D.6 VLMpc

This manual describes the input for the pc version of John Lamar's vortex lattice program. This program is identical to the program given in reference 2. An advanced version described in reference 4 is also available. The input data sets differ slightly between the two versions.

The code is called **VLMpcv2.f** on the disk, and has been modified for WATFOR. This means that the output field length is limited to eighty columns. In WATFOR you may also need to invoke the NOCHECK option to prevent the program from halting because of undefined variables. The code is provided with two OPEN statements near the beginning of the main program:

```
OPEN(5,file=infile, status=old)
OPEN(6,file=outfil, status=new)
```

such that the input data is defined on the file infile, and the output is placed in file outfil. The user is prompted for the names of these files at the start of execution. Users should customize the code to fit their preferences. The disk also contains a sample input file, YF23.IN, and a sample output file, YF23.OUT.

The theory is described in references 1, 2 and 3, and the user's manual provided here is basically the instructions from references 1 and 2, with minor corrections and clarifications. Reference 4 describes the advanced version, VLM4.997.

References:

1. Margason, R.J., and Lamar, J.E., "Vortex-Lattice FORTRAN Program for Estimating Subsonic Aerodynamic Characteristics of Complex Planforms," NASA TN D-6142, Feb., 1971.
2. Lamar, J.E., and Gloss, B. B. "Subsonic Aerodynamic Characteristics of Interacting Lifting Surfaces with Separated Flow around Sharp Edges Predicted by a Vortex-Lattice Method," NASA TN D-7921, Sept., 1975.
3. Lamar, J.E., and Frink, N.T., "Experimental and Analytic Study of the Longitudinal Aerodynamic Characteristics of Analytically and Empirically Designed Strake-Wing Configurations at Subcritical Speeds, " NASA TP-1803, June 1981.
4. Lamar, J.E., and Herbert, H.E., "Production Version of the Extended NASA-Langley Vortex Lattice FORTRAN Computer Code," - Vol. I - User's Guide, NASA TM 83303, April 1982.

VLMpc User's Guide- (from references 1, 2, and 4)

This manual contains the output details for the pc version of the NASA-Langley Vortex Lattice Computer Program described in reference 2. The NASA - Langley Vortex Lattice FORTRAN Program (VLMpc) is designed to estimate the subsonic aerodynamic characteristics of up to two complex planforms. The concepts embodied in this program are mostly detailed in references 1 and 2.

MODELING THE CONFIGURATION

The configuration can be modeled with up to two planforms, all of which must extend to the plane of symmetry (Y = 0.0). The fuselage is represented by its planar projection; experience to date indicates that this produces acceptable global forces and moments for most wing-body-tail configurations.

Winglets can be modeled, but the dihedral angle must be less than 90.0 degrees and greater than -90.0 degrees. Both upper (positive dihedral) and lower (negative dihedral) winglets can be accounted for in this code. The program uses as its solution surface the chord plane which may be inclined due to dihedral. Moreover, the only out of "X-Y plane" displacement specifically allowed for is dihedral. Local camber and twist is assumed to be small and can be represented by its slope projection to the local solution surface. The wind and body axes are assumed to be coincidental in the code.

RUNNING THE PROGRAM

INPUT DATA SETUP

The input data to VLM is organized into two distinct groups - group 1 defines the reference planform(s), and group 2 defines the details for the particular solution. An example input follows the description of the input and output. The individual details of the items in the deck layout are given in the following sections.

GROUP 1 DATA

This group of data defines the planform(s) projected into the X-Y plane, with all the coordinates being given for the left half of the configuration (negative y values!). The axis system is shown in Figure 1. The Y = 0 intercept coincides with the plane of symmetry and is positive to the right of this plane. The X = 0 intercept is taken to occur along the symmetry plane of the configuration; X is positive pointing into the wind.

Important tips for modeling configurations:

Good results require that a few common rules of thumb be used in selecting the planform break points. The number of line segments should be minimized. Breakpoints should line up streamwise on front and rear portions of each planform, and should line up between planforms. Streamwise tips should be used, and small spanwise distances should be avoided by making edges streamwise if they are actually very highly swept.

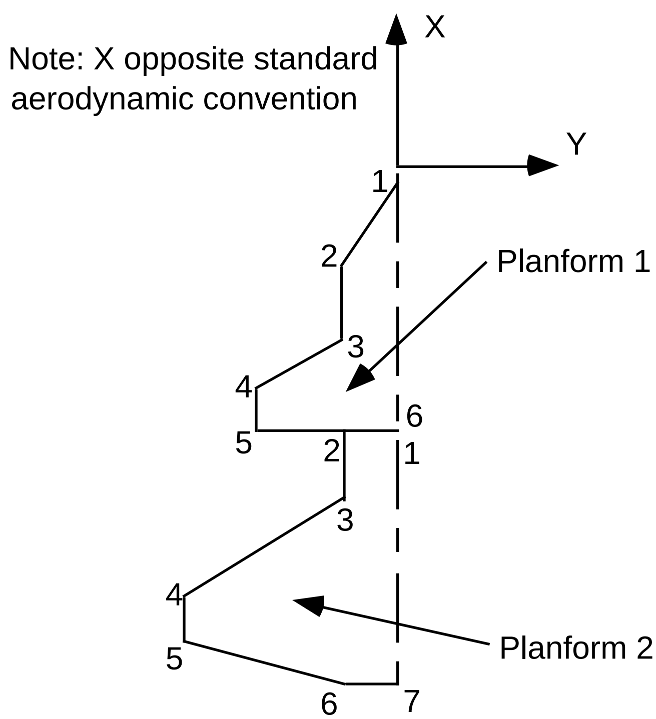

Figure 1. Definition of axis system for VLMpc.

It is important to note that each planform can only go out to a maximum *y* value once, and then return to the centerline. The program assumes that each planform is actuually a wing. Most numerical input for the group 1 data uses an 8F10.6 format . The input is as follows:

0. (Cols. 1-80) Title Card
1. (Cols. 1-10) PLAN - Number of planforms for this configuration; PLAN can assume values of 1.0, or 2.0.
2. (Cols.11-20) TOTAL - Number of sets of group 2 data specified for this configuration.
3. (Cols.21-30) CREF - Reference chord of the configuration. This chord is used only to nondimensionalize the pitching-moment terms and must be greater than zero.
4. (Cols.31-40) SREF - Reference area; this is used only to nondimensionalize the computed output data such as lift and pitching moment and must always be greater than zero.
5. (Col. 41-50) CG - Center of gravity location with respect to the origin of the coordinate system. All moment computations are referenced to this location.

The data required to define the planform(s) is provided in the next set of group 1 cards as follows (the number of line segments is equal to the number of points minus one):

1. (Cols.1-10) AAN - Number of line segments used to define the left half of the planform (does not include the innermost streamwise). A maximum of 24 line segments may be used per planform, and each planform must extend to the plane of symmetry. *ANN is the number of defining point minus one*.
2. (Cols.11-20) XS - X location of the pivot; use 0.0 for a fixed planform.
3. (Cols.21-30) YS - Y location of the pivot; use 0.0 for a fixed planform.
4. (Cols.31-40) RTCDHT - Vertical distance of the particular planform being read in with respect to the reference planform root chord height; use 0. for the reference planform.

