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SUMMARY

This document is a user's manual for the computer program developed to calculate the longitudinal aerodynamic characteristics of upper-surface-blown (USB) wing-flap combinations. A vortex-lattice lifting-surface method is used to model the wing and multiple flaps. Each lifting surface may be of arbitrary planform having camber and twist, and the trailing-edge flap system may consist of up to ten flaps with different spans and deflection angles. Coanda flaps are represented by multiple individual flap segments. The engine wake model consists of a series of closely spaced vortex rings with rectangular cross sections. The rings are positioned relative to a wake centerline which is located such that the lower boundary of the jet is tangent to the wing and flap upper surfaces. The two potential flow models are used to calculate the wing-flap loading distribution including the influence of the wakes from up to two engines on the semispan. The method is limited to the condition where the flow and geometry of the configurations are symmetric about the vertical plane containing the wing root chord. The results available from the program include total configuration forces and moments, individual lifting-surface load distributions, pressure distributions, individual flap hinge moments, and flow field calculation at arbitrary field points.

This program manual contains a description of the use of the program, instructions for preparation of input, a description of the output, program listing, and sample cases.

INTRODUCTION

The short take-off and landing requirements for STOL aircraft necessitates a means of achieving very high lift coefficients on aircraft in both take-off and landing configuration. Recent experimental investigations of upper-surface-blown (USB) flap configurations have indicated the potential for efficient powered-lift performance at reduced ground noise levels. An upper surface blown flap is a STOL high lift device in which the jet efflux from turbofan engines mounted above the wing is allowed to impinge on the upper wing surface such that it becomes attached to the wing surface and flows aft over the wing and flap and is deflected by the trailing edge flap. A large amount of additional lift is produced through engine wake deflection and induced aerodynamic effects.

The purpose of the analysis in reference 1 is to provide an engineering prediction method using potential flow models and requiring little use of empirically determined information, to predict the static longitudinal aerodynamic characteristics of USB configurations. The method involves the combination of a vortex-lattice lifting-surface model of the wing and flaps and a vortex ring model of the rectangular jet wakes. The two flow models are combined by direct superposition,and a tangency boundary condition is satisfied on the wing and flap surfaces. Additional loading is placed on the flap surfaces to account for the turning of the jet wake, and induced aerodynamic effects are obtained by allowing the additional loading to influence the loading on all other lifting surfaces.

The computer program described in this report is an improved and extended version of the program of reference 2. An improved vortex-lattice lifting-surface method is used in which the trailing legs of the horseshoe vortices are allowed to bend around the flap surfaces so that all the trailing vorticity leaves the configuration tangent to the last flap. This is the same vortex lattice method described in reference 3. The jet centerline calculation has been automated so that, after starting with an arbitrary jet location, the centerline is positioned so that it lies parallel to the wing and flap upper surface. The rectangular jet cross-sectional shape at all points along the length of the jet must be specified by the user.

This document is a user's manual for the computer program developed to carry out the calculations in the USB aerodynamic prediction method.

Principal reliance is made herein to reference 1 for a description of the details of the method and the calculation procedure. Reference 1 also contains calculated results and comparisons with data for a variety of configurations. The following sections of this report will provide a description of the program, a description of the input, a description of the output, a program listing, and sample cases. The notation used is the same as that of reference 1.

DESCRIPTION OF PROGRAM

The purpose of this section is to describe the USB aerodynamic prediction program in sufficient detail to permit a general understanding of the flow of the program and to make the user aware of the analytical models used to represent the jets and the lifting surfaces. Basically, the program models the lifting surfaces with horseshoe vortices whose circulation strengths are determined from a set of simultaneous equations provided by the flow tangency boundary condition applied at a finite set of control points distributed over the wing and flaps. The boundary conditions include interference velocities induced by some external source of disturbance such as the wake of a turbofan engine. The jet wake is modeled by a series of closely spaced ring vortices, rectangular in shape, arranged on the boundary of the jet. The strength of the vortices is specified by the initial velocity in the wake which is determined from the momentum in the jet. The jet is allowed to interact with the wing and flaps through the jet induced velocity field on the lifting-surface control points, and through additional loading on the wing and flaps. This additional loading represents the jet reaction force due to the deflection of the jet by the trailing edge flaps.

Calculation Procedure

The general flow of the program, shown in the flow chart in figure 1, proceeds as follows. After run identification information and certain reference quantities are read in, the wing geometry is input and the wing lattice layout is set up and then printed as output. This is accomplished in subroutine WNGLAT. Similar calculations for the flap surfaces are carried out in subroutine FLPLAT. This concludes the lifting-surface geometry specification; therefore, the influence coefficient matrix, which is the left-hand side of the equation set and a function of geometry only, can be calculated in Subroutine INFMAT. The matrix is triangularized (Subroutine LINEQS) for use in the solution of the simultaneous equations. This concludes the first section of the program which need be performed only once in each calculation. Provision is made for the storage of the triangularized matrix (Subroutine FVNOUT) so that recomputation is not necessary in future runs considering the same geometry.

The next section of the main program is that part in which the solution is carried out. The first step is the input of the initial jet parameters (Subroutine JET) and the set up of the tangent jet centerlines (Subroutine JETCL) in preparation for induced velocity calculations. The jet induced velocity field at each lifting-surface control point is computed in Subroutine JET at this time. An additional component of induced velocity at each control point is induced by the additional loading on the flaps (Subroutine JETVEL). This additional loading represents the reaction force on the flaps caused by the deflection of the jet by the flaps. The right-hand side of the equation set is now computed in Subroutine RHSCLC. Solution of the equation set in Subroutine SOLVE produces the values for the circulation strengths of each horseshoe vortex describing the lifting surfaces. Given the circulation strengths and the induced velocity field, the load distributions on the lifting surfaces are calculated in Subroutine LOAD and resolved into total forces and moments in Subroutine FORCES.

The final calculation to be carried out, if requested, is the computation of the induced velocity field at specified field points (Subroutines VELSUM, JET, and JTCIRV). This option is provided so that the user may investigate the induced flow field in the vicinity of a horizontal tail position or other points of interest in the flow field.

Program Operation

The USB prediction program is written in FORTRAN IV and has been run on a CDC 6600 computer. The version described in this document was designed to be used under the FTN compiler with level 1 or 2 optimization. Other compilers can be used with only minor modifications, and lower optimization levels can be used with the only penalty being an increase in run time. No tapes other than standard input and output units are required for a typical run, although two available options allow jet wake parameters and an externally induced velocity field to be brought in via tape unit 4 and the storage of the influence matrix on tape unit 8 to save computer time on later runs.

The main program, USBMAIN, contains one item which is not a standard feature of all FTN compilers. Between cards USB195 and USB207 there are two calls to Subroutine REQFL, a subroutine unique to the CDC 6600. This is a request for an adjustment in the core memory to make room for the influence coefficient matrix, FVN, which is stored in a one-dimensional array. The purpose of this adjustment is to minimize the core storage used until the large array is required. FVN is dimensioned for unit length on card USB055. If Subroutine REQFL or its equivalent is not available, the following changes are required. First, remove cards USB195 through USB207. Second, change the dimension of the FVN array on card USB055 to a value which will cover the maximum number of elements in an influence coefficient matrix; that is, the square of the total number of vortex-lattice panels on the configuration of interest. Thus, the dimension of FVN can be made large enough to cover the largest array anticipated, or the minimum size array needed can be defined and the dimension changed as the number of vortex panels is increased. The maximum number of vortex panels allowed is 250.

There is an alternative solution which minimizes storage requirements for the FVN array when Subroutine REQFL is not available. Program USBMAIN can be turned into a subroutine with cards USB195-207 removed and the FVN dimension set at unity. A short main program can be written which consists of a blank common which sets the dimension of FVN to the required size and a call to Subroutine USBMAIN. In this way, a short five-card main program is all that need be recompiled to change the size of the FVN array. This alternate set up for a main program is illustrated in figure 2 to accommodate a maximum vortex lattice of 136 elements (for example). The changes to the current main program, USBMAIN, to make it a subroutine are also shown in this figure.

The following is a list of the components of the USB program and a brief description of the function of each.

Main Program:

USBMAIN - controls the flow of the calculation and handles some input and output duties

Subroutines:

WNGLAT - reads in wing input data, lays out the vortex lattice on the the wing, and outputs wing geometric information

FLPLAT - reads in flap input data, lays out vortex lattice on the flaps including wing trailing legs which lie on the flaps, and outputs flap geometric information

INFMAT - calculates influence coefficient matrix

FLVF - calculates influence function for a finite length vortex filament

SIVF - calculates influence function for a semi-infinite length vortex filament

RHSCLC - calculates the right-hand side of the simultaneous equations for the vortex strengths

LINEQS - triangularizes the square influence coefficient matrix

SOLVE - solves for the circulation strengths

LOAD - calculates the forces on the bound and trailing vorticity associated with each area element using the traditional method

LOADCP - calculates the upper and lower surface pressure coefficients on each panel and the force associated with each area element

FORCES - calculates and outputs the spanwise loading distributions and total forces and moments and pressure distribution on the complete configuration

VELSUM - computes wing-flap induced velocity field at a specified point

JET - reads in initial jet parameters, outputs total jet configurations, and calculates jet wake induced velocities at specified points

JETCL - calculates the wake position parameters of USB jets which are tangent to the upper wing and flap surfaces

CORECT - corrects field point locations relative to vortex rings to avoid singularities

QRING - computes velocity components induced by a single, quadrilateral vortex ring at an arbitrary field point relative to the ring

Subroutines (Concluded)

JETVEL - calculates additional loading on flaps due to jet deflection

JTCIRV - calculates the velocity components induced by the additional loading on the flaps

TRLG - corrects horseshoe vortex trailing legs at flap junctions to eliminate unusually large local loadings near flap edges

FVNOUT - stores the aerodynamic influence coefficient matrix on tape 8 for future use

FVNIN - inputs the aerodynamic influence coefficient matrix from tape 8

UVWOUT - stores the jet parameters and jet induced velocities at control points on tape 4 for use in future runs

UVWIN - inputs the jet parameters and jet induced velocities at control points from tape 4

Program Usage

Limitations. - It should be remembered that the prediction method is made up of potential flow models which presume the flow to be attached to the lifting surfaces at all times. When applying the program to configurations at very high angles of attack or to configurations with very large flap deflections, the predicted results will generally indicate too much lift as separation may exist on portions of the real model.

The program is a model for the wing and flaps only; therefore, when comparing predicted results with measured characteristics on a complete configuration, the force and moment contributions due to such items as the fuselage, nacelles, and leading-edge slat must be included as additional items. This is illustrated in the data comparisons in reference 1.

There are certain limitations and requirements in laying out the vortex-lattice arrangement on the lifting surfaces. These are discussed in detail in the input section of this manual, but several of the more important items are noted as follows:

(1) Since the current version of the vortex-lattice method bends the trailing legs of the wing horseshoe vortices around the flaps, in laying out the geometry care must be taken that a flap surface not lie above the wing surface. For the same reason, flap surfaces may not overlap.

(2) The program has the capability of computing the induced velocity field at any specified field point, but the modeling of the wing and flaps with horseshoe vortex singularities can cause numerical problems and unrealistic answers if a field point lies too near a singularity. A general rule to follow when computing induced velocities is that the field point should not be closer to a lifting surface than one-half the width of the nearest horseshoe vortex.

