NASA CONTRACTOR REPORT 145311
DOUGLAS REPORT NUMBER MDC J7733

(NASA-CR-145311) A THREE-DIMENSIONAL POTENTIAL-FLOW PROGRAM WITH A GEOMETRY PACKAGE FOR INPUT DATA GENERATION Technical Report, 7 May 1976 - 22 Aug. 1977 (McDonnell-Douglas Corp.) 67 p

N78-21047

Unclas
G3/02 12341

A Three-Dimensional Potential-Flow Program with a Geometry Package for Input Data Generation

N. Douglas Halsey

DOUGLAS AIRCRAFT COMPANY
McDONNELL DOUGLAS CORPORATION
Long Beach, CA 90808

CONTRACT NAS1-14402
MARCH 1978

National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665

1.0 ABSTRACT

This report contains the information needed to run a computer program for the calculation of the potential flow about arbitrary three-dimensional lifting configurations. The program contains a geometry package which greatly reduces the task of preparing the input data. Starting from a very sparse set of coordinate data, the program automatically augments and redistributes the coordinates, calculates curves of intersection between components, and redistributes coordinates in the regions adjacent to the intersection curves in a suitable manner for use in the potential-flow calculations. A brief summary of the program capabilities and options is given, as well as detailed instructions for the data input, a suggested structure for the program overlay, and the output for two test cases.

2.0 TABLE OF CONTENTS

3.0 INTRODUCTION

This report describes the use of a computer program for the calculation of the potential flow about arbitrary three-dimensional lifting configurations. It is intended primarily as a user's manual for a geometry package which has been incorporated into the program, but input instructions for the complete program are included. The theoretical foundations of the potential flow method are described in reference 1. The geometry package, described more fully in reference 2, can significantly reduce the time and expense involved in using this potential-flow program.

Input to the computer program consists of a set of flags to control the overall program execution, coordinate data to define the configuration, and flags to control the operations performed by the geometry package. The coordinate data may be input using basically the original input format described in reference 3 (referred to as "Douglas input") or the format of the program described in reference 4 (referred to as "Deriv input"). The details of both these types of input format have been modified slightly to facilitate the incorporation of the geometry package into the program.

The geometry package allows the defining coordinate data to consist of a very sparse set of points, often with an order of magnitude fewer points than required for the actual potential flow calculations. Isolated components, such as wings, fuselages, etc., are automatically paneled, using one of several possible point distribution algorithms. Curves of intersection between the components are calculated and then components are repaneled so that adjacent elements on either side of intersection curves line up in a satisfactory manner for the potential flow calculations.

Section 4.0 discusses, in general terms, the alternative capabilities included in the program. Further explanations can be found in references 1 and 2. Section 5.0 describes the input data preparation in detail. Section 6.0 suggests the structure of the program overlay to reduce the storage requirements to a reasonable level. Finally, section 7.0 presents the input and output for two test cases.

4.0 INPUT OPTIONS

There are two fundamentally different modes of input for the majority of the data required by this program. The Doug'as input mode is very similar to the original format described in reference 1. Its main feature is that the geometry data is input as a set of points, one or two per card. It is therefore fully general, allowing configurations of any geometry whatsoever to be input. It is sometimes more convenient to use the Deriv input mode. Its main features are the use of namelist input procedures and the inclusion of a geometry package of its own, which allows such simple configurations as might be used in parametric studies to be generated by the program with a minimum amount of input. Choice of the input mode is indicated by a flag on the initial card input.

Both input modes provide for the following execution options:

(a) Use of the geometry package.
(b) Both lifting and nonlifting components present.
(c) Multiple angles of attack.
(d) Planes of symmetry.
(e) Special formulas for the semi-infinite last elements on wakes.
(f) Extra strips.
(g) Ignored elements.
(h) Off-body points.
(i) Intermediate output.
(j) Full or partial execution of the program.

In addition, the Douglas input mode provides the following options:

(a) One or two points per card input.
(b) Piecewise - constant or linear spanwise representation of the vorticity on a lifting component.

The geometry package provides the following options:

(a) Transformation of the input coordinates by translation, scaling, and/or rotation about an axis.

(b) Full or partial execution of the geometry package.

(c) Six different algorithms for distributing on-body points on N-lines.

(d) Four different algorithms for distributing wake points on N-lines.

(3) Four different algorithms for distributing N-lines.

(f) Two modes of operation for distributing N-lines.

(g) Two different procedures for the final redistribution of points on components which intersect other components.

(h) Three different procedures for the final redistribution of points on components which are intersected by other components.

(i) Punched output at three stages of the calculations.

Further information regarding the use of the above options can be found in references 1, 2, and 3.

5.0 INPUT DATA PREPARATIONS

5.1 Card Input

Because of the number of options provided, there are many variables which can be input to the program and therefore many types of cards in the list below. Most typical cases require only a few of the options, however, so a typical deck set-up would be considerably less complicated than shown below. The card numbers listed below refer to the types of cards and not the actual card count, since some card types are optional and some types require more than one card to be input. Multiple cases may be run by stacking decks sequentially.

General Program Cards:

(a) Card #1 Title card

Douglas-Mode Input Cards:

(a) Card #1 Case control card
(b) Card #2 Uniform onset flow card
(c) Card #3 Moment origin card (optional)
(d) Card #4 Component control card
(e) Card #5 Ignored elements card (optional)
(f) Card #6 Coordinate cards
(g) Card #7 Off-body point cards (optional)

Deriv-Mode Namelist Input Cards:

(a) General problem description namelist NPRØB

```
$NPRØB
NBØD=1, NPAN=2, SREF= ...
$END
```

(b) Nonlifting component namelist NBØDY

```
$NBØDY
IBØDY=1, ...
$END
```

(c) Lifting component namelist NPANL

```
$NPANL
IPANEL=1, ...
$END
$NPANL
IPANEL=2, ...
$END
```

Geometry Package Input Cards

(a)	Card #1	Control card	
(b)	Card #2	Component axis card	(optional)
(c)	Card #3	Point distribution card for on-body points on N-lines	(optional)
(d)	Card #4	Point distribution card for wake points on N-lines	(optional)
(e)	Card #5	N-line distribution card	(optional)
(f)	Card #6	Multisegment option card	(optional)
(g)	Card #7	Component transformation card	(optional)

5.2 Input Data Card Descriptions

The input format for each of the above card types is given in the following tables:

5.2.1 General Program Input Cards

This card is always input.

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
1	Required	1	I1	IDERIV	Input mode flag IDERIV=0, Deriv input IDERIV≠0, Douglas input
		2	I1	IGEØM	Geometry package flag IGEØM=0, Skip geometry package IGEØM=1, Panel isolated components only IGEØM=2, Panel isolated components and calculate intersection curves IGEØM=3, Panel isolated components, calculate intersection curves, and repanel intersecting and intersected components.
		9-80	18A4	TITLE	Description of the case to be run

MCDONNELL DOUGLAS CORPORATION

5.2.2 Douglas-Mode Input Cards

These cards are input only if IDERIV≠0 on the initial card.

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
1	Required	1-4	A4	CASE	Case ID (any 4 alphanumeric characters)
		5-7	I3	TØTSEC	Total number of components input
		8-10	I3	MØMENT	Moment origin flag MØMENT=0, Moments calculated about the origin MØMENT≠0, Moment center will be input
		11-13	I3	NPTS	Coordinate input flag NPTS=1, 1 point per card NPTS≠1, 2 points per card
		14-16	I3	NØFF	Off-body points input flag NØFF=0, no off-body points input NØFF≠0, off-body points input
		17-19	I3	LIST	Execution flag LIST=0, full execution LIST≠0, partial execution (basic elements formed only)
		20-22	I3	MPR	Matrix print flag MPR=0, no matrix print MPR=1, Vij matrix print MPR=2, Aij matrix & σ solution print MPR=3, Onset flows & σ solution print
		23-25	I3	IØUT	Geometry print flag IØUT=0, basic geometry print IØUT≠0, additional geometry print
		26-28	I3	IG	Ignored elements flag IG=0, no ignored elements IG≠0, ignored elements

ORIGINAL PAGE IS OF POOR QUALITY

5.2.2 Douglas-Mode Input Cards (Continued)

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
1	Required	29-31	I3	LASWAK	Last wake element flag LASWAK=0, truncated wake LASWAK≠0, semi-infinite wake
		32-34	I3	IATACK	Number of uniform onset flows input
		35-37	I3	IWIDTH	Spanwise vorticity flag IWIDTH=0, piecewise constant vorticity IWIDTH≠0, piecewise linear vorticity
		38-40	I3	IZERO	Noncirculatory solution flag IZERØ=0, basic case IZERØ≠0, basic case plus noncirculatory solution
		41-44	F4.0	SYM1	Symmetry flag for x-z plane SYM1=0.0, no symmetry SYM1=+1.0, symmetric about axis SYM1=-1.0, antisymmetric about axis
		45-48	F4.0	SYM2	Symmetry flag for x-y plane SYM2=0.0, no symmetry SYM2=+1.0, symmetric about axis SYM2=-1.0, antisymmetric about axis
2	Required	1-10	F10.0	ALPHAX	X-component of the first uniform onset flow
		11-20	F10.0	ALPHAY	Y-component of the first uniform onset flow
		21-30	F10.0	ALPHAZ	Z-component of the first uniform onset flow
					For more than 1 uniform onset flow, repeat the same format from CC.31-60. Two onset flows per card

5.2.2 Douglas-Mode Input Cards (Continued)

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
3	Optional	1-10	F10.0	ØRIGNX	X-coordinate of the moment center
		11-20	F10.0	ØRIGNY	Y-coordinate of the moment center
		21-30	F10.0	ØRIGNZ	Z-coordinate of the moment center
					This card is required if MØMENT≠0 on card type 1
4	Required	1-4	I4	NTP(J)	Lifting component flag NTP(J)=0, component J is nonlifting NTP(J)=1, component J is lifting
		5-8	I4	JSTRIP(J)	Number of strips in component J
		9-12	I4	IGG(J)	Ignored elements flag for component J IGG(J)=0, no ignored elements IGG(J)≠0, ignored elements
		13-16	I4	NLIN1(J)	Edge condition flag for first strip on component J (only needed for lifting components using the piecewise linear vorticity option) NLIN1=1, normal strip NLIN1=3, continuation from previous component NLIN1=4, extra strip in front

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
4 (Cont)	Required	17-20	I4	NLINN(J)	Edge condition flag for last strip on component J (only needed for lifting components using the piecewise linear vorticity option) NLINN=1, normal strip NLINN=2, next component is a continuation of this one NLINN=4, extra strip at end of component
		21-24	I4	IXFLG(J)	Extra strip flag for component J IXFLG=1, first strip is an extra strip IXFLG=3, last strip is an extra strip IXFLG=2, first and last strips are extra strips If NTP(J)=0, the last three variables on this card need not be input
5	Optional	1-4	I4	IG1(I,J)	First ignored element on strip I of component J
		5-8	I4	IGN(I,J)	Last ignored element on strip I of component J
				⋮	6 strips per card, JSTRIP(J) total This card is required only when IG≠0 on card type 1 and IGG(J)≠0 on card type 4 Card types 4 and 5 are input for all components before input of card type 6

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
6	Required	1-10 11-20 21-30	F10.0 F10.0 F10.0	X Y Z	x,y,z coordinates of a point (all points input N-line by N-line, component by component)
		31	I1	STATUS	STATUS=0 same N-line STATUS=1 new N-line STATUS=2 new component STATUS=3 last point input (exception below) STATUS=4 first point on wake STATUS=5 first point on wake and also last point input
		33-42 43-52 53-62	F10.0 F10.0 F10.0	X Y Z	x,y,z coordinates of the next point input
		63	I1	STATUS	Same meaning as above Repeat cards to input more points. If NPTS=1 on card type 1, input only 1 point per card (columns 1-32). Card type 6 is input for all components before input of card type 7
7	Optional	1-10 11-21 21-30	F10.0 F10.0 F10.0	XØFF YØFF ZØFF	x,y,z coordinates of an off-body point
		31	I1	STATUS	STATUS=0, more points input STATUS=3, last point input
		32-41 42-51 52-61 62	F10.0 F10.0 F10.0 I1	XØFF YØFF ZØFF STAT	Same meaning as above

ORIGINAL PAGE IS
OF POOR QUALITY

5.2.3 Deriv-Mode Input Cards

These cards are input only if IDERIV=0 on the initial card.