The rest of this set of data describes the breakpoints used to define the AAN line segments on this planform. The format is 4F9.4. There are (AAN+1) breakpoints and all data subsequently described are required on all except the last card of this set; the last card uses only the first two variables in the following list:

1. (Cols.1-9) XREG(I) - X location of the ith breakpoint. The first breakpoint is located at the most inboard location of the leading edge for the left-hand side of this planform. The other breakpoints are numbered around the planform perimeter in increasing order for each intersection of lines in a counterclockwise direction.
2. (Cols.10-18) YREG(I) - Y location of the ith breakpoint. Once the absolute value of Y starts to decrease, it cannot be increased.
3. (Cols.19-27) DIH(I) - Dihedral angle (degrees) in the Y-Z plane of the line from breakpoint of i to i+1, positive upward. Note that along a streamwise line, the dihedral angle is not defined, so use 0.0. for these lines. Note the sign of the dihedral angle is the same along the leading and trailing edges.
4. (Cols.28-36) AMCD - The move code; this number indicates whether the line s is on the movable panel of a variable-sweep wing. Use 1.0 for a fixed line (defaults to 1.0 if not set), or 2.0 for a movable line.

GROUP 2 DATA

There are four sections of group 2 data. Each section may be required or optional, depending on the previous input, and each may have one or more input cards (lines of input). Each section is described individually. Care must be taken to make sure the data is in the proper column.

Section one data (always required).

[1 Card - Format (8F5.2, F10.4,F5.1,F10.4,F5.1)]

1. (Cols.1-5) CONFIG - An arbitrary configuration designation of up to 4 digits.
2. (Cols.6-10) SCW - The number of chordwise horseshoe vortices to be used at a spanwise station for each planform. The maximum value for this variable is 20. If varying values of chordwise horseshoe vortices are desired due to either multiple planforms or large discontinuities in chord across the span, the user can input a value of 0. that will cause the program to expect user-supplied data at this point in the input stream. The data are in the form of a table that contains the number of chordwise horseshoe vortices from the tip to root, and is called TBLSCW(I). This SCW=0. option can only be used for planforms without dihedral and for coplanar configurations.
3. (Cols.11-15) VIC - The nominal number of spanwise stations at which chordwise horseshoe vortices will be located. This variable must not cause more than 50 spanwise stations to be used by the program in describing the left half of the configuration. In addition, the product of the stations spanwise and SCW cannot exceed 200. If SCW is 0., then the sum of the values in TBLSCW(I) cannot exceed 200. The use of variable VIC is discussed in references 1 and 2. VIC should always be greater than, or equal to, 10. so that the near-field drag or vortex flow forces on cambered configurations can be properly computed.
4. (Cols.16-20) MACH - Mach number; use a value other than 0.0 only if the Prandtl-Glauert compressibility correction factor is to be applied. The value used should be less than that of the critical Mach number.
5. (Cols.21-25) CLDES - Desired lift coefficient, $C_{L,d}$. The number specified here is used to obtain the span load distribution at a particular lift coefficient. If the drag polar is required over a CL range from -0.1 to 1.0, use CLDES = 11.
6. (Cols.26-30) PTEST - C_{l_p} indicator; if the damping-in-roll parameter is desired, use 1.0 for this quantity. Except for the Delta C_p and C_{l_p}, all other aerodynamic data will be omitted. Use a 0. if C_{l_p} is not required. The definition is the standard one, as in Etkin, with units of radians per second:

$$C_{l_p} = \frac{\partial C_l}{\partial\left(\dfrac{pb}{2U_\infty}\right)}$$

7. (Cols.31-35) QTEST -C_{Lq} and C_{mq} indicator; if these stability derivatives are desired, use a 1.0 for this quantity. Except for Delta C_p, C_{Lq}, and C_{mq}, all other aerodynamic data will be omitted. It should be noted that both PTEST and QTEST cannot be set equal to 1. simultaneously for a particular configuration. Use 0. if C_{Lq} and C_{mq} are not required. The definition is the standard one, as in Etkin:

$$C_{m_q} = \frac{\partial C_m}{\partial\left(\frac{q c_{ref}}{2U_\infty}\right)}, \qquad C_{L_q} = \frac{\partial C_L}{\partial\left(\frac{q c_{ref}}{2U_\infty}\right)}.$$

8. (Cols. 36-40) TWIST(1) - Twist code for the first planform. If this planform has no twist and/or camber, use a value of 0.; otherwise, specify a value of 1.
9. (Cols.41-50) SA(1) - Variable sweep angle for the first planform. Specify the leading edge sweep-angle (in degrees) for the first movable line adjacent to the fixed portion of the planform. For a fixed planform, this quantity may be omitted.
10. (Cols.51-55) TWIST(2) - same, for the second planform.
11. (Cols.56-65) SA(2) - same, for the second planform.
12. (Cols.66-70) ATPCOD - Set to 0., it will cause only linear aerodynamic results to be printed out. Set to 1., this will cause the program to print out the contributions to the lift, drag and moment from the separated flow around the leading/side edges.

Section two data is required when ATPCOD=1.* This section sets up the limits of integration used in the computations of the wing leading-edge and side-edge suction values. Normally these limits would be the wing root and the wing tip. However, other values could be used. Note: if section four data is used, this data may come after section four data - experiment if you try to use this combination.

[1 Card - Format (4F10.6)]

Card 1:

1. (Cols.1-10) YINNER(1) - Represents the Y inner for the first planform.
2. (Cols.11-20) YOUTER(1) - Represents the Y outer for the first planform.
3. (Cols.21-30) YINNER(2) - Represents the Y inner for the second planform.
4 (Cols. 31-40), YOUTER(2) - Represents the Y outer for the second planform.

Section three data is required when SCW=0. This section determines the number of span stations for each planform, and the number of chordwise control points along each span station. This option is rarely used.

[Multiple card sets per planform - Format (F5.1,n(/16F5.1))]

Card 1:

(Cols.1-5) STA - Number of spanwise stations of horseshoe vortices on the left half of the planform. This variable sets the number of TBLSCW values read in for that planform.

* Watch out about the order of input if both twist and vortex lift are used. Some students have reported problems with this. Actually, this is a somewhat rare calculation. Both twist and vortex lift should be run separately to the user’s satisfaction before they are run together.

Cards 2-n:

(Cols. 1-5,6-10,etc) TBLSCW(I) - Number of horseshoe vortices at each spanwise station beginning at the station nearest the tip of the planform and proceeding toward the station nearest the root.

These sets of STA and TBLSCW(I) cards are repeated for each planform. The sum of all the STA values cannot exceed 100.

Section four data is required for any planform having a nonzero value for TWIST(I). This section determines the mean camber line slopes or angles of attack across the planform. Be careful here. Experience has shown that students find the proper input of this data to be very tricky.

[Multiple cards per planform - Format (8F10.6,n(8F10.6))]

(Cols.1-10,11-20,etc.) ALP - Local streamwise angles of attack, eg. camber or flap deflection, in radians. These are the values at the control point for each horseshoe vortex on the planform when the innermost streamwise edge of the reference planform has an angle of attack of 0. degrees. The volume of this data will usually require several input cards. For the first value on the first card, use the local angle of attack for the horseshoe vortex nearest the first planform leading edge at the tip; for the second value, use the angle of attack for the horseshoe vortex immediately behind in the chordwise direction. Continue in the same manner for the rest of the horseshoe vortices at the tip. *Begin a new card for the next inboard station* and input the data in the same chordwise manner. Repeat for all successive inboard spanwise stations on that planform. For each planform with twist/camber, start the data on a new card and specify the data from the tip and proceed chordwise and then inboard, as detailed above.

OUTPUT DATA

The printed results of this computer program appear in two parts: geometry data and aerodynamic data.

GEOMETRY DATA

The geometry data are described in the order that they are found on the printout.

The first group of the data describes the basic configuration: it states the numbers of lines used to describe each planform, the root chord height, pivot position, and then lists the breakpoints, sweep and dihedral angles, and move codes. These data are basically a listing of input data except that the sweep angle is computed from the input.

The second group of data describes the particular configuration for which the aerodynamic data are being computed. Included are the configuration designation, sweep position, a listing of the breakpoints of the planform (X,Y, and Z), the sweep and dihedral angles, and the move codes. The data are listed primarily for variable-sweep wings to provide a definition of the planform where the outer panel sweep is different from that of the reference planform. The number of horseshoe vortices are then described. In this code a maximum of 200 vortices can be used.

