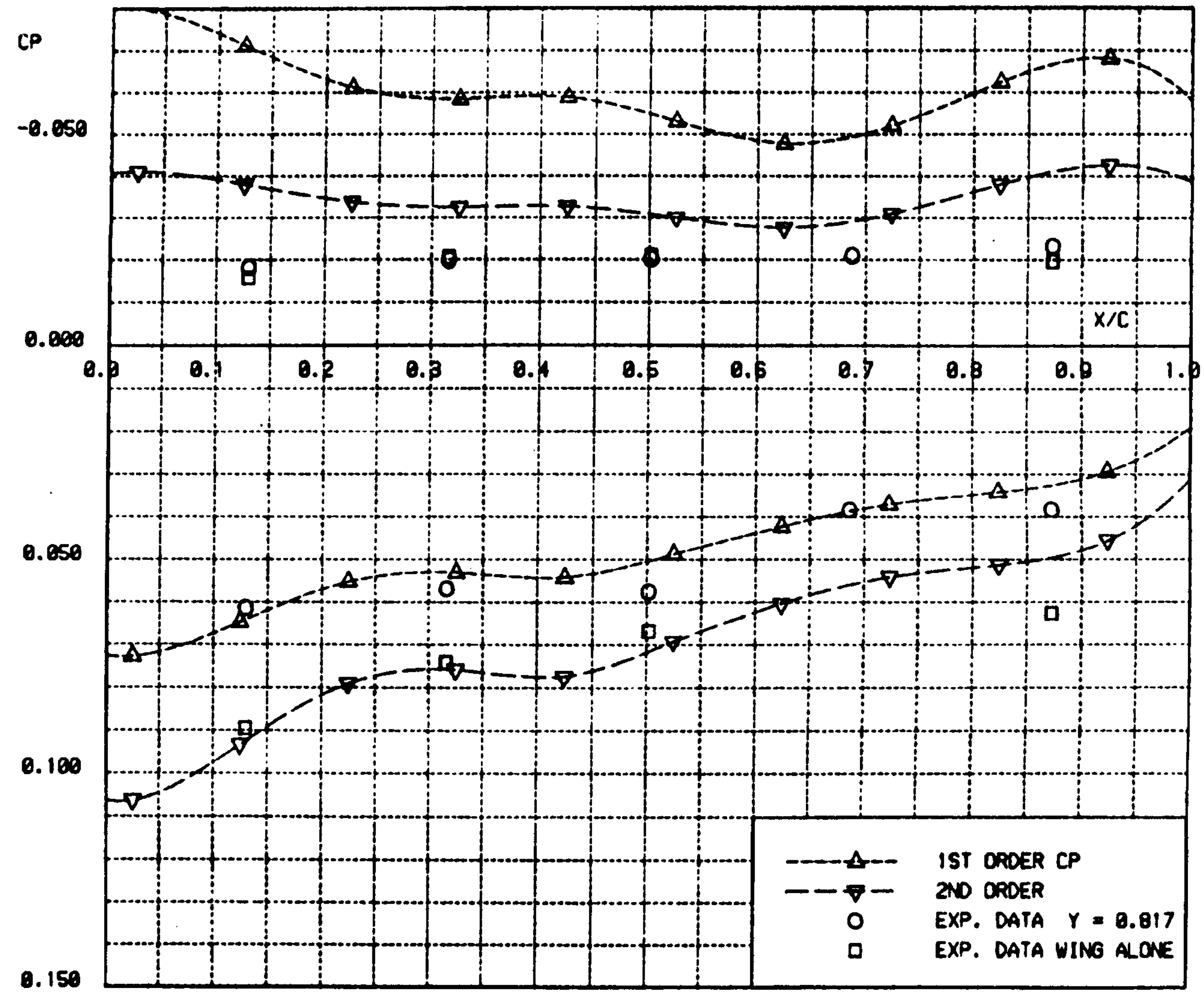
$\Lambda_{LE} = 70°$

$\lambda = 0$



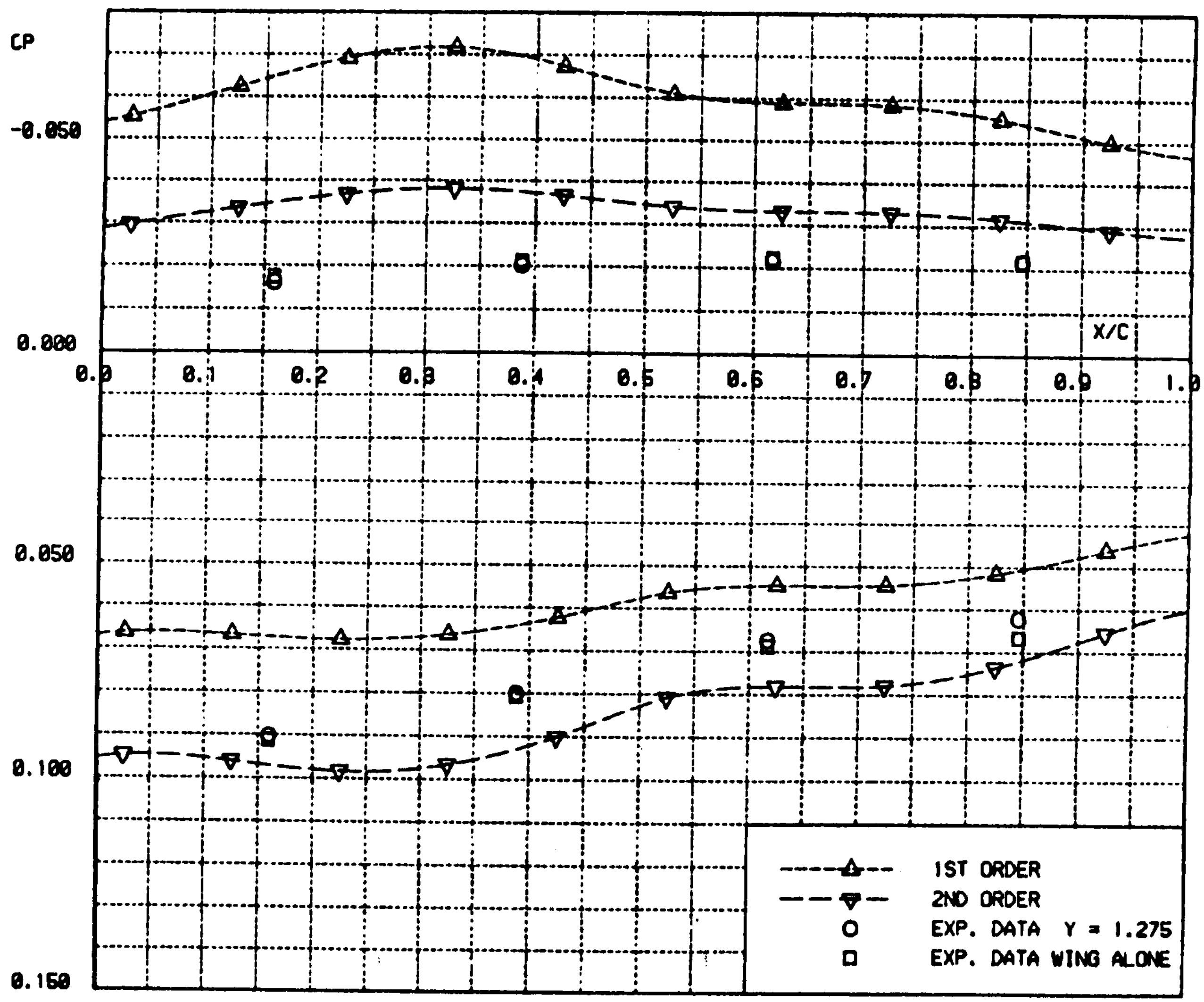
254 Panels

Figure 2. Wing-Body Finite Element Model



a) Y = 0.817

Figure 3. Comparison of Interference Model Wing Surface Pressures in Presence of the Body at $M = 6.0$, $\alpha = 8°$



b) Y = 1.275

Figure 3. Continued

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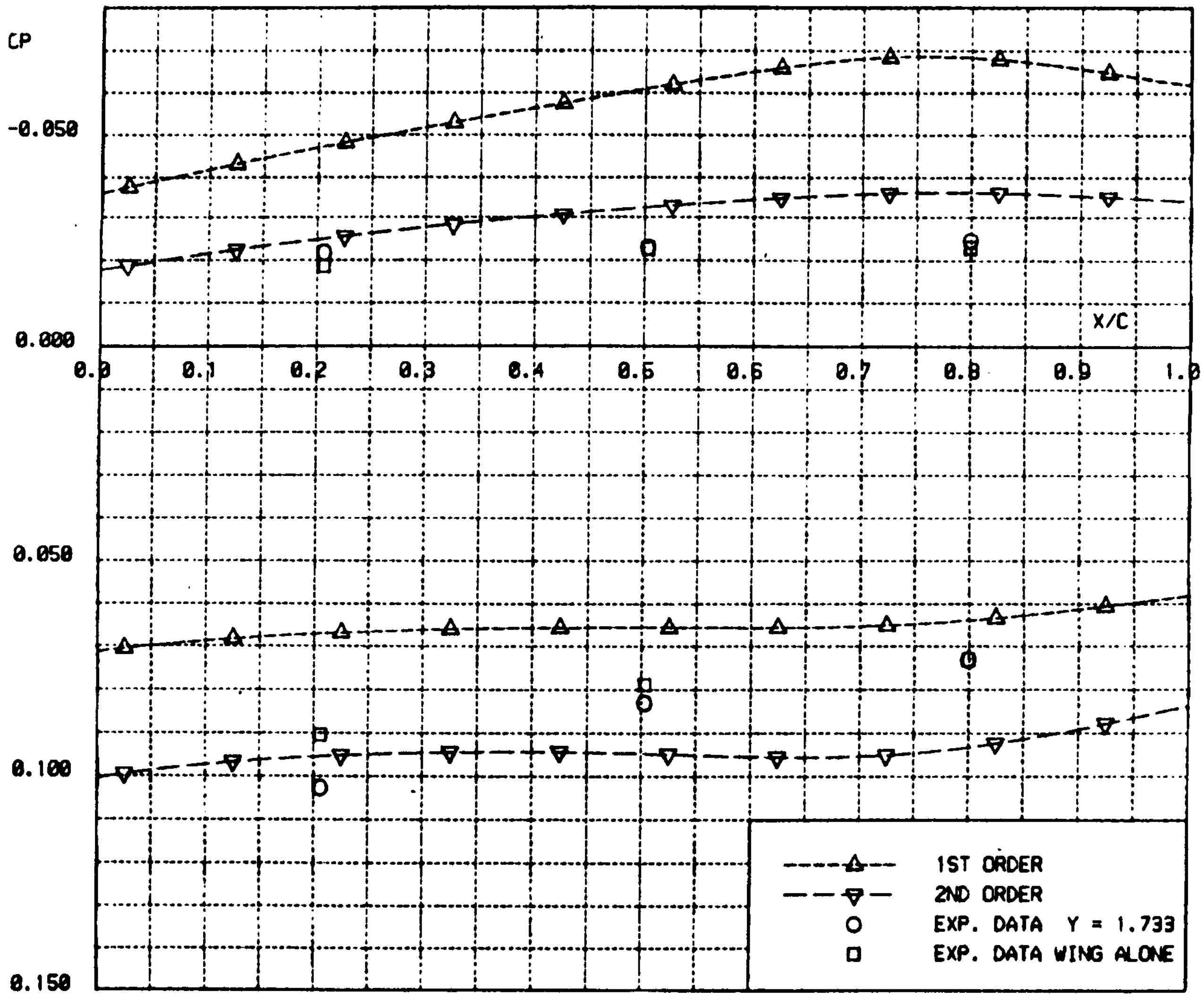

c) Y = 1.733

Figure 3. Continued

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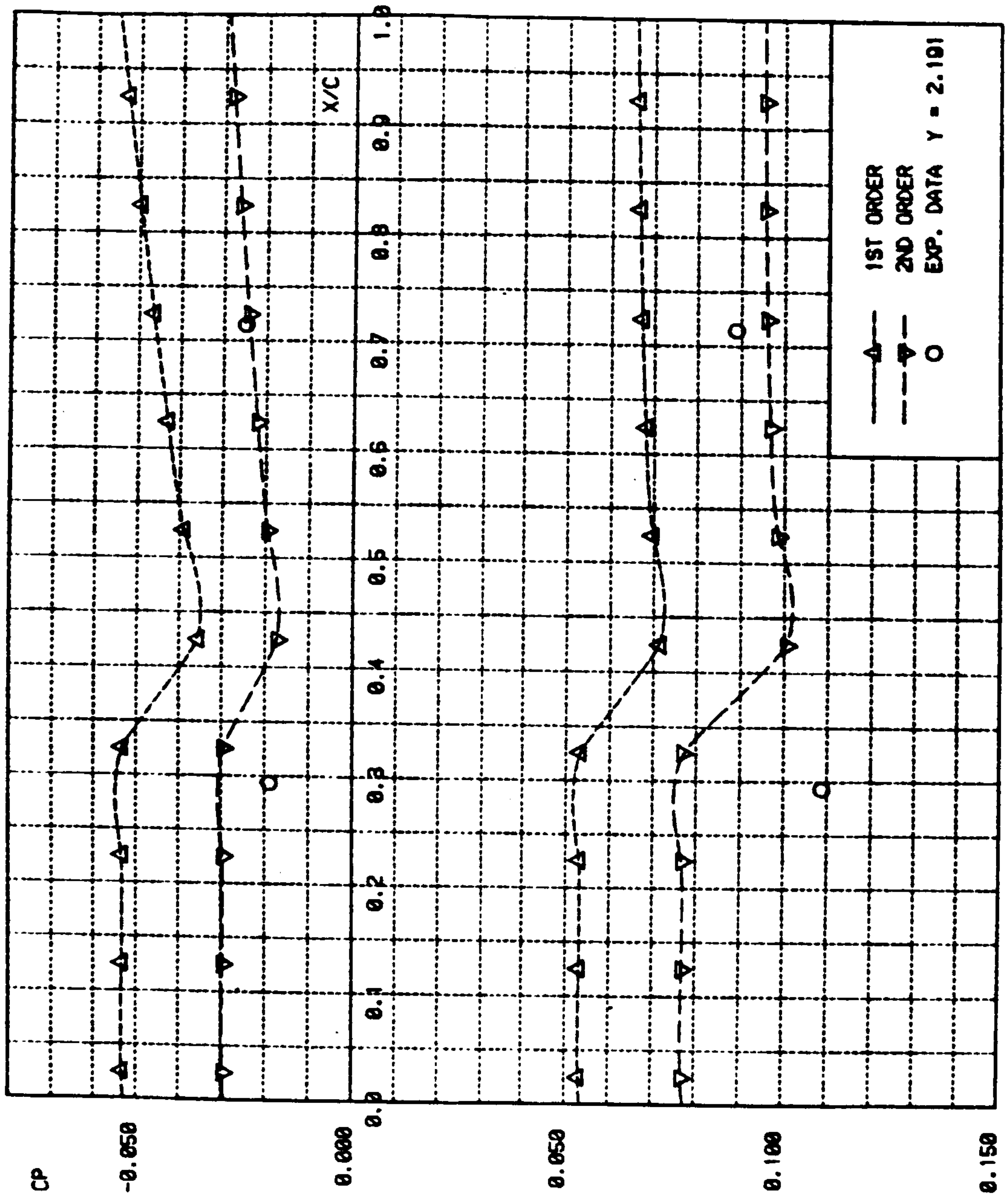

d) Y = 2.187

Figure 3. Continued

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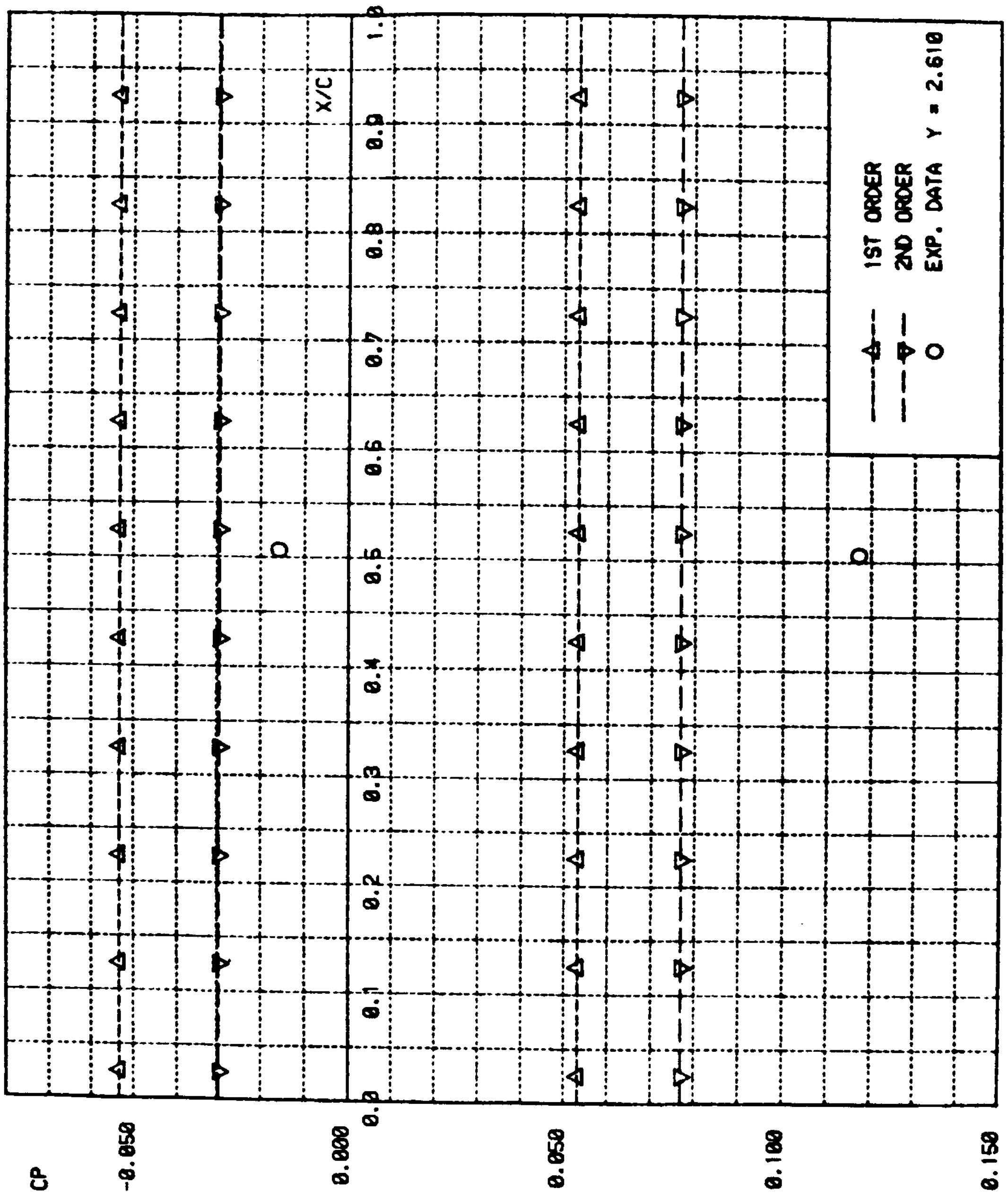

e) Y = 2.642

Figure 3. Completed

TEST CASE INPUT DATA

```
 WBODY.DATA(M600) 1ST-AX   (10 X 11) (8 X 11)    VEL B.C.  NEG    37X37
C      CALCULATE NEW AERO MATRIX AND INVERSE AND SAVE (=2.0)
          7 2.
C      IF < 0.  CALCULATES A SECOND ORDER SOLUTION.
          8-1.
C      = 2.0 FOR SPANWISE AND CHORDWISE LINEARLY VARING SOURCE PANELS.
         10 2.
C     GEOMETRY CALCULATION ONLY
         12 0.
C     CONTROL POINT AT PANEL CENTROID (VORTEX PANELS)
         13 1.
C     NO PRINTING OF SOURCE (THICKNESS) DZDX AND Z/C MATRICIES
         15 0.
C     = 3.0  PRINTS ALL PERTURBATION VELOCITIES DUE TO THICKNESS
C        18 3.5
C     PRINTS ALMOST EVERYTHING  (EACH LOWER NUMBER PRINTS LESS)
         19 0.
C       PLOT DATASET (EXTENDED)     NO PLOT DATASET (= 0.)
         20 3.
C     EXTENDS FIRST SURFACE TO PANEL CENTERLINE WITH NEGATIVE SWEEP
         26 1.2
C        MACH NUMBER
         35 6.0
C     PRINTS ODD AND EVEN SYMMETRY VELOCITIES
C        45 334.
C        46 334.
C        47 334.
C     PRINTS CAMBER AND THICKNESS NORMAL VELOCITIES
         48 0.0
C       ANGLE OF ATTACK  ( > 90. FOR ADD LOAD )
         51 99.0          99.0        8.0          8.0
C        1ST ORDER AXIAL SOLUTION ( > 0. )
C        ISENTROPIC   = 4  (ON BODY)
C          1ST ORDER  = 1  (ON LIFTING SURFACES)
C        NO   CAMBER  = 0
C        NO THICKNESS = 0
         61 41.00        42.00       41.00       42.00
```

```
C       NUMBER OF PANELS AROUND THE BODY (HALF)
          702 8.
C       AXIAL SINGULARITIES.
C          < 0  MEANS EXACT CONICAL SOLUTION AT NOSE.
C             2    = AXIAL VARIATION ORDER OF SOURCE  SINGULARITIES
C              3   = AXIAL VARIATION ORDER OF DOUBLET SINGULARITIES
          706-23.0
C       VEL B.C. = 0.
          708 0.
C       PRINT SOURCE AND DOUBLET SOLUTIONS.
          709 0.
          710 0.0
C       IF > 0. NO BODY AND SURFACE INTERSECTION IS COMPUTED
          711 1.          1.          1.          1.          1.
C       MAXIMUM ALLOWABLE SLOPE ON BODY = 1. / BETA - DATA(715)
          715 0.0029
C       PRESSURE COEFFICIENT CALCULATION ON BODY (AXIAL SOLUTION)
          720 4.0
C       ANGLE FOR PRESSURE COEFFICIENT CALCULATION.
          721 0.          22.5        45.         67.5        90.
C       X VALUES OF THE BODY GEOMETRY SECTIONS.
          801 0.0         1.00        1.09        1.10        1.20
          806 1.30        1.40        1.50        2.00        3.00
          811 4.00        5.00        6.00        6.70        6.75
          816 6.80        6.810       6.820       11.10       11.150
          821 11.203      11.30       11.50       12.00       12.50
          826 13.00       13.50       13.983      14.10       14.20
          831 14.30       14.40       14.50       14.60       14.70
          836 14.80       16.9360
C       X COORDINATES OF THE BODY PANEL CROSS SECTIONS (R INTERPOLATED)
          851  6.1839
          862 14.0775
C       R VALUES OF THE BODY GEOMETRY SECTIONS.
          901 0.          0.250501    0.265452    0.267113    0.283416
          906 0.299132    0.314302    0.328960    0.395480    0.501051
          911 0.577263    0.628500    0.656942    0.663870    0.663961
          916 0.663999    0.664       0.664       0.664       0.664
          921 0.664       0.663791    0.662036    0.649816    0.626208
          926 0.590771    0.542754    0.483287    0.466763    0.451935
          931 0.436431    0.420224    0.403653    0.387083    0.370513
          936 0.353943    0.0
C       X COORDINATES OF THE AXIS SINGULARITIES.
         1001 0.0         0.75        1.25
         1031 0.0         15.75       16.25       16.9360
C       X COORDINATES OF THE AXIAL SINGULARITY CONTROL POINTS
         1101  1.00       1.50        2.00
         1131 16.00       16.50
-            1 0.
```

```
 WING
C          CHORDWISE   SPANWISE   # OF PANELS
           2 10.         11.
C          T/C   A THICKNESS MATRIX IS CALCULATED (UNLESS = 0.)
          89 0.05        -1.0
C           ROOT  ( < 0. INDICATES LEADING AND TRAILING EDGE INPUT)
         103-9.00
C           < 0. INDICATE PANEL SPACING IS EVEN.
         107-1.0
C       Y CORDINATES OF PANEL ENDS
         161  0.6640     0.9323
         172  3.2215
C       X CORDINATES OF LEADING  EDGE
         241  6.8072
         252 13.8333
C       X CORDINATES OF TRAILING EDGE
         281 13.983
         292 13.983
         292 13.983
C         =  1.0  LAST SURFACE HAS BEEN READ.
-          1 1.0
C         = -1.0  NO MORE CASES FOLLOW.
-          1-1.
```

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WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

INPUT DATA ARRAY

6	0.	2.00000	-1.00000	0.	2.00000
11	0.	0.	1.00000	0.	0.
16	0.	0.	0.	0.	3.00000
26	1.20000	0.	0.	0.	0.
31	0.	0.	0.	0.	6.00000
51	99.0000	99.0000	8.00000	8.00000	0.
61	41.0000	42.0000	41.0000	42.0000	0.
701	0.	8.00000	0.	0.	0.
706	-23.0000	0.	0.	0.	0.
711	1.00000	1.00000	1.00000	1.00000	2.900000E-03
716	0.	0.	0.	0.	4.00000
721	0.	22.5000	45.0000	67.5000	90.0000
801	0.	1.00000	1.09000	1.10000	1.20000
806	1.30000	1.40000	1.50000	2.00000	3.00000
811	4.00000	5.00000	6.00000	6.70000	6.75000
816	6.80000	6.81000	6.82000	11.1000	11.1500
821	11.2030	11.3000	11.5000	12.0000	12.5000
826	13.0000	13.5000	13.9830	14.1000	14.2000
831	14.3000	14.4000	14.5000	14.6000	14.7000
836	14.8000	16.9360	0.	0.	0.
851	6.18390	0.	0.	0.	0.
861	0.	14.0775	0.	0.	0.
901	0.	.250501	.265452	.267113	.283416
906	.299132	.314302	.328960	.395480	.501051
911	.577263	.628500	.656942	.663870	.663961
916	.663599	.664000	.664000	.664000	.664000
921	.664000	.663791	.662036	.649816	.626208
926	.590771	.542754	.483287	.466763	.451935
931	.436431	.420224	.403653	.387083	.370513
936	.353943	0.	0.	0.	0.
1001	0.	.750000	1.25000	0.	0.
1031	0.	15.7500	16.2500	16.9360	0.
1101	1.00000	1.50000	2.00000	0.	0.
1131	16.0000	16.5000	0.	0.	0.

WING

1	1.00000	10.0000	11.0000	0.	0.
86	0.	0.	0.	5.000000E-02	-1.00000
101	0.	0.	-9.00000	0.	0.
106	0.	-1.00000	0.	0.	0.
161	.664000	.932300	0.	0.	0.
171	0.	3.22150	0.	0.	0.
241	6.80720	0.	0.	0.	0.
251	0.	13.8333	0.	0.	0.
281	13.9830	0.	0.	0.	0.
291	0.	13.9830	0.	0.	0.

CALL LINEAR MMAX = 40

WING

BICONVEX AIRFOIL

THICKNESS DISTRIBUTION   T/C = .0500

Z = T * (C0*SQRT(X) + C1*X   + C2*X**2 + C3*X**3+ C4*X**4)

0.00000   2.00000   -2.00000   0.00000   0.00000

X	W	Z	DWDX
0.00000	.09500		
.05000	.09000	.00475	-.20000
.10000	.08000		
.15000	.07000	.01275	-.20000
.20000	.06000		
.25000	.05000	.01875	-.20000
.30000	.04000		
.35000	.03000	.02275	-.20000
.40000	.02000		
.45000	.01000	.02475	-.20000
.50000	0.00000		
.55000	-.01000	.02475	-.20000
.60000	-.02000		
.65000	-.03000	.02275	-.20000
.70000	-.04000		
.75000	-.05000	.01875	-.20000
.80000	-.06000		
.85000	-.07000	.01275	-.20000
.90000	-.08000		
.95000	-.09000	.00475	-.20000
1.00000	-.10000	0.00000	
0.00000	.10000		

```
MAX    =  70000    (TOTAL A ARRAY SIZE)

IREQ   =  34476    (TOTAL A ARRAY REQUIRED FOR THIS RUN)

IJMAX  =  35525    (TOTAL A ARRAY LEFT AFTER ALLOCATIONS)

EXTRA  =  35525    (EXTRA SPACE IN A ARRAY)

IXTRA2 =  67417    (EXTRA SPACE IF AN INVERSE IS USED)
IXTRAO =  58105    (EXTRA SPACE IF AN INVERSE IS NOT USED)
IXTRAX =  58105    (EXTRA SPACE BASED ON SOLUTION)

NAA    =  25642    (SPACE WHICH CAN BE REMOVED FOR SOLUTION)
MTX    =  10905    (SPACE REQUIRED FOR MATRIX SOLUTION)

       5  = NB    =  NUMBER OF SETS OF SOLUTIONS
       1  = NS    =  NUMBER OF VORTEX PANEL SECTIONS
      11  = NST   =  NUMBER OF VORTEX SPAN STATIONS
     198  = NTP   =  NUMBER OF PANELS
     110  = NTV   =  NUMBER OF VORTEX PANELS
      88  = NTB   =  NUMBER OF BODY PANELS
     132  = NTS   =  NUMBER OF SOURCE PARAMETERS
       0  = NTL   =  NUMBER OF VORTEX SHELL PANELS
       0  = NSTL  =  NUMBER OF VORTEX SHELL SPAN STATIONS
       0  = NSL   =  NUMBER OF VORTEX SHELL SECTIONS
      11  = NSTS  =  NUMBER OF SOURCE SPAN STATIONS
       0  = NBDY  =  NUMBER OF BODY SEGMENTS
       9  = KKX
       0  = KKY
   63789  = K

        IJ1 =  63789    1 + MAX - IJ1 =   6212     I1 =  57381
        IJ2 =  52279          IJ1 - IJ2 =  11510     I2 =  57731
        IJ3 =  50299          IJ2 - IJ3 =   1980     I3 =  58081
        IJ4 =  45349          IJ3 - IJ4 =   4950     I4 =  58431
        IJ5 =  44359          IJ4 - IJ5 =    990     I5 =  58781
        IJ6 =  44018          IJ5 - IJ6 =    341     I6 =  59131
        IJ7 =  37506          IJ6 - IJ7 =   6512     I7 =  59481
        IJ8 =  35526          IJ7 - IJ8 =   1980     I8 =  59831
        IJX =  66011                NTK =      0     I0 =  57031
        IJY =  69011                 J1 =  52279     J2 =  53269
        IJZ =      0                 J3 =  55051     J4 =  56041

          NUMBER OF DIMENSIONS FOR THE ARRAYS
      11  = NSTC =  NUMBER OF VORTEX SPAN STATIONS
     198  = NTPC =  NUMBER OF PANELS
     110  = NTVC =  NUMBER OF VORTEX PANELS
      88  = NTBC =  NUMBER OF BODY PANELS
     132  = NTSC =  NUMBER OF SOURCE PARAMETERS

SREF  =      18.73497
SPAN  =       6.44300
```

```
CBAR   =      2.90780
MACH   =      6.00000
BETA2  =    -35.00000
BETA   =      5.91608
XCG    =      0.00000
CAVG   =      2.90780
SYM    =      0.00000

  110  =  NUMBER OF PANELS
    1  =  NUMBER OF SURFACES
   11  =  NUMBER OF SPAN STATIONS
    1  =  NUMBER OF VORTEX PANEL SECTIONS

    IA = 11
    IB = 10
    IV =  9
    IT =  8
    IE = 15

          IVTX   =   T
          ITHK   =   T
          IBDY   =   T
          IAXX   =   T

          AAPAS =   F
```

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WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

SURFACE NUMBER 1 WING

J	Y	Z	XLE	XTE	SWP-LE	SWP-TE	SIN	CHORD	TWIST	X/C	NC	IJ0	IS
	.664	0.000	6.807	13.983				7.176					
1	.796	0.000	7.169	13.983	69.998	0.000	0.00000	6.814	0.00000	E	10	1	1
	.932	0.000	7.544	13.983				6.439					
2	1.045	0.000	7.853	13.983	69.998	0.000	0.00000	6.130	0.00000	E	10	11	1
	1.161	0.000	8.173	13.983				5.810					
3	1.273	0.000	8.482	13.983	69.998	0.000	0.00000	5.501	0.00000	E	10	21	1
	1.390	0.000	8.802	13.983				5.181					
4	1.502	0.000	9.110	13.983	69.998	0.000	0.00000	4.873	0.00000	E	10	31	1
	1.619	0.000	9.431	13.983				4.552					
5	1.731	0.000	9.738	13.983	69.998	0.000	0.00000	4.245	0.00000	E	10	41	1
	1.848	0.000	10.060	13.983				3.923					
6	1.959	0.000	10.365	13.983	69.998	0.000	0.00000	3.618	0.00000	E	10	51	1
	2.077	0.000	10.689	13.983				3.294					
7	2.187	0.000	10.992	13.983	69.998	0.000	0.00000	2.991	0.00000	E	10	61	1
	2.306	0.000	11.318	13.983				2.665					
8	2.415	0.000	11.618	13.983	69.998	0.000	0.00000	2.365	0.00000	E	10	71	1
	2.535	0.000	11.947	13.983				2.036					
9	2.642	0.000	12.242	13.983	69.998	0.000	0.00000	1.741	0.00000	E	10	81	1
	2.764	0.000	12.575	13.983				1.408					
10	2.867	0.000	12.860	13.983	69.998	0.000	0.00000	1.123	0.00000	E	10	91	1
	2.993	0.000	13.204	13.983				.779					
11	3.081	0.000	13.448	13.983	69.998	0.000	0.00000	.535	0.00000	E	10	101	1
	3.222	0.000	13.833	13.983				.150					

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BODY SEGMENT NUMBER 1

X	6.1839		6.9015		7.6191		8.3367	
	Y	Z	Y	Z	Y	Z	Y	Z
1	0.0000	.6598	0.0000	.6640	0.0000	.6640	0.0000	.6640
2	.2525	.6096	.2541	.6135	.2541	.6135	.2541	.6135
3	.4665	.4665	.4695	.4695	.4695	.4695	.4695	.4695
4	.6096	.2525	.6135	.2541	.6135	.2541	.6135	.2541
5	.6598	0.0000	.6640	0.0000	.6640	0.0000	.6640	0.0000
6	.6096	-.2525	.6135	-.2541	.6135	-.2541	.6135	-.2541
7	.4665	-.4665	.4695	-.4695	.4695	-.4695	.4695	-.4695
8	.2525	-.6096	.2541	-.6135	.2541	-.6135	.2541	-.6135
9	0.0000	-.6598	0.0000	-.6640	0.0000	-.6640	0.0000	-.6640

X	9.0543		9.7719		10.4895		11.2071	
	Y	Z	Y	Z	Y	Z	Y	Z
1	0.0000	.6640	0.0000	.6640	0.0000	.6640	0.0000	.6640
2	.2541	.6135	.2541	.6135	.2541	.6135	.2541	.6135
3	.4695	.4695	.4695	.4695	.4695	.4695	.4695	.4695
4	.6135	.2541	.6135	.2541	.6135	.2541	.6135	.2541
5	.6640	0.0000	.6640	0.0000	.6640	0.0000	.6640	0.0000
6	.6135	-.2541	.6135	-.2541	.6135	-.2541	.6135	-.2541
7	.4695	-.4695	.4695	-.4695	.4695	-.4695	.4695	-.4695
8	.2541	-.6135	.2541	-.6135	.2541	-.6135	.2541	-.6135
9	0.0000	-.6640	0.0000	-.6640	0.0000	-.6640	0.0000	-.6640

X	11.9247		12.6423		13.3599		14.0775	
	Y	Z	Y	Z	Y	Z	Y	Z
1	0.0000	.6524	0.0000	.6174	0.0000	.5575	0.0000	.4700
2	.2497	.6027	.2363	.5704	.2134	.5151	.1799	.4342
3	.4613	.4613	.4365	.4365	.3942	.3942	.3323	.3323
4	.6027	.2497	.5704	.2363	.5151	.2134	.4342	.1799
5	.6524	0.0000	.6174	0.0000	.5575	0.0000	.4700	0.0000
6	.6027	-.2497	.5704	-.2363	.5151	-.2134	.4342	-.1799
7	.4613	-.4613	.4365	-.4365	.3942	-.3942	.3323	-.3323
8	.2497	-.6027	.2363	-.5704	.2134	-.5151	.1799	-.4342
9	0.0000	-.6524	0.0000	-.6174	0.0000	-.5575	0.0000	-.4700

BODY ALONE SOLUTION USING AXIS SINGULARITIES

```
NXP1   =   34
NX     =   33
NXM1   =   32
NXM2   =   31

NTGX   =   37
NC     =   32

NUKS   =   33
NUKD   =   32
NUKDX  =   32

ALPHA  =     57.296
MACH   =      6.000
XREF   =      2.908
SREF   =     18.735
BETA2  =    -35.000
BETA   =      5.916
```

ORIGINAL PAGE IS
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INTEGRATION OF FORCES FROM 0.00000 TO 1.09444

X	R	THETA	CP	F(S)	CNA	T	S*F'(S)/2	CLBX	CDBX	CXBX
.05472	.12687	35.640	.71595	2.10862	1.37671	.71699	-.02417	.00460	.00239	.00009
.16417	.16457	8.822	.05288	2.24831	2.17183	.15520	-.02417	.00663	.00244	.00020
.27361	.17494	3.390	.00421	1.20473	3.06130	.05924	1.86731	.00780	.00244	.00031
.38305	.18053	2.874	.00106	.42176	3.35780	.05020	2.94450	.00891	.00244	.00046
.49250	.18690	3.933	.00778	1.65372	2.84061	.06875	1.20032	.01025	.00245	.00069
.60194	.19586	5.459	.01928	2.12998	2.47883	.09557	.37149	.01196	.00246	.00104
.71139	.20781	6.969	.03291	2.23554	2.29716	.12224	.09595	.01410	.00249	.00156
.82083	.22246	8.218	.04597	2.24999	2.20547	.14442	.00147	.01670	.00254	.00230
.93028	.23917	9.069	.05582	2.24676	2.15950	.15962	-.03224	.01973	.00262	.00326
1.03972	.25708	9.442	.06039	2.24377	2.14222	.16631	-.04230	.02309	.00272	.00447

A CONICAL NOSE EXTENSION HAS BEEN ADDED TO THE BODY GEOMETRY AT DRDX = .166131 I = 2

I	X	R	DRDX	X-OLD	R-OLD	DR/DX-OLD	CP0	CP1
1	-.50785	0.00000	.16587	0.00000	0.00000	.40440	.30074	-1.45400
2	.69387	.19964	.16620	1.00000	.25050	.16677	.06071	-.71415
3	1.09444	.26619	.16604	1.09000	.26545	.16604	.06020	-.71160
4	1.10000	.26711	.16591	1.10000	.26711	.16596	.06015	-.71133
5	1.20000	.28342	.16013	1.20000	.28342	.16016	.05619	-.69128
6	1.30000	.29913	.15436	1.30000	.29913	.15436	.05233	-.67124
7	1.40000	.31430	.14908	1.40000	.31430	.14908	.04891	-.65305
8	1.50000	.32896	.14411	1.50000	.32896	.14411	.04577	-.63595
9	2.00000	.39548	.12255	2.00000	.39548	.12255	.03309	-.56266
10	3.00000	.50105	.08944	3.00000	.50105	.08944	.01646	-.45425
11	4.00000	.57726	.06299	4.00000	.57726	.06299	.00559	-.37359
12	5.00000	.62850	.03948	5.00000	.62850	.03948	-.00239	-.30805
13	6.00000	.65694	.01741	6.00000	.65694	.01741	-.00856	-.25302
14	6.70000	.66387	.00236	6.70000	.66387	.00236	-.01212	-.21947
15	6.75000	.66396	.00129	6.75000	.66396	.00129	-.01235	-.21722
16	6.80000	.66400	.00021	6.80000	.66400	.00021	-.01258	-.21496
17	6.81000	.66400	.00004	6.81000	.66400	.00004	-.01262	-.21460
18	6.82000	.66400	-.00005	6.82000	.66400	-.00005	-.01264	-.21441
19	11.10000	.66400	.00000	11.10000	.66400	.00000	-.01263	-.03125
20	11.15000	.66400	-.00000	11.15000	.66400	-.00000	-.01263	-.26566
21	11.20300	.66400	-.00039	11.20300	.66400	-.00039	-.01271	-.21370
22	11.30000	.66379	-.00388	11.30000	.66379	-.00388	-.01344	-.20656
23	11.50000	.66204	-.01324	11.50000	.66204	-.01324	-.01529	-.18826
24	12.00000	.64982	-.03575	12.00000	.64982	-.03575	-.01907	-.14958
25	12.50000	.62621	-.05890	12.50000	.62621	-.05890	-.02214	-.11723
26	13.00000	.59077	-.08320	13.00000	.59077	-.08320	-.02464	-.09048
27	13.50000	.54275	-.10942	13.50000	.54275	-.10942	-.02669	-.06853
28	13.98300	.48329	-.13756	13.98300	.48329	-.13756	-.02834	-.05120
29	14.10000	.46676	-.14499	14.10000	.46676	-.14499	-.02870	-.04749
30	14.20000	.45194	-.15162	14.20000	.45194	-.15162	-.02900	-.04444
31	14.30000	.43643	-.15851	14.30000	.43643	-.15851	-.02929	-.04151
32	14.40000	.42022	-.16446	14.40000	.42022	-.16446	-.02952	-.03916
33	14.50000	.40365	-.16631	14.50000	.40365	-.16631	-.02959	-.03845
34	14.60000	.38708	-.16570	14.60000	.38708	-.16570	-.02957	-.03869
35	14.70000	.37051	-.16570	14.70000	.37051	-.16570	-.02957	-.03868
36	14.80000	.35394	-.16570	14.80000	.35394	-.16570	-.02957	-.03868
37	16.93600	0.00000	-.16571	16.93600	0.00000	-.16571	-.02957	-.03868