Run time. - Both the vortex-lattice lifting-surface and the vortex ring jet models can be time consuming in a typical calculation; consequently, their combination into the USB program creates a calculation procedure which can be very costly in terms of computer time. Estimating the computation time required for a calculation is difficult because of the variables involved. Size of the vortex lattice, number of flaps, number of jets, length of the jets, spacing of the vortex rings, and force calculation options all help determine the total run time for a calculation. A list of typical execution times for different combinations of the above parameters is presented in Table I. Explanations of the force calculation options are presented in the following section.

DESCRIPTION OF INPUT

This section describes the preparation of input for the USB computer program. In the following sections, some detailed information regarding the layout of the vortex lattice and the specification of the jet wake are presented. This is followed by a listing of all input variables and their format and positions in the input deck. The last topic in this section is a sample input deck illustrating a typical USB calculation.

Vortex-Lattice Arrangement

The vortex-lattice method used in the present USB program is identical to the version of the vortex-lattice method presented in references 3 and 4. The vortex-lattice method is capable of modeling the following characteristics of the wing and flap:

Wing

- Mean camber surface may have camber and twist.
- Leading-edge sweep angle need not be constant across semispan.
- Trailing-edge sweep angle need not be constant across semispan.

- Taper need not be linear and there may be discontinuities in the local wing chords.
- Non-zero dihedral angle is allowed, but it must be constant over the semispan.
- Thickness effects are neglected.
- Tip chord must be parallel to root chord.

Flaps

- A maximum of ten flaps may be considered, but no more than three flaps may be behind any one wing chordwise row of panels.
- Each flap may have camber and twist.
- Leading- and trailing-edges must be straight and unbroken on each flap surface.
- Flap chord must have linear taper.
- Thickness effects are neglected.
- There may be slots between the flaps, but the leading edge of each flap lies in the plane of the adjacent upstream lifting surface.
- Coanda flaps are modeled by multiple flap segments with no slots.

The vortex-lattice arrangement describing the wing and flaps is general enough to provide good flexibility in describing the lifting surfaces. A maximum of thirty (30) spanwise rows of vortices may be used, and each lifting-surface component can have a maximum of ten (10) chordwise vortices. The area elements on each lifting surface have a uniform chordwise length at each spanwise station. In the spanwise direction, the widths of the area elements may be varied to fit the loading situations; that is, in regions of large spanwise loading gradients, the element widths may be reduced to allow closer spacing and more detailed load predictions.

The maximum lattice size on the complete configuration is fixed at 250 in the program. The elements may be distributed in any proportion over the wing and flaps, and for the sake of economy, considerably less than this total number should be used for most calculations as illustrated by the run times in Table I. The following comments, based on the recommendations of Appendix A of reference 5 and the authors' experience, are offered as an aid to selecting the proper vortex-lattice arrangement for a wing-flap configuration.

Spanwise distribution. - Convergence of gross aerodynamic forces and moments to within 1 percent is obtained by using not less than fourteen equally spaced spanwise rows of vortices. If an unequal spanwise spacing is required to create a locally dense region of vorticity, the initial spacing should be laid out approximately equal, with additional rows added in the regions of interest. The spanwise spacing can be adjusted small amounts to meet some additional requirements without changing the gross loading properties. For example, it is desirable that there be approximate symmetry in the widths of the vortex elements about the engine centerline station. This can cause some unusual distributions of lattice widths as illustrated in figure 3 where a typical lattice arrangement on the two-engine USB model of reference 6 is illustrated. In this case the number of spanwise vortices was limited to sixteen to minimize the total number of elements in the lattice. In this particular case, the only suggested modification in the spanwise layout would be to add two rows of vortices outboard of the jet to obtain more detail in the spanwise loading distribution. One additional row of vortices near the jet would also improve the spanwise loading.

Chordwise distribution. - Results in Appendix A of reference 5 indicate that four is the minimum number of chordwise vortices on the wing for best results and more than six vortices do not change the predicted loads appreciably. A larger number of chordwise vortices on the wing should be used if a chordwise pressure distribution is the goal of the predictions.

The number of chordwise vortices on the flaps is somewhat arbitrary. A rule of thumb is that the chord of the vortex element on the flap should not be greater than the chord of the wing elements. Generally, the chord of the flap elements will be much smaller than the wing elements. If gross forces are the objective of the prediction, two or three chordwise vortices per flap are all that are needed. If pressure distributions are desired, there should be three or more chordwise vortices per flap. The gross force will change very little with additional flap vortices.

Care should be taken in laying out vortices in regions of large jet interference. Since interference of the jet on the lifting surfaces is "felt" only at the control points of the area elements, small lateral changes in the wake boundary can cause large changes in the wake induced loading if the area elements on the flap are too large. This is caused by the covering and uncovering of area elements whose control points fall near the boundary of the jet. Results indicate that if a sufficient number of elements are used in the wake region of the wing and flap, the element sizes will be sufficiently small so that results will not be unduly influenced by changes in wake location.

The chordwise distribution of lattice elements on the USB model in figure 3 should be considered a minimum lattice. Each of the three flap segments making up the Coanda flap (flaps 1, 2, and 3) have two rows of vortices as do each of the two flaps in the center flap region (flaps 4 and 5). The outboard flap (flap 6), or aileron, has but one row of vortices. This distribution is adequate for force and moment calculations, but additional lattice elements should be added if the pressure distribution is of interest.

Coanda flap. - The use of Coanda flaps on USB configurations presents some problems in setting up a vortex-lattice arrangement that are not evident when considering conventional flap systems. With conventional slotted flaps such as those used on externally blown flap configurations, each flap can be represented as a separate flap segment with a specified lattice arrangement. The flap size and deflection alge are well defined in this case.

A typical Coanda flap is specified by a radius of curvature and the slope of the trailing edge of the flap. The slope of the trailing edge is usually used to define the flap deflection angle; for example, δ_f = 32° and 72° in reference 6. A vortex-lattice arrangement on a Coanda flap is determined by dividing the actual Coanda flap into not more than three individual flap segments with no gaps between the segments. Generally the flap segments have equal chords, but this is not a requirement. The deflection of each flap segment should be chosen to best represent the actual deflection of the Coanda flap. This is particularly important for power-on cases where the deflection of the jet wake contributes a large part of the total lift on the wing and flaps. It has been the experience of the author that a graphical representation of a section of the actual Coanda flap and the vortex-lattice model is useful in evaluating the quality of the lattice model. Minor adjustments in chord length and deflection angles as dictated by a drawing can improve the vortex-lattice model and the final results.

Jet Wake Specification

The vortex ring model used in the USB program is a modified version of the vortex ring model presented in reference 4. The present program will handle rectangular cross-section jets with centerlines positioned such that the lower boundary of the jet is parallel to the upper surfaces of the wing and flaps. The program automatically locates the jet wake in the correct position with respect to the wing and flap surfaces, but the user is required to specify some general jet parameters such as the spreading of the wake and its cross sectional shape at various points along the length of the wake. There are several critical points on the jet wake which must be defined carefully. A vortex ring model of a typical USB jet wake is developed as follows.

The first critical point in the jet description is the location of the exhaust nozzle and its shape. If the actual nozzle is not rectangular, it must be represented as a rectangular nozzle. Keep the width of the model the same as the actual nozzle and adjust the height to match the area of the exhaust nozzle. The inlet or initial point of the jet model may be located at the actual engine inlet location, or it may be located at some intermediate point between the inlet and exhaust locations. A good rule of thumb is that the jet model inlet should be at least one jet width ahead of the wing leading edge. The jet model is often shortened in this manner to reduce the number of vortex rings required to model the jet and thus conserve computation time. The initial jet shape must be identical to the chosen shape at the exhaust location.

These first two points describing the jet inlet and exhaust locations are required to initialize the jet model. The following points are chosen by the user to prescribe the expansion and cross sectional shape of the jet downstream of the exhaust nozzle. Usually, only three or four additional points along the jet are required. If some empirical knowledge of the jet to be modeled is available, it should be included in the specifications in order to get the best physical model possible. For example, if the observed lateral spreading of the wake is such that the entire Coanda flap is covered by the wake, the width should be chosen to fit this criteria. Using a typical decay schedule for the average velocity in the jet as described in reference 1, a nominal jet height can be estimated from the following relationship

$$\frac{P_o}{P} = \frac{U}{U_o} \tag{1}$$

where

$$\frac{P_o}{P} = \frac{a_o + b_o}{a + b} \tag{2}$$

In equation (2), a_o and b_o are the initial half-width and half-height, respectively; and a and b are the local values of half-width and half-height. The actual procedure involves choosing a local average jet velocity, U/U_o, at a point downstream of the exhaust, x/h_o; for example, see figure 4. Choosing the jet half-width at the point in question, and knowing the exhaust nozzle characteristics, the half-height of the jet can be obtained from equation (2). If the conditions of the jet wake are such that $b < b_o$, the user has the option of either choosing a smaller half-width or simply specifying $b = b_o$. This latter approach is not unreasonable as measured velocity profiles in the wake of a typical USB model indicate only small growth of the wake thickness while it is attached to the wing and flap surface (ref. 7). Another approach is to assume that the wake cross section aspect ratio is constant over the length of the wake. This approach is the most reliable to assure an acceptable jet model, and it should be used if no detailed information on the extent of the wake spreading is available.

The remaining points describing the jet model should be in the following approximate locations. There should be one point near the wing trailing edge ahead of the Coanda flap. Other points between the exhaust location and the wing trailing edge may be included, but they are not specifically required. Another point in the vicinity of the Coanda flap trailing edge us useful. The last point describing the jet should specify the end of the jet wake. A good rule of thumb for this point is that the jet should extend approximately one wing root chord aft of the flap trailing edge. If the user is uncertain about where to terminate the wake, it is better to be conservative and make the jet too long rather than too short. The penalty for a short jet is inaccurate induced loadings. The user should investigate the effect of jet length on a particular configuration by running one case with an extended jet and comparing predicted results. Generally, jets longer than suggested above are not required unless velocity fields a long distance aft of the wing and flaps are required. If this is the case, the jet should be lengthened so that it extends approximately one wing chord beyond the axial station at which field points are desired.

Thus far in the description of the jet, only the height and width at various points along the centerline have been specified. Since the program automatically determines the height of the jet centerline above the wing, the z_j-coordinate need not be specified. If the lateral coordinate of the jet is not specified, the jet centerline is assumed to move aft at a constant spanwise station. Lateral motion of the jet can be specified by a variation of the y_j-coordinate. Note that the first two entires describing the jet, corresponding to the inlet and the exhaust, must be at $y_j = 0$. If some lateral motion is specified, remember that the jet is defined in a jet coordinate system as illustrated in figure 5. The program also automatically computes the slope of the centerline, θ, thus it need not be specified for typical USB calculations. The jet model shown in figure 5 was calculated from the jet parameters specified in the sample case in figure 7(a).

The last critical parameter to be specified is the spacing between the vortex rings. Ideally, the closer the rings, the more accurate the results; but the closer the spacing, the more rings required to make up the jet model and the longer the computation time needed to compute an induced velocity field. A compromise number for the ring spacing is a distance equal to approximately 0.2 of the minimum dimension of a ring. This is not a firm number, but it is generally a good estimate. The program has an option built into it that allows the spacing to vary along the jet through use of the variable DSFACT. This is simply a multiplying factor used to scale up the ring spacing to two or three times the initial value. This option should never be used in the vicinity of the wing and flaps as the accuracy of the induced velocity field at the control points will be reduced. It is permissible to increase the spacing downstream of the last flap. The use of this scaling factor is illustrated in the sample input decks.