NAMELIST/NPROB/ – GENERAL PROBLEM DESCRIPTION

(1) Configuration Data

NBØD Total number of bodies used to represent the configuration.

NPAN Total number of panels used to represent the configuration.

SREF Total configuration reference area.

CREF Total configuration reference length.

BREF Total configuration reference span.

ØRIGNX, ØRIGNY, ØRIGNZ XYZ coordinates of the moment origin

XMACH Mach number (default value 0.).

(2) Onset Flow Data

IATACK Number of angles of attack and/or sideslip (Max 10).

ALPHA Array of angles of attack in degrees (default values 0.).

BETA Array of angles of sideslip in degrees (default values 0.).

DELØSX, DELØSY, DELØSZ XYZ components of the delta onset flow corresponding to the panel centroids (default values 0.).

(3) Execution Options

SYM1 X-Z plane symmetry flag
- 0, no symmetry
- 1, symmetrical solution
- -1, antisymmetrical solution

SYM2 X-Y plane symmetry flag (SYM2≠0 only if SYM1≠0).
- 0, no symmetry
- 1, symmetrical solution
- -1, antisymmetrical solution

LIST Execution flag
- 0, full execution
- 1, basic elements are formed only to check geometry

IØUT If nonzero, then extended geometric quantities printed.

5.2.3 Deriv-Mode Input Cards (Continued)

MPR — Matrix print flag.
1, V_{ij} matrix printed
2, A_{ij} matrix and sigma solution printed
3, onset flows and sigma solution printed

NØFF — Number of off-body points at which velocities calculated (Max 200).

XØFF, YØFF, ZØFF — XYZ coordinate arrays of the off-body points

LASWAK — Last wake element flag
0, truncated wake
≠0, semiinfinite wake

IG — Ignored elements flag
0, no ignored elements
≠0, ignored elements

IZERØ — Noncirculatory solution flag
0, basic case
≠0, basic case plus noncirculatory solution

NAMELIST/NBODY/ — BODY DESCRIPTIVE AND MODELING DATA

(1) Coordinate System Definition and Symmetry Options

IBØDY — Number of this body.

BAREF — Body reference area.

BCREF — Body reference length.

BCTI — Coordinate system flag (default value 1).
0, input in cylindrical coordinates
1, input in cartesian coordinates

XBØ, YBØ, ZBØ — XYZ coordinates of body coordinate system origins

(2) Cross-Section Input Data

NXS — Number of stations for cross-section input (Max 41). If zero, the body is constructed by transforming a unit radius cylinder according to the multiplication and displacement tables below and XS, NTY, TYS, and RZS need not be input.

XS — Array of X-stations at which cross-sections input.

NTY — Number of circumferential input points at each X-station (Max 21).

TYS Array of (NTY,NXS) circumferential θ or Y coordinates. Input is clockwise from the top of the body. The θ or Y coordinates for the first section are input as TYS(1,1), for the second as TYS(1,2), etc.

RZS Array of (NTY,NXS) circumferential R or Z coordinates corresponding to the TYS and XS stations. The R or Z coordinates for the first section are input, then the second, etc.

(3) Multiplication and Displacement Tables

NXM Number of X-stations for multiplication and displacement grid (Max 49).

XMC Array of X-stations for multiplication and displacement grid. Omit if same as XS array.

YM Y multiplication factor array. (Default values 0.)

ZM Z multiplication factor array. Omit if all cross-sections circular.

DY Array of Y displacements

DZ Array of Z displacements

(4) Subpanel Modeling Data

NVX Number of longitudinal subpanels down the body (Max 300).

BLØI Longitudinal subpanel distribution flag (default value 1).
- -1, spacing input in VX array
- 0, cosine spacing $VXj=BCREF/2[1-\cos(j-1)\pi/NVX]$ $j=1,NVX+1$
- 1, even spacing $VXj=BCREF/NVX[j-1]$ $j=1,NVX+1$

VX Array of X locations defining longitudinal subpanel edges (NVX+1 values input — necessary only if BLØI=-1).

NVY Number of circumferential subpanels around the cross-sections (Max 50).

BTHI Circumferential subpanel distribution flag (default value 0).
- 0, equal increments of theta around cross-section
- 1, theta angle to each subpanel edge, measured in degrees clockwise from the top of the body, input in VY array.
- -1, TYS and RZS geometry arrays define subpanel edges.

VY Array of angles defining circumferential subpanel edges (NVY+1 values — input only necessary if BTHI=1)

IG11 Array of indices of first ignored element on each strip of the body.

IGNN Array of indices of last ignored element on each strip of the body.

5.2.3 Deriv-Mode Input Cards (Continued)

NAMELIST/NPANL/ – PANEL DESCRIPTIVE AND MODELING DATA

(1) Coordinate System Definition and Symmetry Options

IPAN	Number of this panel
XPØ, YPØ, ZPØ	XYZ coordinates of panel coordinate system origins.
RØTA, RØTB, RØTC	First, second, and third rotations in degrees about axes parallel to the X-, Y-, and Z-axes, respectively.
RØTX, RØTY, RØTZ	XYZ coordinates of the point about which the panel is rotated.

(2) Planform Description

NPL	Number of points describing planform leading edge (Max 20).
PXL, PYL, PZL	Array of XYZ coordinates of leading edge points.
CHØRD	Array of chord distances at leading edge points.

(3) Camber and Twist Data

NET	Number of spanwise stations where camber and/or twist is described. If no spanwise variation, set NET=1 (Max 30).
PET	Array of NET spanwise stations (s/Δs where s=computed semispan).
NXC	Number of chordwise stations where the mean camber line is described (Max 30).
PXC	Array of NXC chordwise (x/c) stations.
CAMBER	Array of (NCX,NET) camber values input as fraction chord (z/c). Camber values for the first spanwise station input as CAMBER(1,1), for the second as CAMBER(1,2), etc.
TWIST	Array of NET twist values at the spanwise stations defined in the PET array. (Input in degrees, positive leading edge up.)
TWPCR	Array of NET chordwise (x/c) locations about which airfoil sections twisted.

5.2.3 Deriv-Mode Input Cards (Continued)

(4) Thickness Data

NETA — Number of spanwise stations where thickness input. If no spanwise variation, set NETA=1 (Max 30).

ETAT — Array of NETA spanwise stations.

NXCT — Number of chordwise stations at which thickness input (Max 30).

XØCT — Array of NXCT chordwise (x/c) stations.

THICK — Array of (NXCT,NETA) half-thickness (t/2c) values input in the same manner as the camber tables. If the same stations are used for the thickness and camber input, NETA, ETAT, NXCT, and XØCT need not be input.

(5) Subpanel Modeling Data

NVS — Number of spanwise subpanels (Max 40).

PTHI — Subpanel spanwise distribution flag (default value 0).
0, spacing at even span increments $VS_j=(j-1)/NVS$ $j=1,NVS+1$
1, spacing input as fraction semispan in VS array
-1, cosine spacing $VS_j=1-\cos[(y-1)(\pi/2)/NVS]$

VS — Array of spanwise (s/Δs) subpanel edges (NVS+1 values — input necessary only if PTHI=1).

NVC — Number of chordwise subpanels (Max 40)

PLOI — Subpanel chordwise distribution flag (default value 0).
-1, spacing at even chord increments $VC_j=(j-1)/NVC$ $j=1,NVC+1$
0, cosine spacing $VC_j=0.5[1-\cos(j-1)\pi/NVC]$
1, spacing input as fraction unit chord in VC array
2, spacing with cos/sinh distribution

VC — Array of chordwise (x/c) stations defining subpanel edges (NVC+1 values — necessary only if PLØI=1).

NPWV — Number of wake panels (Max 15).

IEXTRA — Extra strip flag.
1, outboard strip is extra
2, outboard and inboard strips are extra
3, inboard strip is extra

IG11 — Array of indices of first ignored element on each strip of the panel.

IGNN — Array of indices of last ignored element on each strip of the panel.

5.2.4 Geometry Package Input Cards

These cards are input only if IGEØM≠0 on the initial card.

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
1	Required	1-4	I4	NB(J)	Specified number of on-body points per N-line on component J.
		5-8	I4	NW(J)	Specified number of wake points per N-line on component J
		9-12	I4	NS(J)	Specified number of N-lines on component J
		13-16	I4	NALGB(J)	Spacing algorithm for on-body points on N-lines NALGB=0, input distribution, unaltered NALGB=1, input distribution, augmented NALGB=2, constant increments in arc length NALGB=3, cosine distribution NALGB=4, curvature-dependent distribution NALGB=5, user-specified distribution
		17-20	I4	NALGW(J)	Spacing algorithm for wake points on N-lines. (Values have same significance as values of NALGB, except that NALGW=3 and NALGW=4 should not be used.)
		21-24	I4	NALGS(J)	Spacing algorithm for N-lines NALGS=0, input distribution, unaltered NALGS=1, input distribution, augmented NALGS=2, constant increments NALGS=3, user-specified distribution

5.2.4 Geometry Package Input Cards (Continued)

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
1 (Cont)	Required	25-28	I4	IMØDE(J)	Planar-section/arc-length mode flag. IMØDE=0, planar-section mode using default values of direction cosines of axis [(1,0,0) for non-lifting components; (0,-1,0) for lifting components)]. IMØDE=1, planar-section mode using input values of direction cosines of axis. IMØDE=2, arc-length mode.
		29-32	I4	NSEG(J)	Number of segments into which N-lines are borken (default=1).
		33-36	I4	NTR(J)	Component transformation flag. (The value indicates the number of transformations to be performed.)
		37-40	I4	INTS(J)	Index of the component (if any) which component J intersects.
		41-44	I4	INTD(J)	Index of the component (if any) which intersects component J.
		45-48	I4	NALG2(J)	Repaneling flag for intersecting components NALG2=0, minimal repaneling NALG2=1, full repaneling