BODY GEOMETRY DERIVATIVES

I	X	R	DR/DX	DR/DX	DR/DX	DR/DX	RXX	RXX	RXX	RXX
1	-.5079	0.0000	.1659	0.0000	0.0000	0.0000	.0008	0.0000	0.0000	0.0000
2	.6939	.1996	-122.2682	.1662	0.0000	0.0000	1742.9088	-.0002	0.0000	0.0000
3	1.0944	.2662	.1662	1.3435	-102.2281	0.0000	-.0562	-23.8944	-.0005	0.0000
4	1.1000	.2671	.1661	.1659	.1659	223.1528	-.0628	-.0563	24.1341	.0471
5	1.2000	.2834	.1600	.1600	.1601	57.3940	-.0580	-.0587	-.0587	45.3312
6	1.3000	.2991	.1543	.1544	.1544	.1541	-.0538	-.0546	-.0546	-.0611
7	1.4000	.3143	.1490	.1491	.1491	.1491	-.0489	-.0512	-.0512	-.0505
8	1.5000	.3290	.1433	.1442	.1441	.1441	-.0424	-.0473	-.0486	-.0478
9	2.0000	.3955	.1217	.1232	.1226	.1231	-.0337	-.0381	-.0393	-.0356
10	3.0000	.5011	.0894	.0902	.0894	.0912	-.0272	-.0294	-.0294	-.0233
11	4.0000	.5773	.0630	.0634	.0630	.0644	-.0239	-.0250	-.0250	-.0206
12	5.0000	.6285	.0395	.0397	.0395	.0402	-.0222	-.0228	-.0228	-.0206
13	6.0000	.6569	.0175	.0175	.0174	.0178	-.0222	-.0218	-.0217	-.0206
14	6.7000	.6639	.0023	.0024	.0024	.0025	-.0201	-.0213	-.0214	-.0209
15	6.7500	.6640	.0016	.0013	.0013	.0013	-.0409	-.0212	-.0212	-.0214
16	6.8000	.6640	.0002	.0002	.0002	.0002	-.0101	-.0151	-.0223	-.0211
17	6.8100	.6640	.0000	.0000	.0000	-.0000	.0000	-.0100	-.0100	-.0225
18	6.8200	.6640	-.0000	.0000	-.0000	-.0000	.0000	.0000	-.0099	-.0049
19	11.1000	.6640	-.0004	.0000	.0000	.0214	.0220	-.0000	.0000	.0199
20	11.1500	.6640	.0006	.0002	-.0000	.0000	-.0195	.0004	-.0000	.0000
21	11.2030	.6640	.0000	-.0006	-.0004	.0000	-.0445	-.0267	-.0224	.0000
22	11.3000	.6638	-.0043	-.0043	-.0039	-.0046	-.0442	-.0446	-.0399	-.0642
23	11.5000	.6620	-.0133	-.0132	-.0132	-.0146	-.0438	-.0446	-.0447	-.0671
24	12.0000	.6498	-.0359	-.0357	-.0357	-.0357	-.0443	-.0456	-.0456	-.0450
25	12.5000	.6262	-.0591	-.0588	-.0589	-.0588	-.0455	-.0473	-.0473	-.0465
26	13.0000	.5908	-.0834	-.0831	-.0832	-.0830	-.0480	-.0503	-.0503	-.0491
27	13.5000	.5428	-.1095	-.1092	-.1094	-.1091	-.0533	-.0552	-.0552	-.0533
28	13.9830	.4833	-.1375	-.1375	-.1376	-.1372	-.0622	-.0628	-.0621	-.0598
29	14.1000	.4668	-.1450	-.1450	-.1450	-.1449	-.0649	-.0651	-.0651	-.0638
30	14.2000	.4519	-.1504	-.1516	-.1516	-.1516	-.1042	-.0676	-.0676	-.0671
31	14.3000	.4364	-.1590	-.1591	-.1585	-.1585	-.0729	-.0703	-.0703	-.0701
32	14.4000	.4202	-.1657	-.1645	-.1645	-.1657	.0002	-.0364	-.0364	-.0730
33	14.5000	.4037	-.1657	-.1657	-.1663	-.1664	-.0000	.0001	.0001	-.0025
34	14.6000	.3871	-.1657	-.1657	-.1657	-.1645	.0000	-.0000	-.0000	.0366
35	14.7000	.3705	0.0000	-.1657	-.1657	-.1657	0.0000	.0000	.0000	-.0001
36	14.8000	.3539	0.0000	0.0000	-.1657	-.1657	0.0000	0.0000	-.0000	.0000
37	16.9360	0.0000	0.0000	0.0000	0.0000	-.1657	0.0000	0.0000	0.0000	-.0000

MAX = 35291
EXTRA = 31508

SINGULARITY NUMBER 32 IS A LINEAR SOURCE STARTING AT X = -.508

SINGULARITY NUMBER 31 IS A QUADRATIC DOUBLET STARTING AT X = -.508

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

VELOCITIES OF ORDER 1 ALPHA = 1.000 DEGREES ADD LOAD

CP = ((1-0.2*M*M*(2U+U*U+V*V+W*W+2A*W))**(G/(G-1)) - 1) / (0.5*G*M*M)

		THETA	0.000	22.500	45.000	67.500	90.000
	X	R	CP	CP	CP	CP	CP
	-.5079	0.0000					
1	1.0000	.2505	-.00798	-.00743	-.00580	-.00324	-.00001
2	1.5000	.3290	-.00798	-.00743	-.00581	-.00326	-.00003
3	2.0000	.3955	-.00758	-.00707	-.00554	-.00313	-.00006
4	2.5000	.4525	-.00712	-.00664	-.00523	-.00297	-.00010
5	3.0000	.5011	-.00663	-.00619	-.00489	-.00281	-.00014
6	3.5000	.5426	-.00614	-.00574	-.00456	-.00265	-.00018
7	4.0000	.5773	-.00565	-.00529	-.00422	-.00248	-.00022
8	4.5000	.6059	-.00516	-.00484	-.00389	-.00233	-.00027
9	5.0000	.6285	-.00468	-.00440	-.00356	-.00217	-.00031
10	5.5000	.6455	-.00420	-.00396	-.00323	-.00201	-.00035
11	6.0000	.6569	-.00372	-.00352	-.00291	-.00185	-.00039
12	6.5000	.6630	-.00325	-.00309	-.00258	-.00170	-.00043
13	7.0000	.6640	-.00284	-.00272	-.00232	-.00158	-.00049
14	7.5000	.6640	-.00257	-.00247	-.00215	-.00153	-.00056
15	8.0000	.6640	-.00229	-.00223	-.00199	-.00148	-.00062
16	8.5000	.6640	-.00203	-.00200	-.00184	-.00143	-.00069
17	9.0000	.6640	-.00178	-.00177	-.00169	-.00138	-.00074
18	9.5000	.6640	-.00155	-.00156	-.00155	-.00134	-.00080
19	10.0000	.6640	-.00132	-.00136	-.00141	-.00129	-.00084
20	10.5000	.6640	-.00111	-.00118	-.00129	-.00125	-.00089
21	11.0000	.6640	-.00092	-.00100	-.00117	-.00120	-.00092
22	11.5000	.6620	-.00065	-.00075	-.00096	-.00106	-.00088
23	12.0000	.6498	-.00028	-.00039	-.00065	-.00085	-.00081
24	12.5000	.6262	.00013	-.00000	-.00032	-.00063	-.00074
25	13.0000	.5908	.00055	.00039	.00001	-.00042	-.00068
26	13.5000	.5428	.00094	.00076	.00031	-.00021	-.00061
27	14.0000	.4809	.00127	.00107	.00057	-.00004	-.00054
28	14.5000	.4037	.00179	.00154	.00089	.00013	-.00052
29	15.0000	.3208	.00470	.00406	.00247	.00057	-.00105
30	15.5000	.2380	.01195	.01041	.00653	.00194	-.00201
31	16.0000	.1551	.03138	.02769	.01830	.00694	-.00317
32	16.5000	.0722	.05790	.05252	.03804	.01856	-.00135

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

VELOCITIES OF ORDER 1 ALPHA = 1.000 DEGREES ADD LOAD

CP = ((1-0.2*M*M*(2U+U*U+V*V+W*W+2A*W))**(G/(G-1)) - 1) / (0.5*G*M*M)

	THETA		0.000	22.500	45.000	67.500	90.000
	X	R	CP	CP	CP	CP	CP
	-.5079	0.0000					
1	1.0000	.2505	-.00798	-.00743	-.00580	-.00324	-.00001
2	1.5000	.3290	-.00798	-.00743	-.00581	-.00326	-.00003
3	2.0000	.3955	-.00758	-.00707	-.00554	-.00313	-.00006
4	2.5000	.4525	-.00712	-.00664	-.00523	-.00297	-.00010
5	3.0000	.5011	-.00663	-.00619	-.00489	-.00281	-.00014
6	3.5000	.5426	-.00614	-.00574	-.00456	-.00265	-.00018
7	4.0000	.5773	-.00565	-.00529	-.00422	-.00248	-.00022
8	4.5000	.6059	-.00516	-.00484	-.00389	-.00233	-.00027
9	5.0000	.6285	-.00468	-.00440	-.00356	-.00217	-.00031
10	5.5000	.6455	-.00420	-.00396	-.00323	-.00201	-.00035
11	6.0000	.6569	-.00372	-.00352	-.00291	-.00185	-.00039
12	6.5000	.6630	-.00325	-.00309	-.00258	-.00170	-.00043
13	7.0000	.6640	-.00284	-.00272	-.00232	-.00158	-.00049
14	7.5000	.6640	-.00257	-.00247	-.00215	-.00153	-.00056
15	8.0000	.6640	-.00229	-.00223	-.00199	-.00148	-.00062
16	8.5000	.6640	-.00203	-.00200	-.00184	-.00143	-.00069
17	9.0000	.6640	-.00178	-.00177	-.00169	-.00138	-.00074
18	9.5000	.6640	-.00155	-.00156	-.00155	-.00134	-.00080
19	10.0000	.6640	-.00132	-.00136	-.00141	-.00129	-.00084
20	10.5000	.6640	-.00111	-.00118	-.00129	-.00125	-.00089
21	11.0000	.6640	-.00092	-.00100	-.00117	-.00120	-.00092
22	11.5000	.6620	-.00065	-.00075	-.00096	-.00106	-.00088
23	12.0000	.6498	-.00028	-.00039	-.00065	-.00085	-.00081
24	12.5000	.6262	.00013	-.00000	-.00032	-.00063	-.00074
25	13.0000	.5908	.00055	.00039	.00001	-.00042	-.00068
26	13.5000	.5428	.00094	.00076	.00031	-.00021	-.00061
27	14.0000	.4809	.00127	.00107	.00057	-.00004	-.00054
28	14.5000	.4037	.00179	.00154	.00089	.00013	-.00052
29	15.0000	.3208	.00470	.00406	.00247	.00057	-.00105
30	15.5000	.2380	.01195	.01041	.00653	.00194	-.00201
31	16.0000	.1551	.03138	.02769	.01830	.00694	-.00317
32	16.5000	.0722	.05790	.05252	.03804	.01856	-.00135

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

VELOCITIES OF ORDER 1 ALPHA = 8.000 DEGREES

CP = ((1-0.2*M*M*(2U+U*U+V*V+W*W+2A*W))**(G/(G-1)) - 1) / (0.5*G*M*M)

		THETA	0.000	22.500	45.000	67.500	90.000
	X	R	CP	CP	CP	CP	CP
	-.5079	0.0000					
1	1.0000	.2505	.00075	.00140	.00458	.01365	.03362
2	1.5000	.3290	.00018	.00071	.00355	.01222	.03187
3	2.0000	.3955	-.00120	-.00096	.00111	.00855	.02652
4	2.5000	.4525	-.00270	-.00280	-.00166	.00436	.02038
5	3.0000	.5011	-.00427	-.00473	-.00457	-.00003	.01394
6	3.5000	.5426	-.00563	-.00648	-.00731	-.00419	.00781
7	4.0000	.5773	-.00700	-.00824	-.01005	-.00831	.00177
8	4.5000	.6059	-.00818	-.00983	-.01261	-.01216	-.00389
9	5.0000	.6285	-.00930	-.01138	-.01512	-.01588	-.00932
10	5.5000	.6455	-.01024	-.01277	-.01748	-.01935	-.01437
11	6.0000	.6569	-.01107	-.01408	-.01977	-.02264	-.01909
12	6.5000	.6630	-.01171	-.01525	-.02192	-.02568	-.02341
13	7.0000	.6640	-.01109	-.01534	-.02323	-.02789	-.02667
14	7.5000	.6640	-.00861	-.01379	-.02328	-.02896	-.02852
15	8.0000	.6640	-.00613	-.01225	-.02331	-.02989	-.03009
16	8.5000	.6640	-.00368	-.01075	-.02334	-.03070	-.03139
17	9.0000	.6640	-.00126	-.00928	-.02334	-.03139	-.03247
18	9.5000	.6640	.00108	-.00786	-.02331	-.03198	-.03336
19	10.0000	.6640	.00335	-.00648	-.02327	-.03247	-.03408
20	10.5000	.6640	.00553	-.00515	-.02319	-.03287	-.03467
21	11.0000	.6640	.00757	-.00391	-.02310	-.03321	-.03516
22	11.5000	.6620	.00464	-.00675	-.02535	-.03468	-.03646
23	12.0000	.6498	-.00066	-.01174	-.02901	-.03678	-.03815
24	12.5000	.6262	-.00464	-.01591	-.03225	-.03839	-.03924
25	13.0000	.5908	-.00715	-.01919	-.03496	-.03935	-.03965
26	13.5000	.5428	-.00761	-.02140	-.03706	-.03967	-.03968
27	14.0000	.4809	-.00430	-.02199	-.03850	-.03968	-.03968
28	14.5000	.4037	.01365	-.01624	-.03912	-.03968	-.03968
29	15.0000	.3208	.10567	.02525	-.03795	-.03968	-.03968
30	15.5000	.2380	.35840	.14904	-.03179	-.03968	-.03968
31	16.0000	.1551	1.07258	.59735	.04379	-.03967	-.03968
32	16.5000	.0722	1.21780	.98895	.51205	.13988	-.01129

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

VELOCITIES OF ORDER 1 ALPHA = 8.000 DEGREES

CP = ((1-0.2*M*M*(2U+U*U+V*V+W*W+2A*W))**(G/(G-1)) - 1) / (0.5*G*M*M)

		THETA	0.000	22.500	45.000	67.500	90.000
	X	R	CP	CP	CP	CP	CP
	-.5079	0.0000					
1	1.0000	.2505	.00075	.00140	.00458	.01365	.03362
2	1.5000	.3290	.00018	.00071	.00355	.01222	.03187
3	2.0000	.3955	-.00120	-.00096	.00111	.00855	.02652
4	2.5000	.4525	-.00270	-.00280	-.00166	.00436	.02038
5	3.0000	.5011	-.00427	-.00473	-.00457	-.00003	.01394
6	3.5000	.5426	-.00563	-.00648	-.00731	-.00419	.00781
7	4.0000	.5773	-.00700	-.00824	-.01005	-.00831	.00177
8	4.5000	.6059	-.00818	-.00983	-.01261	-.01216	-.00389
9	5.0000	.6285	-.00930	-.01138	-.01512	-.01588	-.00932
10	5.5000	.6455	-.01024	-.01277	-.01748	-.01935	-.01437
11	6.0000	.6569	-.01107	-.01408	-.01977	-.02264	-.01909
12	6.5000	.6630	-.01171	-.01525	-.02192	-.02568	-.02341
13	7.0000	.6640	-.01109	-.01534	-.02323	-.02789	-.02667
14	7.5000	.6640	-.00861	-.01379	-.02328	-.02896	-.02852
15	8.0000	.6640	-.00613	-.01225	-.02331	-.02989	-.03009
16	8.5000	.6640	-.00368	-.01075	-.02334	-.03070	-.03139
17	9.0000	.6640	-.00126	-.00928	-.02334	-.03139	-.03247
18	9.5000	.6640	.00108	-.00786	-.02331	-.03198	-.03336
19	10.0000	.6640	.00335	-.00648	-.02327	-.03247	-.03408
20	10.5000	.6640	.00553	-.00515	-.02319	-.03287	-.03467
21	11.0000	.6640	.00757	-.00391	-.02310	-.03321	-.03516
22	11.5000	.6620	.00464	-.00675	-.02535	-.03468	-.03646
23	12.0000	.6498	-.00066	-.01174	-.02901	-.03678	-.03815
24	12.5000	.6262	-.00464	-.01591	-.03225	-.03839	-.03924
25	13.0000	.5908	-.00715	-.01919	-.03496	-.03935	-.03965
26	13.5000	.5428	-.00761	-.02140	-.03706	-.03967	-.03968
27	14.0000	.4809	-.00430	-.02199	-.03850	-.03968	-.03968
28	14.5000	.4037	.01365	-.01624	-.03912	-.03968	-.03968
29	15.0000	.3208	.10567	.02525	-.03795	-.03968	-.03968
30	15.5000	.2380	.35840	.14904	-.03179	-.03968	-.03968
31	16.0000	.1551	1.07258	.59735	.04379	-.03967	-.03968
32	16.5000	.0722	1.21780	.98895	.51205	.13988	-.01129

THE VALUES OF VN AXIS-SOURCE 1ST ARE = 0.0 ON ALL LIFTING SURFACES

VN AXIS-SOURCE 1ST

X	6.5427	7.2603	7.9779	8.6955	9.4131
J					
1.000	.0045	.0002	.0001	.0002	.0001
2.000	.0045	.0002	.0001	.0002	.0001
3.000	.0045	.0002	.0001	.0002	.0001
4.000	.0045	.0002	.0001	.0002	.0001
5.000	.0045	.0002	.0001	.0002	.0001
6.000	.0045	.0002	.0001	.0002	.0001
7.000	.0045	.0002	.0001	.0002	.0001
8.000	.0045	.0002	.0001	.0002	.0001

X	10.1307	10.8483	11.5659	12.2835	13.0011	13.7187
J						
1.000	-.0005	.0011	-.0197	-.0524	-.0865	-.1239
2.000	-.0005	.0011	-.0197	-.0524	-.0865	-.1239
3.000	-.0005	.0011	-.0197	-.0524	-.0865	-.1239
4.000	-.0005	.0011	-.0197	-.0524	-.0865	-.1239
5.000	-.0005	.0011	-.0197	-.0524	-.0865	-.1239
6.000	-.0005	.0011	-.0197	-.0524	-.0865	-.1239
7.000	-.0005	.0011	-.0197	-.0524	-.0865	-.1239
8.000	-.0005	.0011	-.0197	-.0524	-.0865	-.1239

VN AXIS-DOUBLET

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.48558	.25048	.13524	.06353	.01603
.150	.55424	.29714	.17003	.08979	.03531
.250	.61294	.33794	.20177	.11459	.05430
.350	.66251	.37303	.23003	.13765	.07259
.450	.70379	.40288	.25469	.15872	.08995
.550	.73762	.42795	.27597	.17757	.10621
.650	.76479	.44869	.29412	.19419	.12127
.750	.78557	.46555	.30943	.20868	.13499
.850	.79633	.47893	.32216	.22121	.14730
.950	.79290	.48909	.33255	.23193	.15824

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
.150	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
.250	.01124	0.00000	0.00000	0.00000	0.00000	0.00000
.350	.02484	0.00000	0.00000	0.00000	0.00000	0.00000
.450	.03835	.00030	0.00000	0.00000	0.00000	0.00000
.550	.05150	.00933	0.00000	0.00000	0.00000	0.00000
.650	.06414	.01884	0.00000	0.00000	0.00000	0.00000
.750	.07617	.02833	0.00000	0.00000	0.00000	0.00000
.850	.08752	.03764	0.00000	0.00000	0.00000	0.00000
.950	.09813	.04669	.00418	0.00000	0.00000	0.00000

VN AXIS-DOUBLET

X	6.5427	7.2603	7.9779	8.6955	9.4131
J					
1.000	-1.0055	-1.0049	-1.0076	-1.0097	-1.0118
2.000	-.8524	-.8519	-.8542	-.8560	-.8577
3.000	-.5696	-.5692	-.5708	-.5719	-.5731
4.000	-.2000	-.1999	-.2004	-.2008	-.2013
5.000	.2000	.1999	.2004	.2008	.2013
6.000	.5696	.5692	.5708	.5719	.5731
7.000	.8524	.8519	.8542	.8560	.8577
8.000	1.0055	1.0049	1.0076	1.0097	1.0118

X	10.1307	10.8483	11.5659	12.2835	13.0011	13.7187
J						
1.000	-1.0136	-1.0149	-1.0206	-1.0174	-1.0157	-1.0180
2.000	-.8593	-.8604	-.8652	-.8625	-.8611	-.8630
3.000	-.5742	-.5749	-.5781	-.5763	-.5753	-.5767
4.000	-.2016	-.2019	-.2030	-.2024	-.2020	-.2025
5.000	.2016	.2019	.2030	.2024	.2020	.2025
6.000	.5742	.5749	.5781	.5763	.5753	.5767
7.000	.8593	.8604	.8652	.8625	.8611	.8630
8.000	1.0136	1.0149	1.0206	1.0174	1.0157	1.0180

CONSTANT VORTEX PANELS

SURFACE NUMBER 1 WAS EXTENDED TO Y = 0. THE PANEL SWEEP ANGLES WERE CHANGED IN SIGN.

SPANWISE AND CHORDWISE LINEARLY VARYING SOURCE PANELS. NONZERO LEADING AND TRAILING EDGE STRENGTHS.

SURFACE NUMBER 1 WAS EXTENDED TO Y = 0. THE PANEL SWEEP ANGLES WERE CHANGED IN SIGN.

VN DUE TO THICKNESS

X	6.5427	7.2603	7.9779	8.6955	9.4131
J					
1.000	0.0000	0.0000	0.0000	0.0000	0.0000
2.000	0.0000	0.0000	0.0000	0.0000	0.0000
3.000	0.0000	0.0000	0.0000	0.0000	.0245
4.000	0.0000	0.0000	.0101	.0115	.0097
5.000	0.0000	0.0000	.0101	.0115	.0097
6.000	0.0000	0.0000	0.0000	0.0000	.0245
7.000	0.0000	0.0000	0.0000	0.0000	0.0000
8.000	0.0000	0.0000	0.0000	0.0000	0.0000

X	10.1307	10.8483	11.5659	12.2835	13.0011	13.7187
J						
1.000	0.0000	0.0000	0.0000	.1592	.0405	-.0026
2.000	0.0000	.0421	.0398	.0294	.0409	-.0074
3.000	.0281	.0239	.0165	.0070	.0187	-.0094
4.000	.0068	.0033	-.0004	-.0038	.0130	.0063
5.000	.0068	.0033	-.0004	-.0038	.0130	.0063
6.000	.0281	.0239	.0165	.0070	.0187	-.0094
7.000	0.0000	.0421	.0398	.0294	.0409	-.0074
8.000	0.0000	0.0000	0.0000	.1592	.0405	-.0026

THE ABS VALUES OF THICKNESS VN AT XO ARE < 0.000005 ON ALL LIFTING SURFACES

THICKNESS VORTEX B.C

X	6.5427	7.2603	7.9779	8.6955	9.4131
J					
1.000	0.0000	0.0000	0.0000	0.0000	0.0000
2.000	0.0000	0.0000	0.0000	0.0000	0.0000
3.000	0.0000	0.0000	0.0000	0.0000	-.0245
4.000	0.0000	0.0000	-.0101	-.0115	-.0097
5.000	0.0000	0.0000	-.0101	-.0115	-.0097
6.000	0.0000	0.0000	0.0000	0.0000	-.0245
7.000	0.0000	0.0000	0.0000	0.0000	0.0000
8.000	0.0000	0.0000	0.0000	0.0000	0.0000

X	10.1307	10.8483	11.5659	12.2835	13.0011	13.7187
J						
1.000	0.0000	0.0000	0.0000	-.1592	-.0405	.0026
2.000	0.0000	-.0421	-.0398	-.0294	-.0409	.0074
3.000	-.0281	-.0239	-.0165	-.0070	-.0187	.0094
4.000	-.0068	-.0033	.0004	.0038	-.0130	-.0063
5.000	-.0068	-.0033	.0004	.0038	-.0130	-.0063
6.000	-.0281	-.0239	-.0165	-.0070	-.0187	.0094
7.000	0.0000	-.0421	-.0398	-.0294	-.0409	.0074
8.000	0.0000	0.0000	0.0000	-.1592	-.0405	.0026

THE ABS VALUES OF THICKNESS VORTEX B.C ARE < 0.000005 ON ALL LIFTING SURFACES

```
    K   =  10303
  MTX   =  10905
  MTXO  =  11895
  NAA   =  25642
 MAXOO  =  70000
   IS   =      2
  ISF   =      2
```

A 198 X 198 MATRIX WAS SOLVED WITH SUBROUTINE ORTHO .

THE MATRIX ROWS WERE READ FROM UNIT 9 .

THERE WERE 5 SETS OF RIGHT HAND SIDE VECTORS, AND COLUMN PIVOTING WAS PERFORMED.

SOLUTION TIME = 18.228 SECONDS

DELTA CP ADD LOAD

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.01911	.01683	.01520	.01419	.01354
.150	.01699	.01802	.01616	.01480	.01393
.250	.01455	.01720	.01712	.01549	.01438
.350	.01395	.01518	.01728	.01622	.01488
.450	.01415	.01424	.01622	.01684	.01540
.550	.01272	.01422	.01468	.01686	.01595
.650	.01126	.01358	.01420	.01607	.01645
.750	.01114	.01188	.01412	.01486	.01669
.850	.01208	.01076	.01336	.01426	.01640
.950	.01219	.01158	.01201	.01402	.01566

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.01332	.01332	.01332	.01332	.01332	.01332
.150	.01336	.01332	.01332	.01332	.01332	.01332
.250	.01359	.01333	.01332	.01332	.01332	.01332
.350	.01392	.01334	.01332	.01332	.01332	.01332
.450	.01429	.01340	.01332	.01332	.01332	.01332
.550	.01468	.01362	.01333	.01332	.01332	.01332
.650	.01508	.01390	.01333	.01332	.01332	.01332
.750	.01548	.01422	.01336	.01332	.01332	.01332
.850	.01589	.01455	.01341	.01332	.01332	.01332
.950	.01625	.01487	.01354	.01332	.01332	.01332

BODY ADD LOAD CP

X	6.5427	7.2603	7.9779	8.6955	9.4131
J					
1.000	.0001	.0001	.0001	.0001	.0001
2.000	.0001	.0001	.0001	.0001	.0001
3.000	.0001	.0001	.0001	.0001	.0023
4.000	.0000	.0000	.0009	.0012	.0013
5.000	-.0000	-.0000	-.0009	-.0012	-.0013
6.000	-.0001	-.0001	-.0001	-.0001	-.0023
7.000	-.0001	-.0001	-.0001	-.0001	-.0001
8.000	-.0001	-.0001	-.0001	-.0001	-.0001

X	10.1307	10.8483	11.5659	12.2835	13.0011	13.7187
J						
1.000	.0001	.0001	-.0000	.0187	.0075	.0081
2.000	.0000	.0038	.0048	.0054	.0119	.0043
3.000	.0031	.0032	.0036	.0040	.0058	.0056
4.000	.0014	.0013	.0013	.0012	.0006	.0001
5.000	-.0014	-.0013	-.0013	-.0012	-.0006	-.0001
6.000	-.0031	-.0032	-.0036	-.0040	-.0058	-.0056
7.000	-.0000	-.0038	-.0048	-.0054	-.0119	-.0043
8.000	-.0001	-.0001	.0000	-.0187	-.0075	-.0081

```
VTXDRG      CAVG =     2.9078

   11  110
   10   10   10   10   10   10   10   10   10   10
   10

VTXDRG      CAVG =     2.9078

   11  110
    1    1    1    1    1    1    1    1    1    1
    1
```

SURFACE NUMBER 1 WAS EXTENDED TO Y = 0. IN VTXDRG

THE PANEL SWEEP ANGLES WERE CHANGED IN SIGN. 3

CK2 ARRAY

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.60620	.60620	.60620	.60620	.60620
.150	.60620	.60620	.60620	.60620	.60620
.250	.60620	.60620	.60620	.60620	.60620
.350	.60620	.60620	.60620	.60620	.60620
.450	.60620	.60620	.60620	.60620	.60620
.550	.60620	.60620	.60620	.60620	.60620
.650	.60620	.60620	.60620	.60620	.60620
.750	.60620	.60620	.60620	.60620	.60620
.850	.60620	.60620	.60620	.60620	.60620
.950	.60620	.60620	.60620	.60620	.60620

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.60620	.60620	.60620	.60620	.60620	.60620
.150	.60620	.60620	.60620	.60620	.60620	.60620
.250	.60620	.60620	.60620	.60620	.60620	.60620
.350	.60620	.60620	.60620	.60620	.60620	.60620
.450	.60620	.60620	.60620	.60620	.60620	.60620
.550	.60620	.60620	.60620	.60620	.60620	.60620
.650	.60620	.60620	.60620	.60620	.60620	.60620
.750	.60620	.60620	.60620	.60620	.60620	.60620
.850	.60620	.60620	.60620	.60620	.60620	.60620
.950	.60620	.60620	.60620	.60620	.60620	.60620

A 198 X 198 MATRIX WAS SOLVED WITH SUBROUTINE ORTHO USING A PREVIOUSLY CREATED QUASI-INVERSE MATRIX.

THE MATRIX ROWS WERE READ FROM UNIT 11 .

THERE WERE 9 SETS OF RIGHT HAND SIDE VECTORS, AND COLUMN PIVOTING WAS PERFORMED.

SOLUTION TIME = 2.218 SECONDS

ALPHA = 1.000 DEGREES
ALPHAI = 1.000 DEGREES

NO CAMBER, NO THICKNESS
1ST ORDER AXIAL SOLUTION

ADD LOAD
41 0 0

DELTA CP TO ORDER 1

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.01911	.01683	.01520	.01419	.01354
.150	.01699	.01802	.01616	.01480	.01393
.250	.01455	.01720	.01712	.01549	.01438
.350	.01395	.01518	.01728	.01622	.01488
.450	.01415	.01424	.01622	.01684	.01540
.550	.01272	.01422	.01468	.01686	.01595
.650	.01126	.01358	.01420	.01607	.01645
.750	.01114	.01188	.01412	.01486	.01669
.850	.01208	.01076	.01336	.01426	.01640
.950	.01219	.01158	.01201	.01402	.01566

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.01332	.01332	.01332	.01332	.01332	.01332
.150	.01336	.01332	.01332	.01332	.01332	.01332
.250	.01359	.01333	.01332	.01332	.01332	.01332
.350	.01392	.01334	.01332	.01332	.01332	.01332
.450	.01429	.01340	.01332	.01332	.01332	.01332
.550	.01468	.01362	.01333	.01332	.01332	.01332
.650	.01508	.01390	.01333	.01332	.01332	.01332
.750	.01548	.01422	.01336	.01332	.01332	.01332
.850	.01589	.01455	.01341	.01332	.01332	.01332
.950	.01625	.01487	.01354	.01332	.01332	.01332

ALPHA = 1.000 DEGREES   NO CAMBER, NO THICKNESS   ADD LOAD
ALPHAI = 1.000 DEGREES   1ST ORDER AXIAL SOLUTION

CP = ISENTROPIC PRESSURE FORMULA

BODY U,V,W ORDER 1

X	6.5427	7.2603	7.9779	8.6955	9.4131
J					
1.000	-.0030	-.0026	-.0022	-.0018	-.0015
2.000	-.0027	-.0024	-.0021	-.0018	-.0015
3.000	-.0021	-.0019	-.0017	-.0014	-.0038
4.000	-.0011	-.0011	-.0059	-.0063	-.0061
5.000	.0002	.0000	.0071	.0078	.0074
6.000	.0017	.0013	.0010	.0005	.0043
7.000	.0030	.0025	.0021	.0018	.0014
8.000	.0038	.0032	.0028	.0024	.0020

X	10.1307	10.8483	11.5659	12.2835	13.0011	13.7187
J						
1.000	-.0012	-.0009	.0006	.0009	-.0010	.0005
2.000	-.0007	-.0018	-.0028	-.0030	.0014	-.0013
3.000	-.0046	-.0049	-.0039	-.0030	-.0025	-.0013
4.000	-.0054	-.0053	-.0047	-.0038	-.0026	-.0012
5.000	.0066	.0065	.0058	.0047	.0033	.0016
6.000	.0054	.0058	.0046	.0037	.0031	.0016
7.000	.0004	.0023	.0034	.0036	-.0010	.0017
8.000	.0017	.0014	-.0003	-.0008	.0014	-.0003

CLBX(1) =	.17596	CLBX(2) =	.17596
CDBX(1) =	.00385	CDBX(2) =	.00385
CXBX(1) =	.58585	CXBX(2) =	.58585
CLBB =	.00307	CDBB =	0.00000
CXBB =	.01022		

ORIGINAL PAGE IS
OF POOR QUALITY

NO CAMBER, NO THICKNESS   ORDER = 1   83/08/10   14.01

WBODY.DATA(M600) 1ST-AX   (10 X 11) (8 X 11)   VEL B.C. NEG   37X37

```
ANGLE OF ATTACK      =  1.00000  DEGREES   ADD LOAD
JET DEFLECTION ANGLE =  0.00000  DEGREES
THRUST COEFFICIENT   =  0.00000
MACH NUMBER          =  6.00000
```

SURFACE NUMBER 1   WING

	Y	CN	CN*C/CAVG	CT*C/CAVG	CDC/CAVG	XCP	TWIST	COS	CHORD
1	.796	.01380	.03234	0.000000	.00056	.45538	0.00000	1.00000	6.8139
2	1.045	.01434	.03022	0.000000	.00053	.45491	0.00000	1.00000	6.1296
3	1.273	.01502	.02841	0.000000	.00050	.47535	0.00000	1.00000	5.5014
4	1.502	.01534	.02571	0.000000	.00045	.49708	0.00000	1.00000	4.8732
5	1.731	.01530	.02234	0.000000	.00039	.51735	0.00000	1.00000	4.2453
6	1.959	.01455	.01810	0.000000	.00032	.51968	0.00000	1.00000	3.6178
7	2.187	.01374	.01413	0.000000	.00025	.51046	0.00000	1.00000	2.9908
8	2.415	.01328	.01080	0.000000	.00019	.50103	0.00000	1.00000	2.3649
9	2.642	.01318	.00789	0.000000	.00014	.50000	0.00000	1.00000	1.7411
10	2.867	.01297	.00501	0.000000	.00009	.50000	0.00000	1.00000	1.1232
11	3.081	.01156	.00213	0.000000	.00004	.50000	0.00000	1.00000	.5352

```
TOTAL (SURFACE)        .01440     0.000000     .00025     11.47829 = X-CP

                   0.00000 = CY                           0.00000 = Z-CP    0.00000
                    .00720 = CZ                           1.52691 = Y-CP    1.00000

                    .00720 = TOTAL FORCE COEFFICIENT (SURFACE)

                         CL          CT        CD(0)       X-CP
TOTAL CONFIGURATION    .01973     0.000000     .00034     9.98678
WITH VORTEX LIFT       .01973     0.000000                9.98678

      CD(0)        =   .00034      CD(VTX)        =   .00009
      CD(0)/CL**2  =   .86366      CD(VTX)/CL**2  =   .23880
      E(0)         =   .1663       E(VTX)         =   .6016

      ZERO SUCTION DRAG MINUS LEADING EDGE THRUST     RS  =  .250      MO = 0
      CD           =   .00034
      CD  / CL**2  =   .86366
```

```
CDW / CL**2  =        .62487   (WAVE DRAG DUE TO LIFT)
 E           =        .1663

VORTEX LIFT
 CD          =        .00034
 CD  / CL**2 =        .86366
 E           =        .1663
```

NO CAMBER, NO THICKNESS ORDER = 1 83/08/10 14.01

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

ANGLE OF ATTACK = 1.00000 DEGREES ADD LOAD
JET DEFLECTION ANGLE = 0.00000 DEGREES
THRUST COEFFICIENT = 0.00000
MACH NUMBER = 6.00000

CP = ISENTROPIC PRESSURE FORMULA

BODY SECTION FORCE COEFFICIENTS

BODY SEGMENT NUMBER 1 L = LENGTH = 7.8936

SECTION	XO	XO/L	CL	CD	CL*L/DX	CD*L/DX	DX/L
1	6.54270	.04545	.000274	.000005	.003015	.000052	.09091
2	7.26030	.13636	.000233	.000004	.002558	.000045	.09091
3	7.97790	.22727	.000246	.000004	.002710	.000047	.09091
4	8.69550	.31818	.000216	.000004	.002373	.000041	.09091
5	9.41310	.40909	.000258	.000005	.002842	.000050	.09091
6	10.13070	.50000	.000231	.000004	.002542	.000044	.09091
7	10.84830	.59091	.000277	.000005	.003048	.000053	.09091
8	11.56590	.68182	.000218	.000003	.002403	.000033	.09091
9	12.28350	.77273	.000173	.000001	.001904	.000011	.09091
10	13.00110	.86364	.000080	-.000001	.000876	-.000016	.09091
11	13.71870	.95455	.000057	-.000001	.000631	-.000014	.09091
PANELS	9.53055	1.20738	.002264	.000031			
BOTH	5.96091	.75516	.005335	.000085			

BODY	UPSTREAM	PANELS	BOTH
CL	.003071	.002264	.005335
CD	.000054	.000031	.000085
CX	.010225	.021576	.031801
CX/L	.001295	.002733	.004029

UN(IJ)   ARRAY

SURFACE NUMBER 1   WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	-.01745	-.01745	-.01745	-.01745	-.01745
.150	-.01745	-.01745	-.01745	-.01745	-.01745
.250	-.01745	-.01745	-.01745	-.01745	-.01745
.350	-.01745	-.01745	-.01745	-.01745	-.01745
.450	-.01745	-.01745	-.01745	-.01745	-.01745
.550	-.01745	-.01745	-.01745	-.01745	-.01745
.650	-.01745	-.01745	-.01745	-.01745	-.01745
.750	-.01745	-.01745	-.01745	-.01745	-.01745
.850	-.01745	-.01745	-.01745	-.01745	-.01745
.950	-.01745	-.01745	-.01745	-.01745	-.01745

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745
.150	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745
.250	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745
.350	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745
.450	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745
.550	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745
.650	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745
.750	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745
.850	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745
.950	-.01745	-.01745	-.01745	-.01745	-.01745	-.01745

WSX(IJ) ARRAY

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	-.20000	-.20000	-.20000	-.20000	-.20000
.150	-.20000	-.20000	-.20000	-.20000	-.20000
.250	-.20000	-.20000	-.20000	-.20000	-.20000
.350	-.20000	-.20000	-.20000	-.20000	-.20000
.450	-.20000	-.20000	-.20000	-.20000	-.20000
.550	-.20000	-.20000	-.20000	-.20000	-.20000
.650	-.20000	-.20000	-.20000	-.20000	-.20000
.750	-.20000	-.20000	-.20000	-.20000	-.20000
.850	-.20000	-.20000	-.20000	-.20000	-.20000
.950	-.20000	-.20000	-.20000	-.20000	-.20000

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000
.150	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000
.250	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000
.350	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000
.450	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000
.550	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000
.650	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000
.750	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000
.850	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000
.950	-.20000	-.20000	-.20000	-.20000	-.20000	-.20000

ZTHK(IJ) ARRAY

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.00475	.00475	.00475	.00475	.00475
.150	.01275	.01275	.01275	.01275	.01275
.250	.01875	.01875	.01875	.01875	.01875
.350	.02275	.02275	.02275	.02275	.02275
.450	.02475	.02475	.02475	.02475	.02475
.550	.02475	.02475	.02475	.02475	.02475
.650	.02275	.02275	.02275	.02275	.02275
.750	.01875	.01875	.01875	.01875	.01875
.850	.01275	.01275	.01275	.01275	.01275
.950	.00475	.00475	.00475	.00475	.00475

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.00475	.00475	.00475	.00475	.00475	.00475
.150	.01275	.01275	.01275	.01275	.01275	.01275
.250	.01875	.01875	.01875	.01875	.01875	.01875
.350	.02275	.02275	.02275	.02275	.02275	.02275
.450	.02475	.02475	.02475	.02475	.02475	.02475
.550	.02475	.02475	.02475	.02475	.02475	.02475
.650	.02275	.02275	.02275	.02275	.02275	.02275
.750	.01875	.01875	.01875	.01875	.01875	.01875
.850	.01275	.01275	.01275	.01275	.01275	.01275
.950	.00475	.00475	.00475	.00475	.00475	.00475

WS(IJ) ARRAY

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.09026	.09024	.09030	.09038	.09050
.150	.07021	.07018	.07023	.07029	.07039
.250	.05015	.05013	.05016	.05021	.05028
.350	.03009	.03008	.03010	.03013	.03017
.450	.01003	.01003	.01003	.01004	.01006
.550	-.01003	-.01003	-.01003	-.01004	-.01006
.650	-.03009	-.03008	-.03010	-.03013	-.03017
.750	-.05015	-.05013	-.05016	-.05021	-.05028
.850	-.07021	-.07018	-.07023	-.07029	-.07039
.950	-.09026	-.09024	-.09030	-.09038	-.09050

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.09069	.09101	.09164	.09309	.09805	.16246
.150	.07054	.07079	.07127	.07241	.07626	.12636
.250	.05038	.05056	.05091	.05172	.05447	.09025
.350	.03023	.03034	.03055	.03103	.03268	.05415
.450	.01008	.01011	.01018	.01034	.01089	.01805
.550	-.01008	-.01011	-.01018	-.01034	-.01089	-.01805
.650	-.03023	-.03034	-.03055	-.03103	-.03268	-.05415
.750	-.05038	-.05056	-.05091	-.05172	-.05447	-.09025
.850	-.07054	-.07079	-.07127	-.07241	-.07626	-.12636
.950	-.09069	-.09101	-.09164	-.09309	-.09805	-.16246

US(IJ) ARRAY

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	-.01723	-.01722	-.01723	-.01725	-.01727
.150	-.00915	-.01349	-.01350	-.01350	-.01351
.250	-.00586	-.00699	-.00984	-.00984	-.00984
.350	-.00292	-.00273	-.00626	-.00626	-.00626
.450	-.00003	.00067	.00003	-.00274	-.00273
.550	.00289	.00381	.00389	.00138	.00075
.650	.00586	.00684	.00728	.00660	.00421
.750	.00890	.00985	.01048	.01043	.00764
.850	.01201	.01288	.01361	.01389	.01263
.950	.01317	.01593	.01670	.01720	.01676

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	-.01731	-.01737	-.01749	-.01776	-.01870	-.03084
.150	-.01353	-.01355	-.01361	-.01381	-.01452	-.02363
.250	-.00986	-.00988	-.00991	-.00996	-.01035	-.01644
.350	-.00626	-.00625	-.00628	-.00630	-.00632	-.00928
.450	-.00274	-.00272	-.00268	-.00269	-.00255	-.00213
.550	.00076	.00076	.00082	.00091	.00115	.00488
.650	.00421	.00423	.00426	.00446	.00481	.01102
.750	.00765	.00766	.00771	.00789	.00847	.01678
.850	.01107	.01109	.01113	.01129	.01212	.02237
.950	.01447	.01452	.01456	.01471	.01578	.02785

CK2(IJ) ARRAY

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.60620	.60620	.60620	.60620	.60620
.150	.60620	.60620	.60620	.60620	.60620
.250	.60620	.60620	.60620	.60620	.60620
.350	.60620	.60620	.60620	.60620	.60620
.450	.60620	.60620	.60620	.60620	.60620
.550	.60620	.60620	.60620	.60620	.60620
.650	.60620	.60620	.60620	.60620	.60620
.750	.60620	.60620	.60620	.60620	.60620
.850	.60620	.60620	.60620	.60620	.60620
.950	.60620	.60620	.60620	.60620	.60620

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.60620	.60620	.60620	.60620	.60620	.60620
.150	.60620	.60620	.60620	.60620	.60620	.60620
.250	.60620	.60620	.60620	.60620	.60620	.60620
.350	.60620	.60620	.60620	.60620	.60620	.60620
.450	.60620	.60620	.60620	.60620	.60620	.60620
.550	.60620	.60620	.60620	.60620	.60620	.60620
.650	.60620	.60620	.60620	.60620	.60620	.60620
.750	.60620	.60620	.60620	.60620	.60620	.60620
.850	.60620	.60620	.60620	.60620	.60620	.60620
.950	.60620	.60620	.60620	.60620	.60620	.60620

ALPHA = 1.000 DEGREES NO CAMBER, NO THICKNESS ADD LOAD
ALPHAI = 1.000 DEGREES 1ST ORDER AXIAL SOLUTION 42 0 0

DELTA CP TO ORDER 2

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.01842	.01670	.01555	.01497	.01478
.150	.01643	.01759	.01621	.01531	.01488
.250	.01412	.01673	.01690	.01574	.01509
.350	.01357	.01481	.01688	.01623	.01536
.450	.01381	.01392	.01586	.01664	.01568
.550	.01244	.01393	.01438	.01651	.01604
.650	.01100	.01334	.01393	.01576	.01635
.750	.01066	.01168	.01388	.01460	.01643
.850	.01118	.01057	.01315	.01402	.01610
.950	.01103	.01122	.01183	.01380	.01540

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.01332	.01332	.01332	.01332	.01332	.01332
.150	.01336	.01332	.01332	.01332	.01332	.01332
.250	.01481	.01333	.01332	.01332	.01332	.01332
.350	.01490	.01334	.01332	.01332	.01332	.01332
.450	.01507	.01477	.01332	.01332	.01332	.01332
.550	.01529	.01480	.01333	.01332	.01332	.01332
.650	.01551	.01489	.01333	.01332	.01332	.01332
.750	.01575	.01505	.01336	.01332	.01332	.01332
.850	.01599	.01523	.01341	.01332	.01332	.01332
.950	.01620	.01543	.01478	.01332	.01332	.01332