The individual engine thrust (C_T) must be specified, and in the case of a two-engine USB configuration, this is just one-half the total thrust coefficient. On four-engine configurations, there is no requirement that the thrust of both engines on the semispan be the same; however, this is usually the case. The average velocity at the exhaust nozzle exit is calculated from the relation

$$\frac{V_j}{V} = \frac{1}{2}\left[1 + \sqrt{1 + 2C_T \frac{S}{A_j}\left(\frac{\rho}{\rho_j}\right)}\right] \tag{3}$$

and the vortex sheet strength on the jet boundary is

$$\frac{\gamma}{V} = \frac{V_j}{V} - 1 \tag{4}$$

If some empirical information on the jet exhaust exit velocity is known, the parameter ρ/ρ_j should be adjusted such that equation (3) produces the correct jet velocity ratio.

Input Variables

The purpose of this section is to describe the variables required for input to the USB program. Input forms are presented in figure 6; and for each item of input data shown in the figure, the following information is given. The format for each card and the program variable names are shown first. The card column fields into which the data are to be punched are also shown. Within each block representing the card columns is the FORTRAN format type. Data punched in I format are right justified in the fields, and data punched in F format can be punched anywhere in the field and must contain a decimal point. The name in parentheses at the left of each item in figure 6 is the program or subroutine where the item is read.

Note that all length parameters in the input list have dimensions; therefore, special care must be taken that all lengths and areas are input in a consistent set of units.

Item number 1 is a single card containing the following indices:

NHEAD	number of run identification heading cards in Item 2 (no limit on number of cards)
NFVN = 0	calculate FVN influence matrix
= 1	input FVN influence matrix via tape 8
NUNIT = 0	no action required on calculated influence matrix
= 8	store influence matrix on tape 8 if NFVN = 0, or read influence matrix from tape 8 if NFVN = 1
NFPTS	number of field points at which velocity components are computed ($0 \leq$ NFPTS ≤ 50)

NPRINT = 0 no optional output

= 1 output velocity components (at lattice control points) induced by flap loading associated with jet turning

= 2 also output force components on each individual panel of lattice

Item number 2 is a set of NHEAD cards containing hollerith information identifying the run and may start and end anywhere on the card. The cards are reproduced in the output just as they are read in.

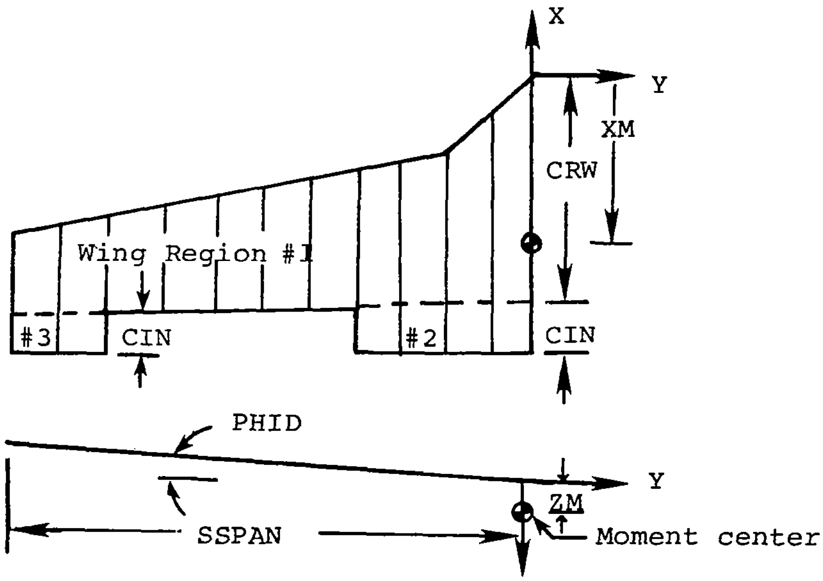
Item number 3 consists of one card and contains the following information:

SREF reference area used in forming aerodynamic coefficients

REFL reference length used in forming aerodynamic moment coefficients

XM,ZM X and Z coordinates of point about which pitching moment is calculated; wing coordinate system and positive directions are shown in figure 3 and sketch 1

ETAJ jet turning efficiency, the ratio of the jet deflection angle to the maximum flap angle ($0 \leq \eta \leq 1.0$)



Sketch 1.- Wing parameters

The variable ETAJ in Item 3 is provided to assist in modeling the turning efficiency of typical USB configurations. Measurements have shown that the jet is often unable to remain attached over the full length of a highly deflected flap.

The next eight items of input data describe the wing.

Item number 4 specifies the value of NWREG, the number of wing regions. The value of NWREG must be one or greater. The purpose of dividing the wing into regions is to handle discontinuities in local chord length. Region 1 must always extend from Y = 0 to the tip. The sequence and position of other regions is arbitrary. A wing with three regions is shown in sketch 1.

Item number 5 contains three quantities which are also shown in sketch 1. They are:

CRW	root chord of region 1, positive quantity
SSPAN	wing semispan, positive quantity
PHID	wing dihedral angle, degrees; positive dihedral is shown in the sketch

Items 6, 7, and 8 are data describing wing region number 1. Data input for this region determine the spanwise distribution of vortices for all wing regions and all flaps. The present program requires that the same spanwise distribution exist on all surfaces.

Item number 6 contains five indices. They are:

NCW	number of chordwise vortices on wing region 1, $1 \leq \text{NCW} \leq 10$
MSW	number of spanwise vortices on left wing panel, $1 \leq \text{MSW} \leq 30$
NTCW	twist and/or camber? NTCW = 0, no NTCW = 1, yes
NUNI	if wing has no twist and the camber distribution is similar at all spanwise stations, NUNI = 1; for all other cases NUNI = 0 (omit if NTCW = 0)
NPRESW	is the wing pressure distribution ($\Delta p/q$) to be calculated and printed? NPRESW = 0, no NPRESW = 1, yes

Note that NPRESW applies to the calculation of the pressure difference on each panel of the wing lattice. This calculation is independent of the upper and lower surface pressure coefficient calculation governed by the index NLOAD in Item 19.

The minimum number of spanwise horseshoe vortices is determined by the wing-flap combination geometry. The program requires that vortex trailing legs lie at the following locations:

(a) the root chord and tip chord

(b) the side edges of all wing regions

(c) the side edges of all flaps

(d) points where there are breaks in leading-edge or trailing-edge sweep

Item number 7 is a set of MSW+1 cards which specify the following:

Y(I)	Y coordinate of the I^{th} trailing leg on the left wing panel; Y is a negative number on the left wing panel, but positive values may be input and the program will change the sign [Y(1) = 0.0,Y(MSW + 1) = -SSPAN]
PSIWLE(I)	leading-edge sweep of wing section to the right of the I^{th} trailing leg, degrees; positive swept back (measured in wing planform plane)
PSIWTE(I)	trailing-edge sweep of wing section to the right of the I^{th} trailing leg, degrees; positive swept back (measured in wing planform plane)
NFSEG(I)	number of flaps behind wing section to the right of the I^{th} trailing leg [$0 \leq$ NFSEG(I) ≤ 3]

When I = 1, Y(I) = 0 and the other three quantities are omitted.

Item number 8 is included in the input data deck only if NTCW = 1 in item number 6. These data specify the twist and/or camber distribution of wing region number 1 in terms of the tangent of the local angle of attack of the camberline for a root chord angle of attack of zero degrees. The input data are:

ALPHAL(J)	tan α_ℓ of the region 1 camberline at the vortex-lattice control points. If NUNI = 1, only data for the chordwise row adjacent to the root chord are input. The first value is for the control point nearest the leading edge. If NUNI = 0, data for all chordwise rows must be input starting nearest the root chord and working outboard. Data for each row start on a new card (omit if NTCW = 0).

The vortex-lattice control points are at the midspan of the three-quarter chordline of each elemental panel laid out by NCW, MSW, and the Y(I)'s of items 6 and 7.

Item numbers 9, 10, and 11 are input data for the other wing regions. If NWREG, item number 4, is one, items 9, 10, and 11 are omitted. If NWREG > 1, these items are repeated in sequence for regions 2 through NWREG.

Item number 9 contains two indices which locate this wing region spanwise relative to region 1. They specify the subscripts of the elements in the Y(I) array, input in item 7, associated with inboard and outboard side edges of this region.

IIN	inboard side edge is at Y(IIN)
IOUT	outboard side edge is at Y(IOUT)

Item number 10 contains five quantities. They are:

NCW	number of chordwise vortices in this region, $1 \leq NCW \leq 10$
NTCW	twist and/or camber for this wing region? NTCW = 0, no NTCW = 1, yes
NUNI	if this wing region has no twist and the camber distribution is similar at all spanwise stations, NUNI = 1; for all other cases NUNI = 0 (omit if NTCW = 0 for this region)
CIN	inboard side-edge chord (see sketch 1), positive quantity
TESWP	sweep angle of the trailing edge of this region, degrees

The vortices are laid out using the value of NCW for this region and the portion of the Y(I) array beginning with Y(IIN) and ending with Y(IOUT).

Item number 11 is included in the input data deck if NTCW = 1 in item 10. These data specify the twist and/or camber distribution for this wing region. These data are prepared in the same manner as described under item number 8, the similar information for wing region 1.

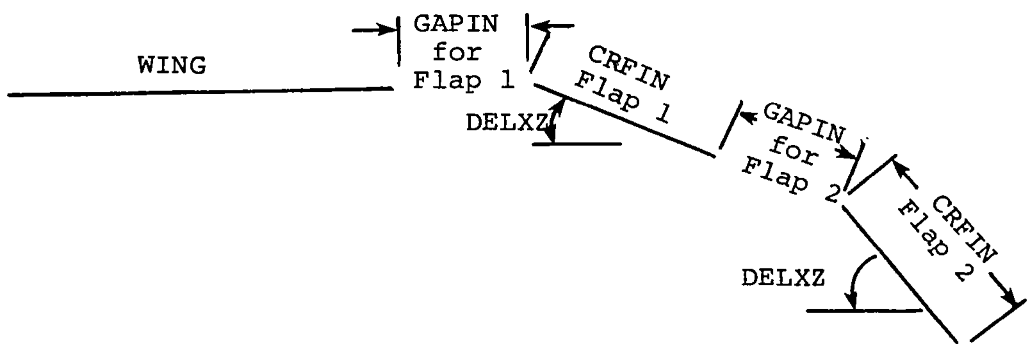
Item number 12 specifies the number of flap regions and identifies the flap edges which require trailing leg position correction.

NFREG	number of flap regions $(0 \leq NFREG \leq 10)$
NIDF	number of flap edges at which trailing leg positions must be corrected $(0 \leq NIDF \leq 3)$
IDF(I)	location of flap edge where correction of trailing leg position is necessary; i.e., at Y(IDF)

For a wing alone, NFREG = 0 and items 13 through 16 are not included in the input data deck. A flap region is a particular flap arrangement behind some spanwise region of the wing. The program will handle a total of ten flaps, thus if there were ten spanwise flaps, there could be a maximum of ten regions.

Correction of the position of the horseshoe vortices trailing legs is necessary when adjacent flaps (spanwise neighbors) have different deflection angles and/or different chord lengths. This occurs when the inboard edge of one flap region shares the same Y-station as the outboard edge of the adjacent flap region. Use of this index is illustrated with the sample cases.

Item numbers 13, 14, 15, and 16 are input data describing the flaps. The user must exercise care in preparing these input data as the order of the items is important. Typically, item numbers 13 through 16 are arranged in the following manner. Item number 13, specifying the number of flaps (NINREG) in the first flap region and their extent, is followed by items 14, 15, and 16 for the first flap in this region. Items 14, 15, and 16 are repeated for each additional flap in the first region. The flaps must be specified in order, with the flap nearest the wing trailing edge occurring first (see sketch 2). When the first flap region is completely specified, items 13 through 16 are repeated for the second flap region, and so on. The sample cases in figures 7(a) and (b) illustrate the input for a wing with multiple flap regions with multiple flaps in each region.