The third group of data presents a detailed description of the horseshoe vortices used to represent the configuration. These data are listed in two sets of five columns each describing one elemental panel of the configuration (see Figure 2) in the same order that the twist and/or camber angles of attack are to be provided.

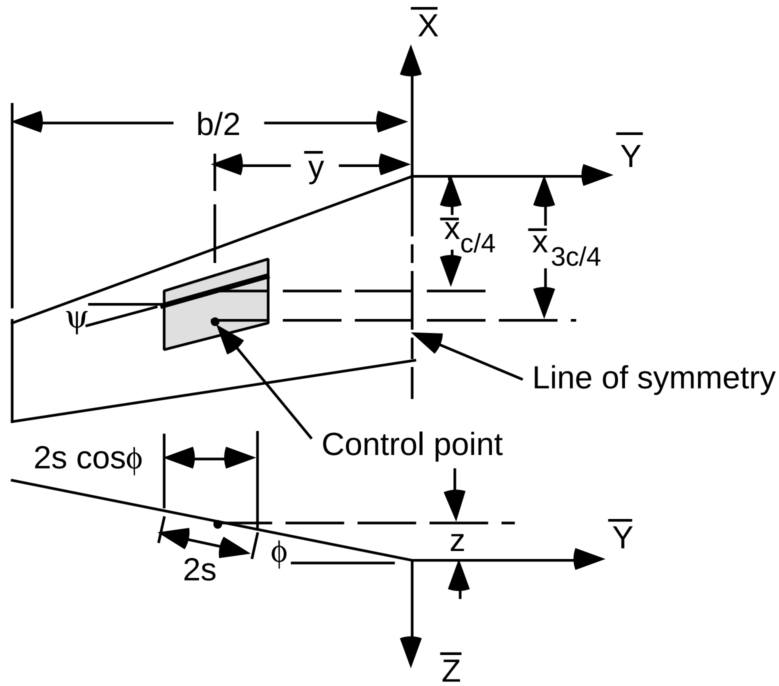

Figure 2. Nomenclature used to describe the geometry of an elemntal panel.

The following items of data are presented for each elemental panel.

For set one:

1. X C/4 - X location of quarter-chord at the horseshoe vortex midspan.

2. X 3C/4 - X location of three-quarter-chord at the horseshoe vortex midspan. This is the X location of the control point.

3. Y - Y location of the horseshoe vortex midspan.

4. Z - Z location of the horseshoe vortex midspan.

5. S - Semiwidth of horseshoe vortex.

Set two:

1. X C/4 - X location of quarter-chord at the horseshoe vortex midspan. (same as set one)

2. C/4 SWEEP ANGLE - Sweep angle of the quarter-chord of the elemental panel and horseshoe vortex.

3. DIHEDRAL ANGLE - Dihedral angle of elemental panel.

4. LOCAL ALPHA IN RADIANS - Local angle of attack in radians at control point (X @ 3C/4,Y,Z).

5. DELTA CP AT DESIRED CL - ΔC_p or Net C_p normal to the surface at dihedral for each elemental panel when the total lift is $C_{L,\mathrm{d}}$. This is located across the panel as an average. It corresponds to the incremental lift associated with the bound vortex strength of the particular panel:

$$\Delta C_p \times \Delta c = \Delta L_i, \quad \text{where} \quad \Delta L_i = \rho U_\infty \Gamma_i$$

The fourth group of data presents the following geometric results:

1. REF.CHORD - Reference chord of the configuration.
2. C AVERAGE - Average chord, cav, true configuration area divided by true span.
3. TRUE AREA - True area computed from the configuration listed in second group of geometry data.
4. REFERENCE AREA - User input reference area.
5. B/2 - Maximum semispan of all planforms listed in second group of geometry data.
6. REF. AR - Reference aspect ratio computed from the reference planform area and true span.
7. TRUE AR - True aspect ratio computed from the true planform area and true span.
8. MACH NUMBER - Mach number.

AERODYNAMIC DATA

If PTEST = 1. or QTEST = 1. on the configuration card, then either C_{l_p} or C_{L_q} and C_{m_q} are computed and printed, followed by program termination. Otherwise, the aerodynamic data are described by at least two groups of results. The first is always present, but the second depends on what is requested on the configuration card. The following items of the first group of data are given in the order that they are found on the printout. Note that CL ALPHA, CL(TWIST), CM/CL, CMO, CDI/CL**2 are based on the specified reference dimensions. Many of the items that follow are for the complete configuration.

1. DESIRED CL - Desired lift coefficient, *CL, d*, specified in Input Data for complete configuration.
2. COMPUTED ALPHA - Angle of attack at which the desired lift is developed: CL, d/(CL ALPHA) + ALPHA at CL=O.
3. CL(WB) - That portion of desired lift coefficient developed by the planform with the maximum span when multiple planforms are specified. When one planform is specified, this is the desired lift coefficient. (If two planforms have the same span, and this value is equal to the maximum, the planform used here is the latter one read in).
4. CDI AT CL(WB) - Induced drag coefficient for lift coefficient in the previous item. When two or more planforms are specified, this is the induced drag coefficient of only the planform with the maximum span. This result is based on the far-field solution.
5. CDI/(CL(WB)**2) - Induced drag parameter computed from the two previous items.

6. 1/(PI*AR REF) - Induced drag parameter for an elliptic load distribution based on reference aspect ratio.
7. CL ALPHA - Lift-curve slope per radian, and per degree.
8. CL(TWIST) - Lift coefficient due to twist and/or camber at zero angle of attack (CL,tc).
9. ALPHA AT CL=O - Angle of attack at zero lift in degrees; nonzero only when twist and/or camber is specified.
10. Y CP - Spanwise distance in fraction of semispan from root chord to center of pressure on the left wing panel.
11. CM/CL - Longitudinal stability parameter based on a moment center about the reference point. This is the negative of the static margin:

$$CM / CL_{Lamar} = \frac{\partial C_m}{\partial C_L}$$

and the value of C_{m_α} can be found from $C_{m_\alpha} = \left(\frac{\partial C_m}{\partial C_L}\right)\left(\frac{\partial C_L}{\partial \alpha}\right)$.

12. CMO - Pitching-moment coefficient at CL=O.

For each spanwise station, the following data are presented; from the left tip towards the root:

1. 2Y/B - Location of midpoint of each spanwise station in fraction of wing semispan.

The next two columns of data describe the additional (or angle of attack) wing loading at a lift coefficient of 1. (based on the total lift achieved and the true configuration area). The third column is the chord ratio result, and the other columns detail specific kinds of span loadings and local centers of pressure for the configuration.

2. SL COEF - span-load coefficient, $c_l c/C_L c_{av}$.
3. CL RATIO - Ratio of local lift to total lift, c_l/C_L.
4. C RATIO - Ratio of local chord to average chord, c/c_{av}.
5. LOAD DUE TO TWIST - Distribution of span-load coefficient due to twist and camber at 0° angle of attack for the configuration.
6. ADD. LOAD AT CL= - Distribution of additional span-load coefficient required to produce zero lift when combined with lift due to twist and camber. This distribution is computed at $C_{L,tc}$.
7. BASIC LOAD AT CL=0 - Basic span-load-coefficient distribution at zero lift coefficient. These data are the difference of the previous two columns of data.
8. SPAN LOAD AT DESIRED CL - Distribution of the combination of the basic span-load and additional span-load coefficients at the desired C_L.
9. AT CL DES - X LOCATION OF LOCAL CENT PR - The X location of the local center of pressure for the resulting span load at $C_{L,d}$ as a function of 2Y/b.