ALPHA = 1.000 DEGREES
ALPHAI = 1.000 DEGREES

NO CAMBER, NO THICKNESS ADD LOAD
1ST ORDER AXIAL SOLUTION

CP = ISENTROPIC PRESSURE FORMULA

BODY U,V,W ORDER 2

X	6.5427	7.2603	7.9779	8.6955	9.4131
J					
1.000	-.0030	-.0026	-.0022	-.0018	-.0015
2.000	-.0027	-.0024	-.0021	-.0018	-.0015
3.000	-.0021	-.0019	-.0017	-.0014	-.0038
4.000	-.0011	-.0011	-.0059	-.0063	-.0061
5.000	.0002	.0000	.0071	.0078	.0074
6.000	.0017	.0013	.0010	.0005	.0043
7.000	.0030	.0025	.0021	.0018	.0014
8.000	.0038	.0032	.0028	.0024	.0020

X	10.1307	10.8483	11.5659	12.2835	13.0011	13.7187
J						
1.000	-.0012	-.0009	.0006	.0009	-.0010	.0005
2.000	-.0007	-.0018	-.0028	-.0030	.0014	-.0013
3.000	-.0046	-.0049	-.0039	-.0030	-.0025	-.0013
4.000	-.0054	-.0053	-.0047	-.0038	-.0026	-.0012
5.000	.0066	.0065	.0058	.0047	.0033	.0016
6.000	.0054	.0058	.0046	.0037	.0031	.0016
7.000	.0004	.0023	.0034	.0036	-.0010	.0017
8.000	.0017	.0014	-.0003	-.0008	.0014	-.0003

CLBX(1) =	.17596	CLBX(2) =	.17596
CDBX(1) =	.00385	CDBX(2) =	.00385
CXBX(1) =	.58585	CXBX(2) =	.58585
CLBB =	.00307	CDBB =	0.00000
CXBB =	.01022		

NO CAMBER, NO THICKNESS ORDER = 2 83/08/10 14.01

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

```
ANGLE OF ATTACK       =    1.00000  DEGREES    ADD LOAD
JET DEFLECTION ANGLE  =    0.00000  DEGREES
THRUST COEFFICIENT    =    0.00000
MACH NUMBER           =    6.00000
```

SURFACE NUMBER 1 WING

	Y	CN	CN*C/CAVG	CT*C/CAVG	CDC/CAVG	XCP	TWIST	COS	CHORD
1	.796	.01325	.03106	0.000000	.00054	.45117	0.00000	1.00000	6.8139
2	1.045	.01404	.02959	0.000000	.00052	.45441	0.00000	1.00000	6.1296
3	1.273	.01484	.02808	0.000000	.00049	.47297	0.00000	1.00000	5.5014
4	1.502	.01534	.02570	0.000000	.00045	.49129	0.00000	1.00000	4.8732
5	1.731	.01558	.02275	0.000000	.00040	.50770	0.00000	1.00000	4.2453
6	1.959	.01498	.01864	0.000000	.00033	.51698	0.00000	1.00000	3.6178
7	2.187	.01430	.01470	0.000000	.00026	.51588	0.00000	1.00000	2.9908
8	2.415	.01340	.01090	0.000000	.00019	.50514	0.00000	1.00000	2.3649
9	2.642	.01318	.00789	0.000000	.00014	.50000	0.00000	1.00000	1.7411
10	2.867	.01297	.00501	0.000000	.00009	.50000	0.00000	1.00000	1.1232
11	3.081	.01156	.00213	0.000000	.00004	.50000	0.00000	1.00000	.5352

```
TOTAL (SURFACE)            .01434     0.000000     .00025    11.48229 = X-CP

                       0.00000 = CY                         0.00000 = Z-CP      0.00000
                        .00717 = CZ                         1.53818 = Y-CP      1.00000

                        .00717 = TOTAL FORCE COEFFICIENT (SURFACE)
```

	CL	CT	CD(0)	X-CP
TOTAL CONFIGURATION	.01967	0.000000	.00034	9.98511
WITH VORTEX LIFT	.01967	0.000000		9.98511

```
CD(0)         =    .00034        CD(VTX)         =    .00009
CD(0)/CL**2   =    .86625        CD(VTX)/CL**2   =    .22216
E(0)          =    .1658         E(VTX)          =    .6466
```

ZERO SUCTION DRAG MINUS LEADING EDGE THRUST RS = .250 MO = 0

```
CD            =    .00034
CD / CL**2    =    .86625
```

```
     CDW / CL**2  =        .64409   (WAVE DRAG DUE TO LIFT)
      E           =        .1658

WITH VORTEX LIFT
     CD           =        .00034
     CD  / CL**2  =        .86625
      E           =        .1658
```

NO CAMBER, NO THICKNESS ORDER = 2 83/08/10 14.01

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

ANGLE OF ATTACK = 1.00000 DEGREES ADD LOAD
JET DEFLECTION ANGLE = 0.00000 DEGREES
THRUST COEFFICIENT = 0.00000
MACH NUMBER = 6.00000

CP = ISENTROPIC PRESSURE FORMULA

BODY SECTION FORCE COEFFICIENTS

BODY SEGMENT NUMBER 1 L = LENGTH = 7.8936

SECTION	XO	XO/L	CL	CD	CL*L/DX	CD*L/DX	DX/L
1	6.54270	.04545	.000274	.000005	.003015	.000052	.09091
2	7.26030	.13636	.000233	.000004	.002558	.000045	.09091
3	7.97790	.22727	.000246	.000004	.002710	.000047	.09091
4	8.69550	.31818	.000216	.000004	.002373	.000041	.09091
5	9.41310	.40909	.000258	.000005	.002842	.000050	.09091
6	10.13070	.50000	.000231	.000004	.002542	.000044	.09091
7	10.84830	.59091	.000277	.000005	.003048	.000053	.09091
8	11.56590	.68182	.000218	.000003	.002403	.000033	.09091
9	12.28350	.77273	.000173	.000001	.001904	.000011	.09091
10	13.00110	.86364	.000080	-.000001	.000876	-.000016	.09091
11	13.71870	.95455	.000057	-.000001	.000631	-.000014	.09091
PANELS	9.53055	1.20738	.002264	.000031			
BOTH	5.96091	.75516	.005335	.000085			

BODY	UPSTREAM	PANELS	BOTH
CL	.003071	.002264	.005335
CD	.000054	.000031	.000085
CX	.010225	.021576	.031801
CX/L	.001295	.002733	.004029

ORIGINAL PAGE IS
OF POOR QUALITY

ALPHA = 8.000 DEGREES
ALPHAI = 8.000 DEGREES

NO CAMBER, NO THICKNESS
1ST ORDER AXIAL SOLUTION 41 0 0

DELTA CP TO ORDER 1

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.15289	.13460	.12159	.11353	.10832
.150	.13592	.14418	.12930	.11843	.11145
.250	.11643	.13758	.13696	.12393	.11503
.350	.11157	.12146	.13826	.12979	.11900
.450	.11317	.11394	.12975	.13473	.12321
.550	.10175	.11376	.11742	.13489	.12761
.650	.09012	.10867	.11357	.12858	.13158
.750	.08912	.09508	.11296	.11890	.13349
.850	.09663	.08610	.10689	.11405	.13120
.950	.09749	.09263	.09606	.11215	.12528

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.10659	.10659	.10659	.10659	.10659	.10659
.150	.10686	.10659	.10659	.10659	.10659	.10659
.250	.10872	.10661	.10659	.10659	.10659	.10659
.350	.11135	.10675	.10659	.10659	.10659	.10659
.450	.11432	.10723	.10660	.10659	.10659	.10659
.550	.11747	.10899	.10661	.10659	.10659	.10659
.650	.12064	.11122	.10666	.10659	.10659	.10659
.750	.12388	.11374	.10685	.10659	.10659	.10659
.850	.12710	.11636	.10726	.10660	.10659	.10659
.950	.13002	.11900	.10835	.10660	.10659	.10659

ALPHA = 8.000 DEGREES
ALPHAI = 8.000 DEGREES

NO CAMBER, NO THICKNESS
1ST ORDER AXIAL SOLUTION

UPPER CP TO ORDER 1

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	-.08004	-.06660	-.05527	-.04625	-.03770
.150	-.07128	-.07431	-.06257	-.05220	-.04315
.250	-.06120	-.07172	-.06920	-.05799	-.04818
.350	-.05849	-.06339	-.07179	-.06365	-.05298
.450	-.05895	-.05941	-.06740	-.06825	-.05756
.550	-.05305	-.05913	-.06102	-.06986	-.06200
.650	-.04779	-.05621	-.05893	-.06658	-.06588
.750	-.05206	-.04934	-.05847	-.06158	-.06840
.850	-.06243	-.04528	-.05521	-.05903	-.06785
.950	-.06809	-.05173	-.04975	-.05794	-.06470

ORIGINAL PAGE IS
OF POOR QUALITY

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	-.05330	-.05330	-.05330	-.05330	-.05330	-.05330
.150	-.05343	-.05330	-.05330	-.05330	-.05330	-.05330
.250	-.03833	-.05331	-.05330	-.05330	-.05330	-.05330
.350	-.04294	-.05337	-.05330	-.05330	-.05330	-.05330
.450	-.04717	-.03572	-.05330	-.05330	-.05330	-.05330
.550	-.05108	-.03926	-.05331	-.05330	-.05330	-.05330
.650	-.05484	-.04301	-.05333	-.05330	-.05330	-.05330
.750	-.05840	-.04649	-.05342	-.05330	-.05330	-.05330
.850	-.06179	-.04976	-.05363	-.05330	-.05330	-.05330
.950	-.06482	-.05285	-.03824	-.05330	-.05330	-.05330

ALPHA = 8.000 DEGREES
ALPHAI = 8.000 DEGREES

NO CAMBER, NO THICKNESS
1ST ORDER AXIAL SOLUTION

LOWER CP TO ORDER 1

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.07286	.06801	.06632	.06728	.07062
.150	.06464	.06987	.06673	.06622	.06829
.250	.05523	.06586	.06776	.06594	.06685
.350	.05308	.05807	.06647	.06614	.06602
.450	.05422	.05453	.06236	.06648	.06565
.550	.04869	.05464	.05639	.06503	.06561
.650	.04232	.05246	.05464	.06200	.06569
.750	.03705	.04573	.05449	.05732	.06510
.850	.03420	.04082	.05168	.05503	.06336
.950	.02939	.04090	.04631	.05421	.06058

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.05330	.05330	.05330	.05330	.05330	.05330
.150	.05343	.05330	.05330	.05330	.05330	.05330
.250	.07039	.05331	.05330	.05330	.05330	.05330
.350	.06841	.05337	.05330	.05330	.05330	.05330
.450	.06715	.07151	.05330	.05330	.05330	.05330
.550	.06639	.06972	.05331	.05330	.05330	.05330
.650	.06580	.06821	.05333	.05330	.05330	.05330
.750	.06548	.06725	.05342	.05330	.05330	.05330
.850	.06531	.06661	.05363	.05330	.05330	.05330
.950	.06520	.06615	.07011	.05330	.05330	.05330

ALPHA = 8.000 DEGREES
ALPHAI = 8.000 DEGREES

NO CAMBER, NO THICKNESS
1ST ORDER AXIAL SOLUTION

CP = ISENTROPIC PRESSURE FORMULA

BODY U,V,W ORDER 1

X / J	6.5427	7.2603	7.9779	8.6955	9.4131
1.000	-.0120	-.0103	-.0071	-.0039	-.0009
2.000	-.0186	-.0188	-.0178	-.0168	-.0158
3.000	-.0251	-.0269	-.0277	-.0288	-.0218
4.000	-.0266	-.0295	-.0290	-.0296	-.0287
5.000	-.0208	-.0253	.1175	.1348	.1270
6.000	-.0023	-.0095	-.0141	-.0208	.0555
7.000	.0313	.0219	.0158	.0107	.0065
8.000	.0627	.0526	.0465	.0412	.0365

X / J	10.1307	10.8483	11.5659	12.2835	13.0011	13.7187
1.000	.0020	.0045	.0070	-.0053	-.0250	-.0180
2.000	-.0157	-.0057	-.0191	-.0305	.0064	-.0345
3.000	-.0244	-.0264	-.0239	-.0275	-.0340	-.0348
4.000	-.0250	-.0239	-.0262	-.0312	-.0342	-.0345
5.000	.1129	.1130	.0978	.0719	.0405	.0017
6.000	.0770	.0807	.0675	.0507	.0320	.0017
7.000	-.0084	.0359	.0443	.0364	-.0238	.0048
8.000	.0325	.0295	-.0012	-.0203	.0028	-.0282

CLBX(1) = .17596   CLBX(2) = .17596
CDBX(1) = .00385   CDBX(2) = .00385
CXBX(1) = .58585   CXBX(2) = .58585
CLBB = .02457   CDBB = .00385
CXBB = .08180

ORIGINAL PAGE IS
OF POOR QUALITY

NO CAMBER, NO THICKNESS   ORDER = 1   83/08/10   14.01

WBODY.DATA(M600) 1ST-AX   (10 X 11) (8 X 11)   VEL B.C. NEG   37X37

```
ANGLE OF ATTACK        =    8.00000  DEGREES
JET DEFLECTION ANGLE   =    0.00000  DEGREES
THRUST COEFFICIENT     =    0.00000
MACH NUMBER            =    6.00000
```

SURFACE NUMBER 1   WING

	Y	CN	CN*C/CAVG	CT*C/CAVG	CDC/CAVG	XCP	TWIST	COS	CHORD
1	.796	.11040	.25870	0.000000	.03612	.45538	0.00000	1.00000	6.8139
2	1.045	.11470	.24179	0.000000	.03376	.45491	0.00000	1.00000	6.1296
3	1.273	.12015	.22731	0.000000	.03174	.47535	0.00000	1.00000	5.5014
4	1.502	.12273	.20568	0.000000	.02872	.49708	0.00000	1.00000	4.8732
5	1.731	.12239	.17869	0.000000	.02495	.51735	0.00000	1.00000	4.2453
6	1.959	.11640	.14482	0.000000	.02022	.51968	0.00000	1.00000	3.6178
7	2.187	.10990	.11304	0.000000	.01578	.51046	0.00000	1.00000	2.9908
8	2.415	.10624	.08640	0.000000	.01206	.50103	0.00000	1.00000	2.3649
9	2.642	.10542	.06312	0.000000	.00881	.50000	0.00000	1.00000	1.7411
10	2.867	.10373	.04007	0.000000	.00559	.50000	0.00000	1.00000	1.1232
11	3.081	.09245	.01701	0.000000	.00238	.50000	0.00000	1.00000	.5352

```
TOTAL (SURFACE)        .11520    0.000000    .01608    11.47829 = X-CP
                     0.00000 = CY                       0.00000 = Z-CP    0.00000
                      .05760 = CZ                       1.52691 = Y-CP    1.00000
                      .05760 = TOTAL FORCE COEFFICIENT (SURFACE)

TOTAL (THICKNESS)                            .00022
                           CL        CT        CD(0)       X-CP
TOTAL CONFIGURATION      .16263    0.000000    .00022     9.99760
WITH VORTEX LIFT         .16263    0.000000               9.99760

    CD(0)        =     .02678        CD(VTX)        =     .00595
    CD(0)/CL**2  =    1.01248        CD(VTX)/CL**2  =     .22504
    E(0)         =     .1419         E(VTX)         =     .6384

      ZERO SUCTION DRAG MINUS LEADING EDGE THRUST      RS  =   .250       MO = 0
    CD           =     .02678
```

```
CD  / CL**2  =     1.01248
CDW / CL**2  =      .78743   (WAVE DRAG DUE TO LIFT)
 E           =      .1419

WITH VORTEX LIFT
CD           =      .02678
CD  / CL**2  =     1.01248
 E           =      .1419
```

ORIGINAL PAGE IS
OF POOR QUALITY

NO CAMBER, NO THICKNESS ORDER = 1 83/08/10 14.01

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

ANGLE OF ATTACK = 8.00000 DEGREES
JET DEFLECTION ANGLE = 0.00000 DEGREES
THRUST COEFFICIENT = 0.00000
MACH NUMBER = 6.00000

CP = ISENTROPIC PRESSURE FORMULA

BODY SECTION FORCE COEFFICIENTS

BODY SEGMENT NUMBER 1 L = LENGTH = 7.8936

SECTION	X0	X0/L	CL	CD	CL*L/DX	CD*L/DX	DX/L
1	6.54270	.04545	.002545	.000354	.027993	.003894	.09091
2	7.26030	.13636	.002104	.000294	.023140	.003231	.09091
3	7.97790	.22727	.002314	.000323	.025456	.003554	.09091
4	8.69550	.31818	.002057	.000287	.022628	.003159	.09091
5	9.41310	.40909	.002552	.000356	.028068	.003919	.09091
6	10.13070	.50000	.002368	.000331	.026043	.003636	.09091
7	10.84830	.59091	.002882	.000402	.031705	.004427	.09091
8	11.56590	.68182	.002353	.000283	.025882	.003111	.09091
9	12.28350	.77273	.001983	.000237	.021808	.002604	.09091
10	13.00110	.86364	.000940	.000182	.010335	.002001	.09091
11	13.71870	.95455	.000767	.000368	.008441	.004044	.09091
PANELS	9.70238	1.22915	.022863	.003416			
BOTH	6.40142	.81096	.047432	.010694			

BODY	UPSTREAM	PANELS	BOTH
CL	.024568	.022863	.047432
CD	.007277	.003416	.010694
CX	.081800	.221830	.303630
CX/L	.010363	.028103	.038465

ALPHA = 8.000 DEGREES
ALPHAI = 8.000 DEGREES

NO CAMBER, NO THICKNESS
1ST ORDER AXIAL SOLUTION 42 0 0

DELTA CP TO ORDER 2

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	.14735	.13356	.12440	.11975	.11827
.150	.13142	.14073	.12970	.12245	.11908
.250	.11296	.13385	.13521	.12594	.12070
.350	.10857	.11847	.13500	.12984	.12290
.450	.11045	.11139	.12689	.13314	.12547
.550	.09952	.11141	.11505	.13212	.12828
.650	.08801	.10671	.11145	.12609	.13080
.750	.08525	.09348	.11101	.11679	.13147
.850	.08947	.08457	.10523	.11216	.12878
.950	.08827	.08973	.09466	.11042	.12317

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	.10659	.10659	.10659	.10659	.10659	.10659
.150	.10686	.10659	.10659	.10659	.10659	.10659
.250	.11852	.10661	.10659	.10659	.10659	.10659
.350	.11923	.10675	.10659	.10659	.10659	.10659
.450	.12057	.11815	.10660	.10659	.10659	.10659
.550	.12230	.11839	.10661	.10659	.10659	.10659
.650	.12407	.11914	.10666	.10659	.10659	.10659
.750	.12598	.12040	.10685	.10659	.10659	.10659
.850	.12791	.12187	.10726	.10660	.10659	.10659
.950	.12961	.12341	.11823	.10660	.10659	.10659

ALPHA = 8.000 DEGREES NO CAMBER, NO THICKNESS
ALPHAI = 8.000 DEGREES 1ST ORDER AXIAL SOLUTION

UPPER CP TO ORDER 2

SURFACE NUMBER 1 WING

X/C	.7957	1.0448	1.2735	1.5021	1.7307
.050	-.04106	-.03546	-.02959	-.02425	-.01871
.150	-.03807	-.03904	-.03356	-.02787	-.02230
.250	-.03388	-.03834	-.03682	-.03116	-.02545
.350	-.03265	-.03507	-.03822	-.03412	-.02831
.450	-.03285	-.03334	-.03666	-.03635	-.03087
.550	-.03007	-.03320	-.03413	-.03729	-.03318
.650	-.02753	-.03186	-.03324	-.03619	-.03506
.750	-.03107	-.02857	-.03303	-.03434	-.03630
.850	-.03803	-.02657	-.03161	-.03333	-.03631
.950	-.04266	-.03079	-.02912	-.03288	-.03529

X/C	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
.050	-.02966	-.02966	-.02966	-.02966	-.02966	-.02966
.150	-.02973	-.02966	-.02966	-.02966	-.02966	-.02966
.250	-.01914	-.02967	-.02966	-.02966	-.02966	-.02966
.350	-.02215	-.02970	-.02966	-.02966	-.02966	-.02966
.450	-.02480	-.01739	-.02966	-.02966	-.02966	-.02966
.550	-.02713	-.01976	-.02966	-.02966	-.02966	-.02966
.650	-.02925	-.02218	-.02968	-.02966	-.02966	-.02966
.750	-.03115	-.02433	-.02972	-.02966	-.02966	-.02966
.850	-.03286	-.02626	-.02982	-.02966	-.02966	-.02966
.950	-.03428	-.02799	-.01907	-.02966	-.02966	-.02966

ALPHA = 8.000 DEGREES
ALPHAI = 8.000 DEGREES

NO CAMBER, NO THICKNESS
1ST ORDER AXIAL SOLUTION

LOWER CP TO ORDER 2

SURFACE NUMBER 1 WING

	.7957	1.0448	1.2735	1.5021	1.7307
0	.10628	.09810	.09481	.09550	.09956
0	.09335	.10169	.09614	.09457	.09678
0	.07907	.09552	.09839	.09478	.09525
0	.07592	.08340	.09678	.09572	.09460
0	.07760	.07805	.09023	.09679	.09460
0	.06944	.07821	.08092	.09482	.09510
0	.06048	.07486	.07821	.08991	.09574
0	.05418	.06491	.07797	.08245	.09517
0	.05144	.05800	.07363	.07883	.09247
0	.04561	.05894	.06554	.07754	.08787

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	1.9591	2.1873	2.4152	2.6422	2.8671	3.0812
0	.07693	.07693	.07693	.07693	.07693	.07693
0	.07712	.07693	.07693	.07693	.07693	.07693
0	.09938	.07695	.07693	.07693	.07693	.07693
0	.09707	.07705	.07693	.07693	.07693	.07693
0	.09577	.10076	.07694	.07693	.07693	.07693
0	.09517	.09863	.07695	.07693	.07693	.07693
0	.09481	.09696	.07699	.07693	.07693	.07693
0	.09483	.09607	.07713	.07693	.07693	.07693
0	.09506	.09562	.07745	.07693	.07693	.07693
0	.09533	.09542	.09916	.07694	.07693	.07693

ALPHA = 8.000 DEGREES
ALPHAI = 8.000 DEGREES

NO CAMBER, NO THICKNESS
1ST ORDER AXIAL SOLUTION

CP = ISENTROPIC PRESSURE FORMULA

C-2

BODY U,V,W ORDER 2

J \ X	6.5427	7.2603	7.9779	8.6955	9.4131
1.000	-.0120	-.0103	-.0071	-.0039	-.0009
2.000	-.0186	-.0188	-.0178	-.0168	-.0158
3.000	-.0251	-.0269	-.0277	-.0288	-.0218
4.000	-.0266	-.0295	-.0290	-.0296	-.0287
5.000	-.0208	-.0253	.1175	.1348	.1270
6.000	-.0023	-.0095	-.0141	-.0208	.0555
7.000	.0313	.0219	.0158	.0107	.0065
8.000	.0627	.0526	.0465	.0412	.0365

J \ X	10.1307	10.8483	11.5659	12.2835	13.0011	13.7187
1.000	.0020	.0045	.0070	-.0053	-.0250	-.0180
2.000	-.0157	-.0057	-.0191	-.0305	.0064	-.0345
3.000	-.0244	-.0264	-.0239	-.0275	-.0340	-.0348
4.000	-.0250	-.0239	-.0262	-.0312	-.0342	-.0345
5.000	.1129	.1130	.0978	.0719	.0405	.0017
6.000	.0770	.0807	.0675	.0507	.0320	.0017
7.000	-.0084	.0359	.0443	.0364	-.0238	.0048
8.000	.0325	.0295	-.0012	-.0203	.0028	-.0282

CLBX(1) = .17596 CLBX(2) = .17596
CDBX(1) = .00385 CDBX(2) = .00385
CXBX(1) = .58585 CXBX(2) = .58585
CLBB = .02457 CDBB = .00385
CXBB = .08180

NO CAMBER, NO THICKNESS ORDER = 2 83/08/10 14.01

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

ANGLE OF ATTACK = 8.00000 DEGREES
JET DEFLECTION ANGLE = 0.00000 DEGREES
THRUST COEFFICIENT = 0.00000
MACH NUMBER = 6.00000

SURFACE NUMBER 1 WING

	Y	CN	CN*C/CAVG	CT*C/CAVG	CDC/CAVG	XCP	TWIST	COS	CHORD
1	.796	.10602	.24844	0.000000	.03469	.45117	0.00000	1.00000	6.8139
2	1.045	.11229	.23671	0.000000	.03305	.45441	0.00000	1.00000	6.1296
3	1.273	.11873	.22463	0.000000	.03136	.47297	0.00000	1.00000	5.5014
4	1.502	.12270	.20563	0.000000	.02871	.49129	0.00000	1.00000	4.8732
5	1.731	.12466	.18201	0.000000	.02541	.50770	0.00000	1.00000	4.2453
6	1.959	.11986	.14913	0.000000	.02082	.51698	0.00000	1.00000	3.6178
7	2.187	.11437	.11763	0.000000	.01642	.51588	0.00000	1.00000	2.9908
8	2.415	.10722	.08720	0.000000	.01218	.50514	0.00000	1.00000	2.3649
9	2.642	.10542	.06312	0.000000	.00881	.50000	0.00000	1.00000	1.7411
10	2.867	.10373	.04007	0.000000	.00559	.50000	0.00000	1.00000	1.1232
11	3.081	.09245	.01701	0.000000	.00238	.50000	0.00000	1.00000	.5352

TOTAL (SURFACE) .11471 0.000000 .01602 11.48229 = X-CP

0.00000 = CY 0.00000 = Z-CP 0.00000
.05736 = CZ 1.53818 = Y-CP 1.00000

.05736 = TOTAL FORCE COEFFICIENT (SURFACE)

TOTAL (THICKNESS) .00040

	CL	CT	CD(0)	X-CP
TOTAL CONFIGURATION	.16215	0.000000	.00040	9.99601
WITH VORTEX LIFT	.16215	0.000000		9.99601

CD(0) = .02671 CD(VTX) = .00550

CD(0)/CL**2 = 1.01596 CD(VTX)/CL**2 = .20933

E(0) = .1414 E(VTX) = .6863

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ZERO SUCTION DRAG MINUS LEADING EDGE THRUST RS = .250 MO = 0

CD = .02671

```
      CD  / CL**2  =      1.01596
      CDW / CL**2  =       .80663   (WAVE DRAG DUE TO LIFT)
       E           =       .1414

 WITH VORTEX LIFT
      CD           =       .02671
      CD  / CL**2  =      1.01596
       E           =       .1414
```

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C2

NO CAMBER, NO THICKNESS ORDER = 2 83/08/10 14.01

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

ANGLE OF ATTACK = 8.00000 DEGREES
JET DEFLECTION ANGLE = 0.00000 DEGREES
THRUST COEFFICIENT = 0.00000
MACH NUMBER = 6.00000

CP = ISENTROPIC PRESSURE FORMULA

BODY SECTION FORCE COEFFICIENTS

BODY SEGMENT NUMBER 1 L = LENGTH = 7.8936

SECTION	X0	X0/L	CL	CD	CL*L/DX	CD*L/DX	DX/L
1	6.54270	.04545	.002545	.000354	.027993	.003894	.09091
2	7.26030	.13636	.002104	.000294	.023140	.003231	.09091
3	7.97790	.22727	.002314	.000323	.025456	.003554	.09091
4	8.69550	.31818	.002057	.000287	.022628	.003159	.09091
5	9.41310	.40909	.002552	.000356	.028068	.003919	.09091
6	10.13070	.50000	.002368	.000331	.026043	.003636	.09091
7	10.84830	.59091	.002882	.000402	.031705	.004427	.09091
8	11.56590	.68182	.002353	.000283	.025882	.003111	.09091
9	12.28350	.77273	.001983	.000237	.021808	.002604	.09091
10	13.00110	.86364	.000940	.000182	.010335	.002001	.09091
11	13.71870	.95455	.000767	.000368	.008441	.004044	.09091
PANELS	9.70238	1.22915	.022863	.003416			
BOTH	6.40142	.81096	.047432	.010694			

BODY	UPSTREAM	PANELS	BOTH
CL	.024568	.022863	.047432
CD	.007277	.003416	.010694
CX	.081800	.221830	.303630
CX/L	.010363	.028103	.038465

NEAR FIELD DRAG CALCULATION - CD(0)
SUCTION + NEAR FIELD DRAG CALCULATION - CD(S+0)
VORTEX DRAG CALCULATION - CD(100)

NORMAL VELOCITY INTERPOLATION X/C = .51500

CL	CD(0)	E(0)	CD(VTX)	E(VTX)	CD(S+0)	ALPHA	X-CP
.00000	.00470	.00000	.00000	.60159	.00470	.000	0.00000
.05000	.00689	.05212	.00060	.60158	.00689	2.534	9.98678
.10000	.01350	.10639	.00239	.60158	.01350	5.067	9.98678
.15000	.02454	.13173	.00537	.60158	.02454	7.601	9.98678
.20000	.03999	.14368	.00955	.60158	.03999	10.134	9.98678
.25000	.05987	.14996	.01492	.60158	.05987	12.668	9.98678
.30000	.08417	.15360	.02149	.60158	.08417	15.202	9.98678
.35000	.11290	.15588	.02925	.60158	.11290	17.735	9.98678
.40000	.14604	.15739	.03821	.60158	.14604	20.269	9.98678
.45000	.18361	.15844	.04836	.60158	.18361	22.803	9.98678
.50000	.22560	.15920	.05970	.60158	.22560	25.336	9.98678
.55000	.27201	.15976	.07224	.60158	.27201	27.870	9.98678
.60000	.32284	.16019	.08597	.60158	.32284	30.403	9.98678
.65000	.37809	.16053	.10089	.60158	.37809	32.937	9.98678
.70000	.43777	.16080	.11701	.60158	.43777	35.471	9.98678
.75000	.50187	.16101	.13432	.60158	.50187	38.004	9.98678
.80000	.57039	.16119	.15283	.60158	.57039	40.538	9.98678
.85000	.64333	.16134	.17253	.60158	.64333	43.072	9.98678
.90000	.72070	.16146	.19343	.60158	.72070	45.605	9.98678
.95000	.80249	.16156	.21552	.60158	.80249	48.139	9.98678
1.00000	.88869	.16165	.23880	.60158	.88869	50.672	9.98678
1.05000	.97933	.16173	.26328	.60158	.97933	53.206	9.98678
1.10000	1.07438	.16179	.28895	.60158	1.07438	55.740	9.98678
1.15000	1.17385	.16185	.31581	.60158	1.17385	58.273	9.98678
1.20000	1.27775	.16190	.34387	.60158	1.27775	60.807	9.98678
1.25000	1.38607	.16194	.37312	.60158	1.38607	63.341	9.98678
1.30000	1.49881	.16198	.40357	.60158	1.49881	65.874	9.98678
1.35000	1.61597	.16202	.43521	.60158	1.61597	68.408	9.98678
1.40000	1.73756	.16205	.46805	.60158	1.73756	70.941	9.98678
1.45000	1.86356	.16208	.50207	.60158	1.86356	73.475	9.98678
1.50000	1.99399	.16210	.53730	.60158	1.99399	76.009	9.98678

CL	CD(0)	E(0)	CD(VTX)	E(VTX)	CD(S+0)	ALPHA	X-CP
1.55000	2.12884	.16212	.57371	.60158	2.12884	78.542	9.98678
1.60000	2.26812	.16214	.61132	.60158	2.26812	81.076	9.98678
1.65000	2.41181	.16216	.65013	.60158	2.41181	83.610	9.98678
1.70000	2.55993	.16218	.69013	.60158	2.55993	86.143	9.98678
1.75000	2.71247	.16220	.73132	.60158	2.71247	88.677	9.98678
1.80000	2.86943	.16221	.77371	.60158	2.86943	91.210	9.98678
1.85000	3.03081	.16222	.81729	.60158	3.03081	93.744	9.98678
1.90000	3.19662	.16224	.86206	.60158	3.19662	96.278	9.98678
1.95000	3.36685	.16225	.90803	.60158	3.36685	98.811	9.98678
2.00000	3.54149	.16226	.95519	.60158	3.54149	101.345	9.98678

```
                                                        83/08/10      14.01
          WBODY.DATA(M600) 1ST-AX   (10 X 11) (8 X 11)  VEL B.C.  NEG    37X37

   SREF  =       18.73497          XCG  =      0.00000
   SPAN  =        6.44300          YCG  =      0.00000
   CAVG  =        2.90780          ZCG  =      0.00000
   CBAR  =        2.90780           RC  =       .51500
   MACH  =        6.00000           AR  =      2.21576

   CL    =      .01973463 * ALPHA    +     .00000

   CM    =    -.06777811 * ALPHA     +    -.00000
         =   -3.43447680 *  CL       +    -.00000  =   -3.43448 * ( CL - -.0000 )


     FORCES DUE TO LEADING EDGE SUCTION

   CX    =    0.00000000 * ALPHA**2 +    0.000000 * ALPHA +  0.00000

         =    0.00000000 * CL**2    +    0.000000 * CL    +  0.00000
```

```
             NEAR FIELD DRAG CALCULATION - CD(0)        NORMAL VELOCITY INTERPOLATION X/C =  .51500
   SUCTION + NEAR FIELD DRAG CALCULATION - CD(S+0)
              VORTEX   DRAG CALCULATION - CD(100)

CD(0)    =     .00034443 * ALPHA**2 +    -.000008 * ALPHA +   .00470

CD(S+0)  =     .00034443 * ALPHA**2 +    -.000008 * ALPHA +   .00470

CD(100)  =     .00009300 * ALPHA**2 +    0.000000 * ALPHA +  0.00000

CD(0)    =     .88439947 * CL**2    +    -.000409 * CL    +   .00470

CD(S+0)  =     .88439947 * CL**2    +    -.000409 * CL    +   .00470

CD(100)  =     .23879769 * CL**2    +    -.000000 * CL    +   .00000

CD(0)    =     .88439947 * ( CL -   .0002 )**2            +   .00470

CD(S+0)  =     .88439947 * ( CL -   .0002 )**2            +   .00470

CD(100)  =     .23879769 * ( CL -   .0000 )**2            +  0.00000
```

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ORIGINAL PAGE IS
OF POOR QUALITY

```
 DATA SET  4            PLOT FILE CREATED BY OPT
 MACH =  6.00
    Q =  0.0
ALPHA =    8.00 DEG
NSFC-K=*********

 ENTER: 1 TO PLOT
   0 TO BYPASS THIS DATA SET
?
1
```

```
ENTER  0 TO PROCEED TO THE NEXT CASE.

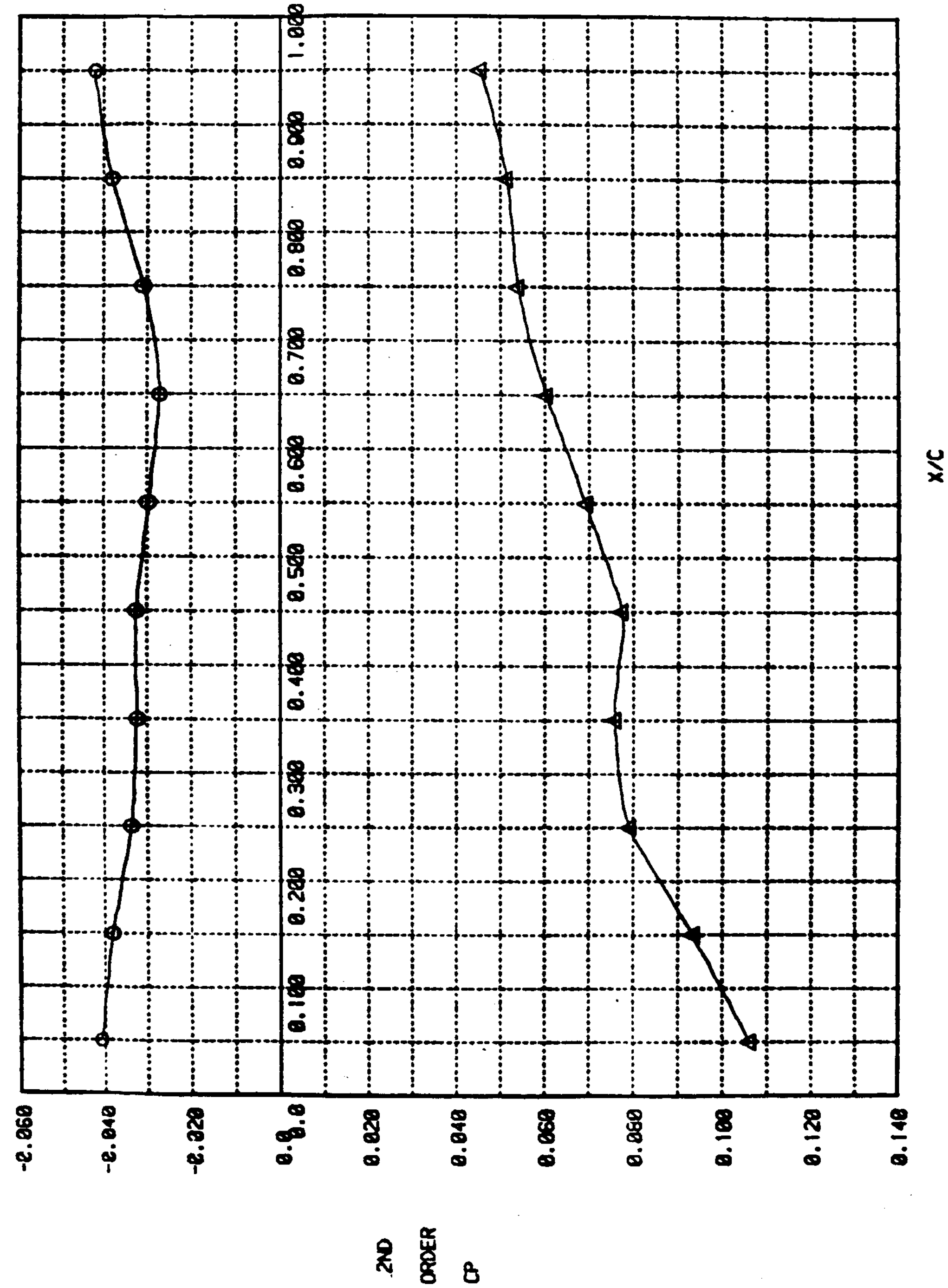
       1 TO PLOT THE THICKNESS DISTRIBUTION.
       2 TO PLOT THE    CAMBER  DISTRIBUTION.
       3 TO PLOT Z/C'S FROM TWIST & CAMBER.
       4 TO PLOT Z/C'S FROM TWIST CAMBER & FLAPS.
       5 TO PLOT CP NET.
       6 TO PLOT CP UPPER.
       7 TO PLOT CP BOTH.
       8 TO PLOT CP UPPER AND CP LOWER
       9 TO PLOT SPANWISE CHARACTERISTICS.

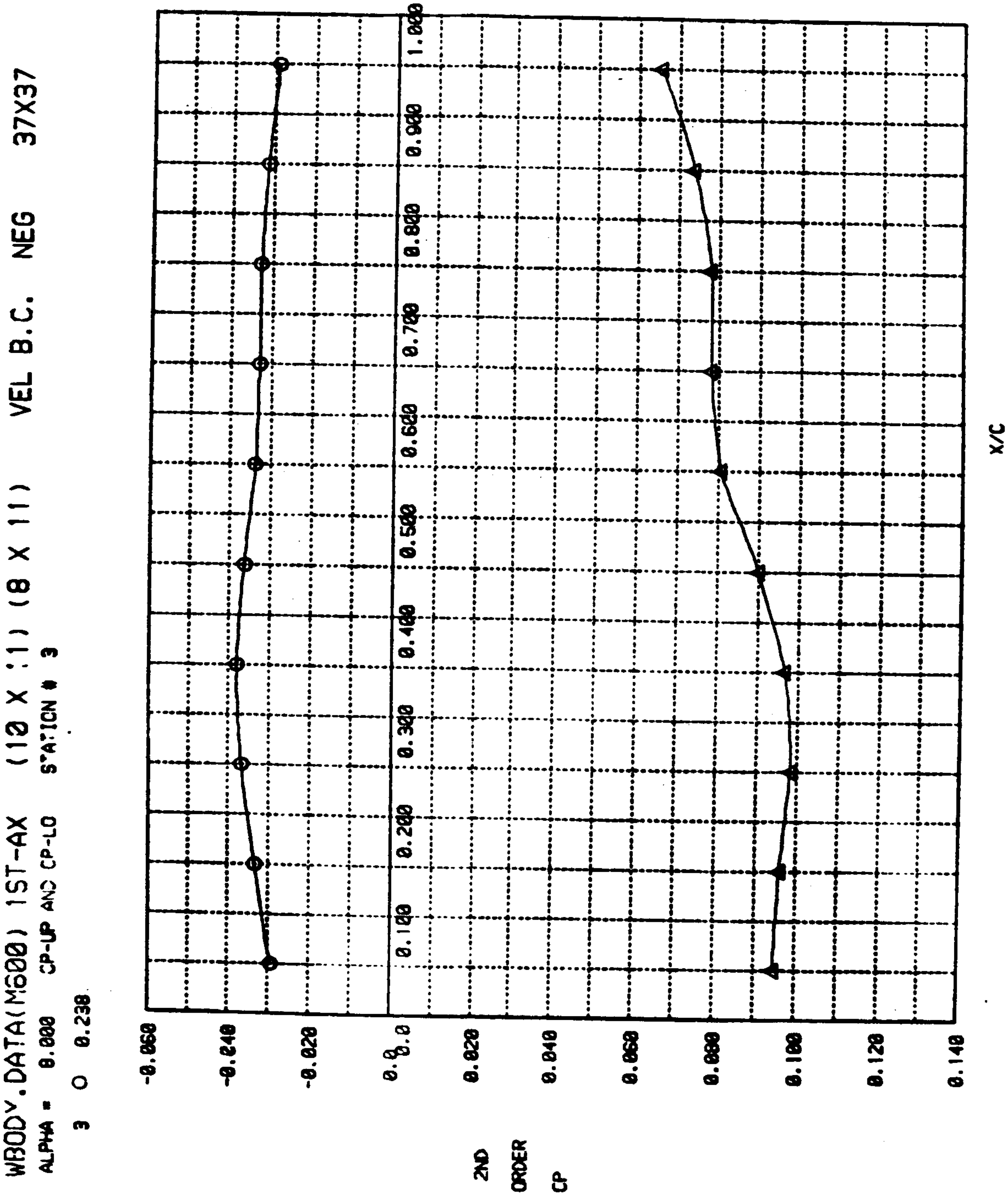
     > 9 TO EXIT CLIST.

?
8
```