ORIGINAL PAGE IS
OF POOR QUALITY

5.2.4 Geometry Package Input Cards (Continued)

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
1 (Cont)	Required	49-52	I4	NALG3(J)	Repaneling flag for intersected components NALG3=0, no repaneling NALG3=1, (a) nonlifting components. Full repaneling with an N-line passing through every point on intersection curve. (b) lifting components. Full repaneling, but with gaps in the region of the intersection curve. NALG3=2, (a) nonlifting components. Full repaneling with an N-line passing through every second point on the intersection curve. (b) lifting components. Full repaneling with additional nonlifting elements to fill the gaps around the intersection curve.
		53-56	I4	IP1(J)	Punch flag for transformed input coordinates IP1=0, no punch IP1≠0, punch
		57-60	I4	IP2(J)	Punch flag for coordinates after repaneling isolated components IP2=0, no punch IP2≠0, punch
		61-64	I4	IP3(J)	Punch flag for final redistributed coordinates IP3=0, no punch IP3≠0, punch

5.2.4 Geometry Package Input Cards (Continued)

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
2	Optional	1-10	F10.0	CØSX(J)	X-direction cosine of the axis of component J.
		11-20	F10.0	CØSY(J)	Y-direction cosine of the axis of component J.
		21-30	F10.0	CØSZ(J)	Z-direction cosine of the axis of component J. This card is required if IMØDE(J)=1 on card type 1
3	Optional	1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80	8F10.0	SSB(J,1) SSB(J,2) . . .	Specified arc lengths of on-body points on N-lines on component J $0.0 \leq SSB \leq 1$ 8 points per card, NB(J) total This card is required if NALGB(J)=5 on card type 1
4	Optional	1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80	8F10.0	SSW(J,1) SSW(J,2) . . .	Specified arc lengths of wake points on N-lines of component J $0.0 \leq SSW \leq 1.0$ 8 points per card, NW(J) total This card is required if NALGW(J)=5 on card type 1
5	Optional	1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80	8F10.0	SSS(J,1) SSS(J,2) . . .	Specified distribution of N-lines on component J $0.0 \leq SSS \leq 1.0$ 8 points per card, NS(J) total This card is required if NALGS(J)=3 on card type 1

5.2.4 Geometry Package Input Cards (Continued)

CARD TYPE	REQUIRED OR OPTIONAL	CARD COLUMN	FORMAT	VARIABLE	DESCRIPTION
6	Optional	1-4 5-8 9-12 13-16 17-20	5I4	IEND(J,1) IEND(J,2) . . .	Point numbers of the ends of the segments on M-lines on component J NSEG(J) total (max = 5) This card is required if NSEG(J)>1 on card type 1
7	Optional	1-4	I4	ITR2(J,K)	Type of transformation to be applied to component J ITR2=1, scaling ITR2=2, translation ITR3=3, rotation
		11-20	F10.0	TR(J,K,1)	First transformation parameter: x multiplication factor if ITR2=1 x translation if ITR2=2 angle of rotation if ITR2=3 (positive counterclockwise, looking in the direction of the axis).
		21-30	F10.0	TR(J,K,2)	Second transformation parameter: y multiplication factor if ITR2=1 y translation if ITR2=2 x direction cosine of axis of rotation if ITR2=3
		31-40	F10.0	TR(J,K,3)	Third transformation parameter: z multiplication factor if ITR2=1 z translation if ITR2=2 y direction cosine of axis of rotation if ITR2=3
		41-50	F10.0	TR(J,K,4)	Fourth transformation parameter: Dummy if ITR2=1 or ITR2=2 z direction cosine of axis of rotation if ITR2=3 Note: The axis of rotation is assumed to pass through the origin. This card is required if ITR(J)≠0 on card type 1. Up to 10 transformations may be performed, in any order.

6.0 OVERLAY STRUCTURE

In order to minimize the core requirements, this program uses several overlays. The general overlay structure and the functions of each overlay level are described below.

- Overlay (0,0) - Program NUED
  - Function - Controls overall program execution
  - Subroutines - HEADER, READ1, WRITE1, READ3, WRITE3, BLØCK DATA, READRS, WRITRS, RITER, BUFFIN, REWIND, SKIPX, ZERØ, CØDMT, CØDIM, MIS1
- Overlay (1,0) - Program INITIAL (IDERIV=1)
  - Function - Data input using Douglas mode
  - Subroutines - INPUT
- Overlay (10,0) - Program READ (IDERIV=0)
  - Function - Data input using Deriv mode
  - Subroutines - SQUEEZE, BØDYIN, BØDGEØM, PANELIN, BØDSYM, SMØØTH, CHLSKY, PANPRT, GPRINT, BØDPRT
- Overlay (12,0) - Program VØRBØD (IDERIV=0)
  - Function - Generates body geometry data
  - Subroutines - XYZVB, MQPTS, TRPS
- Overlay (13,0) - Program VØRPAN (IDERIV=0)
  - Function - Generates wing geometry data
  - Subroutines - XYZVW, PANDAT, LINIM, PERIM, PSLØPE, LFTDRV, LINE, VLINE
- Overlay (7,0) - Program REPAN (IGEØM>0)
  - Function - Controls geometry package calculations
  - Subroutines - INTRP2, DERV, INTERP, ARCLGN, DERV2, CUBPLN, NØRM, AMAXA
- Overlay (7,1) - Program GEINPT (IGEØM>0)
  - Function - Data input for geometry package
  - Subroutines - TRANSF

- Overlay (7,2) - Program PANELC (IGEØM>0)
  - Function - Augmentation and redistribution of points on N-lines
  - Subroutines - SPACEC
- Overlay (7,3) - Program PANELS (IGEØM>0)
  - Function - Augmentation and redistribution of N-lines
  - Subroutines - SPACES, CBPLN2
- Overlay (7,4) - Program CRØSS (IGEØM≥2)
  - Function - Calculates geometric cross-derivative terms
  - Subroutines - None
- Overlay (7,5) - Program INTSEC (IGEØM≥2)
  - Function - Calculates intersection curves between components
  - Subroutines - AMINA,AMAX3, PLANE, BØUNDS, SIDES, REPLN, UWPLN, PCØEFS, CUBCUB
- Overlay (7,6) - Program REPAN1 (IGEØM>2)
  - Function - Repanels intersecting components
  - Subroutines - INTRP3
- Overlay (7,7) - Program REPAN2 (IGEØM>2)
  - Function - Repanels intersected components
  - Subroutines - REPAN3, PRN3C, SHUFL, REPAN4, SRCH1
- Overlay (20,0) - Program ELMNTS
  - Function - Controls calculation of element geometric quantities
  - Subroutines - DNLIFT, DLIFT
- Overlay (2,0) - Program VFØRM
  - Function - Controls velocity matrix formation
  - Subroutines - None
- Overlay (2,1) - Program VFMNLF
  - Function - Forms velocity matrices for nonlifting components
  - Subroutines - None

- Overlay (2,2) - Program VFMLFT
    - Function - Forms velocity matrices for lifting components
    - Subroutines - NEAR, WNEAR
- Overlay (3,0) - Program PSWISE (IWIDTH ≠0)
    - Function - Computed onset flows for piecewise linear spanwise vorticity option
    - Subroutines - None
- Overlay (4,0) - Program AFØRM
    - Function - Computes normal velocity matrix
    - Subroutines - None
- Overlay (5,0) - Program CØLSØL
    - Function - Solves the system of linear equations
    - Subroutines - REQFL
- Overlay (6,0) - Program CØMFLØ
    - Function - Controls final calculations and output
    - Subroutines - None
- Overlay (6,1) - Program PKUTTA
    - Function - Combines individual flow solutions
    - Subroutines - None
- Overlay (6,2) - Program VELPRS
    - Function - Calculates final velocities
    - Subroutines - PRINT

7.0 TEST CASES

The following section describes two test cases which can be used to verify the execution of the program.

7.1 Test Case Number 1

The first test case included in this report is a simple swept, tapered wing input using the Deriv-mode option. The planform is specified by two points on the leading edge (at the root and tip) and two chord values. The cross-section shapes are specified by a table of the thickness distribution. There is no camber or twist. The geometry package is used (in its simplest mode) to produce a wing paneling consisting of three spanwise strips (four N-lines), ten on-body elements (eleven points) per strip, and one wake element per strip. The potential-flow pressure distribution is calculated using the options for piecewise-constant spanwise vorticity distributions, semi-infinite last wake elements, and one plane of symmetry.

7.1.1 Input Data

Card
Column

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890

1 SWEPT TAPERED WING (DERIV INPUT)


$NPROP
NPAN=1,SREF=1.0,CREF=1.0,BREF=1.0,IATACK=2,ALPHA=10.,0.,
SYM1=1.0,NOFF=2,XOFF=-.1,-.5,YOFF=.5,.5,ZOFF=.0,.0,LASWAK=1,
$END


$NPANL
IPANEL=1,NPWV=1,NPL=2,NETA=1,NXCT=6,NVS=1,NVC=5,
PXL=0.,1.76082,PYL=.0,4.,PZL=.0,.0,
CHORD=1.382319,0.69066,
XOCT=0.,.006294,.031401,.351299,.746699,1.0,
THICK=0.,.006730,.014060,.037570,.022130,.00,
$END

 11   1   4   3   0   2
```

7.1.2 Output Data

The output for the first test case is given in the following pages.

PAGE 1

```
------------ * ------------
3-D LIFTING POTENTIAL FLOW PROGRAM
SWEPT TAPERED WING (DERIV INPUT)                    10/27/77.
                                          ------------ * ------------
                                                            CASE ID ---
                                          NO. OF NONLIFTING COMPONENTS ---   0
                                             NO. OF LIFTING COMPONENTS ---   1
                                              NO. OF OFF-BODY POINTS ---     0
                    INPUT MODE ( 0 - DERIV, 1 - LEUCLAS )         ---       -0
          GEOMETRY PACKAGE OPTION (NONZERO - YES, ZERO - NO )     ---        1
 PARTIAL PROGRAM EXECUTION OPTION (NONZERO - YES, ZERO - NO )     ---        0
                    MATRIX OUTPUT (NONZERO - YES, ZERO - NO )     ---        0
      EXTENDED GEOMETRIC OUTPUT   (NONZERO - YES, ZERO - NO )     ---        0
           IGNORE ELEMENT OPTION  (NONZERO - YES, ZERO - NO )     ---        0
     SPECIAL LAST WAKE CALCULATION (NONZERO - YES, ZERO - NO )    ---        1
  STEPWISE LINEAR VORTICITY OPTION (NONZERO - YES, ZERO - NO )    ---        0
ADDITIONAL NONCIRCULATORY SOLUTION (NONZERO - YES, ZERO - NO )    ---        0
                   SYMMETRY OPTION (NONZERO - YES, ZERO - NO )    ---        1

                    COMPONENTS OF THE UNIFORM ONSET FLOWS
                    ( 1)     .984808,     0.000000,     .173648

                    COORDINATES OF MOMENT CENTER
                             0.000000,    0.000000,     0.000000
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
********************************************************************************************************
                                          INPUT FOR PANEL 1

                          PANEL HAS AN IMAGE AND VORTEX STRENGTHS ARE SYMMETRICAL
                                          ...PANEL GEOMETRY...
  THERE ARE  2 (X,Y,Z) INPUT POINTS DESCRIBING THE  LEADING EDGE.
  (    0.000,    0.000,    0.000) (    1.761,    4.000,    0.000) (
  THERE ARE  2 (X,Y,Z) INPUT POINTS DESCRIBING THE TRAILING EDGE.
  (    1.482,    0.000,    0.000) (    2.451,    4.000,    0.000) (
  THE ABOVE COORDINATES ARE DISPLACED FROM THE ORIGIN BY (X,Y,Z) = (    0.0000,    0.0000,    0.0000)
  THE PANEL REFERENCE AREA, CHORD AND SPAN ARE,    0.0000,    0.0000,    0.0000.