Sketch 2.- Typical slotted flap

<u>Item number 13</u> contains three indices required to describe the flaps in a particular region.

NINREG	number of flaps in this region, $1 \leq$ NINREG ≤ 3
IIN	inboard side edge lies at Y(IIN) of item 7
IOUT	outboard side edge lies at Y(IOUT) of item 7

The next three items of input data are repeated in sequence NINREG times beginning with the flap nearest the wing trailing edge and moving rearward.

<u>Item number 14</u> contains four indices. They are:

NCF	number of chordwise vortices on this flap, $1 \leq$ NCF ≤ 10

NTCF	twist and/or camber for this flap? NTCF = 0, no NTCF = 1, yes
NUNI	if this flap has no twist and the camber distribution is similar at all spanwise stations, NUNI = 1; for all other cases NUNI = 0 (omit if NTCF = 0 for this flap)
NPRESF	is a pressure distribution (Δp/q) to be calculated and printed for this flap? NPRESF = 0, no NPRESF = 1, yes

The vortices are laid out using the value of NCF for this flap and the portion of the Y(I) array input as item 7 beginning with Y(IIN) and ending with Y(IOUT). IIN and IOUT were input in item 13.

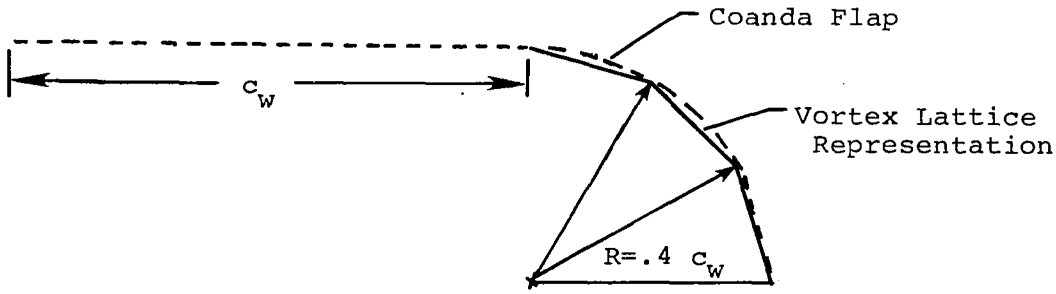
Note that NPRESF applies to the calculation of the pressure difference on each panel of the flap lattice. This calculation is independent of the upper and lower surface pressure coefficient calculation governed by the index NLOAD in Item 19.

Item number 15 contains data which locate this flap with respect to the surface ahead of it, specify the inboard and outboard edge chords, and give the streamwise deflection angle.

GAPIN	the distance between the leading edge of this flap and the trailing edge of the preceding surface, measured in the plane of preceding surface at the inboard side of the flap
CRFIN	inboard side-edge chord of this flap
GAPOUT	the gap distance at the outboard edge of the flap (defined similar to GAPIN)
CRFOUT	outboard side edge of this flap
DELXZ	the streamwise deflection angle measured relative to the wing root chord direction, degrees

A streamwise plane containing the inboard edge of a double-slotted flap configuration is shown in sketch 2. The leading edge of each flap lies in the plane of the preceding surface. All quantities in item 15 are input as positive values.

In a typical USB configuration, the main flap around which the jet is deflected is a Coanda surface or a continuous flap. Generally, the flap is a single surface flap with a constant radius of curvature. A flap of this type is modeled with three straight flap segments with no gaps between them (GAPIN = 0.0 and GAPOUT = 0.0 in Item 15). The individual flap chords represent the actual surface length of the Coanda flap, and the flap deflection angles are chosen to best represent the true deflection angles. Best results are usually achieved when the last flap segment has a deflection angle equal to the maximum deflection angle at the trailing edge of the Coanda flap. This is not the case for a deflection angle of 90°. In this extreme case, the last flap should be deflected a smaller amount. As mentioned in a previous section, a drawing of the section through the Coanda flap will aid in choosing the best vortex lattice model. One possible representation of a highly deflected Coanda flap is shown in sketch 3.



Sketch 3. Typical Coanda flap

Item number 16 is included in the input data deck if NTCF = 1 in item 14. These data specify the twist and/or camber distribution of this flap. They are prepared in the same manner as described under item number 8 for the wing except that the twist and/or camber angles are measured relative to the angle of the flap inboard side-edge chord. These angles are all measured in a streamwise plane.

Item number 17 is a set of NFPTS cards containing the X, Y, Z-coordinates, in the wing coordinate system, at which the total induced velocity components are to be calculated. There is one field point per card, and there can be no more than fifty points in this table. This item is omitted if NFPTS = 0 in item number 1.

Item number 18 contains one index.

NRHS — the number of successive cases to be treated for this wing-flap combination, NRHS $\geq$ 1

The successive cases permitted by NRHS are those which affect only the right-hand side of the equation set for the circulation strengths (egs. (14) and (14) in ref. 5). Thus, the wing-flap geometry must remain unchanged in successive cases. Changes are permitted in items 19 through 25; therefore, the successive cases may involve different angles of attack and/or different jet wakes.

The last six items of input data are repeated in sequence NRHS times.

<u>Item number 19</u> contains thirteen quantities which are:

ALFA — wing root chord angle of attack relative to the free stream, degrees

KJET — index indicating manner of interference calculation
- KJET = 0, jet parameters and interference not calculated, power off
- KJET = 1, jet parameters input and interference velocities calculated
- KJET = 2, previously calculated jet parameters and interference velocities input via tape 4

KEI — index provided to allow multiple sets of jet parameters and induced velocities to be input via tape KEI when KJET = 2. Current version of the program is restricted to KEI = 4 (see the discussion at the end of item number 19 for the use of this index).

KUNIT — index indicating disposition of jet parameters
- KUNIT = 0, no action required for jet parameters and induced velocities
- KUNIT = 1, jet parameters and induced velocities stored on tape 4 for future use. KJET = 1 and KEI = 0.

NLOAD — index specifying force calculation method
- NLOAD = 1, traditional method; i.e., $\vec{V} \times \vec{\Gamma}$ on each panel
- NLOAD = 2, integration of pressure on each panel (not recommended when KJET > 0)
- NLOAD = 0, both methods

NJPNL — number of panels from which forces are omitted during total integrated force calculation (see the discussion at the end of item number 19 for the use of this index) (NJPNL $\leq$ 30)

MFRC — index for force calculation option (see the discussion at the end of item number 19 for the use of this index)
- MFRC = 0, all horseshoe vortices on wing and flaps contribute to the velocity field used in force calculation (power off)
- MFRC = 1, induced velocities from horseshoe vortices are not used in force calculation (power on)

NCFJ — index for force calculation option (see the discussion at the end of item number 19 for the use of this index)
- NCFJ = -1, omit all induced velocities associated with jet from force calculation (power on)
- NCFJ = 0, include jet induced velocities in force calculation

	NCFJ = 1,	include vortex ring jet model induced velocities in force calculation
NTLF	index for force calculation option (see the discussion at the end of item number 19 for the use of this index)	
	NTLF = 0,	forces on the bound portion of the trailing legs in each panel are included in force calculation
	NTLF = 1,	all trailing leg forces neglected
NFJ	number of flaps in direct interference of jet ($1 \leq$ NFJ ≤ 3)	
NFJN(I)	identification number of flaps in direct interference of jet, NFJ values, all flaps must be in same region and must be numbered in order	

The index KEI is included to provide the user with the option of reading multiple sets of previously calculated jet parameters and interference velocities; however, some minor program modifications are required to tailor this option to the specific needs of the user. First, the tape unit numbers desired, in addition to tape 4, must be defined on the program card (USB001). Second, change the rewind command on card USB419 to apply to the general tape number KEI in place of the specific tape unit 4. The last modification required is to change READ(4) to READ(KEI) on card UIN014 in Subroutine UVWIN.

The index NJPNL is included so that the forces on certain specified panels can be neglected in the calculation of section normal forces and span load distributions. This is used only if there are certain portions of the wing on which forces were not measured and thus not included in section characteristics. A case in point is the data of reference 6 in which section normal force coefficients are computed from measured pressures, but pressure data are not available in the region of the nacelle. By omitting the forces on the wing panels which fall in the nacelle region, the predicted loadings can be compared directly with the data. When this option is used, the program also outputs the forces and moments computed considering all panels.

The three indices MFRC, NCFJ, and NTLF are included to provide options in the force calculation method. For power-off calculations, MFRC = 1 and NTLF = 1 will produce large savings in computer time at the sacrifice of accuracy in the final results. At low flap angles, $\delta_f < 30°$, predicted lift coefficients are three to fifteen percent higher when MFRC = 1. The smallest difference occurs at low angles of attack. At higher flap angles, $\delta_f \simeq 70°$, the difference in lift coefficient can be as large as 20 percent. For all power-off calculations, it is recommended that MFRC = 0, NCFJ = 0, and NTLF = 0.

For power on calculations, these three indices are more important. Because of the large additional loading on the flaps associated with the turning of the jet, large forces can occur as the result of a small perturbation velocity acting on a large circulation. Experience has shown that reliable results are obtained consistently if MFRC = 1 and NCFJ = -1. As before, computer time is conserved at small expense of accuracy if NTLF = 1.

Item number 20 contains the NJPNL panel numbers, JPNL(I), from which the forces are omitted (see item 19). These panel numbers may be anywhere on the wing and flap lattice, but they must be in ascending order in the input list.

Items 21 through 25 identify the initial jet wakes, and they are omitted if KJET = 0 or 2.

Item number 21 is a single card containing five indices pertaining to the jet calculation. They are:

NHEAD	number of heading cards to identify the jet model, NHEAD $\geq$ 1. This index is independent of the similar index in Item 1.
NJET	number of jet wakes on the wing semispan; NJET = 1 for two-engine USB model. (NJET $\leq$ 2)
NVLP	number of panels excluded from jet interference calculation (0 $\leq$ NVLP $\leq$ 100)(see the discussion at the end of item number 21 for use of this index)
NCRCT	index indicating whether or not field point locations are corrected with respect to vortex ring locations (see the discussion at the end of item number 21 for use of this index) NCRCT = 0, corrections made NCRCT = 1, corrections not made (to be used for diagnostic purposes only)
JPRINT	index indicating whether or not optional output from the jet program is required (see the discussion at the end of item number 21 for use of this index) JPRINT = -1, minimum output JPRINT = 0, induced velocities at wing control points output from subroutine JET JPRINT = 1, individual jet velocities at each control point output from subroutine JET

The index NVLP is provided to allow exclusion of wing-flap lattice panels from the jet induced velocity calculation. Often there are panels on which the induced velocity field from an external source of disturbance is not needed; for example, the panels on the wing which in reality are located inside the fuselage. There are also panels near the wing tip which are far removed from the jet wake. On thise configurations there is no point in calculating a very small perturbation velocity which will have no noticeable effect on the predicted loading distribution. The major effect of the use of this option is a savings in computer execution time, as the time required to calculate jet induced velocities at control points is directly proportional to the number of points. An example of the use of this option is shown with the sample cases.