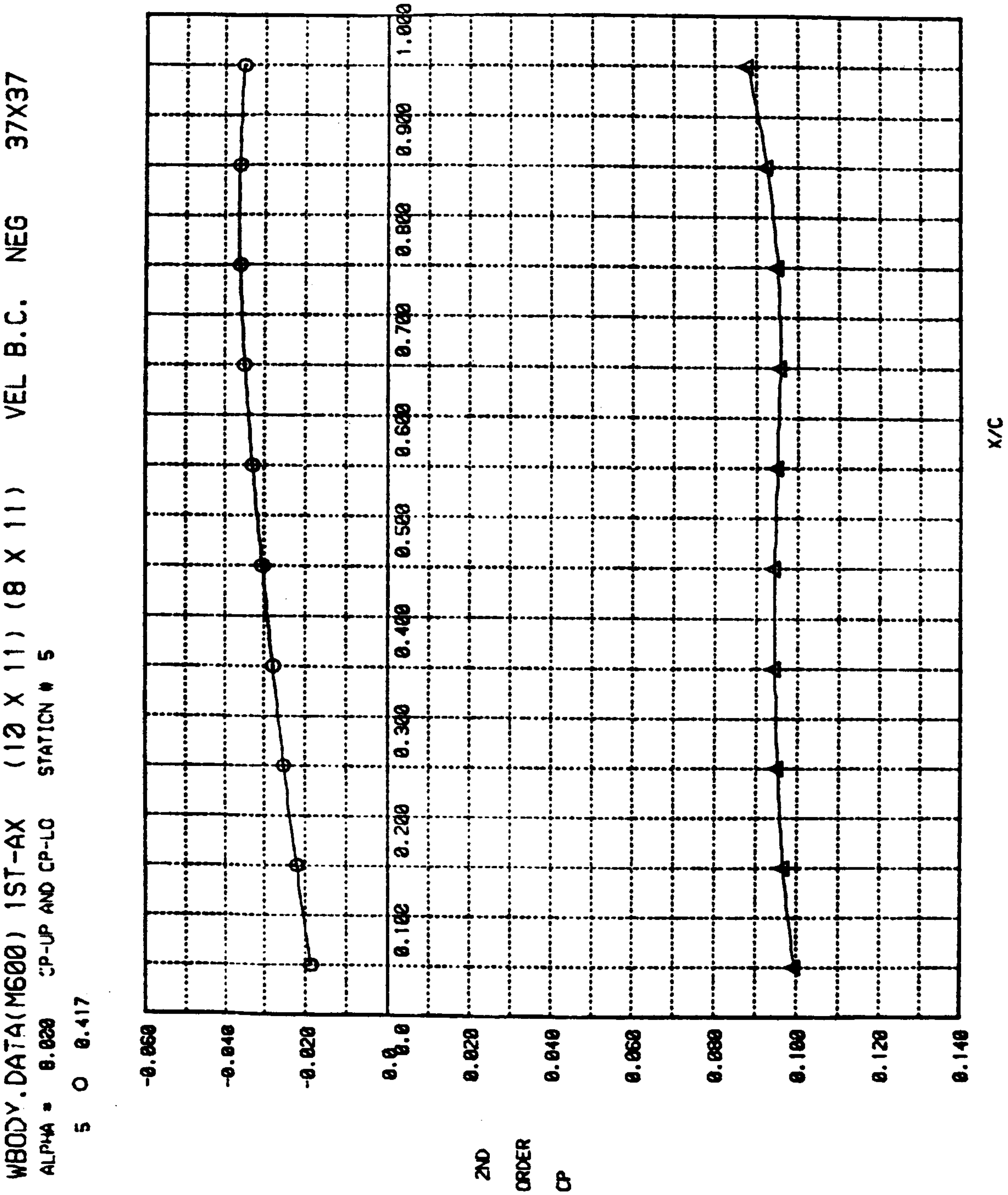
ORIGINAL PAGE IS
OF POOR QUALITY

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37
ALPHA = 0.000 CP-UP AND CP-LO STATION # 1
1 O 2.052




WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37
ALPHA = 0.000 CP-UP AND CP-LO STATION # 3
3 O 0.238
-0.060
-0.040
-0.020
0.0
0.020
0.040
0.060
0.080
0.100
0.120
0.140
2ND
ORDER
CP
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
X/C

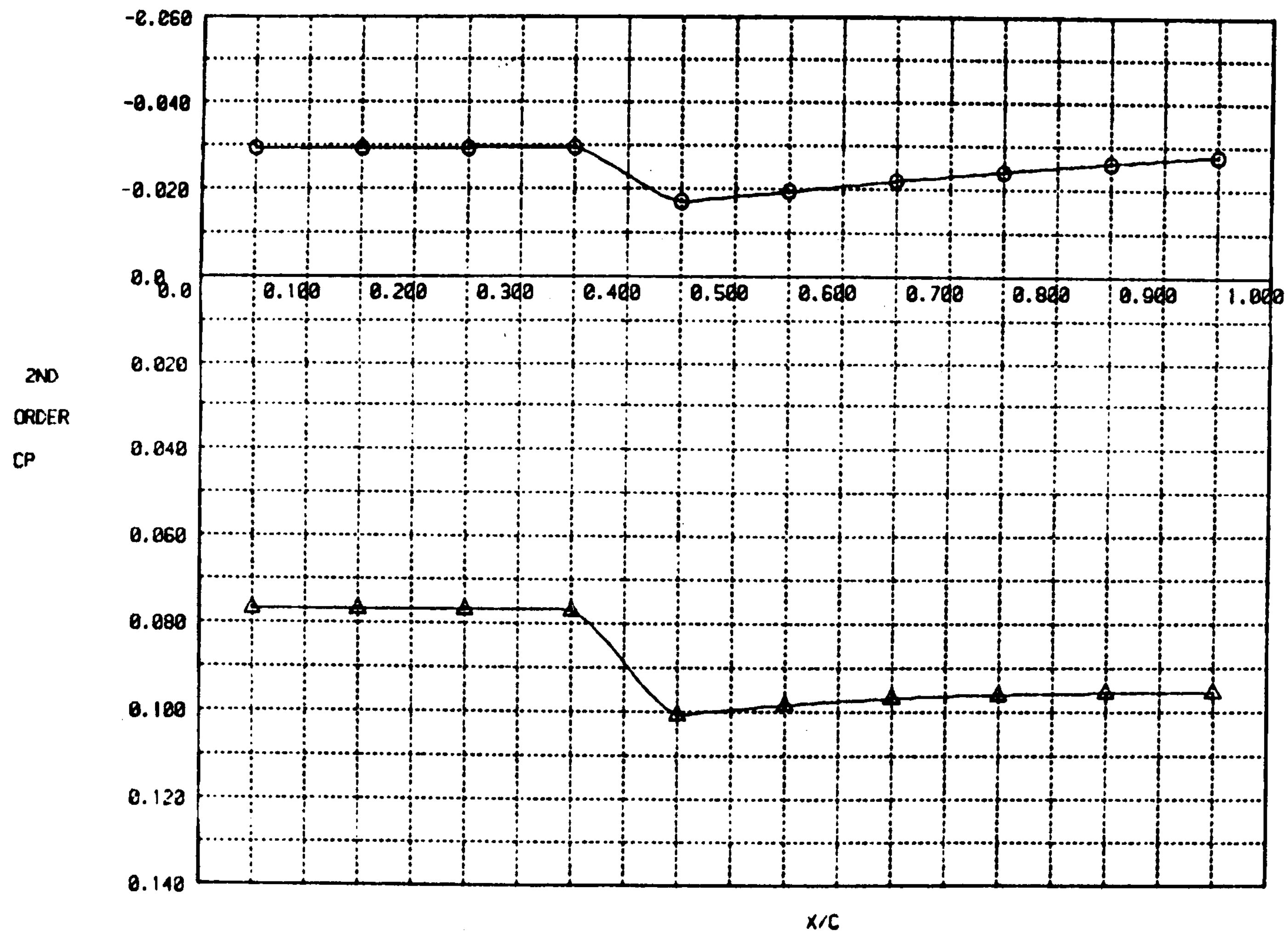
ORIGINAL PAGE IS
OF POOR QUALITY



WBODY.DATA(M600) 1ST--4X (10 X 11) (8 X 11) VEL B.C. NEG 37X37

ALPHA = 0.000 CP-UP AND CP-LO STATION # 7

7 O 0.596

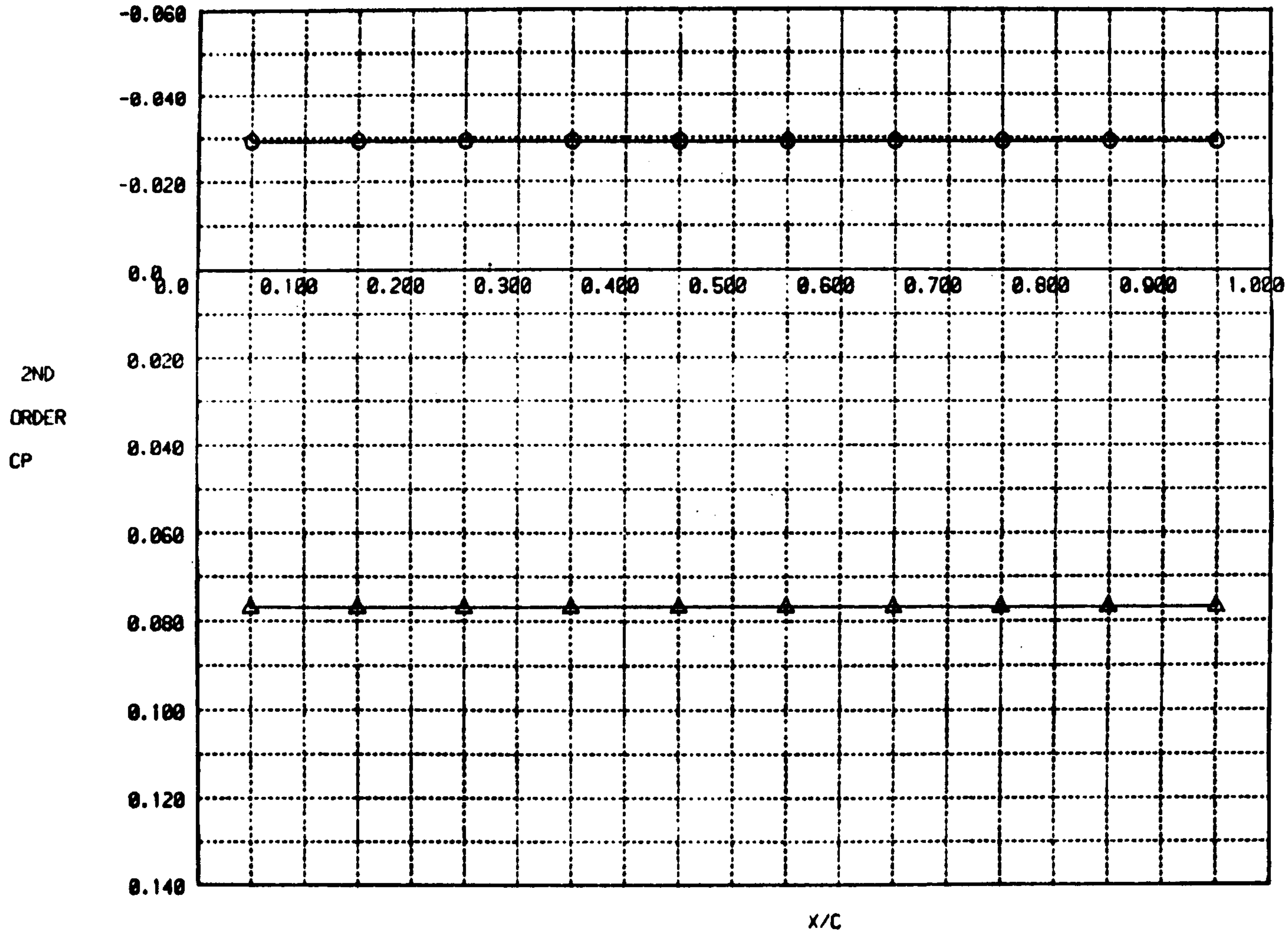


ORIGINAL PAGE IS
OF POOR QUALITY

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

ALPHA = 0.000 CP-UP AND CP-LC STATION # 9

9 O 0.774



```
ENTER  0 TO PROCEED TO THE NEXT CASE.

        1 TO PLOT THE THICKNESS DISTRIBUTION.
        2 TO PLOT THE   CAMBER  DISTRIBUTION.
        3 TO PLOT Z/C'S FROM TWIST & CAMBER.
        4 TO PLOT Z/C'S FROM TWIST CAMBER & FLAPS.
        5 TO PLOT CP NET.
        6 TO PLOT CP UPPER.
        7 TO PLOT CP BOTH.
        8 TO PLOT CP UPPER AND CP LOWER
        9 TO PLOT SPANWISE CHARACTERISTICS.

      > 0 TO EXIT CLIST.

?



   DATA SET  4          PLOT FILE CREATED BY OPT
   MACH = 6.20
      C = 2.0
  ALPHA =    8.00 DEG
  NSFCHK**********

   ENTER: 1 TO PLOT
     0 TO BYPASS THIS DATA SET
?
1

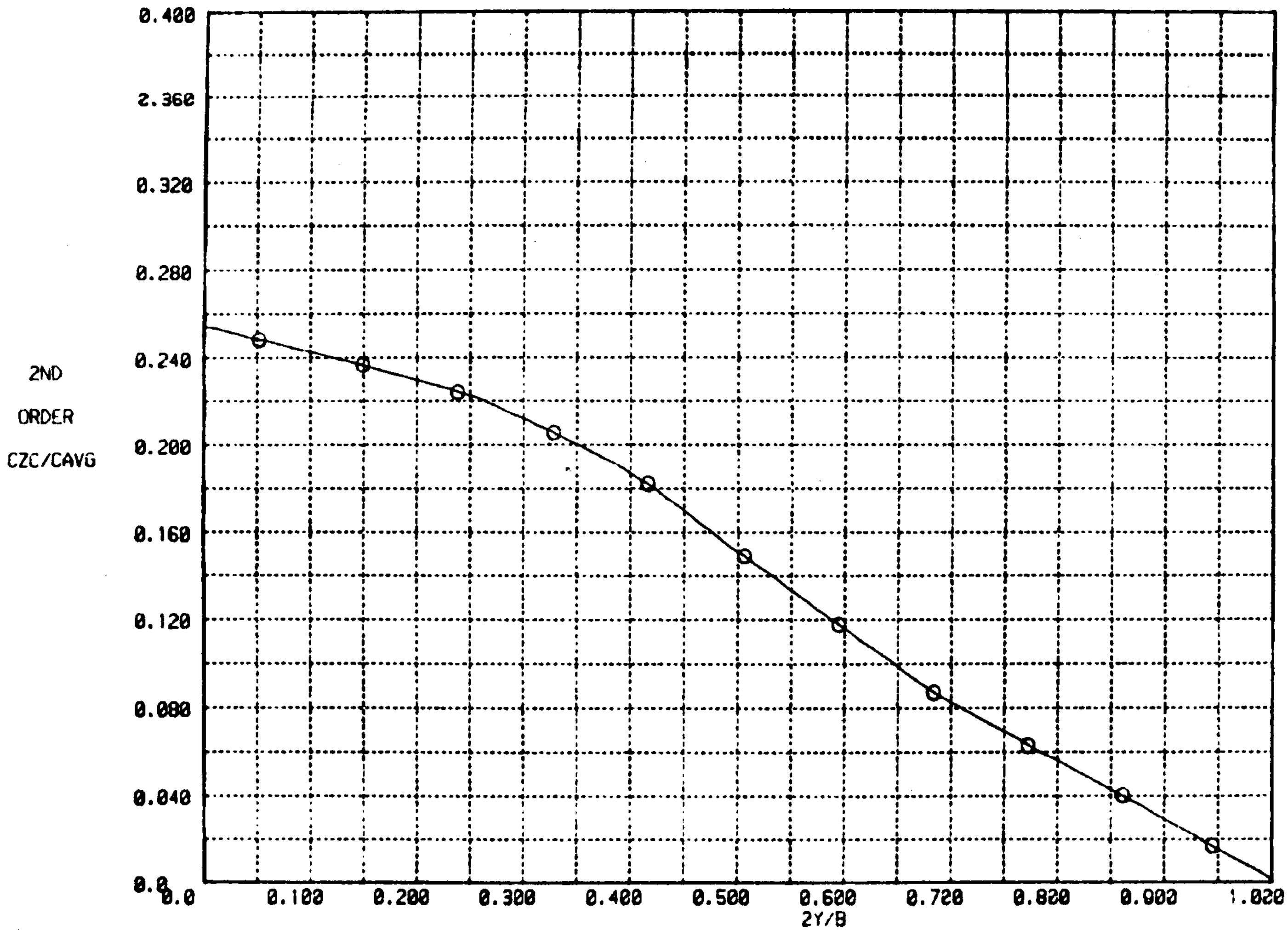


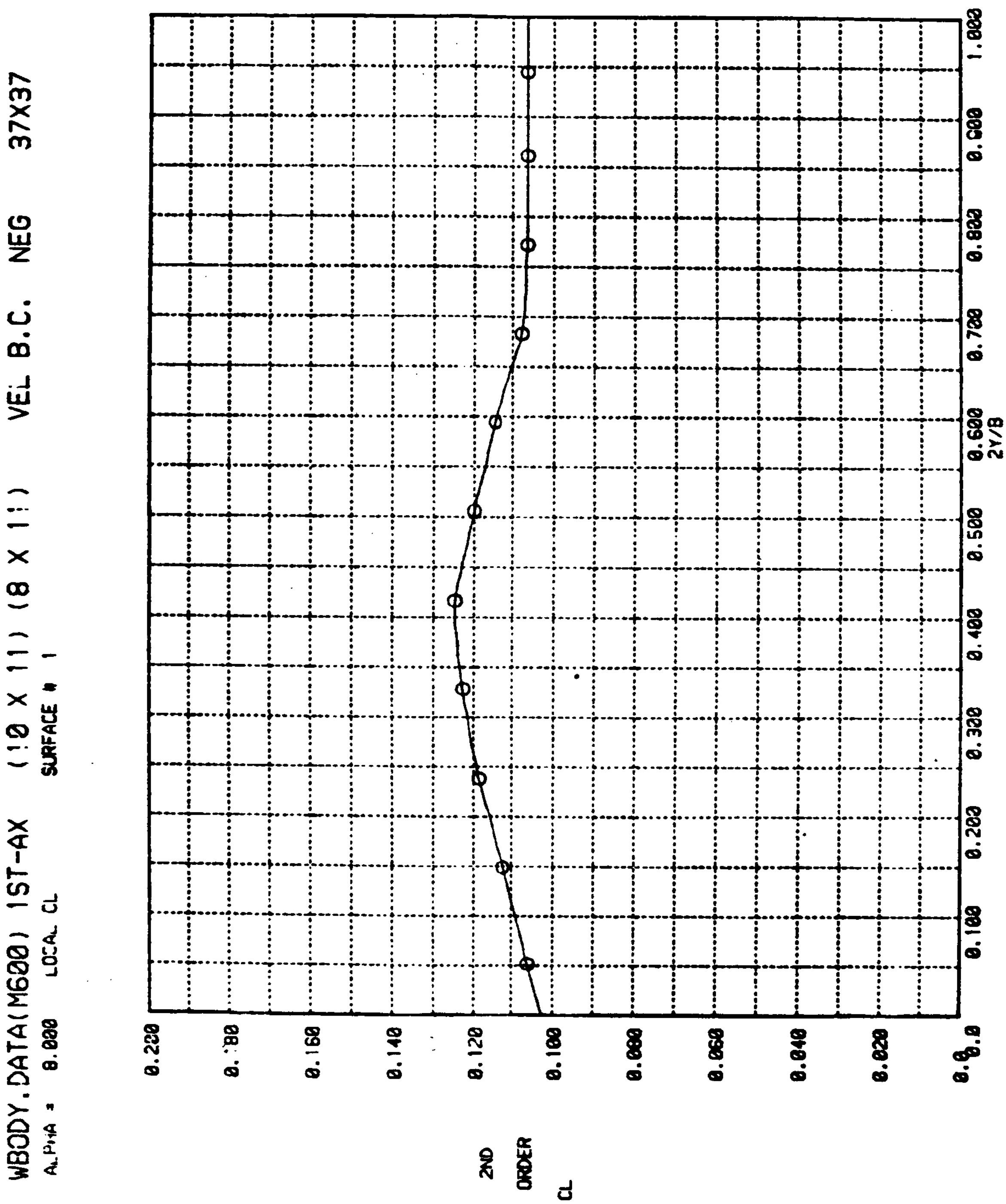
ENTER: 1 TO PLOT SPANWISE CHARACTERISTICS OF SURFACE   1
       0 TO BYPASS
?
1

ENTER 1 UNDER ITEM TO PLOT OR 0 TO BYPASS
TWIST    CN*C/CAVG    CN    CD*C/CAVG    CT*C/CAVG    X/C C.P.
?
1 1 1 1 1 1
```

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

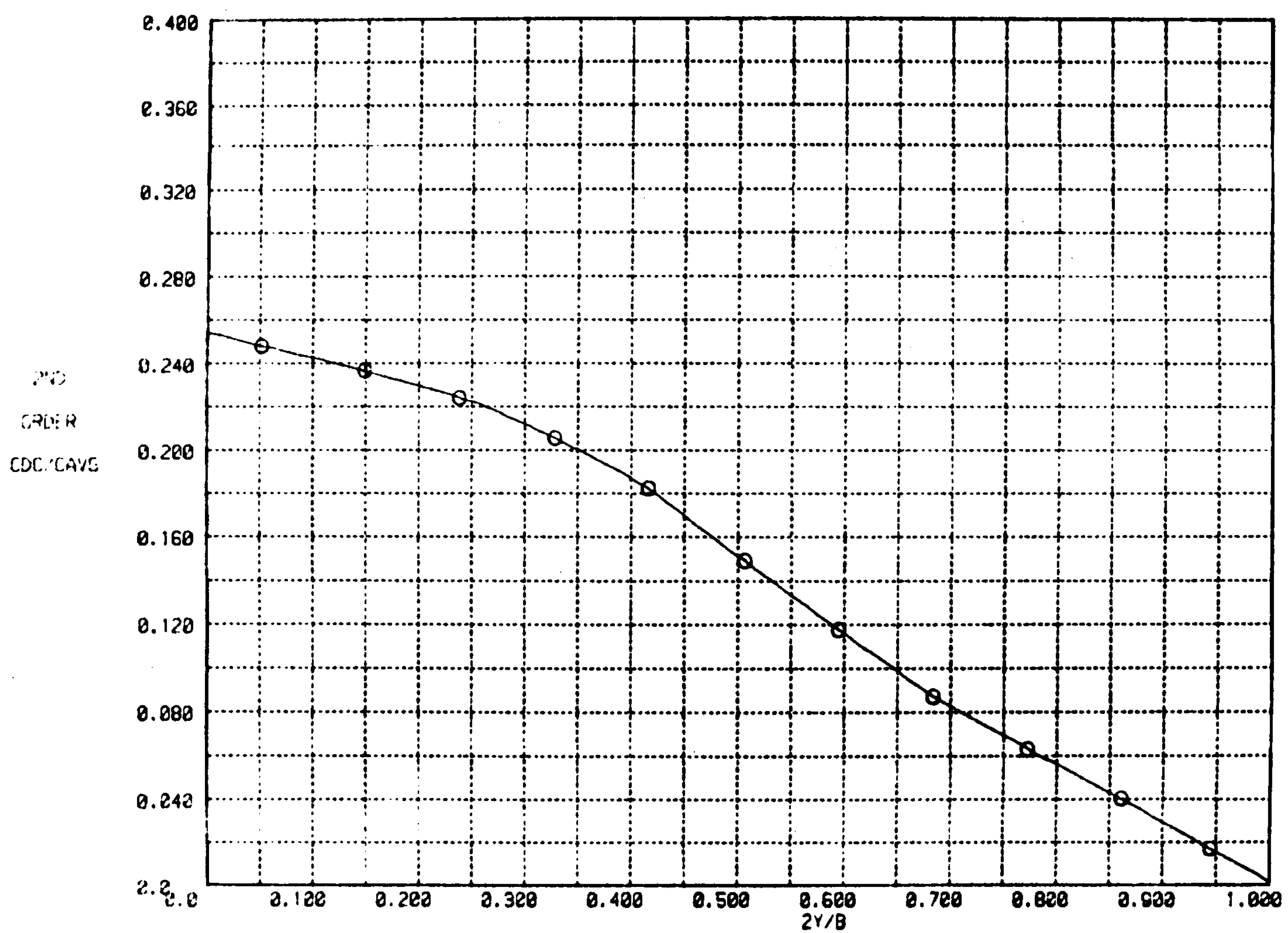
ALPHA = 0.000 NORMAL FORCE SURFACE # 1




WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37
ALPHA = 0.000 LOCAL CL SURFACE # 1
2ND ORDER CL
2Y/B
0.0
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
0.020
0.040
0.060
0.080
0.100
0.120
0.140
0.160
0.200

WBODY.DATA(M600) 1ST-AX (10 X 11) (8 X 11) VEL B.C. NEG 37X37

ALPHA = 8.000 SPANWISE DRAG SURFACE # 1



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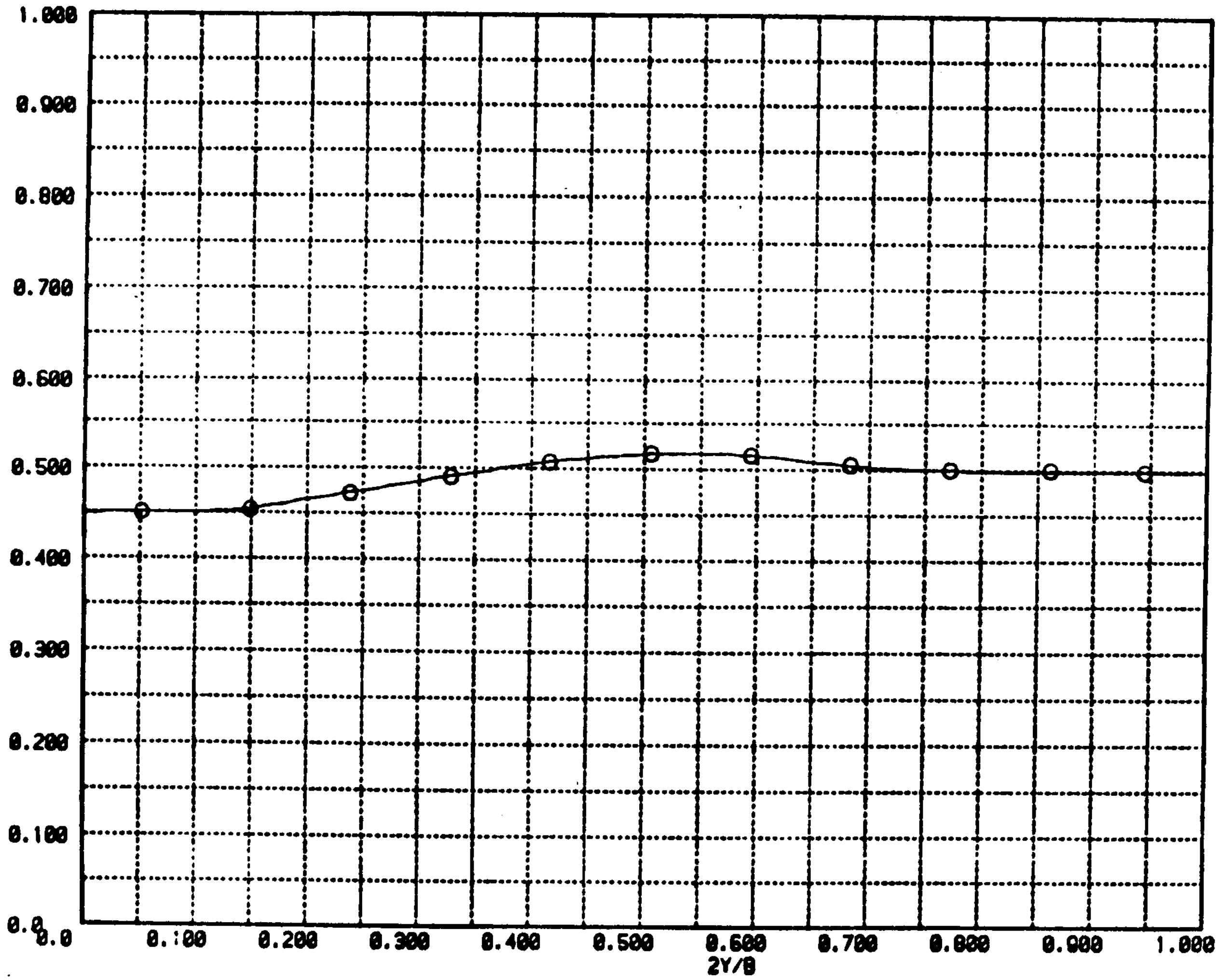
WBODY.DATA(M600) 1ST-4X (10 X 11) (8 X 11) VEL B.C. NEG 37X37

ALPHA = 0.000 CENTER OF PRESS. SURFACE # 1

2ND
ORDER
X/C CP



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OPTIMIZATION PROGRAM OPT

DISCUSSION

The computer program OPT obtains the optimum camber, twist, and/or flap deflections for a given configuration by obtaining the minimum zero suction drag subject to various constraints. On the lifting surface panels, the component of force in the drag direction is equal to the local angle of incidence times the force in the direction normal to the panel. The zero suction drag is thus defined as the sum:

$$Cd * SREF = \sum_{i=1}^{N} Cp(i) * Alpha(i) * Pa(i)$$

The index i runs over all N finite elements (panels) into which the aerodynamic surfaces are divided, and

Cp(i)	Is the delta Cp across element i
Alpha(i)	Is the local angle of attack of element i
Pa(i)	Is the area of element i

All pressures and velocities in program OPT are computed using subroutines from program WBODY which, for first order analysis, uses all of the assumptions of linearized, thin wing theory. Optimizations may be performed at all Mach numbers on configurations having up to ten surfaces, and one body. The program does not compute configuration geometry or aerodynamic influence matricies. This information is read from data files which are created by other programs such as WBODY or APAS.

The final optimized result may be constrained to maintain a total lift coefficient and center of pressure, and various combinations of lift coefficients on any specified set of surfaces, spanwise section lift coefficients, spanwise variation of sectional center of pressure (x/c-C.P.), spanwise twist variation, twist and camber over specified span stations, and flap deflection angle.

For a first order optimization, with or without a paneled body, twc different methods are used. The first uses constraint functions for chordwise pressure distributions at any or all span stations. Span stations having no chordwise pressure constraint functions may be thought of as actually having a number of constraint functions equal to the number of chordwise panels. Each function is then a delta function which is equal to 1.0 on the panel equal to the constraint function number, and equal to 0.0 elsewhere.

The second method uses chordwise polynomial curves, and flap deflection slopes over selected panels as camber constraint functions. The solution in each case consists of the coefficients of these constraint functions at each span station. If a paneled body is present, since its' geometrical shape is fixed, the only degree of freedom allowed for it is the angle of attack, which may be constrained to a fixed value if desired.

Second order optimizations may be performed, using camber constraint functions on planar configurations without a body. The influence of thickness must be considered, otherwise the result will be the same as a first order result.

Cases using chordwise pressure constraint functions, or using no constraint functions, will be referred to as a Cp optimization. This method of solution first yields panel strengths (delta-Cp's on vortex panels and source strengths on body source panels) which result in minimum drag, subject to any constraints, and then the camber and twist is determined from the panel strengths and the aerodynamic influence matrix.

When using camber constraint functions, the optimization will be called a twist optimization, which is a shortened form of saying twist and camber optimization. This name originates because the solution yields the twist and camber shapes which result in minimum drag, subject to any constraints. The panel strengths (delta-Cp's on vortex panels and source strengths on body source panels) may be obtained by solving the set of simultaneous equations using the aerodynamic influence matrix. The simplest case using this method would be a solution which considered only the lowest order camber functions, consisting of uncambered constraint functions (first order polynomials) at each span station. This would mean the angle of attack or twist at each span station was the only degree of freedom, and the solution would consist of the optimum distribution of twist with whatever initial camber was input.

The program uses geometry data, aerodynamic influence matricies, and the quasi-inverse matrix (if present), from either computer program WBODY, APAS or UDP. These data are read from datasets which are allocated to the correct unit numbers.

The program may also be used for analysis only using the geometry and aerodynamic influence matricies read from the respective datasets.

INPUT DATA

Input data, which directs the program operation, is read using subroutine DECRD1, described on page 19, and is stored in the array called "DATA". All locations are initially set equal to 0. Jet flap and vortex lift capability are not available in the program at this time and any input which refers to these capabilities could cause unpredictable results.

There are three different types of program operation, a Cp optimization, a twist optimization, and an analysis. The following is a brief description of the program input necessary for these three different modes. A more detailed description of all input locations follows.

Cp OPTIMIZATION

This option may be used to find optimum twist and camber subject to various constraints. Span stations may be designated where a specified camber is to be maintained, or where a specified chordwise Cp distribution is to be maintained. The unknowns consist of panel Cp's, at span stations where there are no constraint functions, and the coefficients of chordwise Cp functions at span stations where there are constraint functions. The camber is obtained by multiplying the optimized Cp distribution by the aerodynamic influence matrix.

The following data must be input for a Cp optimization.

Input variables	location
Total CL	4
XCG - the desired center of pressure	32

The following input is optional

Input variables	location	default
The number of chordwise Cp constraint functions	5	2
The type of aero matrix and inverse	7	0.
Second order anlysis of optimized result	8	none
Roll, yaw, and side force constraints (asymmetric)	11	none
Reference span station for angle of attack	21	1
Input camber	29	none
Mach number for suction calculation	35	geometry
x/c for n-velocity in drag analysis & optimization	36	0.515,0.875
CBAR	40	geometry
CAVG	41	geometry
SREF	42	geometry

SPAN	43	geometry
Additional angles of attack	52	none
Additional angles of attack (unit solutions)	62	none
Individual surface CL's	71	none
Fixed camber, or fixed Cp span stations	81 +	none
Desired CL*c/Cavg at span stations	151 +	none
Relative delta CL at span stations	201 +	none
x/c of center of pressure (C.P.) at span stations	251 +	none
Relative delta x/c-C.P. at span stations	301 +	none
Relative delta CL at span stations	351 +	none
Span stations with no constraint functions	401 +	see 5
x/c's to input camber (method # 3, see loc 29)	551 +	none
z/c's to input camber (method # 3, see loc 29)	601 +	none
Twist constraint reference stations	951 +	none
Additional input camber (method # 2, see loc 29), or fixed chordwise Cp distributions	2840 +	none
Flap deflections (input camber)	3340 +	none

The default "geometry" means the values from the dataset which contain the geometry are used.

The following input data controls the output which is printed

Type of Printout	location	default
Constraint equation printout	14	none
Thickness z/c, dz/dx, and initial camber	15	none
Geometry	16	some
Additional printout	19	some
Plot dataset created	20	none

TWIST OPTIMIZATION

This option may be used to find optimum twist camber and flap deflections. The constraint functions consist of camber geometry shapes, which result in a series of unit solutions, and the optimization consists of finding the coefficients of these unit solutions. The Cp's are obtained by solving a set of simultaneous equations using the aerodynamic influence matrix.

The final wing camber will be equal to the input wing camber (see data location 29) plus the appropriate sum of the camber constraint functions (if any) plus any flap defections.

The following data must be input for a twist optimization.

Input variables	location
Total CL	4
Twist optimization flag > 0.	17
XCG - the desired center of pressure	32

The following input is optional

Input variables	location	default
The number of camber constraint functions	5	1
The type of aero matrix and inverse	7	0.
Second order optimization or analysis	8	none
Roll, yaw, and side force constraints (asymmetric)	11	none
Trimmed or not trimmed	12	not
Reference span station for angle of attack	21	1
Type of interpolation for flaps	23	none
Input camber	29	none
Mach number for suction calculation	35	geometry
x/c for n-velocity in drag calculation and OPT	36	0.515,0.875
CBAR	40	geometry
CAVG	41	geometry
SREF	42	geometry
SPAN	43	geometry
Additional angles of attack	52	none
Additional angles of attack (unit solutions)	62	none
Individual surface CL's	71	none
Flap panel locations	81 +	none
Constraints on camber functions	151 +	none
Constraints on twist	351 +	none
Zero input camber at span stations	401 +	none
x/c's to input camber (method # 3, see loc 29)	551 +	none
z/c's to input camber (method # 3, see loc 29)	601 +	none
Twist constraint reference stations	951 +	none
Additional input camber (method # 2, see loc 29)	2840 +	1.0
Flap panel ratios and deflections	3340 +	none

The default "geometry" means the values from the dataset which contain the geometry are used.

The print control input is the same as for a Cp optimization.

ANALYSIS

The program may be used to analyze a given configuration at various angles of attack with or without camber. The program uses the specified input geometry and aerodynamic influence matrix. The Cp's at specified span stations may be set equal to zero in order to find the influence of various span stations or surfaces on other span stations or surfaces.

The following data input is required for an analysis.

Input variable	location
Analysis flag = 1.0	12

The following input is optional

Input variables	location	default
The type of aero matrix and inverse	7	0.
Second order analysis	8	none
Roll, yaw, and side force constraints (asymmetric)	11	none
Reference span station for angle of attack	21	1
Type of interpolation for flaps	23	none
Input camber	29	none
Mach number for suction calculation	35	geometry
x/c for n-velocity in drag calculation	36	0.515
CBAR	40	geometry
CAVG	41	geometry
SREF	42	geometry
Span	43	geometry
Angle of attack	51	add load
Unit solutions	61	41.02
Surface CL's	71	none
Span stations to zero Cp or camber	81 +	none
Additional input twist	351 +	none
x/c's to input camber (method # 3, see 29)	551 +	none
z/c's to input camber (method # 3, see 29)	601 +	none
Twist constraint reference stations	951 +	none
Additional input camber (method # 2, see 29)	2840 +	1.0
Flap panel ratios and deflections	3340 +	none

The default "geometry" means the values from the dataset which contain the geometry are used.

The print control input is the same as for a Cp optimization.

DETAILED DESCRIPTION FOR DATA INPUT

Location	Data
1	If this value is nonzero the case is terminated
4	The total CL of all surfaces.
5	I.J NFX = I = The number of chordwise constraint functions NFY = J = The number of spanwise constraint functions

Two cases:

1. DATA(17) = 0.   Called a Cp optimization.
   Cp optimized - camber results from Cp

   I = 0   NFX = 2 is used as a default value.
   I < 0   No constraint functions are used.

   Constraint functions should always be used for subsonic Mach numbers.

   Individual span stations may be specified where no constraint functions are desired using data locations beginning at 401.

   Fixed span stations (see location 81) always have no constraint functions.

   NFY is ignored (NFY = 0 is used regardless of input)

2. DATA(17) > 0. Called a twist optimization.
   Camber optimized - Cp results from camber

   I = 0   Twist only is optimized. (same as I = 1)
   I > 1   Twist + (I-1) camber constraint are used.

   If J = NFY > 0   (works only with a single surface)

   The twist (or camber constraint coefficient) values, U(k,eta), are constrained spanwise on each surface In the form:

$$U(k,eta) = \sum_{i=0}^{NFY} a(k,i+1) * eta^{i} \qquad k = 1,NFX$$

7 IMATRX.JMATRX

IMATRX < 0 If the aero matrix is from WBODY.
IMATRX < - 1 If the last aero matrix is an inverse matrix.
IMATRX < - 2 If 1st aero matrix is a thickness matrix.

JMATRX > 0 This is used only with configurations having bodys which are paneled with source panels.

JMATRX	Bodymx	Body Cp	Un	(for body configurations only)
0	Yes	No	No	
1	Yes	No	Yes	
2	Yes	Yes	Yes	
3-4	Half	No	No	(does constraint functions)
5	No	No	No	
6	No	Yes	No	
7-9	No	No	No	

8 < 0. Second order analysis.
≤ -1. Second order optimization is performed.
< -1. Second order optimization, including thickness drag.
A second order optimization can be used with DATA(17) > 0. only

9 The value of q (dynamic pressure). This input is used to signal that a flexible configuration is being considered. This can be used only with a twist optimization (DATA(17) > 0.).

10 The number of g's at the design CL (DATA(4)). This value is used to multiply the weights from locations 1801-2301 in order to find the deflections due to the inertial loads on a flexible configuration.

11 If 0. The symmetry data from the geometry dataset is ignored.

= 1. Constraint equation included for roll.
= 2. Constraint equations included for roll and yaw.
= 3. Constraint equations included for roll yaw and side force.
> 3. Uses symmetry data with no additional constraints.

These constraints are used only for asymmetric configurations XCG, YCG and ZCG obtained from DATA(32-34)

If a negative number is input, a solution is obtained for flap settings to satisfy a roll constraint for a flexible configuration. When applied to symmetric configurations an anti-symmetric aero matrix should be used. If q = 0. is desired (DATA(9)), set q < 0.

12 If < - 2. Prints geometry only, no optimization or analysis.
If = - 2. No add load and no drag polar.
If = - 1. If DATA(17) > 0. , calculates trimmed polar.
If = 0. An add load and an optimization is computed.
If = 1. Computation using input cambers (analysis only).
If > 1. Computation using Cp's from plot dataset (WBODY).

14 M1X.NUX M1X = the number of constraint equations printed
NUX = the number of Q(I,J) (drag matrix) rows printed.
If greater than the number of equations, all are printed.
If a negative number is input the equations will be printed Only if the matrix is singular.

15 = 1. Print source dz/dx and z/c matricies
= 2. Print both source and camber arrays
= 3. Print camber slope matrix

16 The geometry printout
If > 0. or < -1. A wide range of geometric parameters will be printed.

17 If > 0. A twist optimization will be performed, unless DATA(12) > 0.

It may be recalled that a twist optimization is only a term used to designate the type of optimization procedure involved. The twist optimization procedure may be used to find optimum twist camber and flap deflections. The following input should be considered when performing a twist optimization.

The final wing camber will be equal to the input wing camber (see discussion for data location 29) plus the appropriate sum of the camber constraint functions (if any) plus any flap defections.

18 Printout of velocities due to thickness (source panels).

- ≥ 1. printout of w velocities (normal to panel).
- ≥ 2. printout of u velocities (x direction).
- ≥ 3. printout of v velocities (bi-normal to panel).
- ≥ 4. printout of z/c for thickness.
- ≥ 5. printout of dw/dx (2nd order only).

19 INTMED Various orders of intermediate printout (-2. to 4.)

- -2. Least printout (no drag n-velocities)
- -1. No upper and lower surface cps
- 2. More printout
  Prints flexible unit solutions and
  (w-w), (w-b), (b-w), (b-b)
- 3. Above +
- 4. Above + 2nd order boundary condition solutions

20 DPLOT 0. No data is placed in a plot dataset.
- 1. Data is placed in an APAS plot dataset (geometry).
- 2. Data is placed in a UDP plot dataset.
- > 2. Data is placed in a UDP plot dataset (extended).

21 The reference span station which will be used to calculate the angle of attack. This angle of attack is only used for reference purposes in order to calculate twist. If AO(K) and AO(J) are the local angles of attack with respect to the freestream, COSZ(J) and COSZ(K) are the local dihedral angles, and K is the reference span station, then:

Alpha = AO(K) / COSZ(K)

and the value of twist for span station J will be:

TWIST(J) = AO(J) - Alpha * COSZ(J)

- K < 0 All twist values will be referenced to the freestream, i.e. Alpha = 0.
- K = 0 K = 1 is used. If a body is present then Alpha is determined by the angle of attack of the body.
- K > 0 This station is used as the reference span station. determined by the angle of attack of the body.

24 < 0. All normal velocities (slopes), used to compute the zero suction drag, are interpolated chordwise from the boundary condition control points (usually x/c = 0.875 of each panel) to x/c = RD (see DATA(36)). A third order curve fit is used for this purpose.

Otherwise (default), the normal velocities are interpolated assuming possible discontinuities where flap panels occur (see locations 81-150), and the chordwise interpolation of normal velocities is performed while the flap deflections are removed. The interpolation is performed using information obtained in data location 36.

26-28 S.K Surface to be extended to centerline (paneled bodies only)

If > 0 The surface will only be extended when the aero influence matrix is calculated.

S = surface number (in ascending order).

K = 0 Extend inboard panels with zero sweep.
K = 1 Extend inboard panels with same sweep.
K = 2 Extend inboard panels with negative sweep.

i.e. if DATA(26) = 2.0 The calculation of the aero influence matrix for surface # 2 will be performed by extending the inboard panels to y = 0. with zero sweep.

29 N.MF (N,M,F integers) Initial camber input specification.

N < 0 No initial camber is assumed.

There are three ways of inputing any initial camber and the resulting camber slopes from each method will be added together.

1. Reading span station twists and camber normal velocities at panel control points from the dataset containing the geometry.

2. Inputing normal velocities at panel control points using locations beginning at 2840 or 3340. For cases where it is appropriate, values of twist may be input using data locations beginning at 351.

3. Inputing x/c and z/c using locations beginning at 3951 and 4001.

method # 1

If $M > 0$, the camber will be read from the geometry dataset in the following manner.

$M = 1$ The camber values only (not the twist or angle of attack) are to be read from the geometry dataset. Any twist in the initial camber is removed.

$M = 2$ The camber values only (not the twist or angle of attack) are to be read from the geometry dataset.

$M = 3$ The twist and camber values (no angle of attack) are to be read from the geometry dataset.

$M = 4$ The twist, camber and angle of attack are to be read from the geometry dataset.

If $F \geq 0$, the camber will be read from the geometry dataset in the following manner.

$F \geq 2$ The flap values will be read from the geometry dataset and subtracted from the initial camber.