               BIVARIATE THICKNESS TABLES.  THERE ARE   6CHORDWISE AND  1 SPANWISE TABLE STATIONS.
                                       THE CHORDWISE STATIONS ARE
    0.          .6294E-02   .3140E-01   .3513E+00   .7467E+00   .1000E+01
                                        NO SPANWISE VARIATION
                               FOR EACH SPANWISE STATION THE DELTA-Z/CHORD VALUESARE
  1 0.          .6730E-02   .1400E-01   .3757E-01   .2213E-01  0.

                                          ...PANEL MODELING...
  THERE ARE  5 CHORDWISE SUBPANELS.  SPACING IS POLAR
  THERE ARE  3 SPANWISE SUBPANELS.  SPACING IS EVEN D-ETA
```

3-D LIFTING POTENTIAL FLOW PROGRAM

SWEPT TAPERED WING (DERIV INPUT)

COORDINATES AFTER REPANELING ISOLATED COMPONENTS

COMPONENT NO. 1

N	M	X	Y	Z	TYPE
1	1	.245148E+01	.400000E+01	0.	LIFT
	2	.238553E+01	.400000E+01	-.632155E-02	
	3	.221266E+01	.400000E+01	-.194049E-01	
	4	.199594E+01	.400000E+01	-.258543E-01	
	5	.182677E+01	.400000E+01	-.174284E-01	
	6	.176082E+01	.400000E+01	.113769E-10	
	7	.172677E+01	.400000E+01	.174284E-01	
	8	[illegible]	.400000E+01	.258543E-01	
	9	.221266E+01	.400000E+01	.194049E-01	
	10	.238553E+01	.400000E+01	.632155E-02	
	11	.249148E+01	.400000E+01	0.	
	12	.251749E+01	.400000E+01	0.	WAKE
2	1	.209509E+01	.266667E+01	0.	LIFT
	2	.200712E+01	.266667E+01	-.843178E-02	
	3	.171662E+01	.266667E+01	-.258842E-01	
	4	.149719E+01	.266667E+01	-.344848E-01	
	5	.126185E+01	.266667E+01	-.232462E-01	
	6	.117386E+01	.266667E+01	.151746E-10	
	7	.126185E+01	.266667E+01	.232462E-01	
	8	.149215E+01	.266667E+01	.344848E-01	
	9	.177662E+01	.266667E+01	.258842E-01	
	10	.200712E+01	.266667E+01	.843178E-02	
	11	.209509E+01	.266667E+01	0.	
	12	.211306E+01	.266667E+01	0.	WAKE
3	1	.173671E+01	.133333E+01	0.	LIFT
	2	.162872E+01	.133333E+01	-.105420E-01	
	3	.134078E+01	.133333E+01	-.323685E-01	
	4	.914265E+00	.133333E+01	-.431154E-01	
	5	.696424E+00	.133333E+01	-.290641E-01	
	6	.586940E+00	.133333E+01	.184745E-10	
	7	.696424E+00	.133333E+01	.290641E-01	
	8	.914265E+00	.133333E+01	.431154E-01	
	9	.134078E+01	.133333E+01	.323685E-01	
	10	.162872E+01	.133333E+01	.105420E-01	
	11	.173671E+01	.133333E+01	0.	
	12	.176051E+01	.133333E+01	0.	WAKE
4	1	.135242E+01	0.	0.	LIFT
	2	.124032E+01	0.	-.126522E-01	
	3	.904740E+00	0.	-.386479E-01	
	4	.477579E+00	0.	-.517459E-01	
	5	.132000E+00	0.	-.346819E-01	
	6	.112001E-18	0.	.227727E-10	
	7	.132000E+00	0.	.346819E-01	

ORIGINAL PAGE IS
OF POOR QUALITY

------------ * ------------

3-D LIFTING POTENTIAL FLOW PROGRAM

SWEPT TAPERED WING (DERIV INPUT)

------------ * ------------

COORDINATES AFTER REPANELING ISOLATED COMPONENTS

COMPONENT NO. 1

N	M	X	Y	Z	TYPE
	8	.477579E+00	0.	.517459E-01	
	9	.904740E+00	0.	.388479E-01	
	10	.129032E+01	0.	.126522E-01	
	11	.138232E+01	0.	0.	
	12	.151432E+01	0.	0.	WAKE

3-D LIFTING POTENTIAL FLOW PROGRAM

SWEPT TAPERED WING (DERIV INPUT)

N	M	XC	YC	ZC	XN	YN	ZN	D	T	A	TYPE
1	1	2.220648	3.301548	-.003713	.095382	-.025495	-.995114	.154626	1.405454	.103117	LIFT
	2	2.058477	3.301548	-.015115	.075570	-.017869	-.996443	.404124	1.465839	.269469	
	3	1.858074	3.301548	-.020590	.030181	-.005013	-.999532	.498323	1.515728	.332220	
	4	1.632272	3.301548	-.025426	-.048726	.025002	-.998499	.403448	1.523753	.269049	
	5	1.442100	3.301548	-.010238	-.253887	.111762	-.960755	.159204	1.484705	.106805	
	6	1.442100	3.301548	.010238	-.253887	.111762	.960755	.159204	1.484705	.106805	
	7	1.632272	3.301548	.025426	-.048726	.025002	.998499	.403448	1.523753	.264049	
	8	1.858074	3.301548	.020590	.030181	-.005013	.999532	.498323	1.515728	.332220	
	9	2.058477	3.301548	.015115	.075570	-.019869	.996943	.404124	1.465839	.269469	
	10	2.220648	3.301548	.003713	.095382	-.025495	.995114	.154626	1.405454	.103117	
	11	2.303533	3.301548	0.000000	0.000000	0.000000	1.000000	.153920	1.394624	.102613	WAKE
2	1	1.860601	1.975285	-.004703	.095382	-.025495	-.995114	.148859	1.412583	.132616	LIFT
	2	1.566014	1.975285	-.014387	.075570	-.019869	-.996443	.514732	1.490760	.346556	
	3	1.385412	1.975285	-.024105	.030181	-.005013	-.999532	.640878	1.550893	.427257	
	4	1.049010	1.975285	-.032612	-.048726	.025002	-.998499	.518861	1.552460	.340016	
	5	.919227	1.975285	-.013131	-.253887	.111762	-.960755	.204747	1.494597	.137359	
	6	.919227	1.975285	.013131	-.253887	.111762	.960755	.204747	1.494597	.137359	
	7	1.049010	1.975285	.032612	-.048726	.025002	.998499	.511861	1.552480	.340016	
	8	1.385412	1.975285	.034105	.030181	-.005013	.999532	.640878	1.550893	.427257	
	9	1.566014	1.975285	.019387	.075570	-.019869	.996943	.514732	1.490760	.346556	
	10	1.860601	1.975285	.004703	.095382	-.025495	.995114	.148859	1.412583	.132616	
	11	1.954465	1.975285	0.000000	0.000000	0.000000	1.000000	.197952	1.405428	.131908	WAKE
3	1	1.494940	.646449	-.005815	.095382	-.025495	-.995114	.243093	1.420021	.162114	LIFT
	2	1.274966	.646449	-.023606	.075570	-.019869	-.996443	.635339	1.517475	.427043	
	3	.919139	.646449	-.041634	.030181	-.005013	-.999532	.783432	1.581480	.522295	
	4	.564713	.646449	-.039811	-.048726	.025002	-.998499	.634275	1.582790	.427482	
	5	.342233	.646449	-.016031	-.253887	.111762	-.960755	.250290	1.504708	.167912	
	6	.342233	.646449	.016031	-.253887	.111762	.960755	.250290	1.504708	.167912	
	7	.564713	.646449	.039811	-.048726	.025002	.998499	.634275	1.582790	.422982	
	8	.919139	.646449	.041634	.030181	-.005013	.999532	.783432	1.588480	.522295	
	9	1.274966	.646449	.023606	.075570	-.019869	.996943	.635339	1.517475	.473043	
	10	1.494940	.646449	.005815	.095382	-.025495	.995114	.243093	1.420021	.162114	
	11	1.615771	.646449	0.000000	0.000000	0.000000	1.000000	.241984	1.412544	.161322	WAKE

3-D LIFTING POTENTIAL FLOW PROGRAM

SWEPT TAPERED WING (DERIV INPUT)

------------ * ------------

------------ * ------------

------------ * ------------

TABLE OF INPUT INFORMATION

INPUT SECTION NO.	SECTION TYPE	TOTAL NO. OF ELEMENTS IN EACH SECTION	EXTRA STRIPS	STRIP NO.	SOURCE ELEMENTS IN THE STRIP	WAKE ELEMENTS IN THE STRIP
1	1	33	0	1	10	1
				2	10	1
				3	10	1

TOTAL NO. OF ELEMENTS INPUT = 33

TOTAL NO. OF OFF BODY POINTS = 0

MINIMUM VARIABLE DIMENSION SIZE 30

PROGRAM DIMENSION SIZE 1100

```
                                                  ------------- * ------------
      4-D LIFTING POTENTIAL FLOW PROGRAM
       SWEPT TAPERED WING (DERIV INPUT)           ------------- * ------------              PAGE    6
                                                  ------------- * -------------
                                                  ------------- * -------------
BODY  SECTION  NO. =  1          TYPE = 1        TOTAL  NO.  OF  POINTS =   33         NO.  OF  STRIPS =   3
                    LIFTING  SECTION  NO.   1          NO.  OF  SOURCE  ELEMENTS   10
               NO.  OF  WAKE  ELEMENTS   1         TOTAL  NO.  OF  ELEMENTS  PER  STRIP   11
                    TOTAL  NO.  OF  CONTROL  POINTS ( INCL.  OFF  BODY  POINTS ) =   30
                         LIFTING  STRIP  NO.  1,  NO.  OF  IGNORE  ELEMENTS   0
                         LIFTING  STRIP  NO.  2,  NO.  OF  IGNORE  ELEMENTS   0
                         LIFTING  STRIP  NO.  3,  NO.  OF  IGNORE  ELEMENTS   0
                         TOTAL  NO.  OF  ELEMENTS  IN  THE  LIFTING  SECTION =   33
NO.  OF  FAR  ELEMENTS =    100     NO.  OF  INTERMEDIATE  ELEMENTS =    500     NO.  OF  NEAR  ELEMENTS =   1380
```

```
                              ------------- * -------------
3-D LIFTING POTENTIAL FLOW PROGRAM
 SWEPT TAPERED WING (DERIV INPUT)   -------------- * -------------- )
         (  ALPHA  ,  BETA     )  .174533E+00  ;  0.
                                  -------------- * --------------