The other options available as group two aerodynamic data are accessed based on the values of CLDES and ATPCOD. For instance, with CLDES=11., and ATPCOD=0.0, the program will produce a drag polar, CDI at CL(WB) versus CL(WB), based on the linear aerodynamics in the middle of the first part of group one aerodynamic data. This, and other combinations, are given in the table below, along with their purposes:

Next, the induced drag, leading-edge thrust, and suction coefficient characteristics at each spanwise station are computed from a near-field solution for the total loading at CL,d and presented.

1. 2y/b - the spanwise location for these results
2. L.E. SWEEP ANGLE - Leading-edge sweep angle in degrees.
3. CDII C/2B - Nondimensional section induced-drag-coefficient term.
4. CT C/2B - Nondimensional section leading-edge thrust-coefficient term.
5. CS C/2B - Nondimensional section leading-edge suction in coefficient term.

Next, the total coefficients are given:

CDII/CL**2 -	Total drag coefficient over (CL,d)**2.
CT -	Total leading-edge thrust coefficient.
CS -	Total leading-edge suction coefficient.

Additional printout is produced for vortex flows. In particular, Kp and Kv values, and respective centroids in both chordwise and spanwise directions, and the associated limits of integration for the leading- edge and side-edge values of Kv. (The item entitled "Sum of the positive side edge contributions" which appears here on the printout is indicative of the contribution to the side-edge forces for that particular planform which were oppositely-signed to those that contributed in a manner to increase Kv,se. The value of Kv,se does contain these positive contributions provided the sweep angle is positive. They should not be, and therefore are not added in for the planform with a swept forward leading edge). Furthermore, aerodynamic performance values for each planform and for the entire configuration will be listed over an angle of attack range by the use of the Polhamus Suction Analogy. The headings are explained below: *See the references for detailed explanations of these terms.*

KP	Kp
KVLE	Kv,le
KV SE	Kv,se
ALPHA	α
CN	CN,tot
CLP	CL,p
CLVLE	CL,vle
CLVSE	Kv,se $\lvert\sin\alpha\rvert$ $\lvert\sin\alpha\rvert$ $\cos\alpha$
CMP	pitching-moment coefficient due to CL,p
CMVLE	pitching-moment coefficient due to CL,vle
CMVSE	pitching-moment coefficient due to CL,vse
CM	total pitching moment
CD	CL,tot x $\tan\alpha$
CL**2/(PI*AR)	$(CL,tot)^2$ /(Pi*(Aspect Ratio))

SAMPLE INPUT, - as developed by Bob Narducci to investigate the YF-23.

```
YF-23 Flaps Down
2.        1.        26.8917   950.0     0.0
6.0       0.        0.        0.
 37.80    0.0       0.0       1.
 22.73    -4.35     0.        1.
 14.69    -4.35     0.        1.
 00.11    -21.75    0.        1.
-03.24    -21.75    0.        1.
-14.96    -7.86     0.        1.
-14.96    0.
8.        0.        0.        0.
-14.96    0.        0.        1.
-14.96    -7.86     43.       1.
-22.00    -16.90    0.        1.
-24.51    -16.90    43.       1.
-29.50    -10.71    43.       1.
-27.02    -7.86     0.        1.
-28.36    -6.86     0.        1.
-25.68    -3.85     0.        1.
-29.20    0.
23.  6.   13.  .30  .53  0.   0.   0.   0.        1.   0.        0.
.1745     .1745     .1745     .1745     .1745     .1745
.1745     .1745     .1745     .1745     .1745     .1745
.1745     .1745     .1745     .1745     .1745     .1745
.1745     .1745     .1745     .1745     .1745     .1745
.1745     .1745     .1745     .1745     .1745     .1745
.1745     .1745     .1745     .1745     .1745     .1745
.1745     .1745     .1745     .1745     .1745     .1745
.0000     .0000     .0000     .0000     .0000     .0000
.0000     .0000     .0000     .0000     .0000     .0000
.0000     .0000     .0000     .0000     .0000     .0000
.0000     .0000     .0000     .0000     .0000     .0000
.0000     .0000     .0000     .0000     .0000     .0000
.0000     .0000     .0000     .0000     .0000     .0000
```

SAMPLE OUTPUT: The output is lengthy, but included here to help students check their codes.

This is what shows up on the screen:

```
      enter name of data set: yf23.in
      enter name of output file: yf23out.manual

        all output is routed to disk file
        computing may take quite some time


      STOP
```

The output file yf23out.manual is:

```
               vortex lattice aerodynamic computation program
              nasa-lrc no. a2794 by j.e. lamar and b.b. gloss

                modified for watfor77 with 72 column output

YF-23 Flaps Down

                              geometry data

                  first  reference planform has  6 curves

   center of gravity =   0.00000
   root chord height =   0.00000
   variable sweep pivot position    x(s) =   0.00000   y(s) =   0.00000

                break points for the reference planform

  point        x           y          sweep      dihedral    move
              ref         ref         angle       angle      code

      1    37.80000     0.00000    73.89906     0.00000       1
      2    22.73000    -4.35000    90.00000     0.00000       1
      3    14.69000    -4.35000    39.96069     0.00000       1
      4     0.11000   -21.75000    90.00000     0.00000       1
      5    -3.24000   -21.75000   -40.15675     0.00000       1
      6   -14.96000    -7.86000     0.00000     0.00000       1
      7   -14.96000     0.00000

                 second  reference planform has  8 curves

   center of gravity =   0.00000
   root chord height =   0.00000
   variable sweep pivot position    x(s) =   0.00000   y(s) =   0.00000

                break points for the reference planform

  point        x           y          sweep      dihedral    move
              ref         ref         angle       angle      code

      1   -14.96000     0.00000     0.00000     0.00000       1
      2   -14.96000    -7.86000    37.91007    43.00000       1
      3   -22.00000   -16.90000    90.00000     0.00000       1
      4   -24.51000   -16.90000   -38.87364    43.00000       1
      5   -29.50000   -10.71000    41.02898    43.00000       1
      6   -27.02000    -7.86000   -53.26718     0.00000       1
      7   -28.36000    -6.86000    41.68077     0.00000       1
      8   -25.68000    -3.85000   -42.43623     0.00000       1
      9   -29.20000     0.00000
1
                 configuration no.     23.


          curve  1 is swept    73.89906 degrees on planform  1

          curve  1 is swept     0.00000 degrees on planform  2
```

break points for this configuration

point	x	y	z	sweep angle	dihedral angle	move code
1	37.80000	0.00000	0.00000	73.89906	0.00000	1
2	24.46218	-3.85000	0.00000	73.89906	0.00000	1
3	22.73000	-4.35000	0.00000	90.00000	0.00000	1
4	14.69000	-4.35000	0.00000	39.96069	0.00000	1
5	12.58679	-6.86000	0.00000	39.96069	0.00000	1
6	9.36076	-10.71000	0.00000	39.96069	0.00000	1
7	4.17397	-16.90000	0.00000	39.96069	0.00000	1
8	0.11000	-21.75000	0.00000	90.00000	0.00000	1
9	-3.24000	-21.75000	0.00000	-40.15676	0.00000	1
10	-14.96000	-7.86000	0.00000	0.00000	0.00000	1
11	-14.96000	0.00000	0.00000			

second planform breakpoints

1	-14.96000	0.00000	0.00000	0.00000	0.00000	1
2	-14.96000	-4.35000	0.00000	0.00000	0.00000	1
3	-14.96000	-7.86000	0.00000	37.91007	43.00000	1
4	-22.00000	-16.90000	-8.42994	90.00000	0.00000	1
5	-24.51000	-16.90000	-8.42994	-38.87364	43.00000	1
6	-29.50000	-10.71000	-2.65767	41.02898	43.00000	1
7	-27.02000	-7.86000	0.00000	-53.26718	0.00000	1
8	-28.36000	-6.86000	0.00000	41.68077	0.00000	1
9	-25.68000	-3.85000	0.00000	-42.43624	0.00000	1
10	-29.20000	0.00000	0.00000			