The last two indices in item 21 are provided for diagnostic purposes only. For general program usage, these indices should be JPRINT = -1 and NCRCT = 0. NCRCT is an index used during program development to investigate a situation in which a control point was located very near the edge of a vortex ring. Unrealistically large velocities were induced until the relative positions between the control point and the vortex rings were corrected. This correction places the vortex rings on either side of the control point equidistant from the point. When the index JPRINT is equal to zero, jet induced velocities at the control points are output as they are computed. This is a duplication of output. If the user requires information regarding the contribution of each individual jet to the total induced velocity at a control point, JPRINT = 1 will cause this output to be printed.

Item number 22 is a set of NHEAD cards (from item 21) containing hollerith information identifying the jet. The information may start and end anywhere on the card and the information is reproduced in the output just as it is read in.

The following two items are repeated in sequence NJET times.

Item number 23 consists of one card which contains the following jet specifications:

CMU(J)	the thrust coefficient of the J'th jet on the left wing semispan. This value is usually the total C_μ of the configuration divided by the total number of jets
RHO(J)	the ratio, ρ_j/ρ, of J'th jet density to free stream density
XQ(J) YQ(J) ZQ(J)	the coordinates, in the wing system, of the origin of the J'th jet model (YQ < 0)

DS(J) the ring spacing of the vortex rings in the J'th jet; a typical value is 0.2 b_o where b_o is the initial height of a rectangular jet

NCYL(J) the number of entires in item number 24 to specify J'th jet parameters

Item number 24 consists of NCYL(J) cards containing the following information:

XCLR(J,N), YCLR(J,N), ZCLR(J,N) the N'th set of coordinates specifying the centerline of the J'th jet in the jet coordinate system (fig. 5)

AJET(J,N) the half width of the rectangular ring at the N'th point on the center of the J'th jet

BJET(J,N) the half height at the same point

THETA(J,N) the slope of the centerline in degrees at the point being considered; THETA is input equal to zero for USB jets

DSFACT(J,N) scale factor for the spacing between the vortex rings downstream of the N'th point; in region of wing and flaps, the values should be 1.0; aft of the last flap, the values can be greater than 1.0 to save execution time

Item number 25 is a set of NVLP panel numbers, NVL, at which no jet velocities are calculated. This item is omitted if NVLP = 0. The panel numbers in the NVL list must be input in ascending order.

If successive cases are requested (NRHS > 1 in Item number 18), Items number 19 through 25 may be repeated here. It is recommended that the multiple case option be used only to change angle of attack, thus only Items 19 and 20 are actually repeated. Since the jet model can be assumed independent of angle of attack, this is not a severe limitation. The program will allow all Items 19 through 25 to be input for each run, but this will eliminate the option of placing the jet parameters in permanent storage for future use.

Upon completion of the calculations specified by the above input deck, the program returns to the beginning. Additional input decks, starting with Item 1, may be stacked one after another. If the option involving the storing and retreiving of the influence matrix and jet parameters are used, it is recommended that stacking of cases be avoided. Several sample cases illustrating various types of runs are discussed in the following section.

Sample Cases

In this section, sample cases are described to illustrate the input preparation and the use of the program. The first sample case is a complete calculative example involving a two-engine USB configuration with rectangular cross-section jets (ref. 6). Other sample input decks are provided to illustrate the options described in the previous section.

The vortex-lattice layout on the wing and flaps of the two-engine USB configuration from reference 6 is shown in figure 3. The Coanda flap deflection chosen for this case is 32°. This particular configuration and lattice arrangement are used extensively for the comparisons with data in reference 1.

The Coanda flap, located directly behind the engine, is modeled with three flaps. Each flap has a chord of approximately 13 percent of the wing chord. The deflection angles of flaps 1, 2, and 3 are 12°, 22°, and 32°, respectively. The midspan double slotted flaps, flaps 4 and 5, (δ_f = 15° and 32°) and the aileron, flap 6, (δ_f = 20°) are modeled as single flap segments as illustrated in figure 3. A total of 136 panels make up the vortex lattice model.

The vortex ring jet wake model is set up using the guidelines discussed in the Jet Wake Specification section. The actual inlet of the nacelle is located at X = 2.34 m (7.68 ft) ahead of the wing leading edge. This is a longer run length than required by the jet model; therefore, the model inlet is placed at X_Q = 0.61 m (2.0 ft). The spanwise location of the centerline of the nozzle is at Y_Q = -1.14 m (-3.73 ft). For this particular case, a total thrust coefficient of two (C_μ = 2) is chosen; therefore, the individual engine thrust coefficient is equal to one (C_T = 1.0). Using information on nozzle exit velocities provided in reference 6, the density ratio, ρ/ρ_j = 1.25, is obtained from equation (3). The expansion of the jet from the nozzle is specified in the following manner. From figure 4, the jet velocity ratio at the flap trailing edge is approximately U/U_o = 0.7. Lacking more detailed information on the actual spreading of the wake, it is assumed that the jet cross section maintains a constant aspect ratio (a/b = 6) over its entire length.

A complete input deck, set up for the above sample case, is shown in figure 7(a). This deck is organized to carry out the following series of calculations. The influence matrix is computed and stored on tape 8 where it is available for permanent storage if the user desires. Three successive cases (NRHS = 3) are specified, the first being at $\alpha = 0°$. A general jet model is specified (KJET = 1, KEI = 0), a tangent USB jet is set up by the program, and the jet induced velocities at wing-flap control points are computed. The jet parameters and induced velocity field are stored on tape 4 (KUNIT = 1) for use at other angles of attack and where they are available for permanent storage if desired. Notice that the wing panels which normally lie inside the fuselage are omitted from the jet induced velocity calculation (NVLP = 10). The force calculation is carried out twice, once considering the entire vortex lattice model, and the second time omitting the ten panels which fall in the nacelle region on the wing (NJPNL = 10). The last angles of attack, $\alpha = 8.5$ and 20°, use the set of jet induced velocities calculated at $\alpha = 0°$ at the wing and flap control points (KJET = 2, KEI = 1) for a normal loading calculation. This ends the first input deck. The execution time for this calculation is approximately 50 seconds on the CDC 6600 computer.

A second input deck for the same model with greater flap deflection ($\delta_f = 72°$) is shown in figure 7(b). This deck is set up to calculate the influence matrix and store it on a permanent file if desired. One angle of attack is specified for this, and the calculation is carried out for a power-off condition. Typical execution time for this deck is approximately 100 seconds on the CDC 6600 computer.

DESCRIPTION OF OUTPUT

This section describes the output from the USB program. The contents of a typical set of output from one of the previously described sample cases is discussed. This is followed by a description of some of the program stops and error messages which may occur during execution of the program.

Sample Case

The output generated during the execution of the sample case shown in figure 7(a) is presented in figure 8. The contents of each page of output are described in the following paragraphs. For purposes of this discussion, a page of output is defined as the information printed immediately following a "new page" request in the print commands. Thus, a defined page of output may actually contain several printed pages of copy. The quantity of information on a page of output will depend, in part, on the size of the lattice used to represent the lifting surfaces.

The first page of output, shown as figure 8(a), is headed by the program title "USB AERODYNAMIC PREDICTION PROGRAM," followed by the identification information on the several cards at the front of the input deck. This is followed by the reference quantities consisting of the reference area and length and the center of moment location. Next on the first page is the wing input data. All of the input describing the wing geometry and lattice arrangement is included in this section.

Output page 2 in figure 8(b) contains all the input data describing the flaps including the geometry and the lattice arrangement. Also printed on this page are the coordinates of the four corners of each flap in a coordinate system fixed in the flap with the origin at the leading edge of the inboard chord of the flap. The purpose of these coordinates is two-fold. First, they illustrate the slightly distorted shape of the flaps that occurs because the flaps are attached to swept trailing edges of the upstream surface. The flaps are required to span a certain length which is defined in planform; therefore, the actual surface must be longer when it is deflected around a swept hinge line. Second, the coordinates are useful in locating the flap loading center of pressure defined in the flap coordinate system and printed on a later page.

Output page 3 in figure 8(c) is headed with the title "HORSESHOE VORTEX PROPERTIES." This table lists all the properties of the lattice elements on each lifting surface. The numbers in parenthesis on the line defining the flap number and the region number is the absolute flap number to be used when specifying the flaps with direct jet interference. The quantities in the last column on this page labeled "ALPHAL(J)" are the input values of combined twist and camber. This table completes the configuration dependent information. The first item following the table is a list of the locations at which wing and flap trailing legs are corrected if requested (NIDF > 0). Following this is a single line containing the angle of attack and the option indices from Items 1 and 19 of the input deck. The next line of output contains the flap numbers on which direct jet interference occurs. The last line of output is the input value of the jet turning efficiency.

The fourth page of output headed with the title "INPUT JET PARAMETERS," is a listing of the jet input information as shown in figure 8(d). The variables printed are the same values input via the card deck with the addition of two columns of numbers. The variable SCL is the curvilinear distance measured along the centerline in the same units as the other centerline distance variables. The last column, identified as P, is the perimeter of the jet at the particular input station. The quantity "GAMMA/V" corresponds to equation (4).

The fifth page of output, figure 8(e), has the title "JET PARAMETERS FOR TANGENT USB JET." The first half of this page of output contains an expanded table of jet centerline parameters corresponding to the centerline of the jet, positioned so that it is tangent to the upper wing and flap surfaces, but displaced slightly upward so that it does not directly touch the lifting surfaces. The last half of this page contains the coordinates of the lower surface of the jet boundary. The coordinates XS,YS,ZS define the center of the bottom jet surface; and the coordinates XSN,YSN,ZSN and XST,YST,ZST define the corner points of the inboard and outboard edges, respectively, of the jet lower surface. These points are computed so that the lower jet surface is parallel to the wing and flap surfaces. The last line of output contains the panel numbers from which the jet induced velocities are omitted (NVLP > 0).

The next page of output shown in figure 8(f) is the first output from the program after the circulation strengths are computed. This page, labeled "HORSESHOE VORTEX STRENGTHS FOR ALPHA = xx.x DEGREES," contains the computed circulation strength on each lattice element. The circulation strengths (GAMMA/V) are printed in the last full column on the page. Also shown on this page are the externally induced jet velocities at each control point. These velocities, UEI, VEI, and WEI are made dimensionless by the free-stream velocity, and their positive directions are defined according to the wing coordinate system; that is, UEI is positive forward and WEI is positive downward. The unlabeled column of numbers on the right side of the page denotes the position of the panels relative to the jet wakes. A zero in this column indicates the panel to be outside the direct influence of the jet. A one (1) in this column indicates that the panel is near the jet boundary and is likely to receive direct interference from the jet. A number greater than 1 (i.e., jet number + 1) indicates that the panel is directly beneath the jet and is receiving maximum jet interference.

The output shown in figure 8(g) is headed at the top "AERODYNAMIC LOADING RESULTS FOR ALPHA = xx.xx DEG." This heading is preceded by a heading "TRADITIONAL METHOD" or "PRESSURE INTEGRATION METHOD" which indicates the calculation procedure used to obtain the individual panel forces. The former method is the usual $\vec{V} \times \vec{\Gamma}$ technique generally used with vortex lattice schemes. The latter method involves the calculation of the upper and lower surface pressure coefficients using the Bernoulli equation. Next is a reiteration of the reference quantities. These are followed by the spanwise load distributions. On each lifting surface at each spanwise lattice station the span-load coefficient, the section normal-force coefficient, and the section axial-force coefficient are presented. These results are normal and axial to the plane of the particular lifting surface. Following the complete table of section coefficients are the wing-alone force and moment coefficients. These results are for both right and left wing panels. The axial force, CAW, and the drag force, CDW, are both defined as positive aft. The pitching moment is positive in the direction that tends to increase the angle of attack of the wing.