             FINAL OUTPUT FOR THE FOLLOWING ANGLE OF ATTACK

              (     .984808,    0.000000,     .173648  )
```

ORIGINAL PAGE IS
OF POOR QUALITY

3-D LIFTING POTENTIAL FLOW PROGRAM

SWEPT TAPERED WING (DERIV INPUT) PAGE 8

(ALPHA , BETA) .174533E+00 ; 0.)

UN - BODY POINTS FINAL OUTPUT

N	M	XO	YO	ZO	VX	VY	VZ	CP	VN	A
1	1	2.226048	3.301548	-.005713	.945563	.050013	.089160	.099226	-.000000	.103117
	2	2.085877	3.301548	-.015115	.951079	.040023	.071166	.086859	-.000000	.269469
	3	1.859074	3.301548	-.020590	.895046	.062291	.026680	.193286	-.000000	.332270
	4	1.642272	3.301548	-.022426	.711459	.141456	-.031177	.472844	-.000000	.269049
	5	1.492100	3.301548	-.010238	-.094457	.485549	.061569	.748586	-.000000	.106805
	6	1.492100	3.301548	.010238	2.011625	-.445508	.583412	-3.555482	-.000000	.106805
	7	1.642272	3.301548	.022426	1.414713	-.193230	.073175	-1.044207	-.000000	.269049
	8	1.859074	3.301548	.020590	1.199587	-.111451	-.036780	-.452787	-.000000	.332220
	9	2.085877	3.301548	.015115	1.055971	-.065130	-.081743	-.125934	-.000000	.269469
	10	2.226048	3.301548	.005713	.944091	-.035446	-.091350	.099226	-.000000	.103117
		STRIP	(FORCE/Q)		-.829710E-01		.375171E-01	.112349E+01		
		STRIP	(MOMENT/Q)		.371015E+01		-.134137E+01	.330655E+00		
2	1	1.860601	1.975285	-.004703	.944850	.048859	.089313	.096894	-.000000	.132616
	2	1.680314	1.975285	-.014387	.950500	.040029	.071122	.089327	-.000000	.346556
	3	1.389912	1.975285	-.024165	.891115	.065604	.026639	.197332	-.000000	.427257
	4	1.049010	1.975285	-.032612	.712943	.136608	-.031365	.472012	-.000000	.346016
	5	.419722	1.975285	-.023131	-.079003	.475554	.070244	.761413	-.000000	.137359
	6	.419722	1.975285	.023131	1.994326	-.439546	.578147	-3.504790	-.000000	.137359
	7	1.049010	1.975285	.032612	1.412155	-.193016	.073745	-1.030876	-.000000	.346016
	8	1.389912	1.975285	.034105	1.201745	-.112572	-.036851	-.456220	-.000000	.427257
	9	1.680314	1.975285	.014387	1.059067	-.065157	-.081498	-.132657	-.000000	.346556
	10	1.860601	1.975285	.004703	.945294	-.034807	-.091478	.096894	-.000000	.132616
		STRIP	(FORCE/Q)		-.103147E+00		.467996E-01	.144097E+01		
		STRIP	(MOMENT/Q)		.284512E+01		-.161786E+01	.247769E+00		
3	1	1.494446	.640449	-.005815	.946079	.049623	.089513	.094840	-.000000	.162114
	2	1.274906	.640449	-.023666	.954639	.042394	.071519	.081752	-.000000	.423643
	3	.919839	.640449	-.041034	.904945	.059043	.047028	.176853	-.000000	.522215
	4	.564713	.640449	-.039011	.743626	.122176	-.033217	.430867	-.000000	.422982
	5	.345233	.640449	-.016031	.024696	.440529	.043556	.812138	-.000000	.167912
	6	.345233	.640449	.016031	1.885124	-.413960	.543475	-3.000815	.000002	.167912
	7	.564713	.640449	.049311	1.377566	-.172552	.071146	-.932636	-.000000	.422982
	8	.919839	.640449	.041034	1.190218	-.100402	-.036445	-.428129	-.000000	.522295
	9	1.274906	.640449	.023666	1.057405	-.059066	-.081342	-.129281	-.000000	.423643
	10	1.494446	.640449	.015815	.946528	-.029563	-.091483	.094840	-.000000	.162114

3-D LIFTING POTENTIAL FLOW PROGRAM

SWEPT TAPERED WING (DERIV INPUT)

(ALPHA , BETA) .174533E+00 , 0.)

N	M	XO	YO	ZC	VX	VY	VZ	CP	VN	A

STRIP	(FORCE/Q)	-.101129E+00	.461140E-01	.159552E+01
STRIP	(MOMENT/Q)	.102961E+01	-.944340E+00	.826181E-01
SECTION	(FORCE/Q)	-.287247E+00	.130501E+00	.416048E+01
SECTION	(MOMENT/Q)	.758504E+01	-.440358E+01	.661043E+00
BODY	(FORCE/Q)	-.287247E+00	.130501E+00	.416048E+01
BODY	(MOMENT/Q)	.758504E+01	-.440358E+01	.661043E+00

STRIP NO.	K (STRIP)
1	-.189898E-01
2	-.189983E-01
3	-.173332E-01

ORIGINAL PAGE IS
OF POOR QUALITY

7.2 Test Case Number 2

The second test case is a swept, tapered wing intersecting a fuselage consisting of a cylindrical midsection with ellipsoidal fairings fore and aft. The Douglas-mode input option is used. The shape of the wing is specified by inputting points on the tip and root N-lines. The shape of the fuselage is specified by inputting points on ten N-lines. Since the midsection of the fuselage is cylindrical, the fuselage is paneled using the multisection component option of the geometry package. Both wing and fuselage are paneled using the planar-section mode of distributing N-lines. The intersection curve is calculated and the wing and fuselage are repaneled. The final element distribution on the wing consists of three strips (including one extra strip at the root), four on-body elements per strip, and one wake element per strip. The final element distribution on the fuselage consists of two strips forward of the wing, two strips aft of the wing, one strip above the wing, and one strip below the wing. There are four elements per strip on the portions forward and aft of the wing and two elements per strip on the portions above and below the wing. The potential-flow pressure distribution is calculated using the options for piecewise-constant spanwise vorticity distributions, semi-infinite last wake elements, one plane of symmetry, and one extra strip on the wing.

7.2.1 Input Data

Card
Column

```
         1         2         3         4         5         6
123456789012345678901234567890123456789012345678901234567890

13 WING-FUSELAGE TEST CASE

   1  2     1     0           1  1      1.0
   1.0      0.0       0.0
   1  10           3
   0  30

  2.451475  4.000271  0.0     2
  2.276530  4.000271 -0.0152840
  2.003443  4.000271 -0.0259480
  1.782502  4.000271 -0.0097110
  1.765165  4.000271 -0.0046480
  1.760815  4.000271  0.0     0
  1.765165  4.000271  0.0046480
  1.782502  4.000271  0.0097110
  2.003443  4.000271  0.0259480
  2.276530  4.000271  0.0152840
  2.451475  4.000271  0.0     0
  2.537740  4.000000  0.0     4

  1.382319  0.0       0.0     1
  1.032176  0.0      -0.0305910
  0.485608  0.0      -0.0519340
  0.043406  0.0      -0.0194350
  0.008710  0.0      -0.0093030
  0.0       0.0       0.0     0
  0.008710  0.0       0.0093030
  0.043406  0.0       0.0194350
  0.485608  0.0       0.0519340
  1.032176  0.0       0.0305910
  1.382319  0.0       0.0     0
  1.554960  0.0       0.0     4

 -3.333333  0.0       0.0     2
 -3.333333  0.0       0.0     0
 -3.333333  0.0       0.0     0
 -3.333333  0.0       0.0     0
 -3.333333  0.0       0.0     0
 -3.333333  0.0       0.0     0
 -3.333333  0.0       0.0     0

 -3.250000  0.0       0.1425461
 -3.250000  0.071273  0.1234490
 -3.250000  0.109197  0.0916270
 -3.250000  0.142546  0.0     0
 -3.250000  0.109197 -0.0916270
 -3.250000  0.071273 -0.1234490
 -3.250000  0.0      -0.1425460

 -3.000000  0.0       0.2762601
 -3.000000  0.138130  0.2392480
 -3.000000  0.211627  0.1775760
 -3.000000  0.276260  0.0     0
 -3.000000  0.211627 -0.1775760
 -3.000000  0.138130 -0.2392480
 -3.000000  0.0      -0.2762600
```

7.2.1 (Continued)

Card
Column

```
         1         2         3         4         5         6
123456789012345678901234567890123456789012345678901234567890

 -2.600000 0.0        0.3868711
 -2.600000 0.193436   0.3350400
 -2.600000 0.296361   0.2486760
 -2.600000 0.386871   0.0     0
 -2.600000 0.296361 -0.2486860
 -2.600000 0.193436 -0.3350400
 -2.600000 0.0      -0.3868710

 -1.333333 0.0        0.5000001
 -1.333333 0.250000   0.4330130
 -1.333333 0.383022   0.3213940
 -1.333333 0.500000   0.0     0
 -1.333333 0.383022 -0.3213940
 -1.333333 0.250000 -0.4330130
 -1.333333 0.0      -0.5000000

  2.400000 0.0        0.5000001
  2.400000 0.250000   0.4330130
  2.400000 0.383022   0.3213940
  2.400000 0.500000   0.0     0
  2.400000 0.383022 -0.3213940
  2.400000 0.250000 -0.4330130
  2.400000 0.0      -0.5000000

  3.500000 0.0        0.4545301
  3.500000 0.227265   0.3936340
  3.500000 0.348190   0.2921660
  3.500000 0.454530   0.0     0
  3.500000 0.348190 -0.2921660
  3.500000 0.227265 -0.3936340
  3.500000 0.0      -0.4545300

  4.300000 0.0        0.2885551
  4.300000 0.144277   0.2498960
  4.300000 0.221046   0.1854800
  4.300000 0.286555   0.0     0
  4.300000 0.221046 -0.1854800
  4.300000 0.144277 -0.2498960
  4.300000 0.0      -0.2885550

  4.500000 0.0        0.1998261
  4.500000 0.099913   0.1730550
  4.500000 0.153076   0.1284460
  4.500000 0.199826   0.0     0
  4.500000 0.153076 -0.1284460
  4.500000 0.099913 -0.1730550
  4.500000 0.0      -0.1998260

  4.666667 0.0        0.0     1
  4.666667 0.0        0.0     0
  4.666667 0.0        0.0     0
  4.666667 0.0        0.0     0
  4.666667 0.0        0.0     0
  4.666667 0.0        0.0     0
  4.666667 0.0        0.0     3

    5   1   3   3   0   2               2       1
    5   0   5   2   0   2       3           1       2
    5   6   10
```

7.2.2 Output Data

The output for the second test case is given in the following pages.