168 horseshoe vortices used on the left half of the configuration

planform	total	spanwise
1	90	15
2	78	13

6. horseshoe vortices in each chordwise row

1

aerodynamic data

configuration no. 23.

static longitudinal aerodynamic coefficients are computed

panel no.	x c/4	x 3c/4	y	z	s
1	0.61276	0.21636	-20.91346	0.00000	0.83654
2	-0.18004	-0.57644	-20.91346	0.00000	0.83654
3	-0.97284	-1.36924	-20.91346	0.00000	0.83654
4	-1.76564	-2.16204	-20.91346	0.00000	0.83654
5	-2.55845	-2.95485	-20.91346	0.00000	0.83654
6	-3.35125	-3.74765	-20.91346	0.00000	0.83654
7	1.89745	1.26658	-19.24039	0.00000	0.83654

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   8     0.63571     0.00484   -19.24039     0.00000     0.83654
   9    -0.62603    -1.25690   -19.24039     0.00000     0.83654
  10    -1.88776    -2.51863   -19.24039     0.00000     0.83654
  11    -3.14950    -3.78037   -19.24039     0.00000     0.83654
  12    -4.41124    -5.04211   -19.24039     0.00000     0.83654
  13     3.11717     2.26369   -17.65192     0.00000     0.75192
  14     1.41021     0.55673   -17.65192     0.00000     0.75192
  15    -0.29675    -1.15023   -17.65192     0.00000     0.75192
  16    -2.00371    -2.85719   -17.65192     0.00000     0.75192
  17    -3.71067    -4.56415   -17.65192     0.00000     0.75192
  18    -5.41763    -6.27110   -17.65192     0.00000     0.75192
  19     4.33688     3.26079   -16.06346     0.00000     0.83654
  20     2.18470     1.10861   -16.06346     0.00000     0.83654
  21     0.03253    -1.04356   -16.06346     0.00000     0.83654
  22    -2.11965    -3.19574   -16.06346     0.00000     0.83654
  23    -4.27183    -5.34792   -16.06346     0.00000     0.83654
  24    -6.42401    -7.50010   -16.06346     0.00000     0.83654
  25     5.62157     4.31101   -14.39038     0.00000     0.83654
  26     3.00046     1.68990   -14.39038     0.00000     0.83654
  27     0.37934    -0.93122   -14.39038     0.00000     0.83654
  28    -2.24177    -3.55233   -14.39038     0.00000     0.83654
  29    -4.86289    -6.17345   -14.39038     0.00000     0.83654
  30    -7.48401    -8.79456   -14.39038     0.00000     0.83654
  31     6.90626     5.36123   -12.71731     0.00000     0.83654
  32     3.81621     2.27118   -12.71731     0.00000     0.83654
  33     0.72616    -0.81887   -12.71731     0.00000     0.83654
  34    -2.36390    -3.90892   -12.71731     0.00000     0.83654
  35    -5.45395    -6.99897   -12.71731     0.00000     0.83654
  36    -8.54400   -10.08903   -12.71731     0.00000     0.83654
  37     7.99810     6.25380   -11.29539     0.00000     0.58538
  38     4.50950     2.76521   -11.29539     0.00000     0.58538
  39     1.02091    -0.72339   -11.29539     0.00000     0.58538
  40    -2.46768    -4.21198   -11.29539     0.00000     0.58538
  41    -5.95628    -7.70058   -11.29539     0.00000     0.58538
  42    -9.44487   -11.18917   -11.29539     0.00000     0.58538
  43     9.08994     7.14637    -9.87346     0.00000     0.83654
  44     5.20280     3.25923    -9.87346     0.00000     0.83654
  45     1.31566    -0.62790    -9.87346     0.00000     0.83654
  46    -2.57147    -4.51504    -9.87346     0.00000     0.83654
  47    -6.45861    -8.40218    -9.87346     0.00000     0.83654
  48   -10.34575   -12.28931    -9.87346     0.00000     0.83654
  49    10.18414     8.04087    -8.44846     0.00000     0.58846
  50     5.89760     3.75432    -8.44846     0.00000     0.58846
  51     1.61105    -0.53222    -8.44846     0.00000     0.58846
  52    -2.67549    -4.81876    -8.44846     0.00000     0.58846
  53    -6.96203    -9.10530    -8.44846     0.00000     0.58846
  54   -11.24857   -13.39184    -8.44846     0.00000     0.58846
  55    11.03750     8.77685    -7.36000     0.00000     0.50000
  56     6.51620     4.25554    -7.36000     0.00000     0.50000
  57     1.99489    -0.26576    -7.36000     0.00000     0.50000
  58    -2.52641    -4.78706    -7.36000     0.00000     0.50000
  59    -7.04772    -9.30837    -7.36000     0.00000     0.50000
  60   -11.56902   -13.82967    -7.36000     0.00000     0.50000
  61    12.11076     9.75678    -6.02346     0.00000     0.83654
  62     7.40281     5.04883    -6.02346     0.00000     0.83654
  63     2.69485     0.34087    -6.02346     0.00000     0.83654
  64    -2.01311    -4.36709    -6.02346     0.00000     0.83654
  65    -6.72107    -9.07505    -6.02346     0.00000     0.83654
```

66	-11.42903	-13.78301	-6.02346	0.00000	0.83654
67	13.11855	10.67694	-4.76846	0.00000	0.41846
68	8.23532	5.79371	-4.76846	0.00000	0.41846
69	3.35210	0.91049	-4.76846	0.00000	0.41846
70	-1.53113	-3.97274	-4.76846	0.00000	0.41846
71	-6.41435	-8.85597	-4.76846	0.00000	0.41846
72	-11.29758	-13.73919	-4.76846	0.00000	0.41846
73	21.98959	18.77658	-4.10000	0.00000	0.25000
74	15.56357	12.35056	-4.10000	0.00000	0.25000
75	9.13756	5.92455	-4.10000	0.00000	0.25000
76	2.71154	-0.50147	-4.10000	0.00000	0.25000
77	-3.71447	-6.92748	-4.10000	0.00000	0.25000
78	-10.14049	-13.35350	-4.10000	0.00000	0.25000
79	25.59691	22.07023	-3.01346	0.00000	0.83654
80	18.54354	15.01685	-3.01346	0.00000	0.83654
81	11.49016	7.96347	-3.01346	0.00000	0.83654
82	4.43679	0.91010	-3.01346	0.00000	0.83654
83	-2.61659	-6.14328	-3.01346	0.00000	0.83654
84	-9.66997	-13.19666	-3.01346	0.00000	0.83654
85	31.98795	27.90552	-1.08846	0.00000	1.08846
86	23.82309	19.74066	-1.08846	0.00000	1.08846
87	15.65823	11.57580	-1.08846	0.00000	1.08846
88	7.49337	3.41094	-1.08846	0.00000	1.08846
89	-0.67149	-4.75393	-1.08846	0.00000	1.08846
90	-8.83636	-12.91879	-1.08846	0.00000	1.08846

second planform horseshoe vortex descriptions

91	-21.66854	-21.95851	-16.28819	-7.85942	0.83654
92	-22.24848	-22.53845	-16.28819	-7.85942	0.83654
93	-22.82842	-23.11839	-16.28819	-7.85942	0.83654
94	-23.40836	-23.69833	-16.28819	-7.85942	0.83654
95	-23.98830	-24.27827	-16.28819	-7.85942	0.83654
96	-24.56824	-24.85822	-16.28819	-7.85942	0.83654
97	-20.79644	-21.24802	-15.06458	-6.71838	0.83654
98	-21.69960	-22.15118	-15.06458	-6.71838	0.83654
99	-22.60276	-23.05434	-15.06458	-6.71838	0.83654
100	-23.50591	-23.95749	-15.06458	-6.71838	0.83654
101	-24.40907	-24.86065	-15.06458	-6.71838	0.83654
102	-25.31223	-25.76381	-15.06458	-6.71838	0.83654
103	-19.92434	-20.53753	-13.84097	-5.57735	0.83654
104	-21.15072	-21.76390	-13.84097	-5.57735	0.83654
105	-22.37709	-22.99028	-13.84097	-5.57735	0.83654
106	-23.60347	-24.21665	-13.84097	-5.57735	0.83654
107	-24.82984	-25.44303	-13.84097	-5.57735	0.83654
108	-26.05622	-26.66940	-13.84097	-5.57735	0.83654
109	-19.05225	-19.82704	-12.61736	-4.43631	0.83654
110	-20.60184	-21.37664	-12.61736	-4.43631	0.83654