$F \geq 4$ After subtracting from the initial camber, any flap deflections from the geometry dataset are set equal to zero.

method # 2

Unless N < 0, twist and camber values may be obtained from normal velocities (normal facing upward from the panel) input in the order of the control points beginning in locations 2840 and 3340. The values input in these locations may include both twist and camber. If no values are input, there will be no be no camber input by this method, since all data locations are initially set equal to zero for the first case. The values from the 2840's are assumed to represent a smooth camber distribution and will be interpolated to compute drag. The values from the 3340's are assumed to be due to flap deflections and will not be interpolated when drag is computed (see DATA(24)).

method # 3

If N > 0 camber may be input in the following manner.

N = ND > 2, the number of x/c values where the z/c values for camber are specified (locations 3951,4001). These x/c stations are the same for all span stations and must include x/c = 0. and x/c = 1. The camber, and z/c's apply to fixed span stations only (see DATA(81)), unless DATA(17) > 0.

31 X00 The x value of the pivot point for angle of attack. Used for second order theory only.

32 XCG The desired center of pressure (to override value from the geometry dataset. If a value < -99999. is input the XCG constraint is not used.

33 YCG For non-symmetric rolling moment only (see DATA(11))

34 ZCG For non-symmetric rolling moment only (see DATA(11))

35 The freestream Mach number (used for computing leading edge suction only).
If 0. the value from the geometry dataset will be used.
If < 0. the Mach number will be set equal to 0.

36 RC The x/c on each panel where the normal velocities (local angles of incidence) are interpolated for optimizing drag and for computing drag.

If RC < 0.	OPT @ x/c = - RC	analysis @ x/c = 0.515
If RC = 0.	OPT @ x/c = 0.875	analysis @ x/c = 0.515
If RC > 0.	OPT @ x/c = 0.875	analysis @ x/c = RC

Recall that the drag increment from each panel is equal to the delta Cp times the area times the local angle of incidence. The local angle of incidence may vary in the chordwise direction, and the boundary condition is satisfied on each panel only at x/c = 0.875. Therefore the interpolation is necessary to obtain an angle of incidence for each panel which is a closer approximation to the average value for the panel.

37 RS The x/c fraction of each panel which is used to curvefit (x,Cp(x)) in order to obtain an approximate value for the leading edge suction (default = 0.250).

Since RS < 1.0, if the value is input as M.RS, with M ≥ 1, M will be the number of functions used for the curvefit. If M = 0, the default value is 3 functions (i.e. M = 3). If < 0. a detailed printout results.

Drag polar (41 points given)

38 Delta CL for drag polar. Default = 0.05
39 Starting CL for drag polar. Default = 0.0

40	CBAR	The reference chord length for computing Cm If 0. CBAR = CAVG is used.
41	CAVG	The reference chord length. If 0. value from the geometry dataset is used.
42	SREF	The reference area. If 0. value from the geometry dataset is used.
43	Span	Span, any consistent set of units may be used. This value is used for reference purposes only. If 0. value from the geometry dataset is used.
50		Initial guess for angle of attack (for configurations having bodys paneled with source panels)
51	ALPHAD(1)	The configuration angle of attack with respect to the freestream (degrees). This is in addition to any camber distribution. For an optimization the resulting angle of attack is used for ALPHAD(1). If a value is input for ALPHAD(1), and a body is present, it will be assumed to be a constraint on the body angle of attack.
52 58	ALPHAD(2) ALPHAD(8)	The 2nd angle of attach where an analysis is desired. (maximum number of angles of attack = 8) If ALPHAD(K) < -90. ALPHAD(K-1) is used. If ALPHAD(K) > 90. an add load solution is given. i.e. (Alpha = 1.0) - (Alpha = 0.0)
61	CAMTHK(1)	Input in form OB-OV.CAM.THK, and used with ALPHAD(1) This input is used to define which set of unit solutions to combine into a final solution. Since the solution is linear, the unit solutions may be combined in any combination. OB = the order of the Cp on the body (one digit). OV = the order of the Cp on the lifting surfaces). CAM > 1 camber included. THK > 1 thickness included. CAM = 0 no camber included. THK = 0 no thickness included. OB, OV, CAM, THK are each one digit.

```
If = 0.  OB = 4, is used for the body Cp,
         OV,     is determined by DATA(8), and
                 camber and thickness are included.

         OV = 2, if DATA(8) < 0.

If < 0.  Same as above except the 2nd order axial
           solution (if performed) is used to
           calculate  u,v,w.

The body pressure formula is
  determined by the value of OB.
```

OB	Cp
1	Cp = - 2 * u
2	Cp = - 2 * u - beta2 * u*u - v*v - w*w
3	Cp = - 2 * u - u*u - v*v - w*w
4	Cp = Isentropic pressure formula (default)
5	Cp = Isentropic for Alpha = 0. + isentropic add load.

```
u,v,w  Use 1st order axial contributions if camthk > 0
u,v,w  Use 2nd order axial contributions if camthk < 0
```

E.g. CAMTHK = - 31.02

```
 - Indicates, 2nd order u,v,w from axial solution (if performed).
 3 indicates, pressure formula #3 on body.
 1 indicates, 1st order Cp on lifting surfaces.
 0 indicates, camber is not included.
 2 indicates, thickness  is included.
```

62 CAMTHK(2) Used with ALPHAD(2)
68 CAMTHK(8) Used with ALPHAD(8)

71 The desired values of CL for each surface. (maximum of 10)
If 0. the CL will not be constrained for that surface.

81 The input depends on whether a Cp optimization, a twist optimization, or an analysis is to be performed.

* * * For a Cp optimization (DATA(17) = 0.) * * *

The input consists of the list of span station numbers where a fixed camber is desired, followed by a list of span stations (input as negative numbers) where a fixed Cp distribution is desired.

The span stations where a fixed camber is desired are referred to as fixed span stations, and the resulting camber slopes will be equal to the initial input camber. The list of span station numbers must be in ascending order.

These span stations have the following properties:

1. If a span station number in the list is input as J.K, K > 0, rather than just J., then the J'th span station is assumed to be a fixed span station with an unknown value of twist (see 351 for a definition of twist). All subsequent fixed span stations will have this value of twist (plus any twist difference specified by the inital input camber, which may contain twist, or the values obtained from locations beginning at 351), until another J.K is found in the list of fixed span stations. (e.g. this option could be used for a fixed surface with an unknown deflection).

2. There are no Cp constraint functions used. Each panel Cp is regarded as an unknown (this can be thought of as a delta function type constraint function).

3. The initial twist and camber is used (see the discussion for data location 29).

4. The final slopes are obtained by adding the optimized angle of attack to any initial input twist and camber.

5. No x/c-C.P. constraint is allowed.

6. No CL*c/CAVG constraint is allowed.

The span stations where a fixed Cp distribution is desired are input as negative numbers following the list of span stations where a fixed camber is desired. The list of span station numbers must be in ascending order. The Cp distribution for this span station is input in place of normal velocities in locations beginning at 2840.

i.e. If the span station has panel numbers beginning with ij1 and ending with ij2, the Cp's are input in locations (2840 + ij1 - 1) thru (2840 + ij2 - 1).

These span stations have the following properties:

1. There is one Cp constraint functions used at each of these stations. This constraint function has the desired Cp distribution.

2. If a span station number in the list is input as - J.K, K > 0, rather than just - J., then the J'th span station will have the desired Cp distribution multiplied by a constant to be determined during the optimization.

3. No x/c-C.P. constraint is allowed.

4. No CL*c/CAVG constraint is allowed.

5. Twist constraints may be used in the same manner as with span stations which do not have a fixed camber (see the above discussion of fixed span stations and the discussion of twist constraints at data location 351).

* * * For a twist optimization (DATA(17) > 0.) * * *

These locations are used to define the panels where flaps are located. It may be recalled that a twist optimization is only a term used to designate the type of optimization procedure involved. The twist optimization procedure may be used to find optimum twist camber and flap deflections. Further properties of these flaps (deflection ratios) may be input in locations beginning with 3340.

1. An input value of J.MMNNKK means that for span station J flap number KK runs from panels MM to panels nn. If KK is input as 00 it will be set equal to 01. A maximum of 20 flaps are allowed (KK=20).

*** For an analysis (DATA(12) = 1.) ***

For an analysis these locations are used to specify the span stations where the Cp's are to be set equal to zero, or the normal velocities on all panels of the span station are to be set equal to zero.

This feature may be used to find the normal velocities induced on any set of span stations (or surfaces) by the remaining set of span stations (or surfaces). The normal velocities induced at the panel control points by all span stations where the panel Cp's were not set equal to zero may be found under the heading "DRAG N-VELOCITIES" in the printed output. Angle of attack and the presence or absence of camber may be controlled using locations 51-58 and 61-68. Data location 36 should be set equal to 0.875 to supress the interpolation of the normal velocities to other than the panel control point (x/c = 0.875). The average incidence of induced velocities, for the first angle of attack only, may be found under the twist column in the printed output, or in the plot output dataset as twist.

The span station numbers should be input in ascending order.

1. A span station number input as a positive number will cause the panel Cp's to be set equal to 0.0 on that span station. The panel Cp's on all remaining span stations (except those as described below) will remain at the value achieved after an analysis at the specified angle of attack, and with or without the presence of camber.

2. A span station number input as a negative number will result in the normal velocities on each panel of that span station to be equal to 0.0. The Cp's on all span stations input as negative numbers are adjusted to achieve this result by canceling the normal velocities induced by all panels where the Cp's were not set equal to 0.0.

151 ** For a Cp optimization (DATA(17) = 0.) **

The desired values of CL*C/CAVG at each span station. If 0. is input, the value is unconstrained.

** For a twist optimization (DATA(17) > 0.) **

Used in conjunction with DATA(5), these locations are used to fix the coefficients of the camber constraint functions to desired values (input < 1.), or to constrain the value to be equal to the value at another span station (input the other span station number ≥ 1.). If left 0., the coefficient value is unconstrained and an optimized value will be chosen. Only the camber constraints are input at these locations. For twist constraints see location 351.

If a camber constraint coefficient of a given order is constrained, all higher order coefficients at the same station are also constrained, even if zero is input.

Input is in order of the functions at each span station.

151	1st camber function for station # 1
152	2nd camber function for station # 1
	.
	.
150+(NFX-1)	1st camber function for station # 2
	2nd camber function for station # 2
	.
	.

Locations 201 - 350 are used for Cp optimizations only.

201 The relative value of delta CL at each span station If no values are input, the constraints will be satisfied exactly.

251 The desired values of x/c-C.P. At each span station If 0. is input, the value is unconstrained

301 The relative value of delta x/c-C.P. at span stations At least one of these values must be nonzero if any x/c-C.P. values are asked for. If a uniform change in x/c-C.P. is desired the value in these locations should be equal to the expected value of CL*c/CAVG.

351 These locations are used for inputing initial twist values or twist constraints. The input in these locations depends on whether a Cp optimization, a twist optimization, or an analysis is being performed. The twist of a span station is defined below.

*** For a Cp optimization (DATA(17) = 0.) ***

If span station J is a fixed span station, the values input in DATA(350+J) are treated as part of the initial twist input for span station J. Therefore if span station JP is the immediately preceeding fixed span station (to span station J), which had an unknown value of twist (J.K in DATA(81-150)), the resulting optimization will have:

TWIST(J) = TWIST(JP) + (TWISTO(J) - TWISTO(JP))

where TWISTO(J) and TWISTO(JP) are the initial twist input values for span stations J, and, JP respectively (see data(29) for the input of initial twist and camber.

If J = 1 the angle of attack of the first span station will be equal to DATA(351) plus any initial angle of attack (from locations beginning at 2840 and 3340 and the geometry input dataset (fixed span stations only).

If span station J is not a fixed span station, any values input in DATA(350+J) are will be used to constrain the twist difference between span station, J, and a reference span station, JR. If DATA(350+J) = 0. the value of TWIST(J) will be unconstrained. Therefore the resulting optimization will have:

TWIST(J) = DATA(350+J) + TWIST(JR)

JR = DATA(950+J)

if JR = 0	JR = J-1	is used
if JR > 0	JR = JR	is used
if JR < 0	the constraint is made with respect to the free stream. i.e.	

TWIST(J) = DATA(350+J)

* * * For a twist optimization (DATA(17) > 0.) * * *

If DATA(350+J) = 0., then the twist of span station J will not be constrained.

Any values input in DATA(350+J) will be used to constrain the twist difference between span station, J, and a reference span station, JR. If the initial twist of station J was set equal to zero (see data(401)), the twist constraint is made on the final twist difference between the stations. If the initial twist was not set equal to zero, the constraint is made on the difference in the twist increments which are added to the initial twists at the two span stations.

final twist difference constraint

TWIST(J) = DATA(350+J) + TWIST(JR) + TWISTO(JR)

constraint on increment

TWIST(J) = DATA(350+J) + TWIST(JR)

Where:

TWISTO(L) is the initial input twist of any station L
TWIST(L) is the increment of twist give to station L

TWIST(L) + TWISTO(L) is the final twist of station L

JR = DATA(950+J)

if JR = 0 JR = J-1 is used
if JR > 0 JR = JR is used
if JR < 0 the constraint is made with respect to the free stream. i.e.

TWIST(J) = DATA(350+J)

If J = 1 the angle of attack of the first span station will be equal to DATA(351) plus any initial angle of attack (from locations beginning at 2840 and 3340 and the geometry input dataset.

*** For an analysis (DATA(12) = 1.) ***

```
TWIST(J) = DATA(350+J) +   Twist0(J)
```

i.e. the initial twist of span station J is Increased by a fixed increment (DATA(350+J)).

The twist of a given span station is defined as the angle of attack of the span station (with any camber removed) with respect to the freestream, when the angle of attack of the configuration is zero. This means the twist of span station J is equal to the local angle of attack with respect to the freestream, A0(J), reduced by the angle of attack, Alpha, times the local dihedral angle, COSZ(J).

i.e. TWIST(J) = A0(J) - Alpha * COSZ(J)

Alpha Is either the angle of attack of the reference span station or zero (see DATA(21)).

The angle of attack, Alpha, may be obtained from the local angle of attack, A0(K), of the reference span station K, which is measured with respect to the freestream.

```
Alpha = - A0(K) / COSZ(K)
```

e.g. Suppose reference span station K and span station J have local angles of attack A0(K), and A0(J), with both A0(J) and A0(K) measured with respect to the freestream. Let COSZ(K) and COSZ(J) be the local dihedral angles. Then if a(K) and A(J) are the respective angles of attack after a pitch angle Alpha:

```
A(K) = A0(K) + Alpha * COSZ(K)

A(J) = A0(J) + Alpha * COSZ(J)
```

The twist of span station J is defined as the local angle of attack, A(J), when the reference angle of attack, A(K) = 0. Therefore using the above:

```
Alpha = - A0(K) / COSZ(K)    , and

TWIST(J) = A0(J) - A0(K) * COSZ(J) / COS(K)
```

401 ** Fcr a Cp optimization **

The span stations where no constraint functions are desired. See also location 5.

** For a twist optimization **

Input as J.KL, where J is the span station where the camber or twist from the geometry dataset are to be set equal to zero (see location 29 for a discussion of input camber).

If K = 0 the camber values are set equal to zero.
If L = 0 the twist values are set equal to zero.

e.g. an input value of 12.02 means that span station 12 will have the camber, but not the twist, from the input dataset set equal to zero.

The J values (span stations) must input in ascending order.

551 The x/c values where the camber is specified (see 601).

601 The z/c values for camber.

The values for x/c = 0. and 1. must be specified.

The z/c values for each x/c at every span station are input in consecutive locations starting with location 451. The values are input first in the order of the x/c values for a given span station, and next in the order of the span stations. Any location left blank will be assumed to have a z/c value of 0.

Camber values should be input only for fixed span stations (location 81), or when a twist optimization is preformed (location 17). Twist values may be input using locations 351 to 400.

If an analysis only is being performed, data location 17 should be made > 0. In this case all span stations must be input (although 0. is permissible). This is to avoid confusion of the fixed span stations with span stations where the Cp is to be set equal to zero (see the discussion for an analysis under location 81).

951 Twist constraint stations.
L = DATA(950+J)

Twist constraint at span station J implies a nonzero of DATA(350+J).

L < 0	Any twist constraint at span station j will be made with respect to the free stream.
L = 0	Any twist constraint at span station j will be made with respect to span station (j-1). If j=1 the constraint will be with respect to the freestream unless a body is present.
L > 0	Any twist constraint at span station j will be made with respect to span station L.
L > nst	Any twist constraint at span station j will be made with respect to the body.

Hinge Moments   locations 1001 - 1100

The values in the following locations are for calculating or constraining up to twenty-five hinge moment coefficients. The hinge moments are calculated by taking the sum of the moments induced about a given line by a set of prescribed panels. Hinge moments may be constrained only when performing a twist optimization (DATA(17) > 0.).

The two points which determine each line about which the moments are taken, are input in locations beginning at 1001. The panels determining each integration area are input in locations beginning at 1051.

1001 The x value of the 1st point for hinge moment line number 1.
1002 The y value of the 1st point for hinge moment line number 1.
1003 The z value of the 1st point for hinge moment line number 1.

1004 The x value of the 2nd point for hinge moment line number 1.
1005 The y value of the 2nd point for hinge moment line number 1.
1006 The z value of the 2nd point for hinge moment line number 1.

1007 CBAR for hinge moment number 1 (if 0. uses CAVG).
1008 The constrained value for this hinge moment (no constraint if 0)
1009 if < 0. hinge moment array number 1 will not be printed.
1010 Reference area for hinge moment number 1 (if 0. uses SREF).

1011 The x value of the 1st point for hinge moment line number 2.
1012 The y value of the 1st point for hinge moment line number 2.
1013 The z value of the 1st point for hinge moment line number 2.

1014 The x value of the 2nd point for hinge moment line number 2.
1015 The y value of the 2nd point for hinge moment line number 2.
1016 The z value of the 2nd point for hinge moment line number 2.

1017 CBAR for hinge moment number 2 (if 0. uses CAVG).
1018 The constrained value for this hinge moment (no constraint if 0)
1019 if < 0. hinge moment array number 2 will not be printed.
1010 Reference area for hinge moment number 1 (if 0. uses SREF).

.

.

.

1051 Beginning in this location the panel numbers for determining each hinge moment are listed. An input value of 0. indicates the last panel number for a given hinge moment calculation has been input. A sequence of panel numbers may be input by inputing a negative panel number after a positive number.

i.e. 1051 3 5 10 20 - 55 0 3 - 40

will have panel numbers 3,5,10, and 20 thru 55 for #1
and panel numbers 3 thru 40 for #2

due to camber, input in same order as the control points. These values will added to camber values input by other means. These values are assumed to represent a smooth camber distribution and will be interpolated to compute drag.

1200 If > 0. The effect of the normal velocities due to thickness will be included in the optimization.

1201 The normal velocities at the panel control points due to thickness.

1801 The total weight distributed over each panel. These values are used in conjunction with location 10 to obtain the deflections induced by the inertial loads on a flexible configuration.

2840 The normal (outward) velocities at the control points due to camber, input in same order as the control points. These values will added to camber values input by other means. These values are assumed to represent a smooth camber distribution and will be interpolated to compute drag.

These locations are also used to input a desired Cp distribution for a given span station (see the discussion for data(81)).

i.e. If the span station with a desired Cp distribution has panel numbers beginning with ij1 and ending with ij2, the Cp's are input in locations (2840 + ij1 - 1) thru (2840 + ij2 - 1).

3340 The same as for 2840 except the values are assumed to be due to flap deflections and will not be interpolated when drag is computed, nor will the the deflections contribute to camber when computing twist.

If flap panel ratios are desired for a twist and flap optimization, (DATA(17) > 0.), the flap panel ratios are input in these locations. I.e. if panel IJ is a panel of flap # j, and it is desired that this panel will deflect 0.60 units for each unit deflection of flap # j, then set:

Data(3340+IJ-1) = 100.60

The value of 100. is added to differentiate between initial deflections and flap panel ratios. It is assumed that panel IJ is defined as a flap panel through locations 81-160.

LIST OF VARIABLES

OPTIMIZATION VARIABLES

NFX	The number of constraint functions at each station
NFJ	The number of constraint functions at each station (jet)
ISFX	The surface number where the jet attaches (if ISFX = NSF the jet is removed)
ISFJ	The surface number of the jet (if ISFJ .gt. NSF) There is no jet
ITRIM	The character array number for trim variation variable
JTRIM	The constraint equation number for the trim variation.
KTRIM	The variable which determines the desired variable for trim variation.
NCLS	The number of surface CL constraints
NCLY	The number of spanwise CL constraints
NPB	The number of panels on fixed span stations
NSTB	The number of span stations without constraint functions
NTWIST	The number of twist constraints
NUTWST	The number of unknown twists on fixed span stations
NXCP	The number of x/c-C.P. constraints
CAM(IJ)	The normal velocity at the control point due to camber
WF(IJ)	The deflections at the control points due to flaps.
M1	The number of equations to be solved exactly
M2	The number of equations to be solved least square
NU	The total number of unknowns
MLT	The total number of B(ML)

GENERAL VARIABLES

CHORD(J)	The chord value at the centroid of span station J
IJS(IS)	The value of IJ where section IS begins
IJ0(J)	The number of the first panel at span station J
IS0(ISF)	The section number where surface ISF begins.
JS(IS)	The span station where section IS begins
MS(IS)	The number of span stations in section IS
NB	The number of basic solutions.
NCHORD(J)	The number of panels at span station J
NS	The total number of sections
NSF	The total number of surfaces
NSPAN(ISF)	The number of span stations on surface ISF
NSL	The number of vortex shell sections
NST	The total number of span stations on all lifting

surfaces.

NSTS	The number of source span stations
NTB	The number of body panels.
NTL	The number of vortex shell panels.
NTP	The total number of panels.
NTS	The number of source parameters.
NTSL	The total number of vortex shell span stations
NTV	The number of vortex panels.

LIFTING SURFACE PANELS

CAM(IJ)	The normal velocity at the control point due to
COSZ(IJ)	The cosine of the normal of panel IJ
CX(I,IS)	x/c values for the control points of section IS
DS(J)	Width of span station J
DWDX(IJ)	The local dw/dx at thickness control point IJ
DX(I,IS)	Delta (x/c) for the panels of section IS
ETA(J)	Fraction of span running distance for (YCC(J),ZCC(J)) camber.
PA(IJ)	The area of panel IJ
SINZ(IJ)	The sine of the normal of panel IJ
TWIST(J)	Twist of span station J
WF(IJ)	The deflections at the control points due to flaps.
WTHK(IJ)	The local dz/dx at thickness control point IJ
X(KL,IC)	x values of the corners of vortex panel KL (4)
XC(IJ,1)	x value of the centroid for vortex panel IJ
XC(IJ,2)	x value of the control point for vortex panel IJ
XLE(1,J)	x value at the leading left edge of span station J.
XLE(2,J)	x value at the leading right edge of span station J.
XM(I,IS)	x/c values for the midpoints of panels of section IS
XTE(1,J)	x value at the trailing left edge of span station J.
XTE(2,J)	x value at the trailing right edge of span station J.
XX(I,IS)	x/c values for the panels of section IS
Y(KL,IC)	y values of the corners of vortex panel KL (2)
YC(IJ)	y value of the control point for vortex panel IJ
YCC(J)	y value at the control point of span station J
YO(1,J)	y value at the left edge of span station J.
YO(2,J)	y value at the right edge of span station J.
Z(KL,IC)	z values of the corners of vortex panel KL (2)
ZC(IJ)	z value of the control point for vortex panel IJ
ZCC(J)	z value at the control point of span station J
ZTHK(IJ)	The local z/c at thickness control point IJ
ZO(1,J)	z value at the left edge of span station J.
ZO(2,J)	z value at the right edge of span station J.

BODY PANELS

B(I)	SQRT(DY(I)**2 + BETA2*DX(I)**2) I = 1,4
BT(IC,IJ)	tans**2 + beta2 for each side of body panel IJ
BETA2X	= 1. velocity boundary conditions. = 1.- Mach**2 mass flux boundary conditions.
IBB(K)	The body station number of the first station in body section K.
IJB(K)	The panel number of the first body panel in section K.
NX(K)	The number of x body stations for body section K
NY(K)	The number of panels at each body station (half) for body section K.
XB(IC,KL)	x values of the corners of body panel KL (4)
XBO(I)	The x value of the center of body station I.
XINLET(IJ)	mass flow coefficient of body panel IJ; 0. = impermeable
XN(1,IJ)	x - component of body panel IJ normal
XN(2,IJ)	y - component of body panel IJ normal
XN(3,IJ)	z - component of body panel IJ normal
XN(4)	XN(1) / XN(8)
XN(5)	XN(2) / SQRT(XN(2)**2 + XN(3)**2)
XN(6)	XN(3) / SQRT(XN(2)**2 + XN(3)**2)
XN(7)	SQRT(XN(2)**2 + XN(3)**2) / XN(8)
XN(8)	SQRT(beta2*XN(1)**2 + XN(2)**2 + XN(3)**2)
XN(9)	SQRT(XN(1)**2 + XN(2)**2 + XN(3)**2) = 2. * area
XP(IC,KL)	x values of the corners of body panel KL (4) planar
X0(1,IJ)	x value of the centroid of body panel IJ
X0(2,IJ)	y value of the centroid of body panel IJ
X0(3,IJ)	z value of the centroid of body panel IJ
YB(IC,KL)	x values of the corners of body panel KL (4)
YP(IC,KL)	x values of the corners of body panel KL (4) planar
ZB(IC,KL)	x values of the corners of body panel KL (4)
ZP(IC,KL)	x values of the corners of body panel KL (4) planar

COMPUTED VARIABLES

Cp(IJ,K)	The delta-Cp across panel IJ from basic solution K.
UK(IJ,K)	The control point upper surface x velocity.
VK(IJ,K)	The control point upper surface binormal velocity.
WK(IJ,K)	The control point upper surface normal velocity.
PK(IJ,K)	The control point upper surface velocity potential.
US(IJ)	The thickness induced upper surface x velocity.
VS(IJ)	The thickness induced upper surface binormal velocity.
WS(IJ)	The thickness induced upper surface normal velocity.
PS(IJ)	The thickness induced upper surface velocity potential.

The following variables are required for 2nd order solutions only.

WSX(IJ)	d/dx of WS(IJ)	source normal velocity.
WCX(IJ)	d/dx of WK(IJ,2)	camber normal velocity.

KKX The number of 2nd order boundary condition solutions.

= 6 if there is no body.
= 9 if there is a body.

UBE(IJ,K)	The even symmetry u velocities due to 2nd order b.c.
UBO(IJ,K)	The odd symmetry u velocities due to 2nd order b.c.

SUBPROGRAMS

A * signifies the subroutine is from program WBODY

SUBROUTINE		FUNCTION
MAIN		Sets the main array size for the program.
ABMAIN		Reads input data, computes geometry, and sets array sizes.
ACMAIN		Controls the flow of the program.
AERO2	*	Controls the program flow for the computation of 1st or 2nd order pressures and loads.
AERO2B	*	Computes the u velocities due to 2nd order boundary Conditions.
AERO2P	*	Computes the 1st or 2nd order pressures from the induced velocities.
AERO2V	*	Computes the odd and even symmetry velocities induced by the basic solutions.
AMINMX	*	Finds the largest, smallest or largest absolute value of the elements of an array.
BAINFL	*	Computes normal velocities after the Cp's or normal velocities on specified span stations are set equal to zero.
BODYGM	*	Computes and prints body geometry from input data.
BODYMX		Performs calculations for optimizations with paneled bodies.
BODYRD	*	Reads body panel geometry from APAS dataset.
BODYW	*	Finds the intersection of the body and the aerodynmaic surfaces.
CAMBER		Computes camber from input.
CLCM	*	Computes the lift drag and moment characteristics of aerodynamic surfaces.
CLOPT		Controls flow of calculation for a Cp optimization.
CNSTRn		Calculates the Cp constraint functions for a Cp optimization.
CP2		Adds second order terms to the Cp's for an twist optimization using second order pressures.
DECRD1	*	Reads the input data.
DISPLY	*	Prints arrays of characteristics at the panel control points of the aerodynmaic surfaces.
DMXMVE	*	Moves the elements of a double precision array.
DSSPLY	*	Prints arrays of characteristics at the panel corner points of the aerodynamic surfaces.
ENDREC	*	Used with errset to check for APAS type influence matrix.

FIELD	*	Computes first order field point properties using previously calculated influence coefficients and the first order solution.
FXDX3	*	Integrates data using a third order curve fit through the nearest four points.
FLXSOL		Directs the calculation for the add load and basic load and obtains the deflections due to inertia forces.
FXROLL		Prints rolling moment coefficients for rolling moment flap optimizations on flexible configurations.
GEOM	*	Computes the geometric characteristics of the aerodynamic surfaces and panels.
GEOMR		Reads input geometry from geometry dataset.
GAUSS		Solves simultaneous equations using Gaussian elimination.
HSHLDR	*	Solves sets of linear simultaneous equations in a least square sense.
INTRP3	*	Interpolates or differentiates data using a third order curve fit through the nearest four points.
INTRP4	*	Interpolates or differentiates data using a third or fourth order curve fit through the nearest four points.
INTRPX	*	Interpolates or differentiates properties chordwise on an aerodynamic surface using subroutine INTRP4.
INTRPY	*	Interpolates or differentiates properties spanwise on an aerodynamic surface using subroutine INTRP4.
MATRXF	*	Displays arrays of data.
MATRXT	*	Displays arrays of data.
MAXCHK		Checks for variable which exceed maximum value.
MTXADD	*	Adds multiples of two arrays.
MTXMLT	*	Multiplies two arrays.
MTXMVE	*	Moves the elements of an array.
NOTZRO	*	Checks to see if an array has any nonzero elements.
ORTHO	*	Solves sets of linear simultaneous equations using the method of succesive orthogonalizations. A quasi-inverse matrix may be computed or, if previously computed, used to perform the solution.
PHIXY	*	Calculates v (binormal) velocities on aerodynamic surfaces from phi (for 2nd order solution).
PLOT	*	Writes geometry and aerodynamic data on a disk unit for computer graphics.
POLAR	*	Calculates first order drag polar and aerodynamic cofficients.
PTNFRM		Calculates Cp's from the constraint function coefficients in a Cp optimization.
QIJT		Computes drag coefficients for thickness drag in an optimization using 2nd order Cp's.
QUADMX		Uses the method of Lagrange multipliers to maximize a quadratic form subject to a set of constraint equations.
REGION		Calculates hinge moment coefficients.
SQFIT	*	Calculates leading edge suction using a least square Curve fit of Cp to cot(x/c).

TRIM		Used for trim polar calculations.
TRANSQ		Performs the transformation used for spanwise constraints on twist optimization constraint functions.
TWOPT		Controls flow of calculation for a twist optimization.
TWOPTP		Calculates panel Cp's which result from a twist optimization.
TWOPTQ		Calls QUADMX and checks for optimization of quadratic form.
TWST		Separates twist and camber from normal velocities at panel control points and computes camber z/c's.
VTXDRG	*	Calculates vortex drag in the trefftz plane.
VTXDR2	*	Calculates coefficients for vtxdrg.
VTXMAX	*	Subroutine used for optimization with vortex lift.
VTXLFT	*	Calculates vortex lift from leading edge suction.
WCNSTR		Calculates the camber constraint functions for a twist optimization (NFX > 1).
WINTRP	*	Interplolates velocities to various points on panels.

file	use
5	input data
6	Print output
8	scratch file
9	scratch file
10	scratch file
11	storage of influence matricies and quasi-inverse
12	plot output file
13	APAS geometry input file
14	file for output of trim variation calculation

FLOW DIAGRAM

Program OPT

```
**********
* AAMAIN *
**********
    |
    V
**********          **********
* ABMAIN *<==>|<==>* DECRD1 *
**********    |     **********
    |         V
    |         |     **********
    |         |<==>* ARRAY  *
    |               **********
    |
    V
**********          **********
* ACMAIN *<==>|<==>* GEOMR  *
**********    |     **********
              V
              |     **********
              |<==>* GEOM   *
              |     **********
              V
              |     **********
              |<==>* CAMBER *
              |     **********
              V
              |     **********     **********     ***********
              |<==>* FLXSOL *<==>* WBSOL  *<==>*  ORTHO   *
              |     **********     **********     ***********
    |<========|
  A |         |     **********
  N |         |<==>* CNSTRN *  (Cp opt only)
  A |         |     **********
  L |         V
  Y |         |     **********
  S |         |<==>* BODYMX *
  I |         |     **********
  S |         |
```

TWIST OPTIMIZATION

```
  |       |                                                                   
  |       |     **********            **********
  |       |<==>* TWOPT   *<==>|<==>* WCNSTR *
  |       |     **********    |       **********
  V       V                   V
  |       |                   |       **********          ***********
  |       |                   |<==>*  CP2    *<=====>*  QIJT    *
  |       |                   |       **********          ***********
A |       V                   V
N |       |                   |       **********          ***********
A |       |                   |<==>* WBSOL  *<=====>*  ORTHO   *
L |       |                   |       **********          ***********
Y |       V                   V
S |       |                   |       **********
I |       |                   |<==>* REGION *
S |       |                   |       **********
  |       V                   V
  |       |                   |       **********
  |       |                   |<==>* FXROLL *
  |       |                   |       **********
  |       V                   V
  |       |                   |       **********          ***********
  |       |                   |<==>* TWOPTQ *<=>|<=>* TRANSQ   *
  |       |                   |       **********    |     ***********
  |       V                   V                     |
  |       |                   |                     |     ***********
  |       |                   |                     |<=>* QUADMX   *
  |       |                   |                           ***********
  |       V                   V                                V
  |       |                   |                           ***********
  |       |                   |                           *  WBSOL   *
  |       |                   |                           ***********
  V       V                   |                                V
  |       |                   |                           ***********
  |       |                   |                           *  ORTHO   *
  |       |                   |                           ***********
  V       V
  |       |                   |      **********           ***********
  |       |                   |<==>* TWOPTP *<=====>*  MAXCHK  *
  |       |                          **********           ***********
  V       V
```

```
 |        |
 V        V
 |        |                    Cp OPTIMIZATION
 |        |
 |        |     **********          **********
 |        |<==>* CLOPT   *<==>|<==>* WINTRP *
A|        |     **********    |     **********
N|        |                   V
A|        |                   |     **********    ***********
L|        |                   |<==>* QUADMX *<==>*  WBSOL   *
Y|        |                   |     **********    ***********
S|        |                   V                        V
I|        |                   |     **********    ***********
S|        |                   |<==>*  TRIM  *     *  ORTHO   *
 |        |                   |     **********    ***********
 |        |                   V
 |        |                   |     **********
 |        |                   |<==>* PTNFRM *
 V        V                         **********
 |        |
 |        |                          ANALYSIS
 |        |
 |        |     **********          **********    ***********
 |<=======>|<==>* BAINFL *<=======>* QUADMX *<==>*  WBSOL   *
          |     **********          **********    ***********
          V
          |     **********
          |<==>*  TWST  *
          |     **********
          V
          |     **********
          |<==>* REGION *
          |     **********
          V
          |     **********          **********
          |<==>* VTXDRG *<=======>* VTXDR2 *
          |     **********          **********
          V
          |
```

```
 |
 |      ***********          ***********
 |<==>* AERO2   *<==>|<==>* PHIXY   *
 |      ***********  |       ***********
 V                   V
 |                   |       ***********
 |                   |<==>* AERO2V *
 |                   |       ***********
 V                   V
 |                   |       ***********           ***********
 |                   |<==>* AERO2B *<=====>* WBSOL   *
 |                   |       ***********           ***********
 V                   V                                  |
 |                   |       ***********           ***********
 |                   |<==>* AERO2P *           * ORTHO   *
 |                   |       ***********           ***********
 V                   V
 |                   |       ***********           ***********
 |                   |<==>*  CLCM   *<=>|<=>* SQFIT   *
 |                   |       ***********   |       ***********
 V                   V                     V
 |                   |       ***********   |       ***********
 |                   |<==>*.  PLOT   *    |<=>* VTXLFT *
 |                           ***********           ***********
 V
 |      ***********
 |<==>* POLAR   *
        ***********
```

TEST CASE

Results for the aspect ratio 2.5, sixty-three degree leading edge sweep trapezoidal wing of figure 4 are presented in this section. The 10 X 10 uniform chordwise and spanwise aerodynamic paneling used for optimization is indicated and is typical of planform graphics output of the program.

A M = 2.0, CL = 0.10 trimmed second order minimum drag due to lift case of figure 5 is presented in the remainder of this section. A root chord twist constraint was imposed to remove the small disturbance apex singularity common to subsonic leading edge problems. This result is compared to first and second order optima as a function of the longitudinal stability parameter dCm/dCl or alternatively the pitching moment at zero lift, Cmo. The supersonic nonlinear small disturbance minimum drag results are the first published to the knowledge of the author. The best second order result for the present problem is 6% lower than first order optimization and occurs at approximately twice the stability level. The first and second order lifting efficiency of a flat plate of the same planform is shown for comparison purposes. The impact of twist and camber for the subsonic leading edge case under consideration is substantial. Additional results are presented in reference 3.

Test case input is presented on pages 151 and 152. Detailed program output for this case is presented on pages 153 through 202. Typical aerodynamic data graphics output is presented on pages 203 through 216.

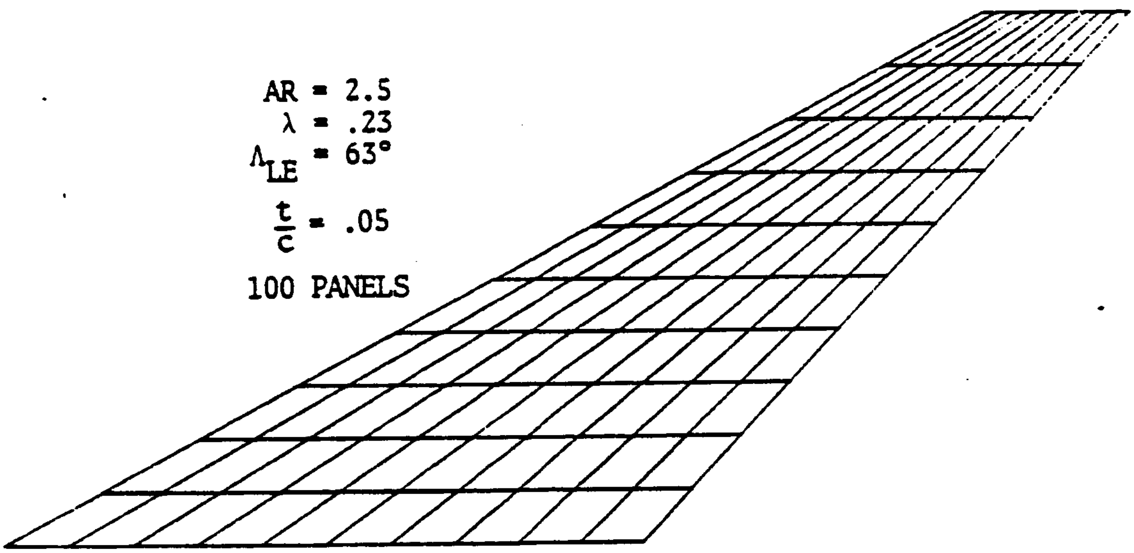

Figure 4. Three Dimensional Second Order Optimum Model Problem

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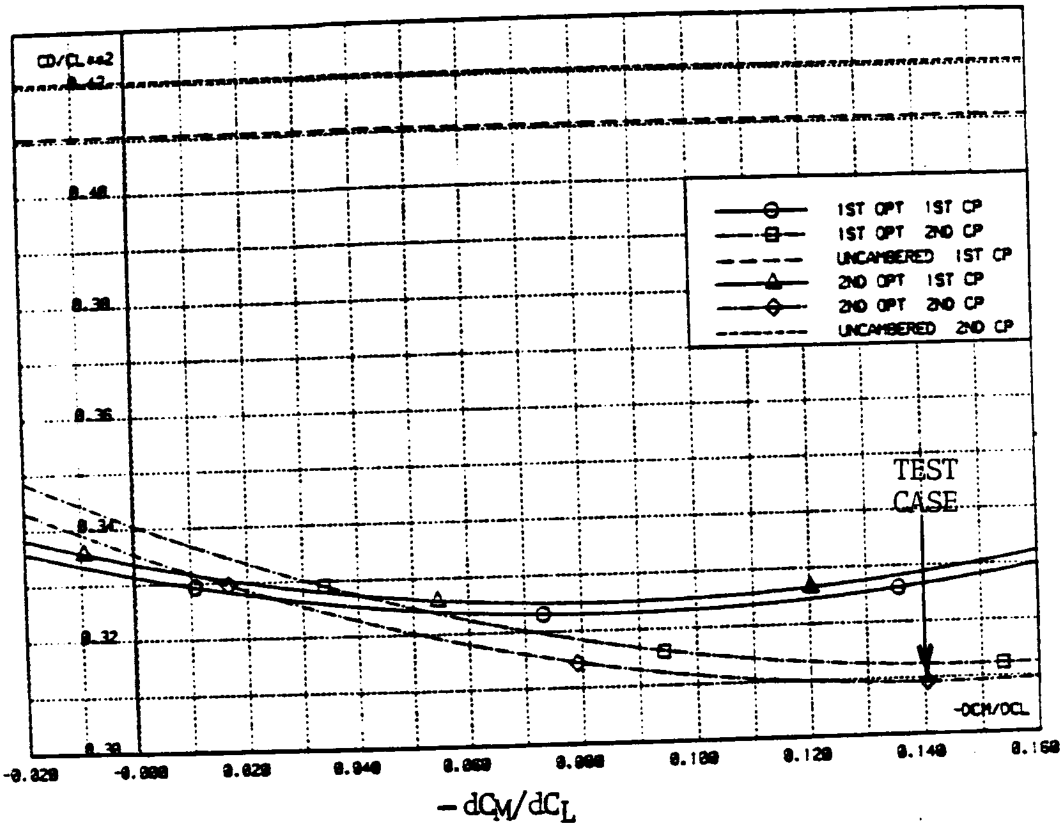

Figure 5. First and Second Order Optima for a Subsonic Edge Condition $M = 2.0$, $C_L = 0.1$

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TEST CASE INPUT

```
C63-45       OPT T/C = 0.050  AT M = 4.0  1ST  NO CONSTRAINT  XCG = FREE
C63-45 THICK OPT T/C = 0.050  AT M = 4.0  2ND  TWIST, NF=3.3  XCG = 12.0
 63-45       OPT T/C = 0.050  AT M = 4.0  2ND  TWIST, NF=3.3  XCG = 12.0
FREE FORMAT
C      < 0. IF NO JETFLAP
           2-1.
C       CL-TOTAL
           4 0.1000
C **   # CHORD-CONST F'S     < 0. = NONE
           5 3.3
C     MATRICIES FROM WBODY, INCLUDING INVERSE  (-3.0 INCLUDES THICKNESS)
           7-3.5
C       2ND ORDER ANALYSIS  <  0.
C*      2ND ORDER OPT     =,< -1. ;  < -2. FOR THKDRG
           8-1.00
C      ADD LOAD   OPT, = 0.   IF < - 2., GEOMETRY ONLY WILL BE PRINTED.
C         12 1.0
          12 0.0
C     IF > 0., THE NUMBER OF CONSTRAINT EQUATIONS PRINTED.
          14-100.100
C     CAMBER   PRINTOUT = 3.0
          15 3.0
C     GEOMETRY PRINTOUT = 2.0
          16 0.
C ** TWIST OPTIMIZATION IF > 0.
          17 1.
C     MOST PRINTOUT = 2.0, NO UPPER   LOWER CP < 0.
          19-1.
C     > 0. FOR A PLOT DATASET
          20 2.0
C*    EXTEND FIRST SURFACE TO CENTERLINE
C         26 1.2
C      CAMBER SPECIFICATION  ( < 0. FOR NO CAMBER INPUT )
          29-1.
C*          XCG
          32 12.000
C        NO XCG CONSTRAINT
C         32 -99999.
C        MACH NUMBER
          35 4.00
C      CONTROL PT FOR DRAG CALCULATION (& OPTIMIZATION IF < 0.)
          36 0.875
C      CONTROL PT FOR SUCTION CALCULATION  < 0  FOR CURVE FIT PRINTOUT
          37 0.250
```

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OF POOR QUALITY

```
C           CAVG        SREF         SPAN
        41 0.0          160.0        0.0
C     ODD AND EVEN SYMMETRY      U,V,W
C       45 334.
C     ODD AND EVEN SYMMETRY D/DX U,V,W
C       46 334.
C     ANGLE OF ATTACK
        51  0.0       -99.00        99.00        0.0          0.0
C         CAM-THK
        61 11.22        12.22        12.02        12.02        11.02
C*    FIXED SPAN STATIONS
C       81 1.           2.
C    CAMBER CONSTRAINTS
       151 1.E-08
       153 0.0          0.0
       155 0.0          0.0
C
C     TWIST
       351 0.0        -1.50         0.0          0.0          0.0
       951 0.0          1.0          1.0          0.0          0.0
C
-        1 0.
-        1-1.
```

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63-45 WING AT M = 2.00 T/C = 0.050 10 X 10 PANELS XCG = 12.0

INPUT DATA ARRAY

1	0.	-1.0000000	0.	.10000000	3.3000000
6	0.	-3.5000000	-1.0000000	0.	0.
11	0.	0.	0.	-100.10000	3.0000000
16	0.	1.0000000	0.	0.	2.0000000
26	0.	0.	0.	-1.0000000	0.
31	0.	11.800000	0.	0.	2.0000000
36	.87500000	.25000000	0.	0.	0.
41	0.	160.00000	0.	0.	0.
51	0.	-99.000000	0.	0.	0.
61	11.220000	12.220000	0.	0.	0.
151	1.0000000000E-08	0.	0.	0.	0.
351	0.	-1.5000000	0.	0.	0.