```
                                   ------------- * ------------
3-D LIFTING POTENTIAL FLOW PROGRAM
WING-FUSELAGE TEST CASE                                                                    PAGE    1
                                             10/26/77.
                                   ------------- * ------------
                                                             CASE ID ---     1
                                         NO. OF NONLIFTING COMPONENTS ---    1
                                            NO. OF LIFTING COMPONENTS ---    1
                                               NO. OF OFF-BODY POINTS ---   -0
                              INPUT MODE ( 0 - DERIV, 1 - DOUGLAS ) ---      1
                GEOMETRY PACKAGE OPTION (NONZERO - YES, ZERO - NO ) ---      3
        PARTIAL PROGRAM EXECUTION OPTION (NONZERO - YES, ZERO - NO ) ---     0
                           MATRIX OUTPUT (NONZERO - YES, ZERO - NO ) ---    -0
              EXTENDED GEOMETRIC OUTPUT (NONZERO - YES, ZERO - NO ) ---     -0
                  IGNORE ELEMENT OPTION (NONZERO - YES, ZERO - NO ) ---     -0
           SPECIAL LAST WAKE CALCULATION (NONZERO - YES, ZERO - NO ) ---     1
       STEPWISE LINEAR VORTICITY OPTION (NONZERO - YES, ZERO - NO ) ---     -0
   ADDITIONAL NONCIRCULATORY SOLUTION (NONZERO - YES, ZERO - NO ) ---       -0
                        SYMMETRY OPTION (NONZERO - YES, ZERO - NO ) ---      1
                                  COMPONENTS OF THE UNIFORM ONSET FLOWS

                                  ( 1)     1.000000,     0.000000,     0.000000

                                 COORDINATES OF MOMENT CENTER

                                           0.000000,     0.000000,     0.000000
```

------------ * ------------

3-D LIFTING POTENTIAL FLOW PROGRAM

WING-FUSELAGE TEST CASE

------------ * ------------

INPUT COORDINATES

COMPONENT NO. 1

N	M	X	Y	Z	TYPE
1	1	.245148E+01	.400027E+01	0.	LIFT
	2	.227653E+01	.400027E+01	-.152840E-01	
	3	.200344E+01	.400027E+01	-.259480E-01	
	4	.178250E+01	.400027E+01	-.971100E-02	
	5	.176517E+01	.400027E+01	-.464800E-02	
	6	.176082E+01	.400027E+01	0.	
	7	.176517E+01	.400027E+01	.464800E-02	
	8	.178250E+01	.400027E+01	.971100E-02	
	9	.200344E+01	.400027E+01	.259480E-01	
	10	.227653E+01	.400027E+01	.152840E-01	
	11	.245148E+01	.400027E+01	0.	
	12	.253774E+01	.400000E+01	0.	WAKE
2	1	.138232E+01	0.	0.	LIFT
	2	.103218E+01	0.	-.305910E-01	
	3	.485608E+00	0.	-.519340E-01	
	4	.434060E-01	0.	-.194350E-01	
	5	.871000E-02	0.	-.930300E-02	
	6	0.	0.	0.	
	7	.871000E-02	0.	.930300E-02	
	8	.434060E-01	0.	.194350E-01	
	9	.485608E+00	0.	.519340E-01	
	10	.103218E+01	0.	.305910E-01	
	11	.138232E+01	0.	0.	
	12	.155496E+01	0.	0.	WAKE

ORIGINAL PAGE IS
OF POOR QUALITY

INPUT COORDINATES

COMPONENT NO. 2

N	M	X	Y	Z	TYPE
1	1	-.333333E+01	0.	0.	NLIF
	2	-.333333E+01	0.	0.	
	3	-.333333E+01	0.	0.	
	4	-.333333E+01	0.	0.	
	5	-.333333E+01	0.	0.	
	6	-.333333E+01	0.	0.	
	7	-.333333E+01	0.	0.	
2	1	-.325000E+01	0.	.142546E+00	NLIF
	2	-.325000E+01	.712730E-01	.123449E+00	
	3	-.325000E+01	.109197E+00	.916270E-01	
	4	-.325000E+01	.142546E+00	0.	
	5	-.325000E+01	.109197E+00	-.916270E-01	
	6	-.325000E+01	.712730E-01	-.123449E+00	
	7	-.325000E+01	0.	-.142546E+00	
3	1	-.300000E+01	0.	.276260E+00	NLIF
	2	-.300000E+01	.138130E+00	.239248E+00	
	3	-.300000E+01	.211627E+00	.177576E+00	
	4	-.300000E+01	.276260E+00	0.	
	5	-.300000E+01	.211627E+00	-.177576E+00	
	6	-.300000E+01	.138130E+00	-.239248E+00	
	7	-.300000E+01	0.	-.276260E+00	
4	1	-.260000E+01	0.	.386871E+00	NLIF
	2	-.260000E+01	.193436E+00	.335040E+00	
	3	-.260000E+01	.296361E+00	.248676E+00	
	4	-.260000E+01	.386871E+00	0.	
	5	-.260000E+01	.296361E+00	-.248686E+00	
	6	-.260000E+01	.193436E+00	-.335040E+00	
	7	-.260000F+01	0.	-.386871E+00	
5	1	-.133333E+01	0.	.500000E+00	NLIF
	2	-.133333E+01	.250000E+00	.433013E+00	
	3	-.133333E+01	.383022E+00	.321394E+00	
	4	-.133333E+01	.500000E+00	0.	
	5	-.133333E+01	.383022E+00	-.321394E+00	
	6	-.133333E+01	.250000E+00	-.433013E+00	
	7	-.133333E+01	0.	-.500000E+00	
6	1	.240000E+01	0.	.500000E+00	NLIF
	2	.240000E+01	.250000E+00	.433013E+00	
	3	.240000E+01	.383022E+00	.321394E+00	
	4	.240000E+01	.500000E+00	0.	
	5	.240000E+01	.383022E+00	-.321394E+00	
	6	.240000E+01	.250000E+00	-.433013E+00	
	7	.240000E+01	0.	-.500000E+00	
7	1	.350000E+01	0.	.454530E+00	NLIF

------------- * -------------

3-D LIFTING POTENTIAL FLOW PROGRAM

WING-FUSELAGE TEST CASE

------------- * -------------

INPUT COORDINATES

COMPONENT NO. 2

N	M	X	Y	Z	TYPE
	2	.350000E+01	.227265E+00	.393634E+00	
	3	.350000E+01	.348190E+00	.292166E+00	
	4	.350000E+01	.454530E+00	0.	
	5	.350000E+01	.348190E+00	-.292166E+00	
	6	.350000E+01	.227265E+00	-.393634E+00	
	7	.350000E+01	0.	-.454530E+00	
8	1	.430000E+01	0.	.288555E+00	NLIF
	2	.430000E+01	.144277E+00	.249896E+00	
	3	.430000E+01	.221046E+00	.185480E+00	
	4	.430000E+01	.288555E+00	0.	
	5	.430000E+01	.221046E+00	-.185480E+00	
	6	.430000E+01	.144277E+00	-.249896E+00	
	7	.430000E+01	0.	-.288555E+00	
9	1	.450000E+01	0.	.199826E+00	NLIF
	2	.450000E+01	.999130E-01	.173055E+00	
	3	.450000E+01	.153076E+00	.128446E+00	
	4	.450000E+01	.199826E+00	0.	
	5	.450000E+01	.153076E+00	-.128446E+00	
	6	.450000E+01	.999130E-01	-.173055E+00	
	7	.450000E+01	0.	-.199826E+00	
10	1	.466667E+01	0.	0.	NLIF
	2	.466667E+01	0.	0.	
	3	.466667E+01	0.	0.	
	4	.466667E+01	0.	0.	
	5	.466667E+01	0.	0.	
	6	.466667E+01	0.	0.	
	7	.466667E+01	0.	0.	

COORDINATES AFTER REPANELING ISOLATED COMPONENTS

COMPONENT NO. 1

N	M	X	Y	Z	TYPE
1	1	.245148E+01	.400027E+01	0.	LIFT
	2	.210477E+01	.400027E+01	-.242178E-01	
	3	.176082E+01	.400027E+01	.119934E-10	
	4	.210477E+01	.400027E+01	.242178E-01	
	5	.245148E+01	.400027E+01	0.	
	6	.253774E+01	.400000E+01	0.	WAKE
2	1	.191690E+01	.200014E+01	0.	LIFT
	2	.139658E+01	.200014E+01	-.363445E-01	
	3	.880407E+00	.200014E+01	.179966E-10	
	4	.139658E+01	.200014E+01	.363445E-01	
	5	.191690E+01	.200014E+01	0.	
	6	.204638E+01	.200014E+01	0.	WAKE
3	1	.138232E+01	0.	0.	LIFT
	2	.688403E+00	0.	-.484712E-01	
	3	.110871E-18	0.	.239998E-10	
	4	.688403E+00	0.	.484712E-01	
	5	.138232E+01	0.	0.	
	6	.155496E+01	0.	0.	WAKE

COORDINATES AFTER REPANELING ISOLATED COMPONENTS

COMPONENT NO. 2

N	M	X	Y	Z	TYPE
1	1	-.333333E+01	0.	0.	NLIF
	2	-.333333E+01	0.	0.	
	3	-.333333E+01	0.	0.	
	4	-.333333E+01	0.	0.	
	5	-.333333E+01	0.	0.	
2	1	-.133333E+01	0.	.500000E+00	NLIF
	2	-.133333E+01	.353974E+00	.354244E+00	
	3	-.133333E+01	.500000E+00	0.	
	4	-.133333E+01	.353974E+00	-.354244E+00	
	5	-.133333E+01	0.	-.500000E+00	
3	1	.666667E+00	0.	.500000E+00	NLIF
	2	.666667E+00	.353974E+00	.354244E+00	
	3	.666667E+00	.500000E+00	0.	
	4	.666667E+00	.353974E+00	-.354244E+00	
	5	.666667E+00	0.	-.500000E+00	
4	1	.266667E+01	0.	.497816E+00	NLIF
	2	.266667E+01	.352427E+00	.352696E+00	
	3	.266667E+01	.497816E+00	0.	
	4	.266667E+01	.352427E+00	-.352696E+00	
	5	.266667E+01	0.	-.497816E+00	
5	1	.466667E+01	0.	0.	NLIF
	2	.466667E+01	0.	0.	
	3	.466667E+01	0.	0.	
	4	.466667E+01	0.	0.	
	5	.466667E+01	0.	0.	

------------- * -------------

------------- * -------------

COORDINATES OF POINTS OF INTERSECTION BETWEEN COMPONENT NO. 1 AND COMPONENT NO. 2

M	X	Y	Z
1	.151595E+01	.500000E+00	0.
2	.858787E+00	.481222E+00	-.455536E-01
3	.220087E+00	.500000E+00	.224991E-10
4	.858787E+00	.481222E+00	.455536E-01
5	.151595E+01	.500000E+00	0.
6	.167781E+01	.500000E+00	0.

------------- * ------------

3-D LIFTING POTENTIAL FLOW PROGRAM

WING-FUSELAGE TEST CASE

------------- * ------------

FINAL REDISTRIBUTED COORDINATES

COMPONENT NO. 1

N	M	X	Y	Z	TYPE
1	1	.245148E+01	.400027E+01	0.	LIFT
	2	.210477E+01	.400027E+01	-.242178E-01	
	3	.176082E+01	.400027E+01	.119934E-10	
	4	.210477E+01	.400027E+01	.242178E-01	
	5	.245148E+01	.400027E+01	0.	
	6	.253774E+01	.400000E+01	0.	WAKE
2	1	.198371E+01	.225014E+01	0.	LIFT
	2	.148510E+01	.225014E+01	-.348288E-01	
	3	.990451E+00	.225014E+01	.172463E-10	
	4	.148510E+01	.225014E+01	.348288E-01	
	5	.198371E+01	.225014E+01	0.	
	6	.210751E+01	.225014E+01	0.	WAKE
3	1	.151595E+01	.500000E+00	0.	LIFT
	2	.858787E+00	.481222E+00	-.455536E-01	
	3	.220087E+00	.500000E+00	.224991E-10	
	4	.858787E+00	.481222E+00	.455536E-01	
	5	.151595E+01	.500000E+00	0.	
	6	.167781E+01	.500000E+00	0.	WAKE
4	1	.138232E+01	0.	0.	LIFT
	2	.688403E+00	0.	-.484712E-01	
	3	.110871E-18	0.	.239998E-10	
	4	.688403E+00	0.	.484712E-01	
	5	.138232E+01	0.	0.	
	6	.155496E+01	0.	0.	WAKE

------------ * ------------

3-D LIFTING POTENTIAL FLOW PROGRAM

WING-FUSELAGE TEST CASE

------------ * ------------

FINAL REDISTRIBUTED COORDINATES

COMPONENT NO. 2

N	M	X	Y	Z	TYPE
1	1	-.333333E+01	0.	0.	NLIF
	2	-.333333E+01	0.	0.	
	3	-.333333E+01	0.	0.	
	4	-.333333E+01	0.	0.	
	5	-.333333E+01	0.	0.	
2	1	-.155662E+01	0.	.496773E+00	NLIF
	2	-.155662E+01	.351689E+00	.351957E+00	
	3	-.155662E+01	.496773E+00	-.186328E-06	
	4	-.155662E+01	.351689E+00	-.351958E+00	
	5	-.155662E+01	0.	-.496773E+00	
3	1	.220087E+00	0.	.500000E+00	NLIF
	2	.220087E+00	.353974E+00	.354244E+00	
	3	.220087E+00	.500000E+00	.224991E-10	
	4	.220087E+00	.353974E+00	-.354244E+00	
	5	.220087E+00	0.	-.500000E+00	

ORIGINAL PAGE IS
OF POOR QUALITY

3-D LIFTING POTENTIAL FLOW PROGRAM

WING-FUSELAGE TEST CASE

FINAL REDISTRIBUTED COORDINATES

COMPONENT NO. 3

N	M	X	Y	Z	TYPE
1	1	.220087E+00	0.	.500000E+00	NLIF
	2	.220087E+00	.353974E+00	.354244E+00	
	3	.220087E+00	.500000E+00	.224991E-10	
2	1	.151595E+01	0.	.500000E+00	NLIF
	2	.151595E+01	.353974E+00	.354244E+00	
	3	.151595E+01	.500000E+00	0.	

3-D LIFTING POTENTIAL FLOW PROGRAM

WING-FUSELAGE TEST CASE

FINAL REDISTRIBUTED COORDINATES

COMPONENT NO. 4

N	M	X	Y	Z	TYPE
1	1	.220087E+00	.500000E+00	.224991E-10	NLIF
	2	.220087E+00	.353974E+00	-.354244E+00	
	3	.220087E+00	0.	-.500000E+00	
2	1	.151595E+01	.500000E+00	0.	NLIF
	2	.151595E+01	.353974E+00	-.354244E+00	
	3	.151595E+01	0.	-.500000E+00	

3-D LIFTING POTENTIAL FLOW PROGRAM ------------ * ------------

WING-FUSELAGE TEST CASE ------------ * ------------

FINAL REDISTRIBUTED COORDINATES

COMPONENT NO. 5

N	M	X	Y	Z	TYPE
1	1	.151595E+01	0.	.500000E+00	NLIF
	2	.151595E+01	.353974E+00	.354244E+00	
	3	.151595E+01	.500000E+00	0.	
	4	.151595E+01	.353974E+00	-.354244E+00	
	5	.151595E+01	0.	-.500000E+00	
2	1	.309131E+01	0.	.483709E+00	NLIF
	2	.309131E+01	.342441E+00	.342702E+00	
	3	.309131E+01	.483709E+00	0.	
	4	.309131E+01	.342441E+00	-.342702E+00	
	5	.309131E+01	0.	-.483709E+00	
3	1	.466667E+01	0.	0.	NLIF
	2	.466667E+01	0.	0.	
	3	.466667E+01	0.	0.	
	4	.466667E+01	0.	0.	
	5	.466667E+01	0.	0.	

ORIGINAL PAGE IS
OF POOR QUALITY

3-D LIFTING POTENTIAL FLOW PROGRAM

WING-FUSELAGE TEST CASE

N	M	XO	YO	ZO	XN	YN	ZN	D	T	A	TYPE
1	1	1.989980	3.072786	-.014921	.069669	-.018620	-.997396	.847381	1.999516	.741644	LIFT
	2	1.564468	3.072786	-.014921	-.070203	.030902	-.997054	.840679	2.074912	.736003	
	3	1.564468	3.072786	.014921	-.070203	.030902	.997054	.840679	2.074912	.736003	
	4	1.989980	3.072786	.014921	.069669	-.018620	.997396	.847381	1.999516	.741644	
	5	2.256732	3.072687	0.000000	0.000000	0.000000	1.000000	.210357	1.835475	.184124	WAKE
2	1	1.448366	1.330091	-.020218	.069670	-.018621	-.997396	1.158724	2.096837	1.014418	LIFT
	2	.873785	1.333029	-.020209	-.070204	.030902	-.997054	1.136353	2.159768	1.006708	
	3	.873785	1.333029	.020209	-.070204	.030902	.997054	1.136353	2.159768	1.006708	
	4	1.448366	1.330091	.020218	.069670	-.018621	.997396	1.158724	2.096837	1.014418	
	5	1.811441	1.336549	0.000000	0.000000	0.000000	1.000000	.285945	1.847502	.250222	WAKE
3	1	1.110681	.243096	-.023513	.069670	-.018621	-.997396	1.354481	.968146	.330896	XTRX
	2	.440609	.242263	-.023515	-.070204	.030902	-.997054	1.330562	.985539	.328381	
	3	.440609	.242263	.023515	-.070204	.030902	.997054	1.330562	.985539	.328381	
	4	1.110681	.243096	.023513	.069670	-.018621	.997396	1.354481	.968146	.330896	
	5	1.532071	.247312	0.000000	0.000000	0.000000	1.000000	.334494	.580787	.083624	WAKE
4	1	-2.148860	.117230	.282910	-.250311	.368634	.895239	.000000	1.845063	.348985	NLIF
	2	-2.148860	.282821	.117319	-.250274	.895107	.368980	.000000	1.845063	.349302	
	3	-2.148860	.282821	-.117319	-.250274	.895107	-.368980	.000000	1.845063	.349302	
	4	-2.148860	.117230	-.282910	-.250311	.368633	-.895240	.000000	1.845063	.348985	
5	1	-.667309	.176416	.425745	-.001680	.380754	.924675	.000000	1.817226	.677946	NLIF
	2	-.667309	.425610	.176551	-.001679	.924529	.381108	.000000	1.817300	.678570	
	3	-.667309	.425611	-.176551	-.001679	.924529	-.381108	.000000	1.817300	.678570	
	4	-.667309	.176416	-.425745	-.001680	.380754	-.924675	.000000	1.817226	.677946	
6	1	.868021	.176987	.427122	.000000	.380754	.924676	.000000	1.351227	.496069	NLIF
	2	.868021	.426987	.177122	-.000000	.924530	.381109	.000000	1.351327	.496526	
7	1	.868021	.426987	-.177122	-.000000	.924530	-.381109	.000000	1.351327	.496526	NLIF
	2	.868021	.176987	-.427122	-.000000	.380754	-.924676	.000000	1.351227	.496069	
8	1	2.299284	.174120	.420202	.009562	.380738	.924634	.000000	1.619817	.593263	NLIF
	2	2.299284	.420069	.174252	.009560	.924488	.381092	.000000	1.619897	.593809	
	3	2.299284	.420069	-.174252	.009560	.924488	-.381092	.000000	1.619897	.593809	
	4	2.299284	.174120	-.420202	.009562	.380738	-.924634	.000000	1.619817	.593263	
9	1	3.616429	.114147	.275470	.273124	.366279	.889518	.000000	1.648168	.303235	NLIF
	2	3.616429	.275383	.114234	.273085	.889388	.366624	.000000	1.648168	.303511	
	3	3.616429	.275383	-.114234	.273085	.889388	-.366624	.000000	1.648168	.303511	
	4	3.616429	.114147	-.275470	.273124	.366279	-.889518	.000000	1.648168	.303235	

TABLE OF INPUT INFORMATION

INPUT SECTION NO.	SECTION TYPE	TOTAL NO. OF ELEMENTS IN EACH SECTION	EXTRA STRIPS	STRIP NO.	SOURCE ELEMENTS IN THE STRIP	WAKE ELEMENTS IN THE STRIP
1	1	10	3	1	4	1
				2	4	1
				3	4	1
2	0	8	0	4	4	0
				5	4	0
3	0	2	0	6	2	0
4	0	2	0	7	2	0
5	0	8	0	8	4	0
				9	4	0

TOTAL NO. OF ELEMENTS INPUT = 30

TOTAL NO. OF OFF BODY POINTS = -0

MINIMUM VARIABLE DIMENSION SIZE 28

PROGRAM DIMENSION SIZE 1100