The next section of output on this page is the individual flap force and moment coefficients. These coefficients are for the flaps on the left side of the configuration only. CNF is normal to the individual flap surface and the center of pressure of the normal force on this flap is at XF(CNF) and YF(CNF) where these coordinates are in the flap coordinate system defined in figure 8(b). The axial-force coefficient, CAF, and its spanwise center of pressure, YF(CAF), follow. The spanwise force, CYF, and its center of pressure, XF(CYF), are the next items; and finally, the hinge-moment coefficient, CHF, is the last item. The sign convention of the flap hinge moments is such that a positive hinge moment would tend to increase the flap deflection angle. The hinge moments are taken about the flap leading edge. The last items on this page are the complete configuration force and moment coefficients. These are resolved into the wing coordinate system and the sign convention is consistent with that described for the wing alone.

If $\Delta p/q$ distributions are requested, they are output on the next page shown in figure 8(h). The chordwise location, X/C, at which the pressure coefficients are calculated corresponds to the location of the bound leg in each lattice element. It should be remembered that the pressure is constant over the entire lattice element.

The next page of output shown in figure 8(i) is output only if a second calculation of the forces with certain panels removed has been requested (NJPNL > 0). This page is identical to figure 8(g) with the addition of note at the top identifying the panel numbers from which the forces are omitted.

The last page of output containing the induced velocity field at specified field points is shown in figure 8(j). Note that both wing-flap perturbation velocities and total velocities are printed on this page. This concludes the output for the first angle of attack. If additional angles of attack are requested, the output starting with figure 8(e) is repeated for each angle of attack.

Error Messages and Program Stops

The following error messages may be printed during program execution.

"EXECUTION TERMINATED, ERROR IN DS"

is printed when the vortex spacing is input as zero or less than zero. This is a fatal error and program terminates at a "STOP" statement.

"JET x OUTBOARD OF WING TIP"

is printed as a warning only to indicate a possible error in the spanwise location of jet "x". Execution will continue, but the program will run into difficulties when it tries to compute jet induced velocities.

"JET x OUTBOARD OF FLAP y"

is printed when the spanwise location jet "x" is not compatible with the flap numbers specified for direct jet interference. This is a fatal error, and the program terminates execution at STOP 16 or STOP 36 in Subroutine JETCL.

The program has a number of error STOPs built into it to prevent the user from executing the program with incorrect input data. These STOP's are identified in the following table.

STOP NO.	SUBROUTINE/LOCATION	PROBABLE CAUSE
STOP	JET/JET 362	DS $\leq$ 0.0 in Item 23.
STOP 1	USBMAIN/USB 123	Normal stop at end of execution.
STOP 16	JETCL/JCL 101	Incorrect YQ in Item 23, or incorrect flap numbers, NFJN, input in Item 19.
STOP 27	JETCL/JCL 156	Too many entries in jet table in Item 24. Reduce number of entries as per Jet Wake Specification section.
STOP 32	JETCL/JCL 202	Input jet length is too short to cover wing and flaps. Move last entry in table in Item 24 farther downstream.
STOP 36	JETCL/JCL 260	Same as STOP 16.
STOP 50	JETCL/JCL 343	Same as STOP 27.
STOP 52	JETCL/JCL 306	Same as STOP 32.
STOP 60	JETCL/JCL 380	Same as STOP 32.