THERE IS A SOURCE MATRIX NSFCHK = 2755640021997322220

```
10
 1
 1
 1
10
 1      1      10      10      0      0
```

```
MAXOO    =  70000     (TOTAL A ARRAY SIZE)

IREQ     =  15563     (TOTAL A ARRAY REQUIRED FOR THIS RUN)

IJMAX    =  54438     (TOTAL A ARRAY LEFT AFTER ALLOCATIONS)

EXTRA    =  54438     (EXTRA SPACE IN A ARRAY)

IXTRA2 =    69095     (EXTRA SPACE IF AN INVERSE IS USED)
IXTRAO =    66743     (EXTRA SPACE IF AN INVERSE IS NOT USED)
IXTRAX =    69095     (EXTRA SPACE BASED ON SOLUTION)

NAA      =  11136     (SPACE WHICH CAN BE REMOVED FOR SOLUTION)
MTX      =    605     (SPACE REQUIRED FOR MATRIX SOLUTION)

            3  = NB    =  NUMBER OF SETS OF SOLUTIONS
            1  = NS    =  NUMBER OF VORTEX PANEL SECTIONS
           10  = NST   =  NUMBER OF VORTEX SPAN STATIONS
          100  = NTP   =  NUMBER OF PANELS
          100  = NTV   =  NUMBER OF VORTEX PANELS
            0  = NTB   =  NUMBER OF BODY PANELS
          121  = NTS   =  NUMBER OF SOURCE PARAMETERS
            0  = NTL   =  NUMBER OF VORTEX SHELL PANELS
            0  = NSTL  =  NUMBER OF VORTEX SHELL SPAN STATIONS
            0  = NSL   =  NUMBER OF VORTEX SHELL SECTIONS
            0  = NSTS  =  NUMBER OF SOURCE SPAN STATIONS
            0  = NBODY =  NUMBER OF BODY SEGMENTS
            6  = KKXO
            6  = KKX
            1  = KKY
        64580  = K

IJ1 =  64580     1 + MAX - IJ1 =   5421     I1 =  63986
IJ2 =  62165         IJ1 - IJ2 =   2415     I2 =  64107
IJ3 =  60865         IJ2 - IJ3 =   1300     I3 =  64228
IJ4 =  59365         IJ3 - IJ4 =   1500     I4 =  64349
IJ5 =  58865         IJ4 - IJ5 =    500     I5 =  64470
IJ6 =  58565         IJ5 - IJ6 =    300     I6 =  64570
IJ7 =  55439         IJ6 - IJ7 =   3126     I7 =  64580
IJ8 =  54439         IJ7 - IJ8 =   1000     I8 =  64580
IJX =  66701               NTK =    600     I0 =  63865
IJY =  69701                J1 =  62165     J2 =  62465
IJZ =  65101                J3 =  63265     J4 =  63565

      DIMENSION NUMBER OF ARRAY SETS

   10  = NSTC =  NUMBER OF VORTEX SPAN STATIONS
  100  = NTPC =  NUMBER OF PANELS
  100  = NTVC =  NUMBER OF VORTEX PANELS
    1  = NTBC =  NUMBER OF BODY PANELS
  121  = NTSC =  NUMBER OF SOURCE PARAMETERS
```

IJ	SYM(IJ)									
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
31	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
41	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
51	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
61	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
71	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
81	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
91	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

IJ	SYM(IJ)									
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
31	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
41	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
51	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
61	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
71	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
81	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
91	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

```
SREF  =     160.00000
SPAN  =      20.00000
CBAR  =       8.00000
MACH  =       2.00000
XCG   =      11.80000
CAVG  =       8.00000
SYM   =       1.00000

  100   =   NUMBER OF VORTEX PANELS
    1   =   NUMBER OF SURFACES
   10   =   NUMBER OF SPAN STATIONS
```

```
            ANGLE OF ATTACK        =       0.00000  DEGREES

     SREF   =      160.00000
     SPAN   =       20.00000
     CBAR   =        8.00000
     MACH   =        2.00000
     BETA2  =       -3.00000
     BETA   =        1.73205
     XCG    =       11.80000
     CAVG   =        8.00000
     SYM    =        0.00000

       100  =  NUMBER OF PANELS
         1  =  NUMBER OF SURFACES
        10  =  NUMBER OF SPAN STATIONS
         1  =  NUMBER OF VORTEX PANEL SECTIONS

        IA =  7
        IB =  8
        IV =  9
        IT = 13
        IE = 13
              IVTX   =    T
              ITHK   =    T
              IBDY   =    F
              IAXX   =    F

              AAPAS  =    F
```

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63-45 WING AT M = 2.00 T/C = 0.050 10 X 10 PANELS XCG = 12.0

SURFACE NUMBER 1 WING

J	Y	Z	XLE	XTE	SWP-LE	SWP-TE	SIN	CHORD	TWIST	X/C	NC	IJO	IS
	0.000	0.000	0.000	13.000				13.000					
1	.493	0.000	.987	13.493	63.435	45.000	0.00000	12.507	0.00000	E	10	1	1
	1.000	0.000	2.000	14.000				12.000					
2	1.493	0.000	2.986	14.493	63.435	45.000	0.00000	11.507	0.00000	E	10	11	1
	2.000	0.000	4.000	15.000				11.000					
3	2.492	0.000	4.984	15.492	63.435	45.000	0.00000	10.508	0.00000	E	10	21	1
	3.000	0.000	6.000	16.000				10.000					
4	3.491	0.000	6.982	16.491	63.435	45.000	0.00000	9.509	0.00000	E	10	31	1
	4.000	0.000	8.000	17.000				9.000					
5	4.490	0.000	8.980	17.490	63.435	45.000	0.00000	8.510	0.00000	E	10	41	1
	5.000	0.000	10.000	18.000				8.000					
6	5.489	0.000	10.978	18.489	63.435	45.000	0.00000	7.511	0.00000	E	10	51	1
	6.000	0.000	12.000	19.000				7.000					
7	6.487	0.000	12.974	19.487	63.435	45.000	0.00000	6.513	0.00000	E	10	61	1
	7.000	0.000	14.000	20.000				6.000					
8	7.485	0.000	14.970	20.485	63.435	45.000	0.00000	5.515	0.00000	E	10	71	1
	8.000	0.000	16.000	21.000				5.000					
9	8.481	0.000	16.963	21.481	63.435	45.000	0.00000	4.519	0.00000	E	10	81	1
	9.000	0.000	18.000	22.000				4.000					
10	9.476	0.000	18.952	22.476	63.435	45.000	0.00000	3.524	0.00000	E	10	91	1
	10.000	0.000	20.000	23.000				3.000					

THE VALUES OF CAMBER SLOPES ARE = 0.0 ON ALL LIFTING SURFACES

```
MSRC4 =  T       U1 =  7
AAPAS =  F       U2 = 13
INVS  =  T       U3 =  9
APAS  =  F       U4 = 13
WBODY =  T       U5 = 11
FLEX  =  F       U6 = 15
ORDER2=  T       U8 = 12
NFX   =  0       NB =  3
NJ    =  0       NF =  3
```



```
MAX MUST BE AT LEAST  28366
THE NUMBER OF EQUATIONS SOLVED EXACTLY   =    6
THE TOTAL NUMBER OF UNKNOWNS             =   31
THE NUMBER EXACT+THE NUMBER OF UNKNOWNS  =   37
```

```
THE MAXIMUM NUMBER OF CHORDWISE PANELS  =   10

U1   U2   U3   U4   U5   U6   U8
 7   13    9   13   11   15   12

     UNKNOWNS     -     TOTAL NUMBER      =  31

PANEL CPS  (ON FIXED SPAN STATIONS)       =   0
CP CONSTRAINT COEFFICIENTS                =   0
JET DEFLECTION                            =   0
TWIST ANGLES                              =  10
CAMBER COEFFICIENTS                       =  20
ANGLE OF ATTACK                           =   0
DELTA X/C-CP                              =   0
DELTA FOR SPANWISE CL                     =   0
CONSTANT COEFFICIENT ( = 1.0 )            =   0

        10     10      0      0      0      0    152
         1      1      1      1      2      2      2      2
       300      0      0

        75   3101   9487   9704   6387   3287   1036   3287
      3100    961    186   3100  12804  12804  12804  12804  12804

     CONSTRAINT EQUATIONS     -     TOTAL   =    6

CONSTRAINTS ON SURFACE CL                 =    1
CONSTRAINTS ON ANGLE OF ATTACK            =    0
CONSTRAINTS ON XCG                        =    1
CONSTRAINTS ON ROLL YAW & SIDE FORCE      =    0
CONSTRAINTS ON DOWNWASH                   =    0
CONSTRAINTS ON X/C-CP                     =    0
CONSTRAINTS ON SPANWISE CL                =    0
CONSTRAINTS ON TWIST                      =    1
CONSTRAINTS ON CAMBER (TWOPT)             =    2
CONSTRAINTS ON INITIAL CAMBER (= 1.0)     =    1
CONSTRAINTS ON JET DEFLECTION             =    0
CONSTRAINTS ON CP (SPAN STATIONS)         =    0

THE NUMBER OF DOWNWASH SPAN STATIONS      =    0
THE NUMBER OF UNKNOWN TWIST  VALUES       =   10
THE NUMBER OF UNKNOWN CAMBER VALUES       =   20
THE NUMBER OF UNKNOWN FLAP DEFLECTIONS    =    0

A  100 X 100 MATRIX WAS SOLVED WITH SUBROUTINE ORTHO USING A PREVIOUSLY CREATED QUASI-INVERSE MATRIX.

THE MATRIX ROWS WERE READ FROM UNIT 13 .

THERE WERE  31 SETS OF RIGHT HAND SIDE VECTORS, AND COLUMN PIVOTING WAS PERFORMED.

SOLUTION TIME =    .580 SECONDS
```

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```
SUBROUTINE CP2 CALLED          31    61    91    91
```

T1(IJ) ARRAY

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	2.00000	2.00000	2.00000	2.00000	2.00000
.150	1.90000	1.90000	1.90000	1.90000	1.90000
.250	1.80000	1.80000	1.80000	1.80000	1.80000
.350	1.70000	1.70000	1.70000	1.70000	1.70000
.450	1.60000	1.60000	1.60000	1.60000	1.60000
.550	1.50000	1.50000	1.50000	1.50000	1.50000
.650	1.40000	1.40000	1.40000	1.40000	1.40000
.750	1.30000	1.30000	1.30000	1.30000	1.30000
.850	1.20000	1.20000	1.20000	1.20000	1.20000
.950	1.10000	1.10000	1.10000	1.10000	1.10000

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	2.00000	2.00000	2.00000	2.00000	2.00000
.150	1.90000	1.90000	1.90000	1.90000	1.90000
.250	1.80000	1.80000	1.80000	1.80000	1.80000
.350	1.70000	1.70000	1.70000	1.70000	1.70000
.450	1.60000	1.60000	1.60000	1.60000	1.60000
.550	1.50000	1.50000	1.50000	1.50000	1.50000
.650	1.40000	1.40000	1.40000	1.40000	1.40000
.750	1.30000	1.30000	1.30000	1.30000	1.30000
.850	1.20000	1.20000	1.20000	1.20000	1.20000
.950	1.10000	1.10000	1.10000	1.10000	1.10000

ADD LOAD DR*VV/4

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	-.02229	-.03165	-.04027	-.04875	-.05758
.150	-.01391	-.01650	-.01945	-.02277	-.02648
.250	-.01373	-.01573	-.01799	-.02029	-.02270
.350	-.01338	-.01491	-.01681	-.01893	-.02126
.450	-.01312	-.01435	-.01595	-.01779	-.01991
.550	-.01309	-.01423	-.01556	-.01711	-.01899
.650	-.01304	-.01410	-.01542	-.01689	-.01849
.750	-.01296	-.01396	-.01522	-.01669	-.01832
.850	-.01295	-.01391	-.01506	-.01644	-.01808
.950	-.01293	-.01388	-.01502	-.01628	-.01782

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	-.06722	-.07827	-.09151	-.10835	-.13146
.150	-.03069	-.03556	-.04141	-.04882	-.05897
.250	-.02535	-.02855	-.03276	-.03833	-.04618
.350	-.02382	-.02656	-.02940	-.03344	-.03961
.450	-.02235	-.02516	-.02838	-.03166	-.03646
.550	-.02122	-.02391	-.02714	-.03095	-.03353
.650	-.02046	-.02291	-.02606	-.02998	-.02750
.750	-.02007	-.02226	-.02516	-.02907	-.02425
.850	-.01992	-.02188	-.02453	-.02824	-.02232
.950	-.01969	-.02178	-.02413	-.02744	-.02107

ADD LOAD CP (SUMMED)

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.04457	.06331	.08053	.09750	.11515
.150	.02694	.03140	.03671	.04280	.04969
.250	.02654	.02970	.03345	.03730	.04130
.350	.02571	.02777	.03068	.03408	.03789
.450	.02507	.02637	.02853	.03124	.03452
.550	.02497	.02604	.02750	.02944	.03207
.650	.02483	.02568	.02710	.02880	.03064
.750	.02461	.02525	.02650	.02818	.03012
.850	.02456	.02506	.02593	.02736	.02932
.950	.02450	.02497	.02579	.02677	.02839

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.13444	.15653	.18303	.21670	.26291
.150	.05754	.06663	.07756	.09137	.11031
.250	.04568	.05104	.05832	.06806	.08189
.350	.04207	.04636	.05042	.05655	.06642
.450	.03839	.04286	.04787	.05211	.05856
.550	.03537	.03953	.04457	.05022	.05074
.650	.03322	.03667	.04147	.04744	.03350
.750	.03200	.03469	.03871	.04463	.02352
.850	.03150	.03342	.03660	.04188	.01706
.950	.03066	.03305	.03516	.03897	.01252

.3194	.6094	.8194	.9494	.9994
.9694	.8594	.6694	.3994	.0494
3.3000	2.5000	1.7000	.9000	.1000
-.7000	-1.5000	-2.3000	-3.1000	-3.9000
-8.0000	-8.0000	-8.0000	-8.0000	-8.0000
-8.0000	-8.0000	-8.0000	-8.0000	-8.0000
.6846	.9895	.9047	.5550	.0649
-.4407	-.8373	-1.0000	-.8041	-.1251
5.4137	.8931	-2.3805	-4.4070	-5.1864
-4.7188	-3.0040	-.0422	4.1667	9.6226
-51.4419	-38.9711	-26.5004	-14.0296	-1.5588
10.9119	23.3827	35.8534	48.3242	60.7950

1	1	1	.73333333	.00475000	.09014421	-.20000000
			.41250000	0.00000000	0.00000000	0.00000000

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2	2	1	.73333333	.01275000	.07011216	-.20000000
			.31250000	0.00000000	0.00000000	0.00000000
3	3	1	.73333333	.01875000	.05008011	-.20000000
			.21250000	0.00000000	0.00000000	0.00000000
4	4	1	.73333333	.02275000	.03004807	-.20000000
			.11250000	0.00000000	0.00000000	0.00000000
5	5	1	.73333333	.02475000	.01001602	-.20000000
			.01250000	0.00000000	0.00000000	0.00000000
6	6	1	.73333333	.02475000	-.01001602	-.20000000
			-.08750000	0.00000000	0.00000000	0.00000000
7	7	1	.73333333	.02275000	-.03004807	-.20000000
			-.18750000	0.00000000	0.00000000	0.00000000
8	8	1	.73333333	.01875000	-.05008011	-.20000000
			-.28750000	0.00000000	0.00000000	0.00000000
9	9	1	.73333333	.01275000	-.07011216	-.20000000
			-.38750000	0.00000000	0.00000000	0.00000000
10	10	1	.73333333	.00475000	-.09014421	-.20000000
			-.48750000	0.00000000	0.00000000	0.00000000
11	1	1	.73333333	.00475000	.09017042	-.20000000
			.41250000	0.00000000	0.00000000	0.00000000
12	2	1	.73333333	.01275000	.07013255	-.20000000
			.31250000	0.00000000	0.00000000	0.00000000
13	3	1	.73333333	.01875000	.05009468	-.20000000
			.21250000	0.00000000	0.00000000	0.00000000
14	4	1	.73333333	.02275000	.03005681	-.20000000
			.11250000	0.00000000	0.00000000	0.00000000
15	5	1	.73333333	.02475000	.01001894	-.20000000
			.01250000	0.00000000	0.00000000	0.00000000
16	6	1	.73333333	.02475000	-.01001894	-.20000000
			-.08750000	0.00000000	0.00000000	0.00000000
17	7	1	.73333333	.02275000	-.03005681	-.20000000
			-.18750000	0.00000000	0.00000000	0.00000000
18	8	1	.73333333	.01875000	-.05009468	-.20000000
			-.28750000	0.00000000	0.00000000	0.00000000
19	9	1	.73333333	.01275000	-.07013255	-.20000000
			-.38750000	0.00000000	0.00000000	0.00000000
20	10	1	.73333333	.00475000	-.09017042	-.20000000
			-.48750000	0.00000000	0.00000000	0.00000000
21	1	1	.73333333	.00475000	.09020449	-.20000000
			.41250000	0.00000000	0.00000000	0.00000000

22	2	1	.73333333 .31250000	.01275000 0.00000000	.07015905 0.00000000	-.20000000 0.00000000
23	3	1	.73333333 .21250000	.01875000 0.00000000	.05011361 0.00000000	-.20000000 0.00000000
24	4	1	.73333333 .11250000	.02275000 0.00000000	.03006816 0.00000000	-.20000000 0.00000000
25	5	1	.73333333 .01250000	.02475000 0.00000000	.01002272 0.00000000	-.20000000 0.00000000
26	6	1	.73333333 -.08750000	.02475000 0.00000000	-.01002272 0.00000000	-.20000000 0.00000000
27	7	1	.73333333 -.18750000	.02275000 0.00000000	-.03006816 0.00000000	-.20000000 0.00000000
28	8	1	.73333333 -.28750000	.01875000 0.00000000	-.05011361 0.00000000	-.20000000 0.00000000
29	9	1	.73333333 -.38750000	.01275000 0.00000000	-.07015905 0.00000000	-.20000000 0.00000000
30	10	1	.73333333 -.48750000	.00475000 0.00000000	-.09020449 0.00000000	-.20000000 0.00000000
31	1	1	.73333333 .41250000	.00475000 0.00000000	.09024992 0.00000000	-.20000000 0.00000000
32	2	1	.73333333 .31250000	.01275000 0.00000000	.07019438 0.00000000	-.20000000 0.00000000
33	3	1	.73333333 .21250000	.01875000 0.00000000	.05013885 0.00000000	-.20000000 0.00000000
34	4	1	.73333333 .11250000	.02275000 0.00000000	.03008331 0.00000000	-.20000000 0.00000000
35	5	1	.73333333 .01250000	.02475000 0.00000000	.01002777 0.00000000	-.20000000 0.00000000
36	6	1	.73333333 -.08750000	.02475000 0.00000000	-.01002777 0.00000000	-.20000000 0.00000000
37	7	1	.73333333 -.18750000	.02275000 0.00000000	-.03008331 0.00000000	-.20000000 0.00000000
38	8	1	.73333333 -.28750000	.01875000 0.00000000	-.05013885 0.00000000	-.20000000 0.00000000
39	9	1	.73333333 -.38750000	.01275000 0.00000000	-.07019438 0.00000000	-.20000000 0.00000000
40	10	1	.73333333 -.48750000	.00475000 0.00000000	-.09024992 0.00000000	-.20000000 0.00000000
41	1	1	.73333333 .41250000	.00475000 0.00000000	.09031238 0.00000000	-.20000000 0.00000000

42	2	1	.73333333	.01275000	.07024296	-.20000000
			.31250000	0.00000000	0.00000000	0.00000000
43	3	1	.73333333	.01875000	.05017354	-.20000000
			.21250000	0.00000000	0.00000000	0.00000000
44	4	1	.73333333	.02275000	.03010413	-.20000000
			.11250000	0.00000000	0.00000000	0.00000000
45	5	1	.73333333	.02475000	.01003471	-.20000000
			.01250000	0.00000000	0.00000000	0.00000000
46	6	1	.73333333	.02475000	-.01003471	-.20000000
			-.08750000	0.00000000	0.00000000	0.00000000
47	7	1	.73333333	.02275000	-.03010413	-.20000000
			-.18750000	0.00000000	0.00000000	0.00000000
48	8	1	.73333333	.01875000	-.05017354	-.20000000
			-.28750000	0.00000000	0.00000000	0.00000000
49	9	1	.73333333	.01275000	-.07024296	-.20000000
			-.38750000	0.00000000	0.00000000	0.00000000
50	10	1	.73333333	.00475000	-.09031238	-.20000000
			-.48750000	0.00000000	0.00000000	0.00000000
51	1	1	.73333333	.00475000	.09040159	-.20000000
			.41250000	0.00000000	0.00000000	0.00000000
52	2	1	.73333333	.01275000	.07031235	-.20000000
			.31250000	0.00000000	0.00000000	0.00000000
53	3	1	.73333333	.01875000	.05022310	-.20000000
			.21250000	0.00000000	0.00000000	0.00000000
54	4	1	.73333333	.02275000	.03013386	-.20000000
			.11250000	0.00000000	0.00000000	0.00000000
55	5	1	.73333333	.02475000	.01004462	-.20000000
			.01250000	0.00000000	0.00000000	0.00000000
56	6	1	.73333333	.02475000	-.01004462	-.20000000
			-.08750000	0.00000000	0.00000000	0.00000000
57	7	1	.73333333	.02275000	-.03013386	-.20000000
			-.18750000	0.00000000	0.00000000	0.00000000
58	8	1	.73333333	.01875000	-.05022310	-.20000000
			-.28750000	0.00000000	0.00000000	0.00000000
59	9	1	.73333333	.01275000	-.07031235	-.20000000
			-.38750000	0.00000000	0.00000000	0.00000000
60	10	1	.73333333	.00475000	-.09040159	-.20000000
			-.48750000	0.00000000	0.00000000	0.00000000
61	1	1	.73333333	.00475000	.09053536	-.20000000
			.41250000	0.00000000	0.00000000	0.00000000

62	2	1	.73333333 .31250000	.01275000 0.00000000	.07041639 0.00000000	-.20000000 0.00000000
63	3	1	.73333333 .21250000	.01875000 0.00000000	.05029742 0.00000000	-.20000000 0.00000000
64	4	1	.73333333 .11250000	.02275000 0.00000000	.03017845 0.00000000	-.20000000 0.00000000
65	5	1	.73333333 .01250000	.02475000 0.00000000	.01005948 0.00000000	-.20000000 0.00000000
66	6	1	.73333333 -.08750000	.02475000 0.00000000	-.01005948 0.00000000	-.20000000 0.00000000
67	7	1	.73333333 -.18750000	.02275000 0.00000000	-.03017845 0.00000000	-.20000000 0.00000000
68	8	1	.73333333 -.28750000	.01875000 0.00000000	-.05029742 0.00000000	-.20000000 0.00000000
69	9	1	.73333333 -.38750000	.01275000 0.00000000	-.07041639 0.00000000	-.20000000 0.00000000
70	10	1	.73333333 -.48750000	.00475000 0.00000000	-.09053536 0.00000000	-.20000000 0.00000000
71	1	1	.73333333 .41250000	.00475000 0.00000000	.09074931 0.00000000	-.20000000 0.00000000
72	2	1	.73333333 .31250000	.01275000 0.00000000	.07058280 0.00000000	-.20000000 0.00000000
73	3	1	.73333333 .21250000	.01875000 0.00000000	.05041628 0.00000000	-.20000000 0.00000000
74	4	1	.73333333 .11250000	.02275000 0.00000000	.03024977 0.00000000	-.20000000 0.00000000
75	5	1	.73333333 .01250000	.02475000 0.00000000	.01008326 0.00000000	-.20000000 0.00000000
76	6	1	.73333333 -.08750000	.02475000 0.00000000	-.01008326 0.00000000	-.20000000 0.00000000
77	7	1	.73333333 -.18750000	.02275000 0.00000000	-.03024977 0.00000000	-.20000000 0.00000000
78	8	1	.73333333 -.28750000	.01875000 0.00000000	-.05041628 0.00000000	-.20000000 0.00000000
79	9	1	.73333333 -.38750000	.01275000 0.00000000	-.07058280 0.00000000	-.20000000 0.00000000
80	10	1	.73333333 -.48750000	.00475000 0.00000000	-.09074931 0.00000000	-.20000000 0.00000000
81	1	1	.73333333 .41250000	.00475000 0.00000000	.09112346 0.00000000	-.20000000 0.00000000

82	2	1	.73333333	.01275000	.07087380	-.20000000
			.31250000	0.00000000	0.00000000	0.00000000
83	3	1	.73333333	.01875000	.05062414	-.20000000
			.21250000	0.00000000	0.00000000	0.00000000
84	4	1	.73333333	.02275000	.03037449	-.20000000
			.11250000	0.00000000	0.00000000	0.00000000
85	5	1	.73333333	.02475000	.01012483	-.20000000
			.01250000	0.00000000	0.00000000	0.00000000
86	6	1	.73333333	.02475000	-.01012483	-.20000000
			-.08750000	0.00000000	0.00000000	0.00000000
87	7	1	.73333333	.02275000	-.03037449	-.20000000
			-.18750000	0.00000000	0.00000000	0.00000000
88	8	1	.73333333	.01875000	-.05062414	-.20000000
			-.28750000	0.00000000	0.00000000	0.00000000
89	9	1	.73333333	.01275000	-.07087380	-.20000000
			-.38750000	0.00000000	0.00000000	0.00000000
90	10	1	.73333333	.00475000	-.09112346	-.20000000
			-.48750000	0.00000000	0.00000000	0.00000000
91	1	1	.73333333	.00475000	.09187075	-.20000000
			.41250000	0.00000000	0.00000000	0.00000000
92	2	1	.73333333	.01275000	.07145503	-.20000000
			.31250000	0.00000000	0.00000000	0.00000000
93	3	1	.73333333	.01875000	.05103930	-.20000000
			.21250000	0.00000000	0.00000000	0.00000000
94	4	1	.73333333	.02275000	.03062358	-.20000000
			.11250000	0.00000000	0.00000000	0.00000000
95	5	1	.73333333	.02475000	.01020786	-.20000000
			.01250000	0.00000000	0.00000000	0.00000000
96	6	1	.73333333	.02475000	-.01020786	-.20000000
			-.08750000	0.00000000	0.00000000	0.00000000
97	7	1	.73333333	.02275000	-.03062358	-.20000000
			-.18750000	0.00000000	0.00000000	0.00000000
98	8	1	.73333333	.01875000	-.05103930	-.20000000
			-.28750000	0.00000000	0.00000000	0.00000000
99	9	1	.73333333	.01275000	-.07145503	-.20000000
			-.38750000	0.00000000	0.00000000	0.00000000
100	10	1	.73333333	.00475000	-.09187075	-.20000000
			-.48750000	0.00000000	0.00000000	0.00000000

THE VALUES OF CP1(1,NU) - 2ND ARE = 0.0 ON ALL LIFTING SURFACES

ADD LOAD CP 2ND

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.04375	.06046	.07550	.09003	.10490
.150	.02704	.03137	.03653	.04242	.04903
.250	.02648	.02969	.03341	.03724	.04124
.350	.02549	.02773	.03068	.03406	.03782
.450	.02471	.02632	.02862	.03143	.03475
.550	.02435	.02571	.02746	.02968	.03249
.650	.02395	.02511	.02675	.02873	.03100
.750	.02349	.02446	.02595	.02785	.03007
.850	.02311	.02390	.02515	.02690	.02909
.950	.02270	.02339	.02456	.02599	.02801

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.12092	.13903	.16047	.18736	.22361
.150	.05652	.06513	.07537	.08818	.10552
.250	.04565	.05102	.05816	.06760	.08086
.350	.04194	.04628	.05068	.05704	.06687
.450	.03862	.04306	.04806	.05299	.05965
.550	.03594	.04014	.04519	.05093	.05116
.650	.03394	.03768	.04255	.04856	.03739
.750	.03256	.03580	.04024	.04621	.02978
.850	.03160	.03438	.03833	.04388	.02516
.950	.03052	.03348	.03674	.04141	.02218

CP2 - CP1 ADD

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	-.00083	-.00285	-.00583	-.00747	-.01025
.150	.00010	-.00002	-.00018	-.00039	-.00066
.250	-.00006	-.00000	-.00004	-.00006	-.00005
.350	-.00022	-.00004	-.00080	-.00002	-.00007
.450	-.00036	-.00006	.00009	.00019	.00023
.550	-.00062	-.00032	-.00004	.00024	.00043
.650	-.00088	-.00058	-.00035	-.00008	.00036
.750	-.00112	-.00079	-.00054	-.00033	-.00004
.850	-.00145	-.00116	-.00078	-.00046	-.00024
.950	-.00180	-.00158	-.00123	-.00078	-.00038

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	-.01352	-.01750	-.02255	-.02935	-.03930
.150	-.00102	-.00150	-.00218	-.00319	-.00479
.250	-.00002	-.00002	-.00016	-.00045	-.00104
.350	-.00013	-.00009	.00026	.00050	.00044
.450	.00023	.00020	.00018	.00088	.00109
.550	.00057	.00061	.00061	.00071	.00042
.650	.00072	.00101	.00108	.00112	.00389
.750	.00056	.00112	.00153	.00158	.00626
.850	.00010	.00096	.00173	.00200	.00810
.950	-.00014	.00043	.00158	.00244	.00965

ADD LOAD CP 1ST

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.04457	.06331	.08053	.09750	.11515
.150	.02694	.03140	.03671	.04280	.04969
.250	.02654	.02970	.03345	.03730	.04130
.350	.02571	.02777	.03068	.03408	.03789
.450	.02507	.02637	.02853	.03124	.03452
.550	.02497	.02604	.02750	.02944	.03207
.650	.02483	.02568	.02710	.02880	.03064
.750	.02461	.02525	.02650	.02818	.03012
.850	.02456	.02506	.02593	.02736	.02932
.950	.02450	.02497	.02579	.02677	.02839

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.13444	.15653	.18303	.21670	.26291
.150	.05754	.06663	.07756	.09137	.11031
.250	.04568	.05104	.05832	.06806	.08189
.350	.04207	.04636	.05042	.05655	.06642
.450	.03839	.04286	.04787	.05211	.05856
.550	.03537	.03953	.04457	.05022	.05074
.650	.03322	.03667	.04147	.04744	.03350
.750	.03200	.03469	.03871	.04463	.02352
.850	.03150	.03342	.03660	.04188	.01706
.950	.03066	.03305	.03516	.03897	.01252

RK = 3
MK = 2 DATA(11) = 0.08000

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 1   1   1   1   .1000E+00   0.                  .1600E+03   0.
   2   1   1   1   0     1.00000   1.00000   1.00000   1.00000   0.00000   0.00000
```

TRANSFORM MATRIX

I \ L	1	2	3	4	5	6
1	1.0000	0.0000	0.0000	.0500	0.0000	0.0000
2	0.0000	1.0000	0.0000	0.0000	.0500	0.0000
3	0.0000	0.0000	1.0000	0.0000	0.0000	.0500
4	1.0000	0.0000	0.0000	.1500	0.0000	0.0000
5	0.0000	1.0000	0.0000	0.0000	.1500	0.0000
6	0.0000	0.0000	1.0000	0.0000	0.0000	.1500
7	1.0000	0.0000	0.0000	.2500	0.0000	0.0000
8	0.0000	1.0000	0.0000	0.0000	.2500	0.0000
9	0.0000	0.0000	1.0000	0.0000	0.0000	.2500
10	1.0000	0.0000	0.0000	.3500	0.0000	0.0000
11	0.0000	1.0000	0.0000	0.0000	.3500	0.0000
12	0.0000	0.0000	1.0000	0.0000	0.0000	.3500
13	1.0000	0.0000	0.0000	.4500	0.0000	0.0000
14	0.0000	1.0000	0.0000	0.0000	.4500	0.0000
15	0.0000	0.0000	1.0000	0.0000	0.0000	.4500
16	1.0000	0.0000	0.0000	.5500	0.0000	0.0000
17	0.0000	1.0000	0.0000	0.0000	.5500	0.0000
18	0.0000	0.0000	1.0000	0.0000	0.0000	.5500
19	1.0000	0.0000	0.0000	.6500	0.0000	0.0000
20	0.0000	1.0000	0.0000	0.0000	.6500	0.0000
21	0.0000	0.0000	1.0000	0.0000	0.0000	.6500
22	1.0000	0.0000	0.0000	.7500	0.0000	0.0000
23	0.0000	1.0000	0.0000	0.0000	.7500	0.0000
24	0.0000	0.0000	1.0000	0.0000	0.0000	.7500
25	1.0000	0.0000	0.0000	.8500	0.0000	0.0000
26	0.0000	1.0000	0.0000	0.0000	.8500	0.0000
27	0.0000	0.0000	1.0000	0.0000	0.0000	.8500
28	1.0000	0.0000	0.0000	.9500	0.0000	0.0000
29	0.0000	1.0000	0.0000	0.0000	.9500	0.0000
30	0.0000	0.0000	1.0000	0.0000	0.0000	.9500
31	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

I \ L	7	8	9	10	11	12	13
1	.0025	0.0000	0.0000	.0001	0.0000	0.0000	0.0000
2	0.0000	.0025	0.0000	0.0000	.0001	0.0000	0.0000
3	0.0000	0.0000	.0025	0.0000	0.0000	.0001	0.0000
4	.0225	0.0000	0.0000	.0034	0.0000	0.0000	0.0000
5	0.0000	.0225	0.0000	0.0000	.0034	0.0000	0.0000
6	0.0000	0.0000	.0225	0.0000	0.0000	.0034	0.0000
7	.0625	0.0000	0.0000	.0156	0.0000	0.0000	0.0000
8	0.0000	.0625	0.0000	0.0000	.0156	0.0000	0.0000
9	0.0000	0.0000	.0625	0.0000	0.0000	.0156	0.0000
10	.1225	0.0000	0.0000	.0429	0.0000	0.0000	0.0000
11	0.0000	.1225	0.0000	0.0000	.0429	0.0000	0.0000
12	0.0000	0.0000	.1225	0.0000	0.0000	.0429	0.0000
13	.2025	0.0000	0.0000	.0911	0.0000	0.0000	0.0000

14	0.0000	.2025	0.0000	0.0000	.0911	0.0000	0.0000
15	0.0000	0.0000	.2025	0.0000	0.0000	.0911	0.0000
16	.3025	0.0000	0.0000	.1664	0.0000	0.0000	0.0000
17	0.0000	.3025	0.0000	0.0000	.1664	0.0000	0.0000
18	0.0000	0.0000	.3025	0.0000	0.0000	.1664	0.0000
19	.4225	0.0000	0.0000	.2746	0.0000	0.0000	0.0000
20	0.0000	.4225	0.0000	0.0000	.2746	0.0000	0.0000
21	0.0000	0.0000	.4225	0.0000	0.0000	.2746	0.0000
22	.5625	0.0000	0.0000	.4219	0.0000	0.0000	0.0000
23	0.0000	.5625	0.0000	0.0000	.4219	0.0000	0.0000
24	0.0000	0.0000	.5625	0.0000	0.0000	.4219	0.0000
25	.7225	0.0000	0.0000	.6141	0.0000	0.0000	0.0000
26	0.0000	.7225	0.0000	0.0000	.6141	0.0000	0.0000
27	0.0000	0.0000	.7225	0.0000	0.0000	.6141	0.0000
28	.9025	0.0000	0.0000	.8574	0.0000	0.0000	0.0000
29	0.0000	.9025	0.0000	0.0000	.8574	0.0000	0.0000
30	0.0000	0.0000	.9025	0.0000	0.0000	.8574	0.0000
31	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000

A 19 X 19 MATRIX WAS SOLVED WITH SUBROUTINE ORTHO .

THE MATRIX ROWS WERE READ FROM UNIT 9 .

THERE WERE 1 SETS OF RIGHT HAND SIDE VECTORS, AND COLUMN PIVOTING WAS PERFORMED.

SOLUTION TIME = .013 SECONDS

THERE IS 1 DUMMY READ FOR EACH ROW READ.

THERE IS 1 DUMMY READ BEFORE THE 1ST READ.

TRANSFORMED UNKNOWNS - V

NU	M1	NTRM	U3	NF	MUS	MUS1	MU	NSF	NST	IO	JO
31	6	1	9	3	3	4	13	1	10	30	12

```
            L-MAX
U(K,J) =    SUM V(L,K) * ETA(J)**L        K = 1,NF
            L=0
```

ISF	L	K =>		
1	0	.09852	-.00180	-.00078
1	1	-.36098	.03874	.01719
1	2	.54535	-.05741	-.03373
1	3	-.30434	.02442	.01741

THE ANGLE OF ATTACK = 4.68644 DEGREES
JET DEFLECTION ANGLE = 0.00000 DEGREES

```
NU                        EXTREMUM ARRAY

31  1.0857E+00  6.5791E-01 -6.9832E-01  1.0393E+00  7.6050E-01  5.4694E-01
    8.0600E-01  6.9298E-01  1.5080E-01  7.0615E-01  7.6918E-01  7.4492E-02
    6.5986E-01  7.4577E-01  9.9250E-02  6.1734E-01  6.6768E-01  6.4444E-02
    5.5772E-01  5.8712E-01  5.7225E-03  4.7952E-01  4.9917E-01 -7.5738E-02
    3.7844E-01  4.0282E-01 -1.7170E-01  2.4319E-01  2.5959E-01 -2.2557E-01
    9.0000E-01

M1                        CONSTRAINT EQUATION ERRORS

 6 -4.4409E-16 -2.8974E-16  0.          2.2204E-16  1.3818E-17 -3.1785E-18

M1                        CONSTRAINT EQUATION BOUNDARY CONDITIONS

 6  1.0000E-01  0.          1.0000E+00 -2.6180E-02  1.0000E-08  0.

31  3.1279E-03  0.          3.1279E-03

MA                        UNKNOWNS AND LAGRANGE MULTIPLIERS

37  8.1794E-02  1.0000E-08 -3.1785E-18  5.5614E-02  2.8049E-03  1.1012E-03
    3.7602E-02  4.6814E-03  1.6846E-03  2.5932E-02  5.7761E-03  1.8546E-03
    1.8778E-02  6.2354E-03  1.7158E-03  1.4313E-02  6.2058E-03  1.3725E-03
    1.0713E-02  5.8338E-03  9.2921E-04  6.1505E-03  5.2659E-03  4.9047E-04
   -1.2003E-03  4.6487E-03  1.6070E-04 -1.3165E-02  4.1285E-03  4.4385E-05
    1.0000E+00  2.5000E+00  1.7000E+00  9.0000E-01  1.0000E-01 -7.0000E-01
   -1.5000E+00
```

TWIST OPTIMIZATION

THE ANGLE OF ATTACK GIVEN AT FLAPS AND SPAN STATIONS IS IN ADDITION TO ANY INITIAL TWIST, CAMBER AND ANGLE OF ATTACK. THIS ADDITIONAL ANGLE OF ATTACK IS MEASURED WITH RESPECT TO THE FREESTREAM.