```
                                        ------------- * ------------
      3-D LIFTING POTENTIAL FLOW PROGRAM
      WING-FUSELAGE TEST CASE                                                         PAGE   15
                                        ------------- * ------------
                                        -------------- * --------------
                                        -------------- * --------------
BODY  SECTION  NO. =  1        TYPE = 1        TOTAL  NO.  OF  POINTS =   10        NO.  OF  STRIPS =   2
                        THE FINAL STRIP OF THIS SECTION IS AN EXTRA STRIP

                                        -------------- * --------------
                  LIFTING  SECTION  NO.   1         NO.  OF  SOURCE  ELEMENTS    4
            NO.  OF  WAKE  ELEMENTS   1         TOTAL  NO.  OF  ELEMENTS  PER  STRIP    5
                  TOTAL  NO.  OF  CONTROL  POINTS ( INCL.  OFF  BODY  POINTS ) =   28
                        LIFTING  STRIP  NO.  1,  NO.  OF  IGNORE  ELEMENTS   0
                        LIFTING  STRIP  NO.  2,  NO.  OF  IGNORE  ELEMENTS   0
                        TOTAL  NO.  OF  ELEMENTS  IN  THE  LIFTING  SECTION =  10
```

```
                              ------------- * ------------
     3-D LIFTING POTENTIAL FLOW PROGRAM
     WING-FUSELAGE TEST CASE                                               PAGE   16
                              ------------- * ------------
                              ------------- * -------------
BODY  SECTION  NO. =  2        TYPE = 0        TOTAL  NO.  OF  POINTS =   8        NO.  OF  STRIPS =   2
                  TOTAL  NO.  OF  CONTROL  POINTS ( INCL.  OFF  BODY  POINTS ) =  28
                    TOTAL  NO.  OF  ELEMENTS  IN  THE  NON-LIFTING  SECTION =   8
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                              ------------- * ------------
3-D LIFTING POTENTIAL FLOW PROGRAM
WING-FUSELAGE TEST CASE                                                   PAGE   17
                              ------------- * ------------
                              -------------- * -------------
BODY  SECTION  NO. =  3        TYPE = 0        TOTAL  NO.  OF  POINTS =    2        NO.  OF  STRIPS =   1
                 TOTAL  NO.  OF  CONTROL  POINTS ( INCL.  OFF  BODY  POINTS ) =   28
                   TOTAL  NO.  OF  ELEMENTS  IN  THE  NON-LIFTING  SECTION =   2
```