PROGRAM LISTING

The USB aerodynamic prediction program consists of a main program, USBMAIN, and twenty-three subroutines. Each deck is identified by a three-letter code in columns 74-76 and each deck is sequenced with a three-digit number in columns 78-80. The table below will act as a table of contents for the program listing on the following pages.

```
      PROGRAM USBMAIN(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE4,TAPE8)
C*********************************************************************
C
C     TAPE4 IS THE INPUT AND OUTPUT UNIT FOR THE JET INDUCED VELOCITIES
C     TAPE8 IS THE INPUT AND OUTPUT UNIT FOR THE FVN ARRAY
C
C*********************************************************************
C
C     WING AND MULTIPLE FLAP VORTEX LATTICE PROGRAM WITH DEFLECTED WAKE
C
C      MODIFIED TO INCLUDE JET INDUCED VELOCITY FIELD CALCULATION
C      FROM USB JETS TANGENT TO UPPER SURFACE OF WING AND FLAPS
C
C     DIMENSION STATEMENT
C
      DIMENSION HEAD(20)
      DIMENSION U(2),V(2),W(2),XFPT(50),YFPT(50),ZFPT(50)
C
C     TYPE STATEMENT
C
      LOGICAL EXVEL
C
C     COMMON STATEMENTS
C
      COMMON /REFQUA/ SSPAN,SREF,REFL,XM,ZM
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /CPDAT/ ALPHAL(250),XCP(250),YCP(250),ZCP(250),
     1 CALPHL(250),SALPHL(250)
      COMMON / INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /BLDAT/ XBL(250),YBL(250),ZBL(250),TPSI(250),SW(250)
      COMMON /RSIDE/ CIR(250),UEI(250),VEI(250),WEI(250)
      COMMON /ATAK/ SINALF,COSALF
      COMMON /RVELS/ UP,VP,WP
      COMMON /XYZCL/ NJET,NCYL(2),XQ(2),YQ(2),ZQ(2),GAMVJ(2),DS(2),
     1 RHO(2),CMU(2),XCLR(2,25),YCLR(2,25),ZCLR(2,25),THETA(2,25),
     2                 BCLR(2,25),AJET(2,25),BJET(2,25),DSFACT(2,25),
     3                  UCL(2,25), VCL(2,25), WCL(2,25),  CFJ,CFK
      COMMON /NFJCL/ NFJ,NFJN(5)
      COMMON /CLDAT/ NSS(2),SS(2,11),XSS(2,11),YSS(2,11),ZSS(2,11),
     1                 TSS(2,11),BSS(2,11),ASS(2,11),XSN(2,11),YSN(2,11),
     2                 ZSN(2,11),XST(2,11),YST(2,11),ZST(2,11),DSS(2,11)
      COMMON /PTDAT/ NPTJ(2,250),NCRCT
      COMMON /NDIFF/ NIDF,IDF(10)
      COMMON /LINSOL/ IP(300)
      COMMON /FTLV/ NVTLF
      COMMON /FPNL/ NPRINT,NJPNL,JPNL(30)
      COMMON /JETCIR/ JFLP(150),LJFLP,CIRJ(150),CNJ(150),CAJ(150)
      COMMON /FRCVEL/ NFRC
      COMMON /JETEFF/ ETAJ
      COMMON /FRCTL/ NTLF
C
C     BLANK COMMON -- INCREASE LENGTH IF REQFL PACKAGE NOT AVAILABLE
C
      COMMON FVN(1)
C
C     FORMAT STATEMENTS
C
  701 FORMAT(16I5)
  702 FORMAT(1H1,20X,34HUSB AERODYNAMIC PREDICTION PROGRAM //)
  703 FORMAT(20A4)
  704 FORMAT(1X,20A4)
  705 FORMAT(8F10.0)
  706 FORMAT(//5X,57HREFERENCE QUANTITIES USED IN FORCE AND MOMENT CALCU
     1LATION/10X,4HAREA,10X,1H=,F11.5/10X,6HLENGTH,8X,1H=,F11.5/10X,
     213HMOMENT CENTER/15X,2HXM,7X,1H=,F11.5/15X,2HZM,7X,1H=,F11.5
     3    ,     10X,2F10.3)
  722 FORMAT(1H1,45X,27HHORSESHOE VORTEX PROPERTIES//12X,10(1H*),11H WIN
     1G DATA ,10(1H*))
  723 FORMAT(/1X,6HVORTEX,2X,34H=COORDINATES OF BOUND LEG MIDPOINT,2X,
     1 34H===COORDINATES OF CONTROL POINT===,2X,10HS.L. SWEEP,2X,
     2  10HHALF=WIDTH,5X,7HSURFACE/1X,6HNUMBER,102X,5HSLOPE/6X,1HJ,6X,
     3 6HXBL(J),6X,6HYBL(J),6X,6HZBL(J),6X,6HXCP(J),6X,6HYCP(J),6X,
     4  6HZCP(J),6X,6HPSI(J),7X,5HS=(J),3X,9HALPHAL(J)/)
  724 FORMAT(4X,I3,9(2X,F10.5))
  725 FORMAT(/12X,10(1H*),6HREGION,I2,5H FLAP,I2,6H DATA ,10(1H*),
     1        2H (,I2,1H) )
  726 FORMAT(1H1,20X,39HHORSESHOE VORTEX STRENGTHS FOR ALPHA = ,
     1  F5.1,8H DEGREES//12X,10(1H*),11H WING DATA ,10(1H*) )
  727 FORMAT(/1X,6HVORTEX,2X,34H=====CONTROL POINT COORDINATES====,2X,
     1  34H===EXTERNALLY INDUCED VELOCITIES==              /   1X,6HNUMBER
     2 /6X,1HJ,6X,6HXCP(J),6X,6HYCP(J),6X,6HZCP(J),6X,6HUEI(J),6X,
     3 6HVEI(J),6X,6HWEI(J),5X,7HGAMMA/V  /)
  728 FORMAT(4X,I3,7(2X,F10.5),2I7)
  732 FORMAT(F10.5,14I5)
  734 FORMAT (1H1,28X,44HINDUCED VELOCITIES AT SPECIFIED FIELD POINTS //
     1          40X,61HI======== WING/FLAP ==========I======= WING/FLAP+VI
     2NF ======I/43X,23HPERTURBATION VELOCITIES  /
     3  15X,1HX,9X,1HY,9X1HZ,4X,2(4X,6HU/VINF,4X6HV/VINF,4X6HW/VINF ))
  735 FORMAT(10X,9F10.5)
  736 FORMAT (//10X28HNO JET INTERFERENCE ON FLAPS)
  737 FORMAT (//10X25HJET INTERFERENCE ON FLAPS,3I4)
  738 FORMAT (// 10X,41HWING TRAILING LEGS CORRECTED AT Y(I), I = ,10I4)
  740 FORMAT (1H1,20X,18HTRADITIONAL METHOD )
  741 FORMAT (1H1,20X,27HPRESSURE INTEGRATION METHOD  )
  745 FORMAT (/10X,24HJET TURNING EFFICIENCY = F5.2)
  752 FORMAT (////10X5HALPHA,5X4HNFVN,4X5HNUNIT,2X5HNFPTS,3X6HNPRINT,
     1            3X4HKJET,5X3HKEI,4X5HKUNIT,3X5HNLOAD,3X5HNJPNL,3X4HMFRC,
     2            4X4HNCFJ,4X4HNTLF,5X3HNFJ          /5XF10.3,13I8)
  755 FORMAT (1H1,28X,44HINDUCED VELOCITIES AT SPECIFIED FIELD POINTS //
     1          40X,61HI======== WING/FLAP ==========I=== WING/FLAP+JET+VI
     2NF ======I/43X,23HPERTURBATION VELOCITIES  /
     3  15X,1HX,9X,1HY,9X1HZ,4X,2(4X,6HU/VINF,4X6HV/VINF,4X6HW/VINF ))
C
C     CONSTANTS
C
      DATA DTOR/.01745329/,FOURPI/12.56637062/,ZERO/0./
      NVTLF=0
      NJET=0
      CFK=0.0
      NFRC=0
C
C         OPTIONS FOR CALCULATING, STORING, AND REUSING FVN ARRAY....
C                NFVN=0 , NUNIT=0    =   CALCULATE FVN, DO NOT STORE
C                NFVN=0 , NUNIT=8    =   CALCULATE FVN, STORE ON TAPE8
C                NFVN=1 , NUNIT=8    =   READ FVN ARRAY FROM TAPE8
C
C           NFPTS=NUMBER OF FIELD POINTS AT WHICH WING=FLAP INDUCED
C                     VELOCITIES ARE TO BE COMPUTED
C
 1000 READ (5,701) NHEAD,NFVN,NUNIT,NFPTS,NPRINT
      IF(EOF(5)) 1,2
    1 STOP 1
    2 CONTINUE
      IF (NFVN.GT.0 .AND. NUNIT.LE.0) NFVN=0
      IF (NUNIT.NE.0 .AND. NUNIT.NE.8) NUNIT=8
      WRITE(6,702)
C     INPUT AND OUTPUT CASE IDENTIFYING INFORMATION
      DO 3 I=1,NHEAD
      READ(5,703) HEAD
    3 WRITE(6,704) HEAD
C
C     INPUT AND OUTPUT REFERENCE QUANTITIES AND MOMENT CENTER LOCATION
C
      READ(5,705) SREF,REFL,XM,ZM ,ETAJ
      WRITE(6,706) SREF,REFL,XM,ZM
      IF (ETAJ.LE.0.0) ETAJ=1.0
C
C     INPUT AND OUTPUT WING DATA AND LAYOUT WING VORTEX LATTICE
C
      CALL WNGLAT
C
C     INPUT NUMBER OF FLAP REGIONS, NFREG
C         NIDF = NUMBER OF SEMISPAN STATIONS AT WHICH TRAILING LEGS
C                FROM WING VORTICES MUST BE CORRECTED FOR DIFFERENTIAL
C                FLAP DEFLECTION ANGLES
C         IDF  = SEMISPAN STATIONS CORRESPONDING TO FLAP JUNCTIONS
C                    (IDF .NE. 1  OR  IDF .NE. MSW+1)
C
      READ (5,701) NFREG,NIDF,(IDF(I),I=1,NIDF)
C
C     INPUT DATA FOR ALL FLAPS AND LAY OUT VORTICES
C
      NFLAPS =0
      IF (NFREG.GT.0) CALL FLPLAT
```

```
C
C     COMPUTE SINE AND COSINE OF LOCAL ANGLE OF ATTACK DUE TO TWIST AND
C     CAMBER
C
      DO 41 J=1,MTOT
      ALF=ATAN(ALPHAL(J))
      CALPHL(J)=COS(ALF)
   41 SALPHL(J)=SIN(ALF)
C
C     WRITE WING VORTEX DATA
C
      WRITE(6,722)
      WRITE(6,723)
      DO 50 K=1,MW
      PSIGH=ATAN(TPSI(K))/DTOR
   50 WRITE(6,724) K,XBL(K),YBL(K),ZBL(K),XCP(K),YCP(K),ZCP(K),PSIGH,
     1  SW(K),ALPHAL(K)
      IF(NFLAPS.EQ.0) GO TO 65
C
C     WRITE FLAP VORTEX DATA
C
      DO 60 NF=1,NFLAPS
      WRITE (6,725) IDFLAP(NF,1),IDFLAP(NF,2),NF
      WRITE(6,723)
      KL=MSTART(NF)
      KU=MEND(NF)
      DO 55 K=KL,KU
      PSIGH=ATAN(TPSI(K))/DTOR
   55 WRITE(6,724) K,XBL(K),YBL(K),ZBL(K),XCP(K),YCP(K),ZCP(K),PSIGH,
     1  SW(K),ALPHAL(K)
   60 CONTINUE
   65 CONTINUE
C
C       CORRECT TRAILING LEG POSITIONS AT FLAP JUNCTIONS
      IF (NIDF.LE.0) GO TO 66
      CALL TRLG
      WRITE (6,738) (IDF(J),J=1,NIDF)
   66 CONTINUE
C
C*************************************************************************
C
C      ADD CORE AREA FOR INFLUENCE COEFFICIENT MATRIX
C     IF REQFL IS NOT AVAILABLE , REMOVE THIS SECTION AND INCREASE
C     THE DIMENSIONS OF FVN IN BLANK COMMON, ABOVE, TO MTOT*MTOT
C        WHERE MTOT = TOTAL NUMBER OF VORTEX PANELS ON WING AND FLAP
C
      IFLB=0
      CALL REQFL(IFLB)
      LFL=IFLB+MTOT*MTOT-1
      CALL REQFL(LFL)
C
C*************************************************************************
      IF (NFVN.GT.0) GO TO 210
C
C     CALCULATE INFLUENCE COEFFICIENT LEFT HAND SIDE, FVN
C
      CALL INFMAT
C
C     TRIANGLULARIZE LEFT HAND SIDE
C
      CALL LINEQS(MTOT,FVN)
      IF (NUNIT.GT.0) CALL FVNOUT(FVN,MTOT,NUNIT,IP)
      GO TO 211
  210 CALL FVNIN(FVN,MTOT,NUNIT,IP)
  211 CONTINUE
      IF (NFPTS.LE.0) GO TO 212
      DO 209 KJ=1,NFPTS
  209 READ (5,705) XFPT(KJ),YFPT(KJ),ZFPT(KJ)
C
C     READ NUMBER OF RIGHT SIDES, AND FOR EACH FIND VORTEX
C     STRENGTHS AND LOAD DISTRIBUTION
C
  212 READ(5,701) NRHS
      DO 75 KR=1,NRHS
      READ(5,732) ALFA,KJET,KEI,KUNIT,NLOAD,NJPNL,MFRC,NCFJ,NTLF,
     1                 NFJ,(NFJN(KJ),KJ=1,NFJ)
      IF (NJPNL.GT.0) READ (5,701) (JPNL(J),J=1,NJPNL)
C
C        OPTIONS FOR CALCULATING AND STORING JET INDUCED VELOCITY ARRAY
C
C          KJET=0  NO JET CALCULATION, INDUCED VELOCITIES MAY BE INPUT
C              =1  JET CALCULATION
C              =2  JET PARAMETERS AND INDUCED VELOCITIES INPUT
C
C        OPTIONS FOR FORCE CALCULATION METHODS
C              NLOAD=1  CONVENTIONAL METHOD
C              NLOAD=2  INTEGRATED PRESSURES
C              NLOAD=0  BOTH METHODS
C
C          NFJ = NUMBER OF FLAPS IN DIRECT INTERFERENCE WITH JET
C          NFJN = FLAP NUMBER, ALL MUST BE IN SAME REGION
C
C           NJPNL= NUMBER OF PANELS ON WHICH FORCES ARE NOT INCLUDED
C                  (NJPNL.LE.30)
C           JPNL= PANEL NUMBER