ANGLE OF ATTACK = 4.6864 DEGREES (REFERENCE STATION 1)

SPAN STATION	INCREMENTAL FREESTREAM ANGLE OF ATTACK	INITIAL TWIST	FINAL TWIST	INITIAL CAMBER	INCREMENTAL VALUES => TWIST		
1	4.6864	0.0000	0.0000	F	0.0000	.0000	-.0000
2	3.1864	0.0000	-1.5000	F	-1.5000	.0028	.0011
3	2.1544	0.0000	-2.5320	F	-2.5320	.0047	.0017
4	1.4858	0.0000	-3.2007	F	-3.2007	.0058	.0019
5	1.0759	0.0000	-3.6106	F	-3.6106	.0062	.0017
6	.8201	0.0000	-3.8663	F	-3.8663	.0062	.0014
7	.6138	0.0000	-4.0726	F	-4.0726	.0058	.0009
8	.3524	0.0000	-4.3340	F	-4.3340	.0053	.0005
9	-.0688	0.0000	-4.7552	F	-4.7552	.0046	.0002
10	-.7543	0.0000	-5.4408	F	-5.4408	.0041	.0000

CP(IJ,2) 2ND ORDER

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.20516	.21234	.19079	.16402	.14325
.150	.12248	.12910	.12989	.12579	.11909
.250	.10098	.10630	.11245	.11815	.12158
.350	.08953	.09576	.10386	.11185	.11864
.450	.08252	.08875	.09733	.10584	.11319
.550	.07760	.08171	.08929	.09743	.10488
.650	.07454	.07524	.07963	.08624	.09355
.750	.07234	.06852	.06876	.07275	.07966
.850	.07007	.06043	.05624	.05741	.06354
.950	.06767	.05051	.04132	.04014	.04599

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.13310	.13351	.13923	.13849	.11232
.150	.11138	.10316	.09367	.08051	.05661
.250	.12148	.11751	.10964	.09660	.07440
.350	.12290	.12305	.11803	.10832	.09141
.450	.11866	.12113	.11921	.11232	.10003
.550	.11097	.11500	.11577	.11176	.11668
.650	.10059	.10650	.11009	.10911	.10817
.750	.08788	.09623	.10302	.10557	.10036
.850	.07338	.08460	.09515	.10157	.09162
.950	.05745	.07201	.08692	.09822	.08353

CP(IJ,2) 1ST ORDER

SURFACE NUMBER 1   WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.20889	.20576	.17225	.13385	.10286
.150	.12141	.12426	.12440	.12128	.11622
.250	.10032	.10348	.10918	.11544	.11993
.350	.09000	.09598	.10427	.11239	.11915
.450	.08357	.09086	.10040	.10946	.11687
.550	.07875	.08450	.09368	.10297	.11092
.650	.07594	.07903	.08493	.09273	.10095
.750	.07400	.07360	.07550	.08024	.08761
.850	.07154	.06667	.06445	.06593	.07172
.950	.06841	.05814	.05082	.04918	.05366

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.08413	.07682	.07420	.06191	.01376
.150	.11016	.10320	.09423	.08031	.05491
.250	.12094	.11788	.11063	.09806	.07688
.350	.12322	.12308	.11796	.10811	.09130
.450	.12194	.12358	.12041	.11276	.10046
.550	.11693	.12028	.11966	.11347	.10708
.650	.10826	.11400	.11670	.11368	.11059
.750	.09633	.10484	.11158	.11295	.11043
.850	.08147	.09319	.10443	.11111	.10790
.950	.06415	.07910	.09547	.10831	.10363

EXECUTION TIME FOR OPTIMIZATION = 2.308 SECONDS

DZ/DX WITHOUT TWIST

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.088	.00000	.01528	.02466	.02920	.02995
.188	.00000	.00805	.01330	.01619	.01721
.288	.00000	.00220	.00404	.00550	.00660
.388	.00000	-.00227	-.00312	-.00288	-.00186
.488	.00000	-.00537	-.00818	-.00894	-.00819
.588	-.00000	-.00710	-.01114	-.01270	-.01237
.688	-.00000	-.00746	-.01280	-.01414	-.01442
.788	-.00000	-.00644	-.01075	-.01327	-.01432
.888	-.00000	-.00405	-.00741	-.01008	-.01209
.988	-.00000	-.00029	-.00196	-.00458	-.00772

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.088	.02798	.02433	.02006	.01622	.01387
.188	.01681	.01546	.01363	.01177	.01036
.288	.00735	.00775	.00781	.00753	.00692
.388	-.00039	.00120	.00260	.00348	.00352
.488	-.00643	-.00419	-.00199	-.00036	.00018
.588	-.01075	-.00842	-.00598	-.00400	-.00310
.688	-.01336	-.01149	-.00935	-.00745	-.00632
.788	-.01426	-.01341	-.01211	-.01069	-.00950
.888	-.01345	-.01416	-.01426	-.01373	-.01261
.988	-.01092	-.01376	-.01579	-.01658	-.01567

Z/C WITHOUT TWIST

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.100	3.6000E-09	1.8338E-03	2.9458E-03	3.4671E-03	3.5285E-03
.200	6.4000E-09	2.8938E-03	4.6768E-03	5.5470E-03	5.7024E-03
.300	8.4000E-09	3.3174E-03	5.4030E-03	6.4709E-03	6.7355E-03
.400	9.6000E-09	3.2420E-03	5.3345E-03	6.4702E-03	6.8418E-03
.500	1.0000E-08	2.8049E-03	4.6814E-03	5.7761E-03	6.2354E-03
.600	9.6000E-09	2.1434E-03	3.6539E-03	4.6199E-03	5.1301E-03
.700	8.4000E-09	1.3948E-03	2.4618E-03	3.2329E-03	3.7399E-03
.800	6.4000E-09	6.9651E-04	1.3155E-03	1.8464E-03	2.2789E-03
.900	3.6000E-09	1.8579E-04	4.2482E-04	6.9168E-04	9.6092E-04
1.000	-3.9968E-16	-1.2056E-16	-1.4745E-16	1.2143E-16	4.8572E-17

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.100	3.2610E-03	2.7954E-03	2.2627E-03	1.7938E-03	1.5195E-03
.200	5.3409E-03	4.6606E-03	3.8595E-03	3.1355E-03	2.6865E-03
.300	6.4109E-03	5.7115E-03	4.8515E-03	4.0452E-03	3.5067E-03
.400	6.6421E-03	6.0639E-03	5.2999E-03	4.5429E-03	3.9855E-03
.500	6.2058E-03	5.8338E-03	5.2659E-03	4.6487E-03	4.1285E-03
.600	5.2729E-03	5.1369E-03	4.8106E-03	4.3825E-03	3.9412E-03
.700	4.0147E-03	4.0892E-03	3.9952E-03	3.7646E-03	3.4292E-03
.800	2.6024E-03	2.8066E-03	2.8809E-03	2.8148E-03	2.5980E-03
.900	1.2071E-03	1.4049E-03	1.5287E-03	1.5533E-03	1.4531E-03
1.000	-6.9389E-18	-4.8572E-17	2.7756E-17	-3.4694E-17	-2.0817E-17

Z/C WITHOUT TWIST

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.100	.00000	.00183	.00295	.00347	.00353
.200	.00000	.00289	.00468	.00555	.00570
.300	.00000	.00332	.00540	.00647	.00674
.400	.00000	.00324	.00533	.00647	.00684
.500	.00000	.00280	.00468	.00578	.00624
.600	.00000	.00214	.00365	.00462	.00513
.700	.00000	.00139	.00246	.00323	.00374
.800	.00000	.00070	.00132	.00185	.00228
.900	.00000	.00019	.00042	.00069	.00096
1.000	-.00000	-.00000	-.00000	.00000	.00000

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.100	.00326	.00280	.00226	.00179	.00152
.200	.00534	.00466	.00386	.00314	.00269
.300	.00641	.00571	.00485	.00405	.00351
.400	.00664	.00606	.00530	.00454	.00399
.500	.00621	.00583	.00527	.00465	.00413
.600	.00527	.00514	.00481	.00438	.00394
.700	.00401	.00409	.00400	.00376	.00343
.800	.00260	.00281	.00288	.00281	.00260
.900	.00121	.00140	.00153	.00155	.00145
1.000	-.00000	-.00000	.00000	-.00000	-.00000

THE VALUES OF CAMBER DATA - 2840 S ARE = 0.0 ON ALL LIFTING SURFACES

THE VALUES OF FLAP DATA - 3340 S ARE = 0.0 ON ALL LIFTING SURFACES

DELTA CP CAMBER

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	-.00000	-.09092	-.20515	-.32306	-.43680
.150	-.00484	-.02288	-.04766	-.07931	-.11666
.250	-.02405	-.03570	-.04760	-.05936	-.07360
.350	-.03047	-.03417	-.03951	-.04734	-.05841
.450	-.03393	-.03274	-.03329	-.03696	-.04490
.550	-.03829	-.03752	-.03518	-.03500	-.03936
.650	-.04042	-.04134	-.04207	-.04226	-.04265
.750	-.04132	-.04472	-.04868	-.05182	-.05353
.850	-.04355	-.05080	-.05708	-.06229	-.06571
.950	-.04639	-.05886	-.07004	-.07627	-.07938

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	-.54591	-.65674	-.78356	-.95364	-1.21836
.150	-.15949	-.20907	-.26923	-.34790	-.46203
.250	-.09312	-.12134	-.16268	-.22088	-.30691
.350	-.07393	-.09419	-.11831	-.15689	-.22000
.450	-.05796	-.07729	-.10395	-.13146	-.17398
.550	-.04883	-.06499	-.08922	-.12189	-.13069
.650	-.04743	-.05784	-.07763	-.10865	-.04643
.750	-.05362	-.05772	-.06984	-.09621	.00021
.850	-.06616	-.06344	-.06710	-.08518	.02794
.950	-.07955	-.07578	-.06932	-.07433	.04494

ORIGINAL PAGE IS
OF POOR QUALITY

V-NORMAL CAMBER

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.088	.00000	.04140	.06876	.08496	.09288
.188	.00000	.03418	.05740	.07196	.08014
.288	.00000	.02833	.04814	.06127	.06953
.388	.00000	.02385	.04098	.05289	.06107
.488	.00000	.02075	.03592	.04682	.05474
.588	-.00000	.01902	.03297	.04307	.05056
.688	-.00000	.01866	.03211	.04163	.04851
.788	-.00000	.01968	.03335	.04250	.04860
.888	-.00000	.02207	.03670	.04568	.05084
.988	-.00000	.02584	.04214	.05118	.05521

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.088	.09539	.09536	.09568	.09920	.10882
.188	.08422	.08650	.08925	.09476	.10532
.288	.07476	.07879	.08343	.09051	.10187
.388	.06702	.07224	.07822	.08647	.09848
.488	.06098	.06684	.07363	.08263	.09514
.588	.05666	.06261	.06964	.07898	.09186
.688	.05405	.05954	.06627	.07554	.08863
.788	.05315	.05762	.06351	.07230	.08546
.888	.05396	.05687	.06136	.06925	.08235
.988	.05648	.05727	.05983	.06641	.07929

DELTA CP ADD LOAD

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.04457	.06331	.08053	.09750	.11515
.150	.02694	.03140	.03671	.04280	.04969
.250	.02654	.02970	.03345	.03730	.04130
.350	.02571	.02777	.03068	.03408	.03789
.450	.02507	.02637	.02853	.03124	.03452
.550	.02497	.02604	.02750	.02944	.03207
.650	.02483	.02568	.02710	.02880	.03064
.750	.02461	.02525	.02650	.02818	.03012
.850	.02456	.02506	.02593	.02736	.02932
.950	.02450	.02497	.02579	.02677	.02839

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.13444	.15653	.18303	.21670	.26291
.150	.05754	.06663	.07756	.09137	.11031
.250	.04568	.05104	.05832	.06806	.08189
.350	.04207	.04636	.05042	.05655	.06642
.450	.03839	.04286	.04787	.05211	.05856
.550	.03537	.03953	.04457	.05022	.05074
.650	.03322	.03667	.04147	.04744	.03350
.750	.03200	.03469	.03871	.04463	.02352
.850	.03150	.03342	.03660	.04188	.01706
.950	.03066	.03305	.03516	.03897	.01252

ORIGINAL PAGE IS
OF POOR QUALITY

V-NORMAL ADD LOAD

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.088	-.01745	-.01745	-.01745	-.01745	-.01745
.188	-.01745	-.01745	-.01745	-.01745	-.01745
.288	-.01745	-.01745	-.01745	-.01745	-.01745
.388	-.01745	-.01745	-.01745	-.01745	-.01745
.488	-.01745	-.01745	-.01745	-.01745	-.01745
.588	-.01745	-.01745	-.01745	-.01745	-.01745
.688	-.01745	-.01745	-.01745	-.01745	-.01745
.788	-.01745	-.01745	-.01745	-.01745	-.01745
.888	-.01745	-.01745	-.01745	-.01745	-.01745
.988	-.01745	-.01745	-.01745	-.01745	-.01745

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.088	-.01745	-.01745	-.01745	-.01745	-.01745
.188	-.01745	-.01745	-.01745	-.01745	-.01745
.288	-.01745	-.01745	-.01745	-.01745	-.01745
.388	-.01745	-.01745	-.01745	-.01745	-.01745
.488	-.01745	-.01745	-.01745	-.01745	-.01745
.588	-.01745	-.01745	-.01745	-.01745	-.01745
.688	-.01745	-.01745	-.01745	-.01745	-.01745
.788	-.01745	-.01745	-.01745	-.01745	-.01745
.888	-.01745	-.01745	-.01745	-.01745	-.01745
.988	-.01745	-.01745	-.01745	-.01745	-.01745

THE VALUES OF FLAP DZ/DX (= - AOA) ARE = 0.0 ON ALL LIFTING SURFACES

DRAG V-NORMAL CAMBER

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.00000	.04140	.06876	.08496	.09288
.150	.00000	.03418	.05740	.07196	.08014
.250	.00000	.02833	.04814	.06127	.06953
.350	.00000	.02385	.04098	.05289	.06107
.450	.00000	.02075	.03592	.04682	.05474
.550	-.00000	.01902	.03297	.04307	.05056
.650	-.00000	.01866	.03211	.04163	.04851
.750	-.00000	.01968	.03335	.04250	.04860
.850	-.00000	.02207	.03670	.04568	.05084
.950	-.00000	.02584	.04214	.05118	.05521

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.09539	.09536	.09568	.09920	.10882
.150	.08422	.08650	.08925	.09476	.10532
.250	.07476	.07879	.08343	.09051	.10187
.350	.06702	.07224	.07822	.08647	.09848
.450	.06098	.06684	.07363	.08263	.09514
.550	.05666	.06261	.06964	.07898	.09186
.650	.05405	.05954	.06627	.07554	.08863
.750	.05315	.05762	.06351	.07230	.08546
.850	.05396	.05687	.06136	.06925	.08235
.950	.05648	.05727	.05983	.06641	.07929

VTXDRG CAVG = 8.0000

```
10  100
10  10  10  10  10  10  10  10  10  10
```

ORIGINAL PAGE IS
OF POOR QUALITY

CK2 ARRAY

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.73333	.73333	.73333	.73333	.73333
.150	.73333	.73333	.73333	.73333	.73333
.250	.73333	.73333	.73333	.73333	.73333
.350	.73333	.73333	.73333	.73333	.73333
.450	.73333	.73333	.73333	.73333	.73333
.550	.73333	.73333	.73333	.73333	.73333
.650	.73333	.73333	.73333	.73333	.73333
.750	.73333	.73333	.73333	.73333	.73333
.850	.73333	.73333	.73333	.73333	.73333
.950	.73333	.73333	.73333	.73333	.73333

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.73333	.73333	.73333	.73333	.73333
.150	.73333	.73333	.73333	.73333	.73333
.250	.73333	.73333	.73333	.73333	.73333
.350	.73333	.73333	.73333	.73333	.73333
.450	.73333	.73333	.73333	.73333	.73333
.550	.73333	.73333	.73333	.73333	.73333
.650	.73333	.73333	.73333	.73333	.73333
.750	.73333	.73333	.73333	.73333	.73333
.850	.73333	.73333	.73333	.73333	.73333
.950	.73333	.73333	.73333	.73333	.73333

A 100 X 100 MATRIX WAS SOLVED WITH SUBROUTINE ORTHO USING A PREVIOUSLY CREATED QUASI-INVERSE MATRIX.
THE MATRIX ROWS WERE READ FROM UNIT 13 .
THERE WERE 6 SETS OF RIGHT HAND SIDE VECTORS, AND COLUMN PIVOTING WAS PERFORMED.
SOLUTION TIME = .134 SECONDS

ALPHA = 4.686 DEGREES
ALPHAI = 4.686 DEGREES

CAMBER, AND THICKNESS

11 1 1

DELTA CP TO ORDER 1

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.20889	.20576	.17225	.13385	.10286
.150	.12141	.12426	.12440	.12128	.11622
.250	.10032	.10348	.10918	.11544	.11993
.350	.09000	.09598	.10427	.11239	.11915
.450	.08357	.09086	.10040	.10946	.11687
.550	.07875	.08450	.09368	.10297	.11092
.650	.07594	.07903	.08493	.09273	.10095
.750	.07400	.07360	.07550	.08024	.08761
.850	.07154	.06667	.06445	.06593	.07172
.950	.06841	.05814	.05082	.04918	.05366

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.08413	.07682	.07420	.06191	.01376
.150	.11016	.10320	.09423	.08031	.05491
.250	.12094	.11788	.11063	.09806	.07688
.350	.12322	.12308	.11796	.10811	.09130
.450	.12194	.12358	.12041	.11276	.10046
.550	.11693	.12028	.11966	.11347	.10708
.650	.10826	.11400	.11670	.11368	.11059
.750	.09633	.10484	.11158	.11295	.11043
.850	.08147	.09319	.10443	.11111	.10790
.950	.06415	.07910	.09547	.10831	.10363

ALPHA = 4.686 DEGREES
ALPHAI = 4.686 DEGREES

CAMBER, AND THICKNESS

UPPER CP TO ORDER 1

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	-.03259	-.01002	.02173	.05240	.07711
.150	-.01663	-.01801	-.01601	-.01216	-.00747
.250	-.02307	-.03179	-.03857	-.04442	-.04881
.350	-.03348	-.04706	-.05862	-.06862	-.07709
.450	-.04559	-.06167	-.07608	-.08877	-.09973
.550	-.05855	-.07488	-.09060	-.10500	-.11787
.650	-.07270	-.08821	-.10326	-.11810	-.13239
.750	-.08757	-.10148	-.11514	-.12929	-.14416
.850	-.10245	-.11408	-.12603	-.13912	-.15394
.950	-.11735	-.12602	-.13558	-.14752	-.16222

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.09409	.10417	.11099	.12190	.15026
.150	-.00249	.00268	.00859	.01668	.03022
.250	-.05116	-.05132	-.04936	-.04481	-.03615
.350	-.08373	-.08799	-.08961	-.08880	-.08470
.450	-.10897	-.11616	-.12079	-.12322	-.12346
.550	-.12923	-.13893	-.14651	-.15141	-.15662
.650	-.14572	-.15799	-.16865	-.17659	-.19664
.750	-.15931	-.17411	-.18800	-.19943	-.22188
.850	-.17050	-.18795	-.20515	-.22037	-.24172
.950	-.17982	-.19974	-.22050	-.23983	-.25799

ALPHA = 4.686 DEGREES
ALPHAI = 4.686 DEGREES

CAMBER, AND THICKNESS

LOWER CP TO ORDER 1

SURFACE NUMBER 1   WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.17630	.19573	.19397	.18625	.17996
.150	.10478	.10625	.10839	.10912	.10875
.250	.07725	.07168	.07061	.07102	.07112
.350	.05652	.04892	.04565	.04378	.04205
.450	.03798	.02919	.02432	.02070	.01714
.550	.02020	.00962	.00308	-.00203	-.00695
.650	.00323	-.00918	-.01833	-.02537	-.03144
.750	-.01357	-.02788	-.03964	-.04905	-.05655
.850	-.03092	-.04741	-.06158	-.07320	-.08222
.950	-.04893	-.06788	-.08476	-.09834	-.10856

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.17822	.18100	.18519	.18381	.16402
.150	.10767	.10588	.10282	.09699	.08513
.250	.06978	.06656	.06127	.05325	.04073
.350	.03948	.03509	.02835	.01931	.00660
.450	.01297	.00742	-.00038	-.01046	-.02301
.550	-.01230	-.01865	-.02685	-.03793	-.04953
.650	-.03746	-.04398	-.05194	-.06292	-.08605
.750	-.06299	-.06927	-.07643	-.08649	-.11145
.850	-.08903	-.09476	-.10071	-.10926	-.13382
.950	-.11567	-.12063	-.12503	-.13152	-.15436

CLBX(1) =	0.00000	CLBX(2) =	0.00000
CDBX(1) =	0.00000	CDBX(2) =	0.00000
CXBX(1) =	0.00000	CXBX(2) =	0.00000
CLBB =	0.00000	CDBB =	0.00000
CXBB =	0.00000		

C-3

PANEL X/C USED FOR DRAG COMPUTATION = .8750

DRAG N-VELOCITIES

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.088	-.08179	-.04040	-.01303	.00317	.01109
.188	-.08179	-.04762	-.02439	-.00984	-.00166
.288	-.08179	-.05347	-.03365	-.02053	-.01226
.388	-.08179	-.05794	-.04081	-.02891	-.02073
.488	-.08179	-.06104	-.04587	-.03497	-.02705
.588	-.08179	-.06277	-.04883	-.03873	-.03124
.688	-.08179	-.06313	-.04968	-.04017	-.03328
.788	-.08179	-.06211	-.04844	-.03930	-.03319
.888	-.08179	-.05972	-.04510	-.03611	-.03096
.988	-.08179	-.05596	-.03965	-.03061	-.02659

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.088	.01360	.01357	.01388	.01741	.02703
.188	.00243	.00470	.00745	.01297	.02353
.288	-.00703	-.00301	.00163	.00872	.02008
.388	-.01478	-.00956	-.00357	.00468	.01669
.488	-.02081	-.01495	-.00817	.00083	.01335
.588	-.02513	-.01918	-.01215	-.00281	.01007
.688	-.02775	-.02226	-.01552	-.00626	.00684
.788	-.02864	-.02417	-.01828	-.00950	.00367
.888	-.02783	-.02493	-.02043	-.01254	.00055
.988	-.02531	-.02452	-.02197	-.01538	-.00251

CAMBER, AND THICKNESS   ORDER = 1   83/07/18   10.41

63-45 WING AT M = 2.00 T/C = 0.050 10 X 10 PANELS XCG = 12.0

ANGLE OF ATTACK	=	4.68644	DEGREES
JET DEFLECTION ANGLE	=	0.00000	DEGREES
THRUST COEFFICIENT	=	0.00000	
MACH NUMBER	=	2.00000	

SURFACE NUMBER 1   WING

	Y	CN	CN*C/CAVG	CT*C/CAVG	CDC/CAVG	XCP	TWIST	COS	CHORD
1	.493	.09723	.15201	.000361	.01243	.40790	0.00000	1.00000	12.5067
2	1.493	.09817	.14120	.000311	.00761	.40133	-1.49672	1.00000	11.5072
3	2.492	.09791	.12861	.000171	.00462	.41093	-2.52699	1.00000	10.5079
4	3.491	.09826	.11679	.000070	.00296	.42928	-3.19513	1.00000	9.5088
5	4.490	.09987	.10624	.000023	.00208	.45117	-3.60545	1.00000	8.5098
6	5.489	.10260	.09633	.000007	.00154	.47306	-3.86225	1.00000	7.5111
7	6.487	.10539	.08580	.000004	.00110	.49312	-4.06986	1.00000	6.5128
8	7.485	.10623	.07324	.000002	.00062	.51235	-4.33258	1.00000	5.5152
9	8.481	.10165	.05741	.000001	.00009	.53552	-4.75474	1.00000	4.5185
10	9.476	.08710	.03837	.000004	-.00035	.58051	-5.44063	1.00000	3.5238

TOTAL (SURFACE)   .09960   .000095   .00327   11.90756 = X-CP

0.00000 = CY   0.00000 = Z-CP   0.00000
.04980 = CZ   3.99107 = Y-CP   1.00000

.04980 = TOTAL FORCE COEFFICIENT (SURFACE)

TOTAL (THICKNESS)   .00820

	CL	CT	CD(0)	X-CP
TOTAL CONFIGURATION	.09960	.000095	.00820	11.90756
WITH VORTEX LIFT	.09939	0.000000		11.92628

CD(0)	=	.00327	CD(VTX)	=	.00125
CD(0)/CL**2	=	.32958	CD(VTX)/CL**2	=	.12572
E(0)	=	.3863	E(VTX)	=	1.0128

ZERO SUCTION DRAG MINUS LEADING EDGE THRUST   RS = .250   MO = 0

CD = .00317

CD / CL**2 = .31996

C3

```
     CDW / CL**2  =        .19425   (WAVE DRAG DUE TO LIFT)
      E           =        .3979

WITH VORTEX LIFT
     CD           =        .00326
     CD  / CL**2  =        .33800
      E           =        .3858
```

ALPHA = 4.686 DEGREES
ALPHAI = 4.686 DEGREES

CAMBER, AND THICKNESS

12 1 1

DELTA CP TO ORDER 2

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.20631	.21267	.19099	.16429	.14367
.150	.12464	.13063	.13123	.12697	.12012
.250	.10270	.10733	.11326	.11884	.12218
.350	.09101	.09673	.10463	.11252	.11924
.450	.08363	.08955	.09799	.10642	.11372
.550	.07827	.08230	.08981	.09791	.10533
.650	.07474	.07558	.07999	.08661	.09392
.750	.07203	.06858	.06893	.07297	.07992
.850	.06918	.06019	.05620	.05747	.06369
.950	.06619	.04994	.04104	.04004	.04601

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.13371	.13429	.14016	.13963	.11384
.150	.11229	.10399	.09447	.08128	.05725
.250	.12202	.11801	.11012	.09708	.07491
.350	.12346	.12357	.11853	.10880	.09189
.450	.11917	.12162	.11970	.11280	.10050
.550	.11141	.11545	.11621	.11222	.11711
.650	.10096	.10689	.11050	.10954	.10850
.750	.08818	.09656	.10338	.10596	.10063
.850	.07359	.08487	.09546	.10193	.09184
.950	.05757	.07221	.08718	.09853	.08370

ORIGINAL PAGE IS
OF POOR QUALITY

ALPHA = 4.686 DEGREES
ALPHAI = 4.686 DEGREES

CAMBER, AND THICKNESS

UPPER CP TO ORDER 2

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	-.02903	-.01344	.00763	.02774	.04389
.150	-.01157	-.01760	-.01966	-.01813	-.01374
.250	-.01680	-.02864	-.03767	-.04425	-.04748
.350	-.02618	-.04103	-.05300	-.06218	-.06786
.450	-.03751	-.05329	-.06636	-.07604	-.08489
.550	-.04989	-.06464	-.07711	-.08882	-.10541
.650	-.06152	-.07551	-.08796	-.10492	-.11992
.750	-.08015	-.08567	-.10124	-.11704	-.13242
.850	-.09057	-.10436	-.11516	-.12826	-.14361
.950	-.10744	-.11481	-.12888	-.14321	-.15808

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.05544	.06299	.06983	.08109	.32257
.150	-.00703	.00228	.01071	.00698	.17829
.250	-.04626	-.04356	-.04805	-.04725	.12900
.350	-.07241	-.08259	-.08832	-.08426	.08320
.450	-.09938	-.11008	-.11228	-.11568	.04888
.550	-.11843	-.12719	-.13718	-.13202	.01735
.650	-.13282	-.14602	-.15684	-.14632	-.08066
.750	-.14714	-.16132	-.17842	-.15523	-.12599
.850	-.16092	-.17975	-.19406	-.15867	-.15255
.950	-.17597	-.19370	-.21107	-.16007	-.36048

ALPHA = 4.686 DEGREES
ALPHAI = 4.686 DEGREES

CAMBER, AND THICKNESS

LOWER CP TO ORDER 2

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.17728	.19922	.19862	.19203	.18757
.150	.11307	.11303	.11157	.10884	.10637
.250	.08590	.07870	.07559	.07459	.07471
.350	.06483	.05570	.05163	.05034	.05138
.450	.04612	.03626	.03163	.03038	.02883
.550	.02839	.01766	.01270	.00909	-.00008
.650	.01322	.00008	-.00797	-.01831	-.02600
.750	-.00812	-.01709	-.03231	-.04406	-.05250
.850	-.02139	-.04417	-.05897	-.07079	-.07992
.950	-.04125	-.06487	-.08784	-.10317	-.11207

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.18914	.19728	.20999	.22071	.43641
.150	.10526	.10627	.10518	.08826	.23554
.250	.07576	.07445	.06207	.04983	.20391
.350	.05106	.04099	.03021	.02454	.17510
.450	.01979	.01155	.00750	-.00288	.14938
.550	-.00701	-.01175	-.02097	-.01980	.13446
.650	-.03186	-.03913	-.04634	-.03678	.02785
.750	-.05895	-.06476	-.07503	-.04927	-.02536
.850	-.08733	-.09488	-.09860	-.05675	-.06071
.950	-.11840	-.12149	-.12389	-.06154	-.27677

CLBX(1) = 0.00000 CLBX(2) = 0.00000
CDBX(1) = 0.00000 CDBX(2) = 0.00000
CXBX(1) = 0.00000 CXBX(2) = 0.00000
CLBB = 0.00000 CDBB = 0.00000
CXBB = 0.00000

PANEL X/C USED FOR DRAG COMPUTATION = .8750

DRAG N-VELOCITIES

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.088	-.08179	-.04040	-.01303	.00317	.01109
.188	-.08179	-.04762	-.02439	-.00984	-.00166
.288	-.08179	-.05347	-.03365	-.02053	-.01226
.388	-.08179	-.05794	-.04081	-.02891	-.02073
.488	-.08179	-.06104	-.04587	-.03497	-.02705
.588	-.08179	-.06277	-.04883	-.03873	-.03124
.688	-.08179	-.06313	-.04968	-.04017	-.03328
.788	-.08179	-.06211	-.04844	-.03930	-.03319
.888	-.08179	-.05972	-.04510	-.03611	-.03096
.988	-.08179	-.05596	-.03965	-.03061	-.02659

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.088	.01360	.01357	.01388	.01741	.02703
.188	.00243	.00470	.00745	.01297	.02353
.288	-.00703	-.00301	.00163	.00872	.02008
.388	-.01478	-.00956	-.00357	.00468	.01669
.488	-.02081	-.01495	-.00817	.00083	.01335
.588	-.02513	-.01918	-.01215	-.00281	.01007
.688	-.02775	-.02226	-.01552	-.00626	.00684
.788	-.02864	-.02417	-.01828	-.00950	.00367
.888	-.02783	-.02493	-.02043	-.01254	.00055
.988	-.02531	-.02452	-.02197	-.01538	-.00251

```
CAMBER, AND THICKNESS        ORDER = 2          83/07/18       10.41
   63-45  WING AT M = 2.00  T/C = 0.050 10 X 10 PANELS XCG = 12.0

        ANGLE OF ATTACK        =      4.68644  DEGREES
        JET DEFLECTION ANGLE   =      0.00000  DEGREES
        THRUST COEFFICIENT     =      0.00000
        MACH NUMBER            =      2.00000

      SURFACE NUMBER   1           WING
```

	Y	CN	CN*C/CAVG	CT*C/CAVG	CDC/CAVG	XCP	TWIST	COS	CHORD
1	.493	.09682	.15136	.000350	.01238	.40416	0.00000	1.00000	12.5067
2	1.493	.09729	.13994	.000340	.00750	.38587	-1.49672	1.00000	11.5072
3	2.492	.09733	.12785	.000229	.00448	.38817	-2.52699	1.00000	10.5079
4	3.491	.09831	.11686	.000134	.00280	.40243	-3.19513	1.00000	9.5088
5	4.490	.10066	.10708	.000079	.00190	.42213	-3.60545	1.00000	8.5098
6	5.489	.10408	.09772	.000054	.00138	.44241	-3.86225	1.00000	7.5111
7	6.487	.10753	.08754	.000047	.00096	.46028	-4.06986	1.00000	6.5128
8	7.485	.10927	.07533	.000046	.00051	.47576	-4.33258	1.00000	5.5152
9	8.481	.10634	.06006	.000039	-.00001	.49161	-4.75474	1.00000	4.5185
10	9.476	.09338	.04113	.000017	-.00048	.50883	-5.44063	1.00000	3.5238

```
TOTAL (SURFACE)              .10049     .000133     .00314    11.79081 = X-CP

                             0.00000 = CY                      0.00000 = Z-CP     0.00000
                              .05024 = CZ                      4.03859 = Y-CP     1.00000

                              .05024 = TOTAL FORCE COEFFICIENT (SURFACE)

TOTAL (THICKNESS)                                   .00809
                                CL         CT       CD(0)       X-CP
TOTAL CONFIGURATION           .10049     .000133    .00809    11.79081
WITH VORTEX LIFT              .10019    0.000000              11.81022

      CD(0)          =        .00314        CD(VTX)         =     .00126
      CD(0)/CL**2    =        .31133        CD(VTX)/CL**2   =     .12443
       E(0)          =        .4090          E(VTX)         =    1.0232

     ZERO SUCTION DRAG MINUS LEADING EDGE THRUST        RS  =    .250       MO = 0
      CD            =         .00301
      CD   / CL**2  =         .29811
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
CDW / CL**2  =     .17367   (WAVE DRAG DUE TO LIFT)
 E           =     .4271

WITH VORTEX LIFT
 CD          =     .00313
 CD  / CL**2 =     .31227
 E           =     .4077
```

BETA * Y / X

SURFACE NUMBER 1 WING

X/C	.4933	1.4928	2.4921	3.4912	4.4902
.050	.53007	.72609	.78344	.81082	.82685
.150	.29849	.54876	.65795	.71913	.75825
.250	.20773	.44104	.56712	.64607	.70016
.350	.15930	.36867	.49832	.58649	.65034
.450	.12918	.31671	.44441	.53697	.60713
.550	.10864	.27758	.40102	.49516	.56931
.650	.09373	.24706	.36535	.45939	.53593
.750	.08243	.22258	.33551	.42844	.50624
.850	.07355	.20252	.31018	.40140	.47967
.950	.06640	.18578	.28840	.37756	.45575

X/C	5.4889	6.4872	7.4848	8.4815	9.4762
.050	.83738	.84482	.85036	.85464	.85805
.150	.78542	.80538	.82067	.83275	.84253
.250	.73953	.76946	.79299	.81195	.82756
.350	.69870	.73661	.76711	.79217	.81311
.450	.66215	.70645	.74287	.77333	.79916
.550	.62923	.67866	.72011	.75536	.78568
.650	.59943	.65297	.69870	.73821	.77265
.750	.57233	.62916	.67854	.72182	.76004
.850	.54757	.60702	.65950	.70614	.74784
.950	.52486	.58639	.64150	.69113	.73602

NEAR FIELD DRAG CALCULATION - CD(0)
SUCTION + NEAR FIELD DRAG CALCULATION - CD(S+0)
VORTEX DRAG CALCULATION - CD(100)

NORMAL VELOCITY INTERPOLATION X/C = .87500

CL	CD(0)	E(0)	CD(VTX)	E(VTX)	CD(S+0)	ALPHA	X-CP
.00000	.00120	.00000	.00037	.00000	.00076	2.343	0.00000
.05000	.00122	.26082	.00047	.67020	.00109	3.519	10.93760
.10000	.00329	.38651	.00126	1.01369	.00320	4.696	11.91149
.15000	.00742	.38602	.00271	1.05767	.00709	5.872	12.23612
.20000	.01360	.37443	.00483	1.05388	.01276	7.049	12.39843
.25000	.02184	.36444	.00763	1.04323	.02020	8.225	12.49582
.30000	.03212	.35673	.01109	1.03284	.02943	9.402	12.56075
.35000	.04446	.35079	.01523	1.02390	.04044	10.578	12.60712
.40000	.05886	.34612	.02004	1.01641	.05323	11.755	12.64191
.45000	.07530	.34239	.02552	1.01015	.06780	12.931	12.66896
.50000	.09381	.33933	.03168	1.00487	.08415	14.108	12.69060
.55000	.11436	.33680	.03850	1.00039	.10228	15.284	12.70831
.60000	.13697	.33466	.04600	.99653	.12219	16.461	12.72306
.65000	.16163	.33283	.05416	.99319	.14388	17.637	12.73555
.70000	.18834	.33126	.06300	.99028	.16735	18.814	12.74625
.75000	.21711	.32988	.07251	.98771	.19260	19.990	12.75553
.80000	.24793	.32867	.08269	.98543	.21963	21.167	12.76364
.85000	.28080	.32760	.09355	.98339	.24844	22.343	12.77080
.90000	.31573	.32665	.10507	.98157	.27903	23.519	12.77717
.95000	.35271	.32579	.11727	.97992	.31140	24.696	12.78286
1.00000	.39174	.32502	.13013	.97842	.34555	25.872	12.78799
1.05000	.43283	.32432	.14367	.97706	.38148	27.049	12.79263
1.10000	.47597	.32368	.15788	.97582	.41919	28.225	12.79684
1.15000	.52117	.32310	.17276	.97467	.45868	29.402	12.80069
1.20000	.56841	.32256	.18831	.97362	.49995	30.578	12.80422
1.25000	.61771	.32207	.20454	.97265	.54301	31.755	12.80747
1.30000	.66907	.32161	.22143	.97175	.58784	32.931	12.81046
1.35000	.72247	.32119	.23900	.97091	.63445	34.108	12.81324
1.40000	.77793	.32079	.25724	.97013	.68284	35.284	12.81581
1.45000	.83545	.32043	.27615	.96940	.73301	36.461	12.81821
1.50000	.89502	.32008	.29573	.96872	.78496	37.637	12.82045

CL	CD(0)	E(0)	CD(VTX)	E(VTX)	CD(S+0)	ALPHA	X-CP
1.55000	.95664	.31976	.31598	.96808	.83870	38.814	12.82255
1.60000	1.02031	.31946	.33691	.96747	.89421	39.990	12.82451
1.65000	1.08604	.31918	.35850	.96691	.95150	41.167	12.82635
1.70000	1.15382	.31891	.38077	.96637	1.01057	42.343	12.82809
1.75000	1.22365	.31866	.40371	.96587	1.07142	43.519	12.82973
1.80000	1.29554	.31842	.42732	.96539	1.13406	44.696	12.83127
1.85000	1.36948	.31820	.45160	.96494	1.19847	45.872	12.83274
1.90000	1.44547	.31799	.47655	.96451	1.26466	47.049	12.83412
1.95000	1.52352	.31778	.50218	.96410	1.33264	48.225	12.83544
2.00000	1.60362	.31759	.52848	.96371	1.40239	49.402	12.83668

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```
                                                    83/07/18      10.41
     63-45  WING AT M = 2.00  T/C = 0.050 10 X 10 PANELS XCG = 12.0

SREF  =     160.00000             XCG  =     11.80000
SPAN  =      20.00000             YCG  =      0.00000
CAVG  =       8.00000             ZCG  =      0.00000
CBAR  =       8.00000              RC  =       .87500
MACH  =       2.00000              AR  =      2.50000

CL    =   .04250002 * ALPHA    +    -.09958

CM    =  -.00576608 * ALPHA    +     .02568
      =  -.13567229 *  CL      +     .01217  =   -.13567 * ( CL -  .0897 )

   FORCES DUE TO LEADING EDGE SUCTION

CX    =  -.00009870 * ALPHA**2 +     .000840 * ALPHA +  -.00187

      =  -.05464301 * CL**2    +     .008889 * CL    +  -.00044

      =  -.05464301 * ( CL -    .0813 )**2           +  -.00008
```

```
                NEAR FIELD DRAG CALCULATION - CD(0)        NORMAL VELOCITY INTERPOLATION X/C =  .87500
      SUCTION + NEAR FIELD DRAG CALCULATION - CD(S+0)
                  VORTEX   DRAG CALCULATION - CD(100)

CD(0)    =     .00074177 * ALPHA**2 +     -.004331 * ALPHA +    .00728

CD(S+0) =      .00064307 * ALPHA**2 +     -.003491 * ALPHA +    .00541

CD(100) =      .00024256 * ALPHA**2 +     -.001329 * ALPHA +    .00215

CD(0)    =     .41066549 * CL**2    +     -.020123 * CL    +    .00120

CD(S+0) =      .35602249 * CL**2    +     -.011234 * CL    +    .00076

CD(100) =      .13428747 * CL**2    +     -.004521 * CL    +    .00037

CD(0)    =     .41066549 * ( CL -    .0245 )**2            +    .00095

CD(S+0) =      .35602249 * ( CL -    .0158 )**2            +    .00067

CD(100) =      .13428747 * ( CL -    .0168 )**2            +    .00033
```

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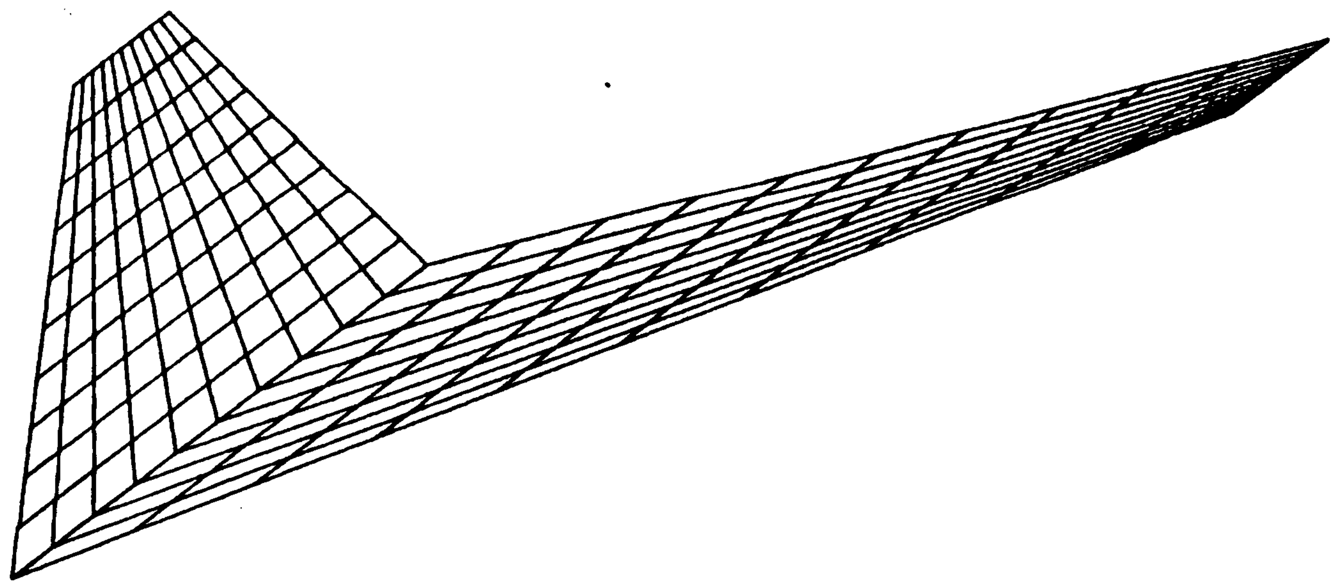
63-45 WING AT M = 2.00 T/C = 0.050 10 X 10 PANELS

INPUT DISPLAY ANGLES
(YAW,PITCH,ROLL)? -30 -20 0

PANELS 1 THRU 100



```
 DATA SET   1            PLOT FILE CREATED BY OPT
 MACH = 2.00
    Q = 0.0
ALPHA =    4.60 DEG
NSFCHK=          1

 ENTER: 1 TO PLOT
   0 TO BYPASS THIS DATA SET
?
:

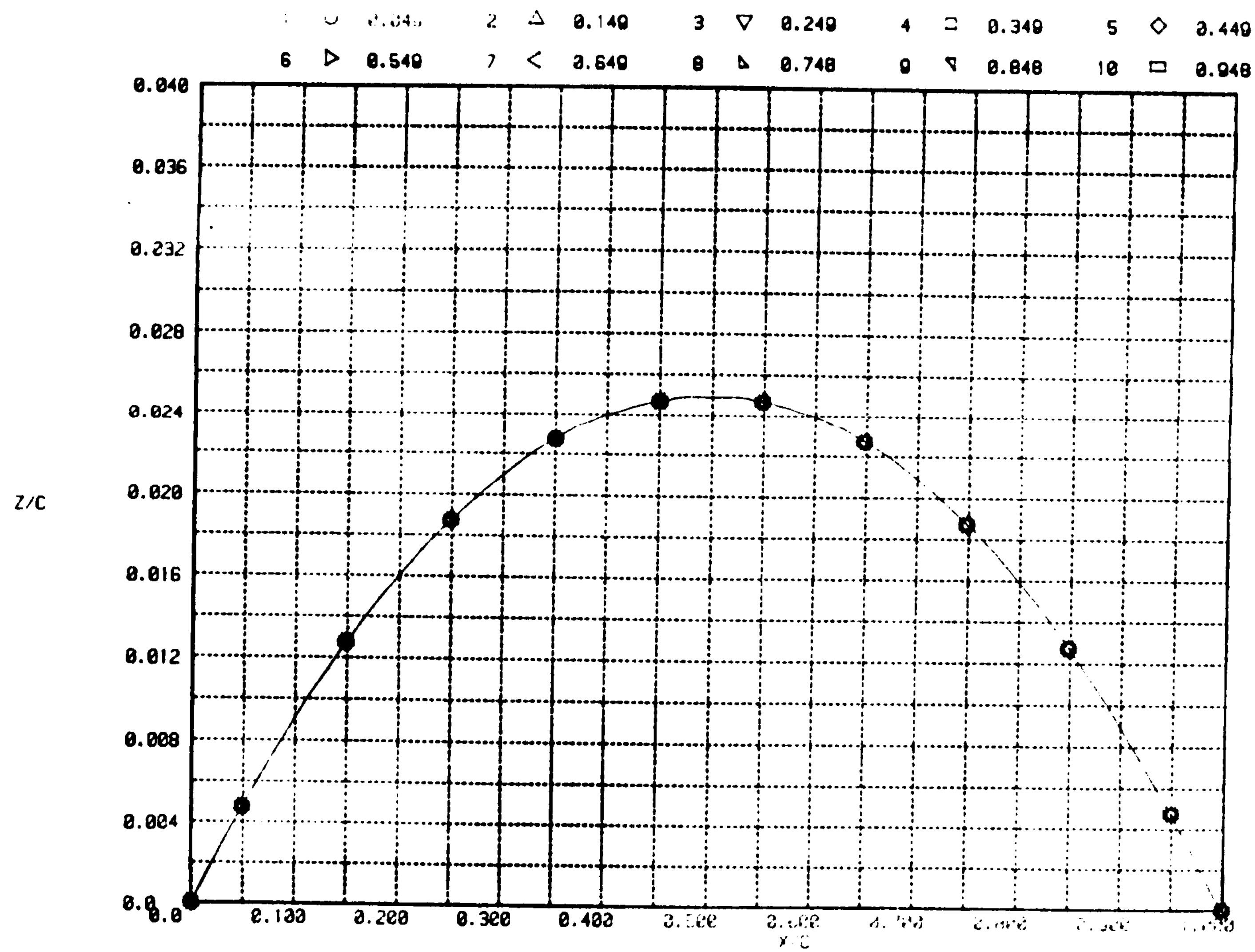
ENTER  0 TO PROCEED TO THE NEXT CASE.