```
------------- * ------------
------------- * ------------
------------- * -------------
BODY  SECTION  NO. =  4        TYPE = 0        TOTAL  NO.  OF  POINTS =   2        NO.  OF  STRIPS =   1
                  TOTAL  NO.  OF  CONTROL  POINTS ( INCL.  OFF  BODY  POINTS ) =  28
                     TOTAL  NO.  OF  ELEMENTS  IN  THE  NON-LIFTING  SECTION =   2
```

```
                                     ------------- * ------------
3-D LIFTING POTENTIAL FLOW PROGRAM
WING-FUSELAGE TEST CASE                                                          PAGE  19
                                     ------------- * ------------
                                     ------------- * ------------
BODY  SECTION  NO. =  5        TYPE = 0        TOTAL  NO.  OF  POINTS =   8        NO.  OF  STRIPS =   2
                 TOTAL  NO.  OF  CONTROL  POINTS ( INCL.  OFF  BODY  POINTS ) =   28
                    TOTAL  NO.  OF  ELEMENTS  IN  THE  NON-LIFTING  SECTION =   8
NO.  OF  FAR  ELEMENTS =     0     NO.  OF  INTERMEDIATE  ELEMENTS =    304     NO.  OF  NEAR  ELEMENTS =  1656
```

```
3-D LIFTING POTENTIAL FLOW PROGRAM
WING-FUSELAGE TEST CASE
        (   ALPHA  ,  BETA    ) 0.            ; 0.            )

            FINAL OUTPUT FOR THE FOLLOWING ANGLE OF ATTACK

            (    1.000000,    0.000000,    0.000000  )
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                                                 ------------ * ------------
3-D LIFTING POTENTIAL FLOW PROGRAM
WING-FUSELAGE TEST CASE                                                                            PAGE   21
                                                 ------------ * ------------
                  (  ALPHA  ,  BETA       ) 0.              ;  0.           )
                                                 ------------ * ------------
                                          ON - BODY  POINTS  FINAL  OUTPUT
                                          ----------------------------------
N  M     XO        YO        ZO        VX        VY        VZ        CP        VN        A
1  1  1.989980  3.072786  -.014921  1.028174  -.013575   .072072  -.062520   .000000   .741644
   2  1.564468  3.072786  -.014921  1.030016  -.008284  -.072781  -.066298  -.000000   .736003
   3  1.564468  3.072786   .014921  1.030016  -.008284   .072781  -.066298  -.000000   .736003
   4  1.989980  3.072786   .014921  1.028174  -.013575  -.072072  -.062520   .000000   .741644
                ************                       ************                  ************
                 STRIP   (  FORCE/Q )      -.390400E-03      .128895E-02     -.610976E-08
                 STRIP   ( MOMENT/Q )      -.187712E-07      .956494E-08      .248137E-02
                ************                       ************                  ************
2  1  1.448366  1.330091  -.020218  1.036325  -.011358   .072601  -.079369   .000000  1.014418
   2   .873785  1.333029  -.020209  1.034273  -.005962  -.073009  -.075086  -.000000  1.006708
   3   .873785  1.333029   .020209  1.034273  -.005962   .073009  -.075086  -.000000  1.006708
   4  1.448366  1.330091   .020218  1.036325  -.011358  -.072601  -.079369   .000000  1.014418
                ************                       ************                  ************
                 STRIP   (  FORCE/Q )       .605224E-03      .167334E-02     -.241295E-07
                 STRIP   ( MOMENT/Q )      -.321502E-07      .211184E-07     -.103449E-02
                ************                       ************                  ************
                 SECTION (  FORCE/Q )       .214823E-03      .296230E-02     -.302393E-07
                 SECTION ( MOMENT/Q )      -.509214E-07      .306833E-07      .144688E-02
                ************                       ************                  ************
4  1 -2.148860   .117230   .232910   .955466   .094143   .228385   .026062  -.000000   .348985
   2 -2.148860   .282821   .117319   .955446   .228275   .094295   .026123  -.000000   .349302
   3 -2.148860   .282821  -.117319   .955446   .228275  -.094294   .026123  -.000000   .349302
   4 -2.148860   .117230  -.232910   .955466   .094143  -.228386   .026062  -.000000   .348985
                ************                       ************                  ************
                 STRIP   (  FORCE/Q )       .912074E-02     -.230410E-01      .276409E-07
                 STRIP   ( MOMENT/Q )      -.122626E-10      .558272E-07      .476863E-01
                ************                       ************                  ************
5  1  -.667309   .176416   .425745  1.029390   .000016   .001863  -.059646  -.000000   .677946
   2  -.667309   .425610   .176551  1.028876   .001300   .001380  -.058590  -.000000   .678570
   3  -.667309   .425611  -.176551  1.028876   .001300  -.001380  -.058590  -.000000   .678570
   4  -.667309   .176416  -.425745  1.029390   .000016  -.001863  -.059646  -.000000   .677946
                ************                       ************                  ************
                 STRIP   (  FORCE/Q )      -.269379E-03      .104306E+00     -.101048E-07
                 STRIP   ( MOMENT/Q )      -.225640E-09     -.111513E-07     -.695239E-01
                ************                       ************                  ************
                 SECTION (  FORCE/Q )       .885136E-02      .812655E-01      .175361E-07
                 SECTION ( MOMENT/Q )      -.237903E-09      .446759E-07     -.218375E-01
                ************                       ************                  ************
6  1   .868021   .176987   .427122  1.022747  -.002908   .001198  -.046022  -.000000   .496069
```


ORIGINAL PAGE IS
OF POOR QUALITY

3-D LIFTING POTENTIAL FLOW PROGRAM

WING-FUSELAGE TEST CASE

(ALPHA , BETA) 0. ; 0.)

N	M	XO	YO	ZO	VX	VY	VZ	CP	VN	A
6	2	.868021	.426987	.177122	1.039311	-.002776	.006734	-.080221	-.000000	.496526
			STRIP (FORCE/Q)			-.248420E-13	.455182E-01		.362907E-01	
			STRIP (MOMENT/Q)			-.174263E-04	-.315011E-01		.395108E-01	
			SECTION (FORCE/Q)			-.248420E-13	.455182E-01		.362907E-01	
			SECTION (MOMENT/Q)			-.174263E-04	-.315011E-01		.395108E-01	
7	1	.868021	.426987	-.177122	1.039311	-.002776	-.006734	-.080221	-.000000	.496526
	2	.868021	.176987	-.427122	1.022747	-.002908	-.001198	-.046022	-.000000	.496069
			STRIP (FORCE/Q)			-.239214E-12	.455182E-01		-.362907E-01	
			STRIP (MOMENT/Q)			.174263E-04	.315011E-01		.395103E-01	
			SECTION (FORCE/Q)			-.239214E-12	.455182E-01		-.362907E-01	
			SECTION (MOMENT/Q)			.174263E-04	.315011E-01		.395108E-01	
8	1	2.299284	.174120	.420202	1.034685	-.002183	-.009801	-.070673	.000000	.593263
	2	2.299284	.420069	.174252	1.033561	-.008334	-.005712	-.068350	-.000000	.593809
	3	2.299284	.420069	-.174252	1.033561	-.008334	.005712	-.068350	-.000000	.593809
	4	2.299284	.174120	-.420202	1.034685	-.002183	.009801	-.070673	-.000000	.593263
			STRIP (FORCE/Q)			.157784E-02	.106971E+00		.101158E-08	
			STRIP (MOMENT/Q)			.893591E-12	-.232676E-08		.245491E+00	
9	1	3.616429	.114147	.275470	.946857	-.102327	-.248595	.031192	.000000	.303235
	2	3.616429	.275383	.114234	.946727	-.248344	-.102728	.031481	.000000	.303511
	3	3.616429	.275383	-.114234	.946727	-.248344	.102728	.031481	.000000	.303511
	4	3.616429	.114147	-.275470	.946857	-.102327	.248595	.031192	.000000	.303235
			STRIP (FORCE/Q)			-.103852E-01	-.239248E-01		-.498942E-09	
			STRIP (MOMENT/Q)			-.651805E-13	.176092E-08		-.844956E-01	
			SECTION (FORCE/Q)			-.880739E-02	.830459E-01		.512633E-09	
			SECTION (MOMENT/Q)			.828410E-12	-.565842E-09		.160995E+00	
			BODY (FORCE/Q)			.258801E-03	.258310E+00		-.252856E-08	
			BODY (MOMENT/Q)			-.511515E-07	.664064E-07		.219626E+00	

STRIP NO.	B (STRIP)
1	.650841E-10
2	.159058E-09

ORIGINAL PAGE IS
OF POOR QUALITY

8.0 REFERENCES

1. Hess, J.L.: Calculation of Potential Flow about Arbitrary Three-Dimensional Lifting Bodies. Final Tech. Rept., McDonnell Douglas Report No. MDC J5679-01, October 1972.

2. Halsey, N. Douglas and Hess, John L.: A Geometry Pakcage for Generation of Input Data for a Three-Dimensional Potential-Flow Program. NASA CR-2962, 1978.

3. Mack, D.P.: Calculation of Potential Flow about Arbitrary Three-Dimensional Lifting Bodies. Users Manual. McDonnell Douglas Report No. MDC J5679-02, October 1972.

4. Tulinius, J., Clever, W., Niemann, A., Dunn, K., and Gaither, B.: Theoretical Prediction of Airplane Stability Derivatives at Subscritical Speeds. NASA CR-132681, 1975.

1. Report No.
NASA CR-145311

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle
A Three-Dimensional Potential-Flow Program With a Geometry Package for Input Data

5. Report Date
March 1978

6. Performing Organization Code

7. Author(s)
N. Douglas Halsey

8. Performing Organization Report No.
MDC J7733

9. Performing Organization Name and Address
McDonnell Douglas Corporation
Douglas Aircraft Company
3855 Lakewood Blvd.
Long Beach, California 90846

10. Work Unit No.

11. Contract or Grant No.
NAS1-14402

12. Sponsoring Agency Name and Address
National Aeronautics and Space Administration
Washington, D.C. 20546

13. Type of Report and Period Covered
7 May 76 - 22 Aug 77

14. Sponsoring Agency Code

15. Supplementary Notes
User's Manual

16. Abstract
This report contains the information needed to run a computer program for the calculation of the potential flow about arbitrary three-dimensional lifting configurations. The program contains a geometry package which greatly reduces the task of preparing the input data. Starting from a very sparse set of coordinate data, the program automatically augments and redistributes the coordinates, calculates curves of intersection between components, and redistributes coordinates in the regions adjacent to the intersection curves in a suitable manner for use in the potential-flow calculations. A brief summary of the program capabilities and options is given, as well as detailed instructions for the data input, a suggested structure for the program overlay, and the output for two test cases.

ORIGINAL PAGE IS OF POOR QUALITY

17. Key Words (Suggested by Author(s))
Aerodynamics
Computer Program
Geometry Preparation
Three-Dimensional Flow

18. Distribution Statement
Unclassified – Unlimited

19. Security Classif. (of this report)
Unclassified

20. Security Classif. (of this page)
Unclassified

21. No. of Pages
66

22. Price*
$5.25

*For sale by the National Technical Information Service, Springfield, Virginia 22161