111	-22.15143	-22.92623	-12.61736	-4.43631	0.83654
112	-23.70102	-24.47582	-12.61736	-4.43631	0.83654
113	-25.25062	-26.02541	-12.61736	-4.43631	0.83654
114	-26.80021	-27.57500	-12.61736	-4.43631	0.83654
115	-18.15451	-19.09567	-11.35778	-3.26173	0.88572
116	-20.03682	-20.97798	-11.35778	-3.26173	0.88572
117	-21.91913	-22.86029	-11.35778	-3.26173	0.88572
118	-23.80145	-24.74260	-11.35778	-3.26173	0.88572
119	-25.68376	-26.62491	-11.35778	-3.26173	0.88572
120	-27.56607	-28.50722	-11.35778	-3.26173	0.88572

121	-17.21404	-18.23609	-10.09819	-2.08715	0.83654
122	-19.25814	-20.28019	-10.09819	-2.08715	0.83654
123	-21.30224	-22.32430	-10.09819	-2.08715	0.83654
124	-23.34634	-24.36839	-10.09819	-2.08715	0.83654
125	-25.39045	-26.41250	-10.09819	-2.08715	0.83654
126	-27.43455	-28.45660	-10.09819	-2.08715	0.83654
127	-16.09888	-17.11008	-8.67319	-0.75832	1.11190
128	-18.12127	-19.13247	-8.67319	-0.75832	1.11190
129	-20.14366	-21.15486	-8.67319	-0.75832	1.11190
130	-22.16605	-23.17725	-8.67319	-0.75832	1.11190
131	-24.18844	-25.19963	-8.67319	-0.75832	1.11190
132	-26.21083	-27.22202	-8.67319	-0.75832	1.11190
133	-15.49042	-16.55125	-7.36000	0.00000	0.50000
134	-17.61208	-18.67292	-7.36000	0.00000	0.50000
135	-19.73375	-20.79458	-7.36000	0.00000	0.50000
136	-21.85542	-22.91625	-7.36000	0.00000	0.50000
137	-23.97708	-25.03792	-7.36000	0.00000	0.50000
138	-26.09875	-27.15958	-7.36000	0.00000	0.50000
139	-15.48730	-16.54190	-6.02346	0.00000	0.83654
140	-17.59650	-18.65109	-6.02346	0.00000	0.83654
141	-19.70569	-20.76029	-6.02346	0.00000	0.83654
142	-21.81489	-22.86949	-6.02346	0.00000	0.83654
143	-23.92408	-24.97868	-6.02346	0.00000	0.83654
144	-26.03328	-27.08788	-6.02346	0.00000	0.83654
145	-15.44074	-16.40222	-4.76846	0.00000	0.41846
146	-17.36370	-18.32518	-4.76846	0.00000	0.41846
147	-19.28666	-20.24814	-4.76846	0.00000	0.41846
148	-21.20962	-22.17110	-4.76846	0.00000	0.41846
149	-23.13258	-24.09406	-4.76846	0.00000	0.41846
150	-25.05555	-26.01703	-4.76846	0.00000	0.41846
151	-15.41594	-16.32782	-4.10000	0.00000	0.25000
152	-17.23971	-18.15159	-4.10000	0.00000	0.25000
153	-19.06347	-19.97536	-4.10000	0.00000	0.25000
154	-20.88724	-21.79912	-4.10000	0.00000	0.25000
155	-22.71100	-23.62289	-4.10000	0.00000	0.25000
156	-24.53477	-25.44665	-4.10000	0.00000	0.25000
157	-15.43854	-16.39561	-3.01346	0.00000	0.83654
158	-17.35267	-18.30974	-3.01346	0.00000	0.83654
159	-19.26681	-20.22388	-3.01346	0.00000	0.83654
160	-21.18095	-22.13802	-3.01346	0.00000	0.83654
161	-23.09509	-24.05216	-3.01346	0.00000	0.83654
162	-25.00923	-25.96630	-3.01346	0.00000	0.83654
163	-15.51187	-16.61560	-1.08846	0.00000	1.08846
164	-17.71934	-18.82308	-1.08846	0.00000	1.08846
165	-19.92681	-21.03055	-1.08846	0.00000	1.08846
166	-22.13429	-23.23802	-1.08846	0.00000	1.08846
167	-24.34176	-25.44550	-1.08846	0.00000	1.08846
168	-26.54923	-27.65297	-1.08846	0.00000	1.08846

panel no.	x	c/4 sweep angle	dihedral angle	local alpha in rad	delta cp at cl=
1	0.61276	37.51921	0.00000	0.00000	1.93466
2	-0.18004	25.99276	0.00000	0.00000	0.80132
3	-0.97284	11.71110	0.00000	0.00000	0.44417
4	-1.76564	-4.17472	0.00000	0.00000	0.26877
5	-2.55845	-19.45708	0.00000	0.00000	0.16716

6	-3.35125	-32.35670	0.00000	0.00000	0.09160
7	1.89745	37.51921	0.00000	0.00000	1.76990
8	0.63571	25.99275	0.00000	0.00000	0.76368
9	-0.62603	11.71110	0.00000	0.00000	0.45451
10	-1.88776	-4.17472	0.00000	0.00000	0.28471
11	-3.14950	-19.45708	0.00000	0.00000	0.17716
12	-4.41124	-32.35670	0.00000	0.00000	0.09637
13	3.11717	37.51921	0.00000	0.00000	1.61448
14	1.41021	25.99276	0.00000	0.00000	0.70163
15	-0.29675	11.71110	0.00000	0.00000	0.42928
16	-2.00371	-4.17472	0.00000	0.00000	0.27496
17	-3.71067	-19.45708	0.00000	0.00000	0.17320
18	-5.41763	-32.35670	0.00000	0.00000	0.09524
19	4.33688	37.51921	0.00000	0.00000	1.47893
20	2.18470	25.99276	0.00000	0.00000	0.65076
21	0.03253	11.71110	0.00000	0.00000	0.40415
22	-2.11965	-4.17472	0.00000	0.00000	0.26327
23	-4.27183	-19.45708	0.00000	0.00000	0.16857
24	-6.42401	-32.35670	0.00000	0.00000	0.09444
25	5.62157	37.51921	0.00000	0.00000	1.35651
26	3.00046	25.99275	0.00000	0.00000	0.60063
27	0.37934	11.71110	0.00000	0.00000	0.37829
28	-2.24177	-4.17472	0.00000	0.00000	0.25096
29	-4.86289	-19.45708	0.00000	0.00000	0.16475
30	-7.48401	-32.35670	0.00000	0.00000	0.09603
31	6.90626	37.51921	0.00000	0.00000	1.25084
32	3.81621	25.99275	0.00000	0.00000	0.55670
33	0.72616	11.71110	0.00000	0.00000	0.35540
34	-2.36390	-4.17472	0.00000	0.00000	0.24065
35	-5.45395	-19.45708	0.00000	0.00000	0.16334
36	-8.54400	-32.35670	0.00000	0.00000	0.10177
37	7.99810	37.51921	0.00000	0.00000	1.17259
38	4.50950	25.99275	0.00000	0.00000	0.52388
39	1.02091	11.71110	0.00000	0.00000	0.33913
40	-2.46768	-4.17472	0.00000	0.00000	0.23444
41	-5.95628	-19.45708	0.00000	0.00000	0.16514
42	-9.44487	-32.35670	0.00000	0.00000	0.11344
43	9.08994	37.51922	0.00000	0.00000	1.10114
44	5.20280	25.99276	0.00000	0.00000	0.49372
45	1.31566	11.71110	0.00000	0.00000	0.32473
46	-2.57147	-4.17472	0.00000	0.00000	0.22932
47	-6.45861	-19.45708	0.00000	0.00000	0.16777
48	-10.34575	-32.35669	0.00000	0.00000	0.13011
49	10.18414	37.51921	0.00000	0.00000	1.03049
50	5.89760	25.99276	0.00000	0.00000	0.46250
51	1.61105	11.71110	0.00000	0.00000	0.31155
52	-2.67549	-4.17472	0.00000	0.00000	0.22487
53	-6.96203	-19.45708	0.00000	0.00000	0.17004
54	-11.24857	-32.35670	0.00000	0.00000	0.15708
55	11.03750	38.76506	0.00000	0.00000	0.99032
56	6.51620	33.55879	0.00000	0.00000	0.44531
57	1.99489	27.64136	0.00000	0.00000	0.30956
58	-2.52641	21.00937	0.00000	0.00000	0.22725
59	-7.04772	13.73368	0.00000	0.00000	0.17350
60	-11.56902	5.97943	0.00000	0.00000	0.18265
61	12.11076	38.76506	0.00000	0.00000	0.95236
62	7.40281	33.55879	0.00000	0.00000	0.43009
63	2.69485	27.64136	0.00000	0.00000	0.31413

64	-2.01311	21.00937	0.00000	0.00000	0.23344
65	-6.72107	13.73368	0.00000	0.00000	0.17482
66	-11.42903	5.97943	0.00000	0.00000	0.20034
67	13.11855	38.76506	0.00000	0.00000	0.88945
68	8.23532	33.55879	0.00000	0.00000	0.42661
69	3.35210	27.64136	0.00000	0.00000	0.33185
70	-1.53113	21.00937	0.00000	0.00000	0.23456
71	-6.41435	13.73368	0.00000	0.00000	0.15684
72	-11.29758	5.97943	0.00000	0.00000	0.21695
73	21.98959	73.23754	0.00000	0.00000	0.21302
74	15.56357	69.96743	0.00000	0.00000	0.38221
75	9.13756	65.21040	0.00000	0.00000	0.38601
76	2.71154	57.79776	0.00000	0.00000	0.29039
77	-3.71447	45.29755	0.00000	0.00000	0.25414
78	-10.14049	23.41484	0.00000	0.00000	0.19888
79	25.59691	73.23754	0.00000	0.00000	0.28844
80	18.54354	69.96743	0.00000	0.00000	0.19152
81	11.49016	65.21040	0.00000	0.00000	0.36631
82	4.43679	57.79776	0.00000	0.00000	0.30348
83	-2.61659	45.29755	0.00000	0.00000	0.23120