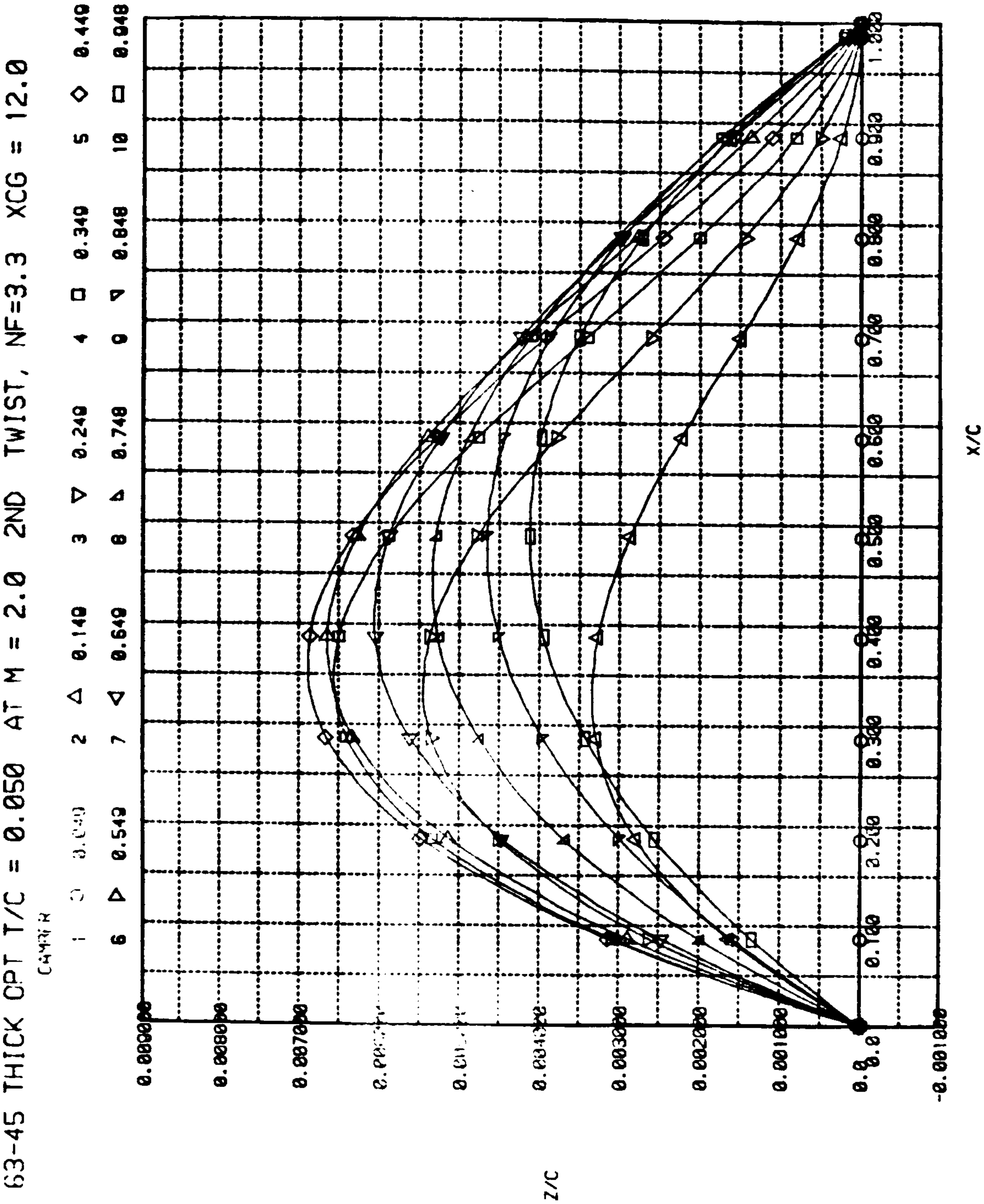
       1 TO PLOT THE THICKNESS DISTRIBUTION.
       2 TO PLOT THE   CAMBER  DISTRIBUTION.
       3 TO PLOT Z/C'S FROM TWIST & CAMBER.
       4 TO PLOT Z/C'S FROM TWIST CAMBER & FLAPS.
       5 TO PLOT CP NET.
       6 TO PLOT CP UPPER.
       7 TO PLOT CP BOTH.
       8 TO PLOT CP UPPER AND CP LOWER
       9 TO PLOT SPANWISE CHARACTERISTICS.

    > 9 TO EXIT CLIST.

?
1
```

63 45 THICK OPT = 0.050 AT M = 2.0 2ND TWIST, NF=3.3 XCG = 12.0



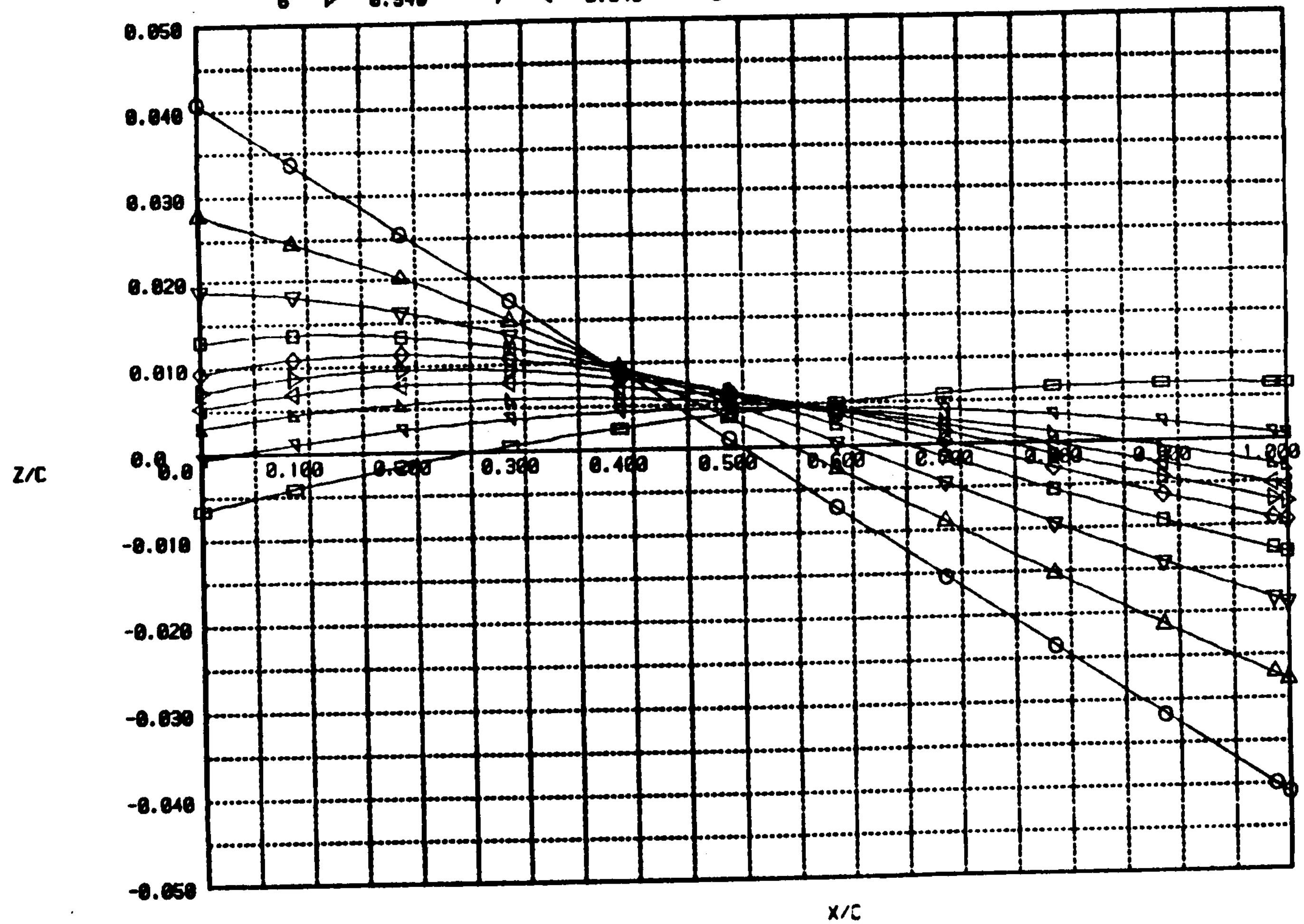

63-45 THICK OPT T/C = 0.050 AT M = 2.0 2ND TWIST, NF=3.3 XCG = 12.0
CAMBER
0.140
0.240
0.340
0.440
0.540
0.640
0.740
0.840
0.940
X/C
Z/C
0.009000
0.008000
0.007000
0.003000
0.002000
0.001000
-0.001000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000

63-45 THICK OPT T/C = 0.050 AT M = 2.0 2ND TWIST, NF=3.3 XCG = 12.0

ALPHA = 4.600 Z/C - TWIST & CAMBER

1 ○ 0.040 2 △ 0.140 3 ▽ 0.240 4 □ 0.340 5 ◇ 0.440

6 ▷ 0.540 7 ◁ 0.640 8 ◣ 0.740 9 ◥ 0.840 10 ▭ 0.940



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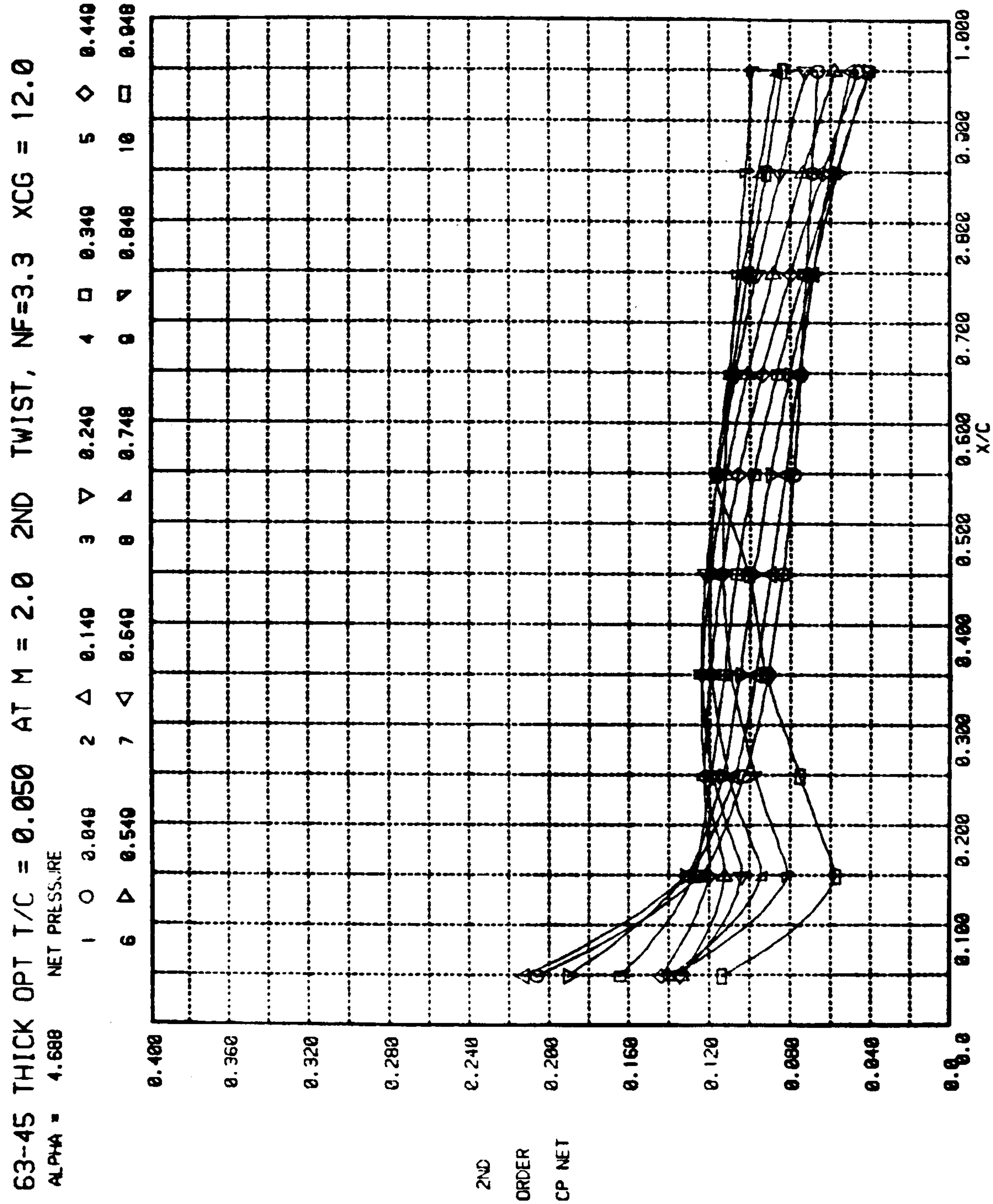

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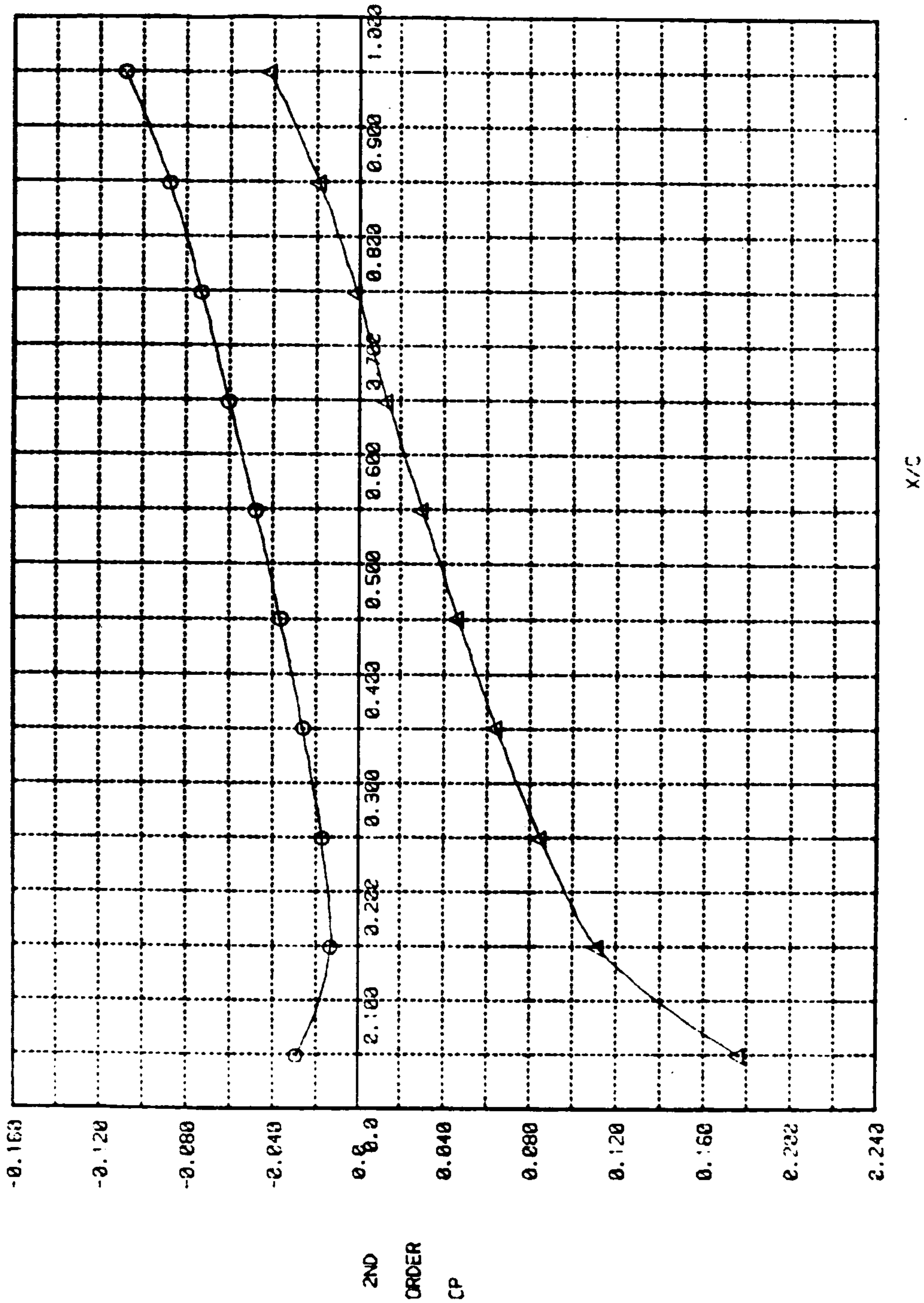
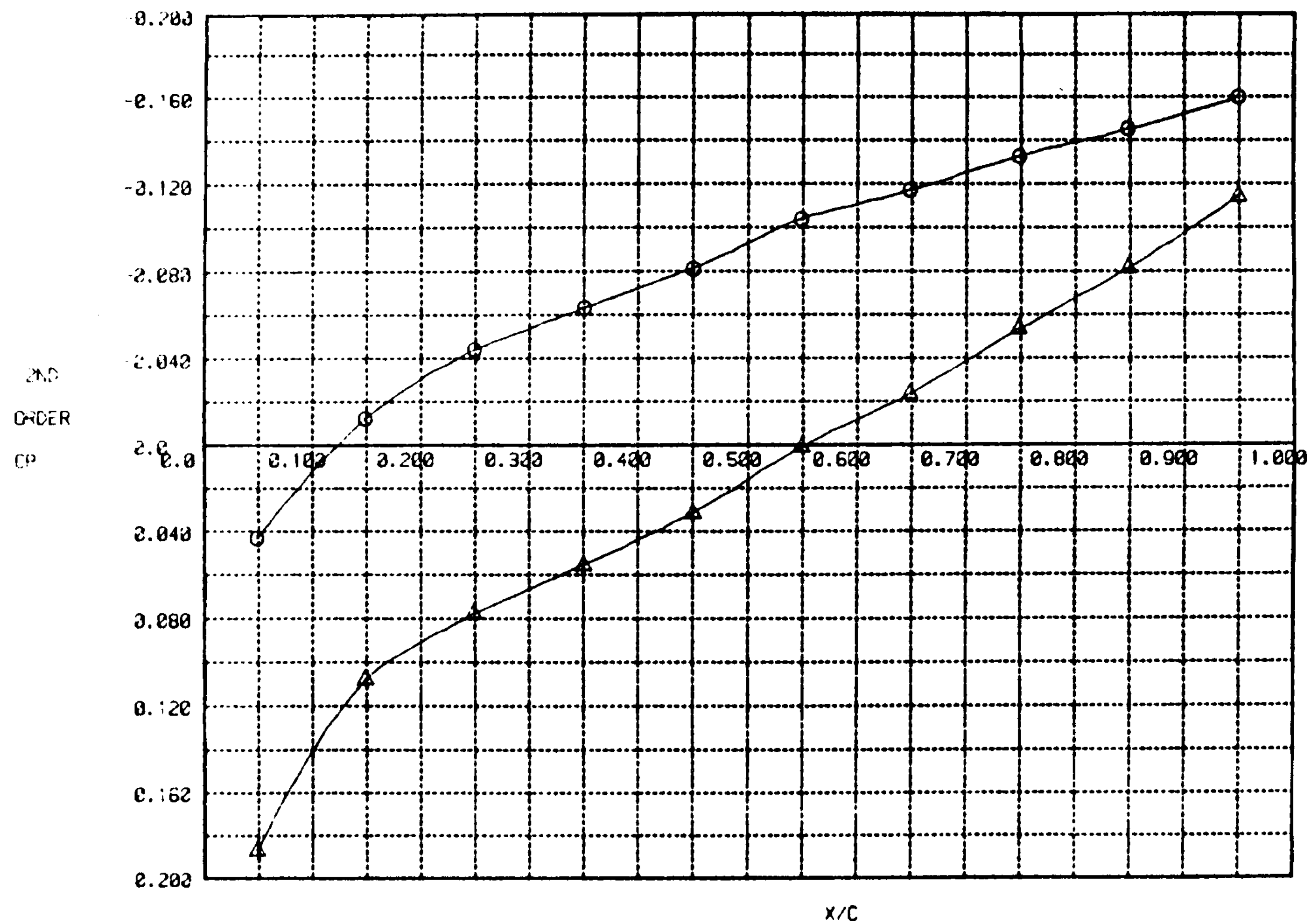
ALPHA - 4.688 ... STATION # 1
1 O 0.046

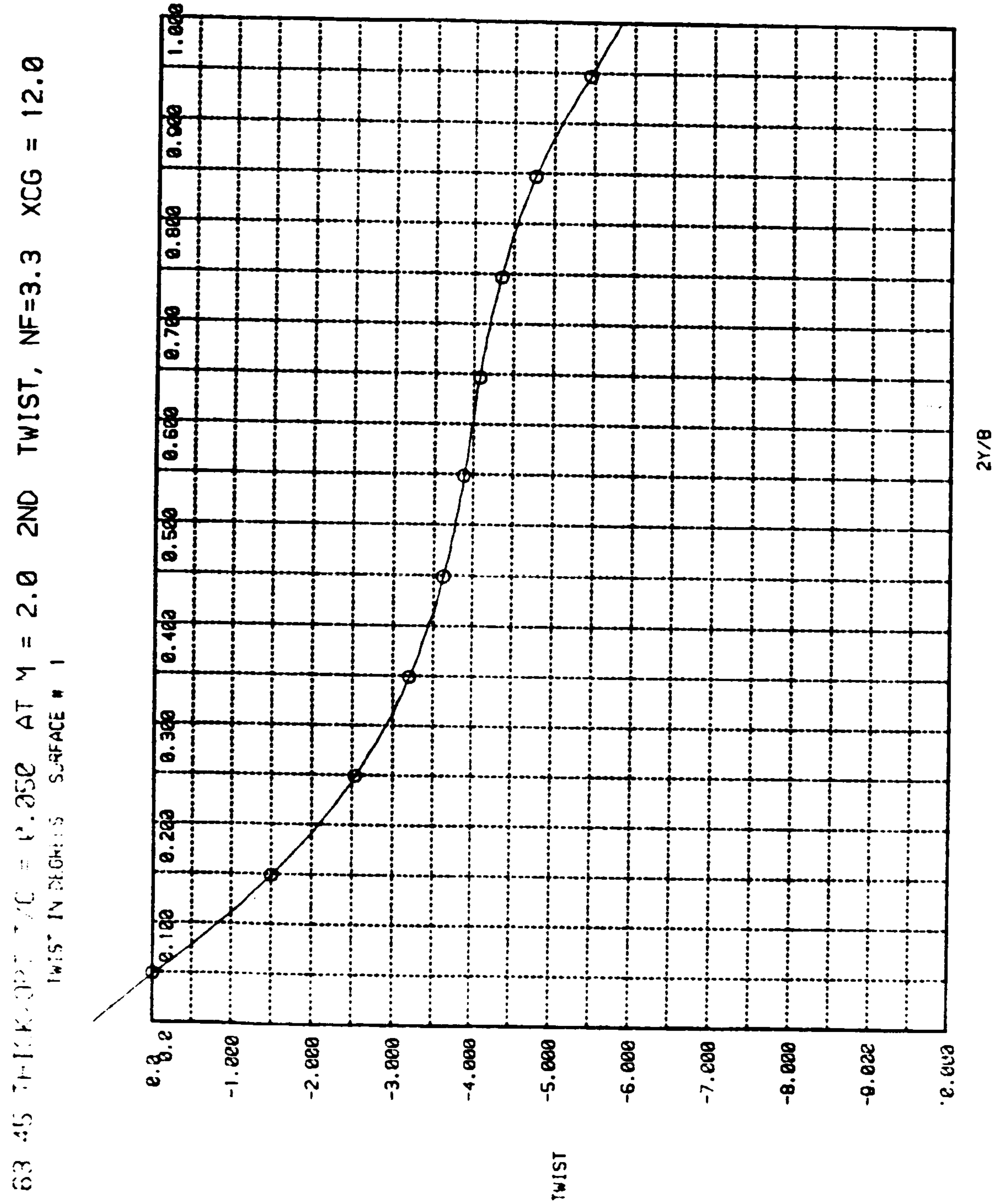


63-45 THICK OPT T/C = 0.050 AT M = 2.0 2ND TWIST, NF=3.3 XCG = 12.0

ALPHA = 4.000 CP-UP AND CP-LO STATION # 5

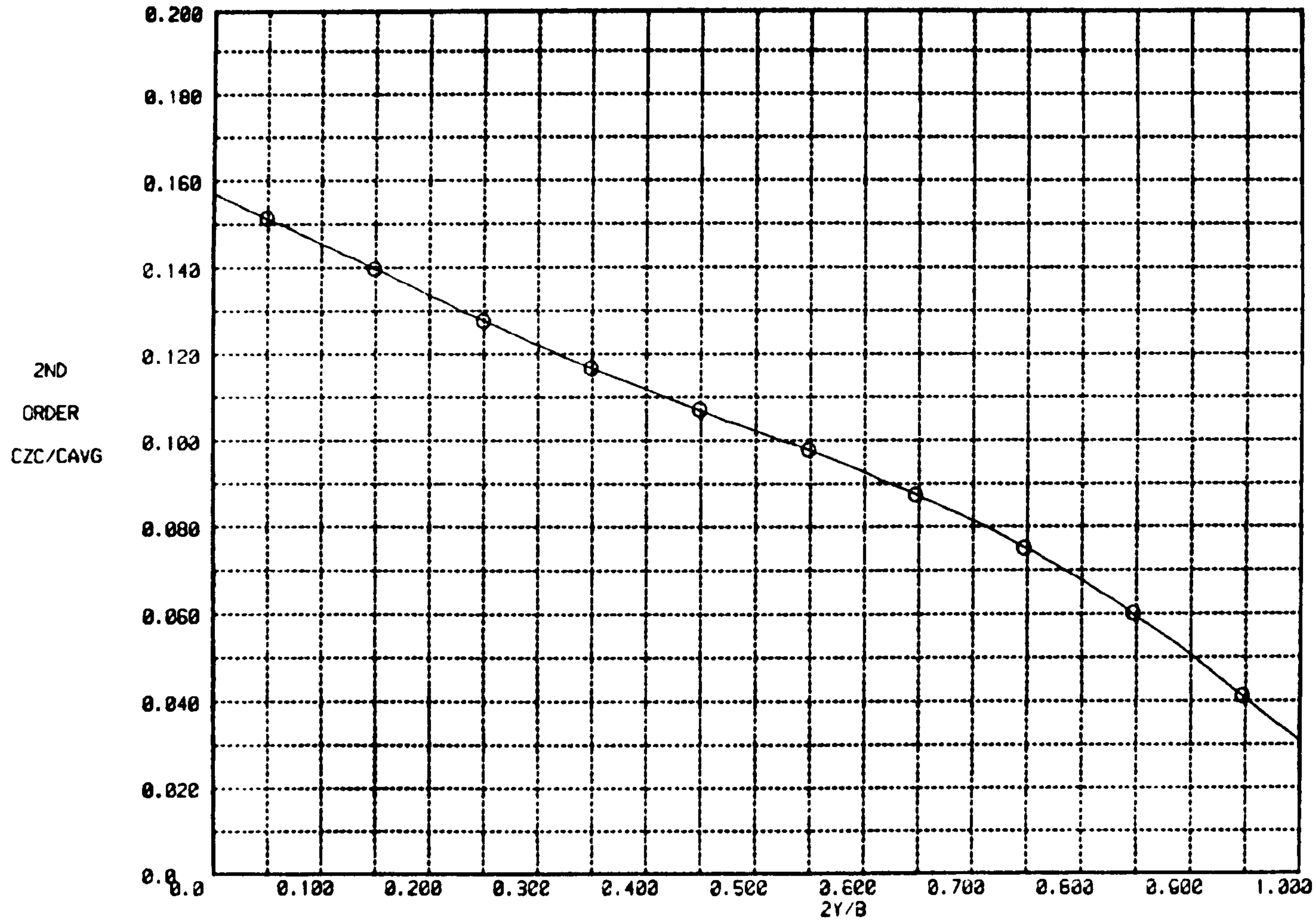
5 O 0.449

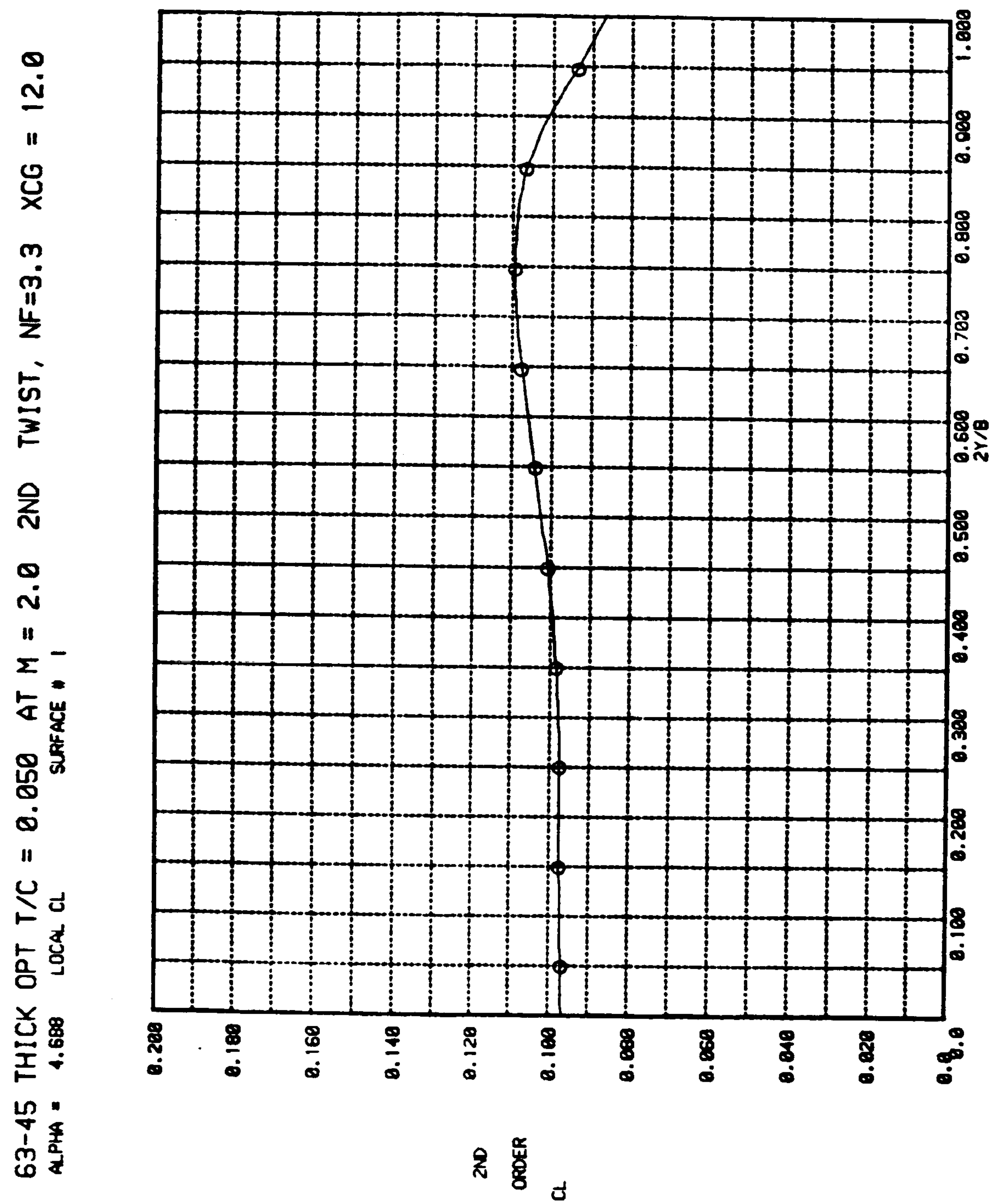



AT M = 2.0 2ND TWIST, NF=3.3 XCG = 12.0
SURFACE # 1
TWIST
2Y/B
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
-7.000
-8.000

63-45 THICK OPT T/C = 0.050 AT M = 2.0 2ND TWIST, NF=3.3 XCG = 12.0

ALPHA = 4.680 NORMAL FORCE SURFACE # 1




63-45 THICK OPT T/C = 0.050 AT M = 2.0 2ND TWIST, NF=3.3 XCG = 12.0
ALPHA = 4.688 LOCAL CL SURFACE # 1
2ND ORDER CL
0.200
0.180
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.0
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
2Y/B

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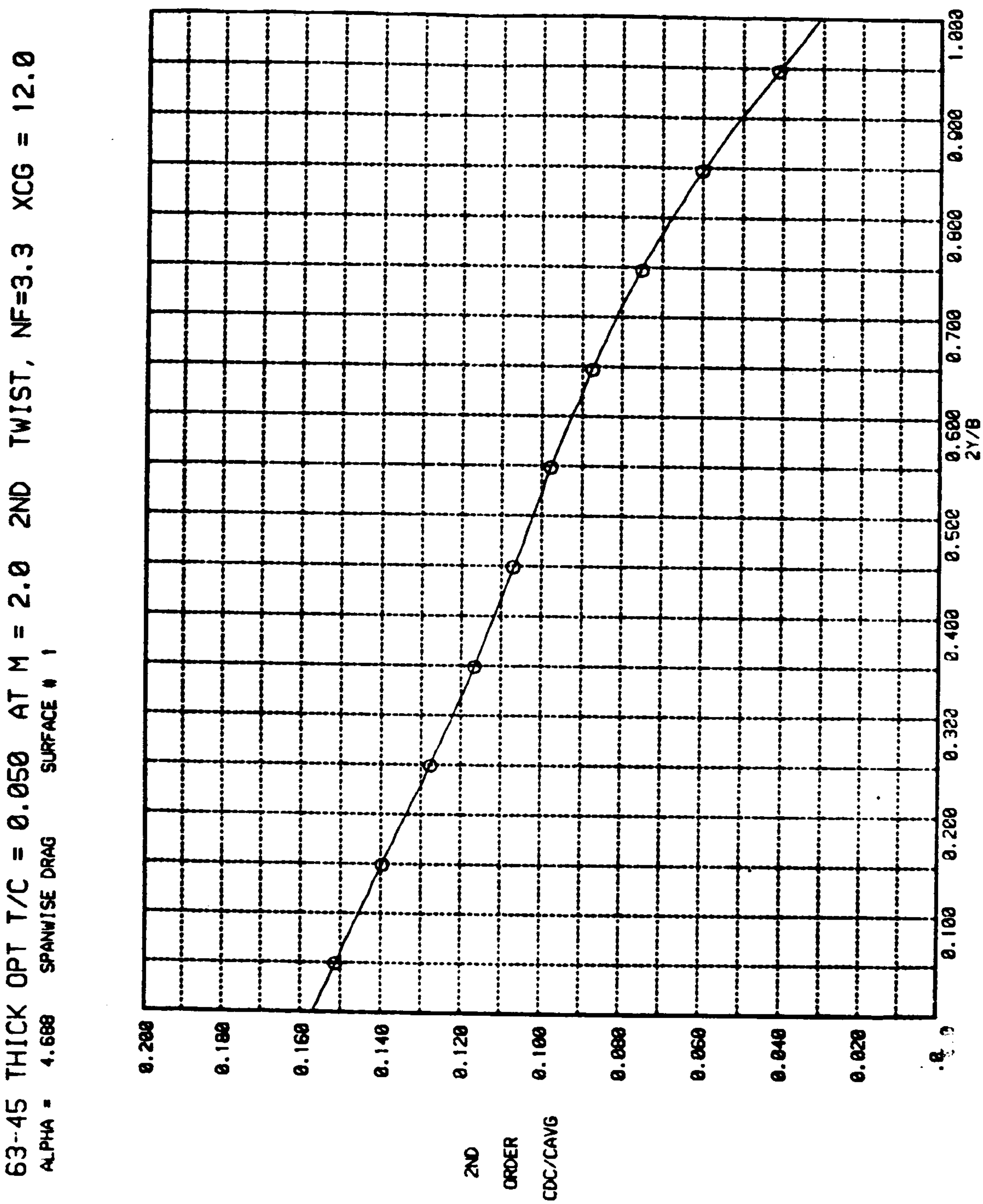
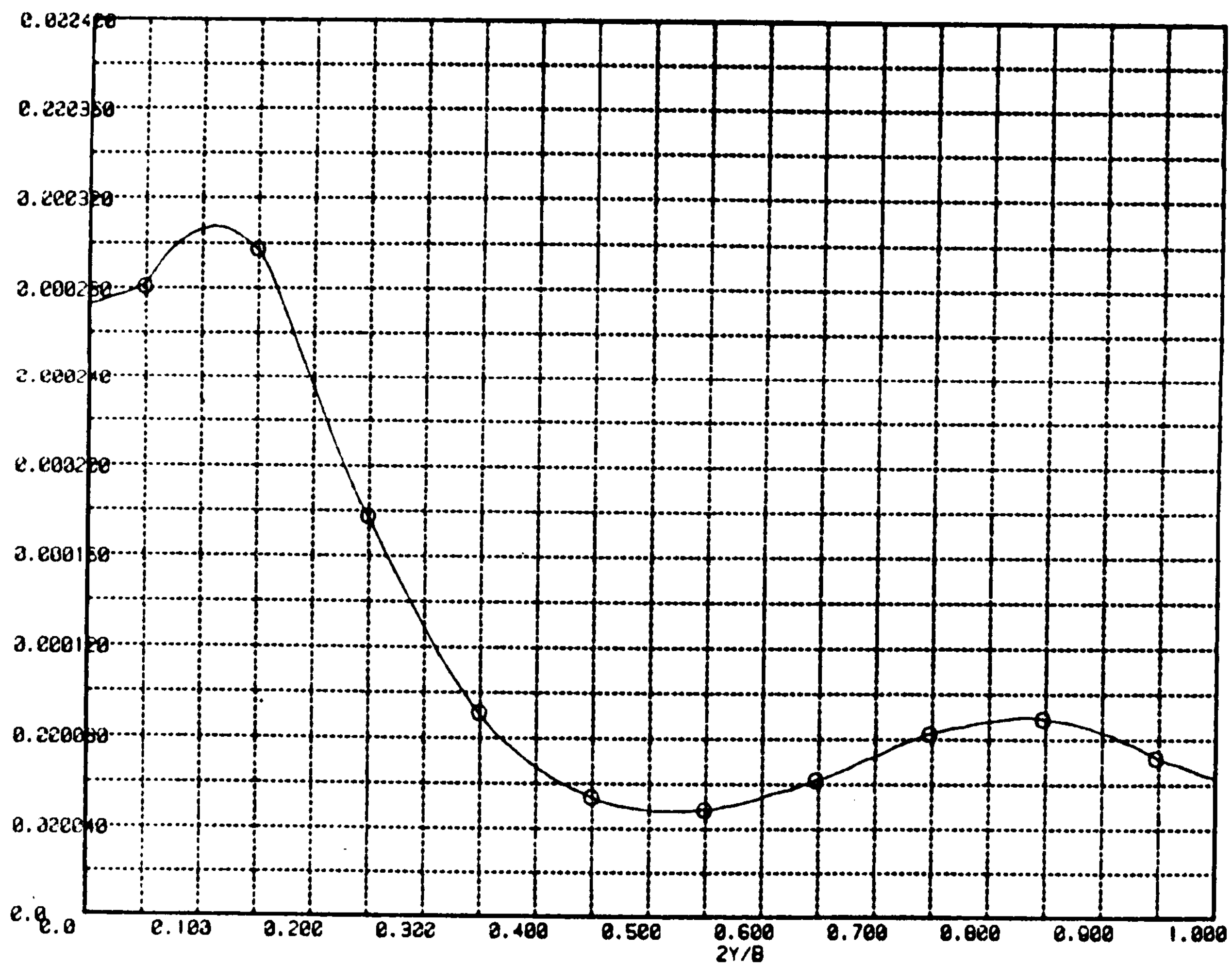


63-45 THICK CPT T/C = 0.050 AT M = 2.0 2ND TWIST, NF=3.3 XCG = 12.0

ALPHA = 4.688 SUCTION FORCE SURFACE # 1



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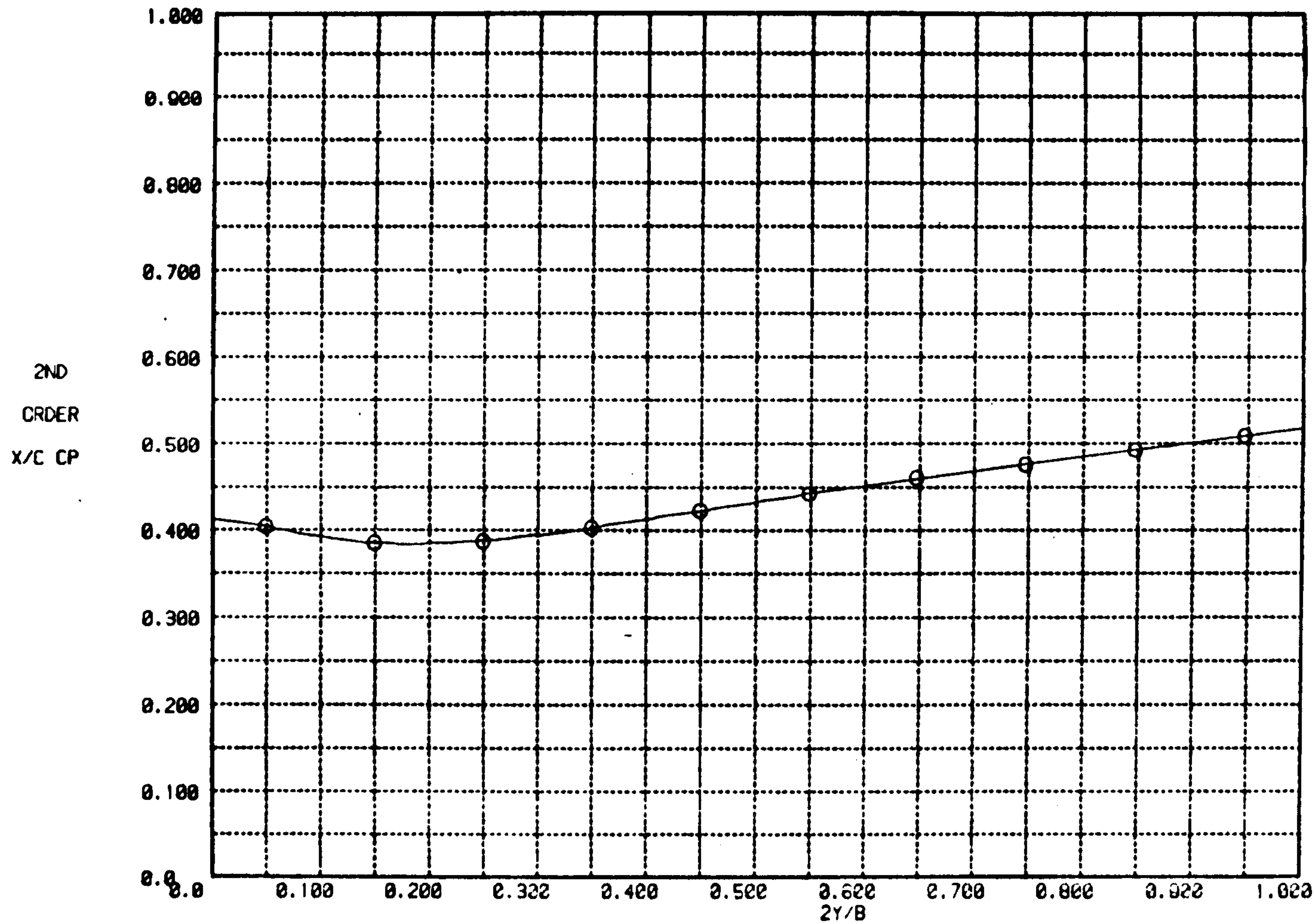
63-45 THICK OPT T/C = 0.050 AT M = 2.0 2ND TWIST, NF=3.3 XCG = 12.0

ALPHA = 4.688 CENTER OF PRESS. SURFACE # 1



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16. Abstract

Approximate nonlinear inviscid theoretical techniques for predicting aerodynamic characteristics and surface pressures for relatively slender vehicles at supersonic and moderate hypersonic speeds were developed. Emphasis was placed on approaches that would be responsive to conceptual configuration design level of effort. Second order small disturbance theory was utilized to meet this objective.

Numerical codes were developed for analysis and design of relatively general three dimensional geometries. Results from the computations indicate good agreement with experimental results for a variety of wing, body, and wing-body shapes. Case computational times of one minute on a CDC 176 are typical for practical aircraft arrangements.

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