84	-9.66997	23.41484	0.00000	0.00000	0.20109
85	31.98795	73.23754	0.00000	0.00000	0.21732
86	23.82309	69.96743	0.00000	0.00000	0.16858
87	15.65823	65.21040	0.00000	0.00000	0.25630
88	7.49337	57.79776	0.00000	0.00000	0.30933
89	-0.67149	45.29755	0.00000	0.00000	0.23234
90	-8.83636	23.41482	0.00000	0.00000	0.19074

second planform horseshoe vortex descriptions

91	-21.66854	35.47837	43.00000	0.17450	2.07234
92	-22.24848	24.15973	43.00000	0.17450	0.86344
93	-22.82842	10.44929	43.00000	0.17450	0.50181
94	-23.40836	-4.55831	43.00000	0.17450	0.31432
95	-23.98830	-18.97688	43.00000	0.17450	0.19781
96	-24.56824	-31.30072	43.00000	0.17450	0.10867
97	-20.79644	35.47836	43.00000	0.17450	1.86622
98	-21.69960	24.15975	43.00000	0.17450	0.79905
99	-22.60276	10.44927	43.00000	0.17450	0.48369
100	-23.50591	-4.55835	43.00000	0.17450	0.31020
101	-24.40907	-18.97688	43.00000	0.17450	0.19537
102	-25.31223	-31.30072	43.00000	0.17450	0.10614
103	-19.92434	35.47837	43.00000	0.17450	1.62276
104	-21.15072	24.15975	43.00000	0.17450	0.69665
105	-22.37709	10.44928	43.00000	0.17450	0.42654
106	-23.60347	-4.55832	43.00000	0.17450	0.27531
107	-24.82984	-18.97687	43.00000	0.17450	0.17295
108	-26.05622	-31.30070	43.00000	0.17450	0.09307
109	-19.05225	35.47837	43.00000	0.17450	1.39650
110	-20.60184	24.15974	43.00000	0.17450	0.60027
111	-22.15143	10.44929	43.00000	0.17450	0.36950
112	-23.70102	-4.55834	43.00000	0.17450	0.23890
113	-25.25062	-18.97689	43.00000	0.17450	0.14921
114	-26.80021	-31.30070	43.00000	0.17450	0.07915
115	-18.15451	35.47837	43.00000	0.17450	1.17860
116	-20.03682	24.15975	43.00000	0.17450	0.50846
117	-21.91913	10.44929	43.00000	0.17450	0.31541
118	-23.80145	-4.55835	43.00000	0.17450	0.20462

119	-25.68376	-18.97689	43.00000	0.17450	0.12671
120	-27.56607	-31.30071	43.00000	0.17450	0.06503
121	-17.21404	38.04567	43.00000	0.17450	1.01268
122	-19.25814	38.58307	43.00000	0.17450	0.44608
123	-21.30224	39.11254	43.00000	0.17450	0.28734
124	-23.34634	39.63417	43.00000	0.17450	0.19345
125	-25.39045	40.14806	43.00000	0.17450	0.12395
126	-27.43455	40.65429	43.00000	0.17450	0.06535
127	-16.09888	38.04567	43.00000	0.17450	0.83667
128	-18.12127	38.58307	43.00000	0.17450	0.39566
129	-20.14366	39.11254	43.00000	0.17450	0.27313
130	-22.16605	39.63417	43.00000	0.17450	0.19673
131	-24.18844	40.14806	43.00000	0.17450	0.13605
132	-26.21083	40.65429	43.00000	0.17450	0.07985
133	-15.49042	-3.19570	0.00000	0.00000	0.56637
134	-17.61208	-15.59796	0.00000	0.00000	0.42340
135	-19.73375	-26.67953	0.00000	0.00000	0.31785
136	-21.85542	-35.97340	0.00000	0.00000	0.23703
137	-23.97708	-43.50610	0.00000	0.00000	0.16547
138	-26.09875	-49.53985	0.00000	0.00000	0.09394
139	-15.48730	2.12462	0.00000	0.00000	0.38372
140	-17.59650	10.50852	0.00000	0.00000	0.33354
141	-19.70569	18.46350	0.00000	0.00000	0.27610
142	-21.81489	25.74715	0.00000	0.00000	0.21449
143	-23.92408	32.23863	0.00000	0.00000	0.15167
144	-26.03328	37.92108	0.00000	0.00000	0.08438
145	-15.44074	2.12462	0.00000	0.00000	0.34990
146	-17.36370	10.50851	0.00000	0.00000	0.29853
147	-19.28666	18.46349	0.00000	0.00000	0.25906
148	-21.20962	25.74714	0.00000	0.00000	0.21134
149	-23.13258	32.23862	0.00000	0.00000	0.15849
150	-25.05555	37.92108	0.00000	0.00000	0.09723
151	-15.41594	2.12462	0.00000	0.00000	0.35024
152	-17.23971	10.50852	0.00000	0.00000	0.28116
153	-19.06347	18.46350	0.00000	0.00000	0.24782
154	-20.88724	25.74714	0.00000	0.00000	0.20712
155	-22.71100	32.23864	0.00000	0.00000	0.16006
156	-24.53477	37.92108	0.00000	0.00000	0.10421
157	-15.43854	-2.18164	0.00000	0.00000	0.32319
158	-17.35267	-10.78430	0.00000	0.00000	0.24905
159	-19.26681	-18.92465	0.00000	0.00000	0.22019
160	-21.18095	-26.34637	0.00000	0.00000	0.18542
161	-23.09509	-32.92787	0.00000	0.00000	0.14319
162	-25.00923	-38.65982	0.00000	0.00000	0.09029
163	-15.51187	-2.18164	0.00000	0.00000	0.29260
164	-17.71934	-10.78430	0.00000	0.00000	0.22016
165	-19.92681	-18.92465	0.00000	0.00000	0.19116
166	-22.13429	-26.34637	0.00000	0.00000	0.15602
167	-24.34176	-32.92787	0.00000	0.00000	0.11287
168	-26.54923	-38.65981	0.00000	0.00000	0.06313

ref. chord	c average	true area	reference area
26.89170	31.36179	1364.23767	950.00000

b/2	ref. ar	true ar	mach number
21.75000	1.99184	1.38704	0.30000

complete configuration

cl	computed alpha	lift cl(wb)	induced drag(far field solution) cdi at cl(wb)	cdi/(cl(wb)**2)
0.5300	7.6834	0.3851	0.0238	0.1608

complete configuration characteristics

cl per rad	alpha per deg	cl(twist)	alpha at cl=0	y cp	cm/cl	cmo
3.11731	0.05441	0.11197	-2.05798	-0.42053	0.06834	-0.07080

additional loading
with cl based on s(true) -at cl des-

stat	2y/b	sl coef	cl ratio	c ratio	load dueto twist	add. load at cl = 0.112	basic load at cl = 0	span load at cl desir	x loc of local cent of press
1	-0.962	0.310	2.045	0.152	0.003	0.024	-0.021	0.094	-0.162
2	-0.885	0.471	1.950	0.241	0.006	0.037	-0.031	0.143	0.575
3	-0.812	0.588	1.802	0.327	0.008	0.046	-0.038	0.179	1.273
4	-0.739	0.687	1.669	0.412	0.010	0.054	-0.044	0.210	1.949
5	-0.662	0.775	1.545	0.501	0.012	0.060	-0.048	0.238	2.630
6	-0.585	0.850	1.438	0.591	0.016	0.066	-0.051	0.263	3.257
7	-0.519	0.909	1.362	0.667	0.019	0.071	-0.052	0.284	3.709
8	-0.454	0.963	1.295	0.744	0.023	0.075	-0.052	0.303	4.081
9	-0.388	1.011	1.233	0.820	0.028	0.079	-0.051	0.322	4.316
10	-0.338	1.046	1.209	0.865	0.031	0.082	-0.050	0.336	4.526
11	-0.277	1.075	1.193	0.901	0.033	0.084	-0.051	0.346	5.045
12	-0.219	1.092	1.168	0.934	0.034	0.085	-0.052	0.351	5.530
13	-0.189	1.100	0.895	1.229	0.033	0.086	-0.053	0.353	6.950
14	-0.139	1.109	0.822	1.349	0.033	0.086	-0.053	0.356	8.812
15	-0.050	1.117	0.715	1.562	0.033	0.087	-0.054	0.358	11.245

contribution of the second planform to span load distribution

stat	2y/b	sl coef	cl ratio	c ratio	load dueto twist	add. load at cl = 0.112	basic load at cl = 0	span load at cl desir	x loc of local cent of press
16	-0.749	0.116	1.047	0.111	0.041	0.009	0.032	0.075	-22.261
17	-0.693	0.164	0.948	0.173	0.061	0.013	0.048	0.108	-21.759
18	-0.636	0.189	0.806	0.235	0.073	0.015	0.059	0.129	-21.242
19	-0.580	0.200	0.676	0.296	0.082	0.016	0.066	0.140	-20.719
20	-0.522	0.200	0.555	0.360	0.086	0.016	0.070	0.144	-20.183
21	-0.464	0.187	0.479	0.391	0.084	0.015	0.070	0.139	-19.541
22	-0.399	0.164	0.423	0.387	0.076	0.013	0.063	0.124	-18.709
23	-0.338	0.174	0.429	0.406	0.071	0.014	0.058	0.122	-18.903
24	-0.277	0.148	0.366	0.404	0.054	0.012	0.043	0.097	-19.224
25	-0.219	0.133	0.363	0.368	0.045	0.010	0.035	0.084	-19.037
26	-0.189	0.128	0.366	0.349	0.041	0.010	0.031	0.079	-18.872
27	-0.139	0.124	0.339	0.366	0.038	0.010	0.028	0.074	-19.025
28	-0.050	0.126	0.297	0.422	0.036	0.010	0.027	0.073	-19.428

```
 induced drag,leading edge thrust , suction coefficient characteristics
          computed at the desired cl from a near field solution

                                    section coefficients
                              l.e. sweep
 station        2y/b          angle      cdii c/2b    ct c/2b     cs c/2b
   1          -0.96154     39.96069     0.00412     0.00085     0.00111
   2          -0.88462     39.96069     0.00182     0.00507     0.00661
   3          -0.81158     39.96069     0.00042     0.00821     0.01071
   4          -0.73855     39.96069     0.00101     0.00912     0.01190
   5          -0.66163     39.96069     0.00187     0.00962     0.01255
   6          -0.58470     39.96069     0.00286     0.00985     0.01285
   7          -0.51933     39.96069     0.00392     0.00978     0.01276
   8          -0.45395     39.96069     0.00499     0.00967     0.01261
   9          -0.38844     39.96069     0.00581     0.00975     0.01272
  10          -0.33839     39.96069     0.00675     0.00940     0.01226
  11          -0.27694     39.96069     0.00795     0.00872     0.01138
  12          -0.21924     39.96069     0.00884     0.00813     0.01389
  13          -0.18851     73.89906     0.00974     0.00733     0.02002
  14          -0.13855     73.89906     0.01161     0.00557     0.02009
  15          -0.05004     73.89906     0.02071    -0.00342    -0.01233

 contribution of the second planform to the chord or drag force

  16          -0.74888     37.91007     0.00645     0.00292     0.00370
  17          -0.69262     37.91007     0.00477     0.00715     0.00906
  18          -0.63637     37.91007     0.00430     0.00984     0.01247
  19          -0.58011     37.91007     0.00588     0.00953     0.01208
  20          -0.52220     37.91007     0.00755     0.00832     0.01054
  21          -0.46428     37.91007     0.00901     0.00640     0.00812
  22          -0.39877     37.91007     0.00956     0.00324     0.00400
  23          -0.33839      0.00000     0.00665     0.00124     0.00128
  24          -0.27694      0.00000     0.00449     0.00034     0.00034
  25          -0.21924      0.00000     0.00408     0.00003     0.00003
  26          -0.18851      0.00000     0.00389    -0.00001    -0.00001
  27          -0.13855      0.00000     0.00361     0.00002     0.00002
  28          -0.05004      0.00000     0.00331     0.00022     0.00022


                                  total coefficients

          cdii/cl**2=   0.15439     ct=   0.04177     cs=   0.05673
1

           end of file encountered after configuration    23.
```