C
      IF (KR.GT.1) WRITE (6,702)
      WRITE (6,752) ALFA,NFVN,NUNIT,NFPTS,NPRINT,KJET,KEI,KUNIT,
     1                    NLOAD,NJPNL,MFRC,NCFJ,NTLF,NFJ
      CFJ=NCFJ
      IF (NFJ.EQ.0.AND.KJET.NE.0) WRITE(6,736)
      IF(NFJ.LE.0) GO TO 70
      WRITE (6,737) (NFJN(KJ),KJ=1,NFJ)
      WRITE (6,745) ETAJ
   70 CONTINUE
C
      ALF=ALFA
      ALFA=ALFA*DTOR
      SINALF=SIN(ALFA)
      COSALF=COS(ALFA)
      EXVEL=KJET.NE.0
      IF (KJET-1) 77,71,74
C
C      INPUT INITIAL JET PARAMETERS
C
   71 NTIME=0
   73 CALL JET (MTOT,XCP,YCP,ZCP,UEI,VEI,WEI,NTIME)
      NTIME=NTIME+1
C
C       CALCULATE TANGENT JET CENTERLINE
C
      CALL JETCL
C
C       CALCULATE JET INDUCED VELOCITIES AT WING-FLAP CONTROL POINTS
C
   72 CALL JET (MTOT,XCP,YCP,ZCP,UEI,VEI,WEI,NTIME)
C
      IF (KUNIT.LE.0) GO TO 77
C      STORE EXTERNALLY INDUCED VELOCITIES ON TAPE 4
      CALL UVWOUT
      GO TO 77
   74 CONTINUE
C
C     IF KJET=2, READ EXTERNALLY INDUCED VELOCITIES FROM TAPE 4
C
      CALL UVWIN (KEI)
      DUM=CFK
      CFK=1.0
      NTIME=1
      NCRCT=5
C       PRINT INPUT JET PARAMETERS AND SET UP NPTJ(-,-) ARRAY
      CALL JET (MTOT,XCP,YCP,ZCP,UEI,VEI,WEI,NTIME)
      CFK=DUM
C
   77 CONTINUE
C
C        ADJUST CIRCULATION ON WING-FLAP PANELS TO ACCOUNT FOR JET
C        TURNING, AND CALC. INDUCED VELOCITY AT CONTROL POINTS
      MTIME=1
      CALL JETVEL (MTIME)
C
C
C     CALCULATE RIGHT HAND SIDE OF EQUATIONS
C
      CALL RHSCLC(EXVEL)
```

```
C
C     SOLVE FOR VORTICITY DISTRIBUTION FOR THIS RIGHT HAND SIDE
C
      CALL SOLVE(CIR,FVN,MTOT)
C
C     PRINT VORTEX STRENGTHS
C
      WRITE(6,726) ALF
      WRITE(6,727)
      IF(.NOT.EXVEL) GO TO 85
      IF (LJFLP.LE.0) GO TO 81
      DO 82 NP=1,LJFLP
      NF=JFLP(NP)
   82 CIR(NF)=CIR(NF)+CIRJ(NP)
   81 DO 80 NP=1,MW
      GAMMA=CIR(NP)*FOURPI
   80 WRITE(6,728) NP,XCP(NP),YCP(NP),ZCP(NP),UEI(NP),VEI(NP),WEI(NP),
     1  GAMMA , (NPTJ(J,NP),J=1,NJET)
      GO TO 89
   85 CONTINUE
      DO 88 NP=1,MW
      GAMMA=CIR(NP)*FOURPI
   88 WRITE(6,728) NP,XCP(NP),YCP(NP),ZCP(NP),ZERO,ZERO,ZERO,GAMMA
   89 IF(NFLAPS.EQ.0) GO TO 96
      DO 95 NF=1,NFLAPS
      WRITE (6,725) IDFLAP(NF,1),IDFLAP(NF,2),NF
      WRITE(6,727)
      MS=MSTART(NF)
      ME=MEND(NF)
      IF(.NOT.EXVEL) GO TO 92
      DO 91 NP=MS,ME
      GAMMA=CIR(NP)*FOURPI
   91 WRITE(6,728) NP,XCP(NP),YCP(NP),ZCP(NP),UEI(NP),VEI(NP),WEI(NP),
     1  GAMMA , (NPTJ(J,NP),J=1,NJET)
      GO TO 95
   92 CONTINUE
      DO 93 NP=MS,ME
      GAMMA=CIR(NP)*FOURPI
   93 WRITE(6,728) NP,XCP(NP),YCP(NP),ZCP(NP),ZERO,ZERO,ZERO,GAMMA
   95 CONTINUE
      IF (LJFLP.LE.0) GO TO 96
      DO 83 NP=1,LJFLP
      NF=JFLP(NP)
   83 CIR(NF)=CIR(NF)-CIRJ(NP)
   96 CONTINUE
C
C      ADJUST JET INDUCED CIRCULATION ON FLAP PANELS FOR LOAD CALC.
      MTIME=2
      CALL JETVEL (MTIME)
C
      IF (NLOAD-1) 98,98,97
   98 CONTINUE
C
C     CALCULATE LOADS, FORCES AND MOMENTS  -  TRADITIONAL METHOD
C
      IF (MFRC.GT.0) NFRC=1
      CALL LOAD(EXVEL)
      WRITE (6,740)
      CALL FORCES
      NFRC=0
      IF (NLOAD-1) 97,78,97
   97 CONTINUE
C
C      CALCULATE LOADS, FORCES AND MOMENTS  -  PRESSURE METHOD
C
      IF (MFRC.GT.0) NFRC=1
      CALL LOADCP (EXVEL)
      WRITE (6,741)
      CALL FORCES
      NFRC=0
C
C     CALCULATE VELOCITIES AT SPECIFIED FIELD POINTS
C
   78 IF (NFPTS.EQ.0) GO TO 110
      IF (NJET .LE.0) GO TO 103
      WRITE (6,755)
      GO TO 102
  103 WRITE (6,734)
  102 CONTINUE
      NTIME=-11
      JA=1
      NCRCT=0
      DO 105 J=1,NFPTS
      XFP=XFPT(J)
      YFP=YFPT(J)
      ZFP=ZFPT(J)
      CALL VELSUM (XFP,YFP,ZFP)
      IF (NJET .LE.0) GO TO 104
      CALL JET (JA,XFP,YFP,ZFP,U,V,W,NTIME)
      UJ=UP
      VJ=VP
      WJ=WP
      CALL JTCIRV (XFP,YFP,ZFP,JA)
      UP=UP+UJ
      VP=VP+VJ
      WP=WP+WJ
C              U,V,W ARE COMPONENTS OF TOTAL FLOW FIELD
      U  (1)=U  (1)+UP*COSALF
      V  (1)=V  (1)+VP
      W  (1)=W  (1)+WP*SINALF
      WRITE (6,735) XFP,YFP,ZFP,UP,VP,WP,U(1),V(1),W(1)
      GO TO 105
  104 UJ=UP*COSALF
      VJ=VP
      WJ=WP*SINALF
      WRITE (6,735) XFP,YFP,ZFP,UP,VP,WP,UJ,VJ,WJ
  105 CONTINUE
  110 CONTINUE
      IF (NRHS.GT.1) REWIND 4
   75 CONTINUE
      GO TO 1000
      END
```

```
      SUBROUTINE WNGLAT
C
C     THIS SUBROUTINE READS IN THE WING INPUT DATA AND LAYS OUT THE
C          WING VORTEX LATTICE
C
C     COMMON STATEMENTS
C
      COMMON /TOLRNC/ TOL
      COMMON /REFQUA/ SSPAN,SREF,REFL,XM,ZM
      COMMON / WNGDAT/ Y(30),PSIWLE(30),PSIWTE(30),SPHIW,CPHIW,TPHIW
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /CPDAT/ ALPHAL(250),XCP(250),YCP(250),ZCP(250),
     1 CALPHL(250),SALPHL(250)
      COMMON /TLDAT/ XTER(30),XTEL(30),XTLR(250),YTLR(250),ZTLR(250),
     1 XTLL(250),YTLL(250),ZTLL(250)
      COMMON /BLDAT/ XBL(250),YBL(250),ZBL(250),TPST(250),SW(250)
      COMMON /FTLDAT/ FTLXR(250),FTLXL(250),FTLZR(250),FTLZL(250)
      COMMON /LDCONS/ CONA(250),CONBR(250),CONBL(250),TEMP,TEMR
      COMMON /CHORDS/ CHRDLW(30),CROOTF(10),CTIPF(10)
      COMMON /PRSDAT/NPRESW,NPRESF(10),ELAREA(250),XLE(30)
C
C     DIMENSION STATEMENT
C
      DIMENSION XTE(30)
C
C     FORMAT STATEMENTS
C
  701 FORMAT(10I5)
  702 FORMAT(8F10.0)
  703 FORMAT(//5X,15HWING INPUT DATA)
```

```
  704 FORMAT(//10X,13HREGION NUMBER,I3)
  705 FORMAT(15X,20HINBOARD EDGE CHORD =,F10.5/15X,8HSEMISPAN,11X,1H=,
     1F10.5/15X,14HDIHEDRAL ANGLE,5X,1H=,F10.5)
  706 FORMAT(/15X,I3,43H VORTICES ARE TO BE LAID OUT IN THIS REGION/20X,
     1I2,12H SPANWISE BY,I3,10H CHORDWISE)
  707 FORMAT(/15X,59HSPANWISE LOCATIONS OF TRAILING VORTEX LEGS, SWEEP A
     1NGLES OF/20X,65HWING SECTION TO THE RIGHT AND NUMBER OF FLAPS BEHI
     2ND THIS SECTION//21X,8HSPANWISE,7X,8HLE SWEEP,7X,8HTE SWEEP,7X,
     36HNUMBER/21X,8HLOCATION,37X,8HOF FLAPS)
  708 FORMAT(3F10.0,I5)
  709 FORMAT(15X,3F15.5,9X,I2)
  710 FORMAT(/15X,28HTHIS REGION EXTENDS FROM Y =,F10.5,7H TO Y =,F10.5)
  711 FORMAT(3I5,2F10.0)
  712 FORMAT(/15X,25HINBOARD SIDE-EDGE CHORD =,F10.5/15X,19HTRAILING EDG
     1E SWEEP,5X,1H=,F10.5)
C
C     CONSTANTS
C
      DATA DTOR/0.01745329/,PI/3.14159265/
C
C     INPUT NUMBER OF WING REGIONS
C
      READ (5,701) NWREG
C
C     INPUT REGION 1 DATA AND LAY OUT VORTICES
C
      READ (5,702) CRW,SSPAN,PHID
      NREG=1
      WRITE (6,703)
      WRITE (6,704) NREG
      WRITE (6,705) CRW,SSPAN,PHID
      TOL   =(SSPAN*15.0E-05)**2
      READ (5,701) NCW,MSW,NTCW,NUNI,NPRESW
      MW=NCW*MSW
      MTOT=MW
      WRITE (6,706) MW,MSW,NCW
      IMAX=MSW+1
      WRITE (6,707)
      DO 10 I=1,IMAX
      READ (5,708) Y(I),PSIWLE(I),PSIWTE(I),NFSEG(I)
      NCWI(I)=NCW
      IF (I.EQ.1) WRITE (6,709) Y(I)
      IF (I.NE.1)
     1WRITE (6,709) Y(I),PSIWLE(I),PSIWTE(I),NFSEG(I)
      IF (Y(I).GT.0.0) Y(I)=-Y(I)
   10 CONTINUE
      DO 11 I=1,MSW
   11 NFSEG(I)=NFSEG(I+1)
      IF (NTCW.NE.0) GO TO 21
      DO 20 J=1,MW
   20 ALPHAL(J)=0.0
      GO TO 25
   21 IF (NUNI.NE.0) GO TO 23
      MN=0
      DO 22 JNW=1,MW,NCW
      MN=MN+NCW
   22 READ (5,702) (ALPHAL(J),J=JNW,MN)
      GO TO 25
   23 READ (5,702) (ALPHAL(J),J=1,NCW)
      DO 24 J=2,MSW
      JJ=(J-1)*NCW
      DO 24 K=1,NCW
      KK=JJ+K
   24 ALPHAL(KK)=ALPHAL(K)
   25 CONTINUE
C
C     LAY OUT REGION 1 WING VORTICES
C
      TEMP=16.0*PI/SREF
      TEMR=0.5*TEMP
      PHI=DTOR*PHID
      SPHIW=SIN(PHI)
      CPHIW=COS(PHI)
      TPHIW=SPHIW/CPHIW
      FNCW=NCW
      XLE(1)=0.0
      XTE(1)=-CRW
      CTLL=CRW
      DUMA=TEMR/FNCW
C
C     LOOP OVER CHORDWISE ROWS
C
      DO 40 I=2,IMAX
      IM=I-1
      LASTF(IM)=0
      TLRY=Y(IM)
      TLLY=Y(I)
      TLRZ=TLRY*TPHIW
      TLLZ=TLLY*TPHIW
      TPSILE=TAN(PSIWLE(I)*DTOR)
      TPSITE=TAN(PSIWTE(I)*DTOR)
      DY=TLLY-TLRY
      XLE(I)=XLE(IM)+DY*TPSILE
      XTE(I)=XTE(IM)+DY*TPSITE
      RLX=(XLE(I)+XLE(IM))*0.5
      XTER(IM)=XTE(IM)
      XTEL(IM)=XTE(I)
      DPSI=TPSILE-TPSITE
      CTLR=CTLL
      CTLL=CTLR+DY*DPSI
      CBL=(CTLR+CTLL)*0.5
      DCRD=CBL/FNCW
      CHRDLW(IM)=CBL
      TLRX=XLE(IM)
      TLLX=XLE(I)
      TCONBR=DUMA*CTLR
      TCONBL=DUMA*CTLL
C
C     LOOP OVER VORTICES IN THIS ROW
C
      JJ=(I-2)*NCW
      DO 41 J=1,NCW
      IV=JJ+J
      FJ=J
      FACB=(FJ-0.75)/FNCW
      FACC=(FJ-0.25)/FNCW
      XCP(IV)=RLX-FACC*CBL
      XTLR(IV)=TLRX-FACB*CTLR
      YTLR(IV)=TLRY
      ZTLR(IV)=TLRZ
      XTLL(IV)=TLLX-FACB*CTLL
      YTLL(IV)=TLLY
      ZTLL(IV)=TLLZ
      FTLXR(IV)=TLRX-FACC*CTLR
      FTLZR(IV)=TLRZ
      FTLXL(IV)=TLLX-FACC*CTLL
      FTLZL(IV)=TLLZ
      ELAREA(IV)=DCRD
      CONBR(IV)=TCONBR
      CONBL(IV)=TCONBL
   41 CONTINUE
   40 CONTINUE
C
C     LOOP OVER OTHER WING REGIONS IF PRESENT
C
      IF (NWREG.EQ.1) GO TO 100
      DO 50 N=2,NWREG
      WRITE (6,704) N
      READ (5,701) IIN,IOUT
      WRITE (6,710) Y(IIN),Y(IOUT)
      READ (5,711) NCW,NTCW,NUNI,CIN,TESWP
      NSW=IOUT-IIN
      NVOR=NSW*NCW
      WRITE (6,706) NVOR,NSW,NCW
      WRITE (6,712) CIN,TESWP
C
C     LAY OUT VORTICES FOR THIS REGION
C
      FNCW=NCW
      CTLL=CIN
      DUMA=TEMR/FNCW
C
C     LOOP OVER CHORDWISE ROWS
C
      IBEG=IIN+1
      DO 60 I=IBEG,IOUT
```

```
      IM=I-1
C
C     SHIFT VORTEX DATA SO NEW VORTICES CAN BE INSERTED
C
      NCWSUM=0
      DO 61 J=1,IM
   61 NCWSUM=NCWSUM+NCWI(J)
      MW=MW+NCW
      MTOT=MW
      NCWSUM=NCWSUM+1
      IF (I.EQ.IMAX) GO TO 63
      J=MW+1
      K=J-NCW
   62 J=J-1
      K=K-1
      XCP(J)=XCP(K)
      XTLR(J)=XTLR(K)
      YTLR(J)=YTLR(K)
      ZTLR(J)=ZTLR(K)
      XTLL(J)=XTLL(K)
      YTLL(J)=YTLL(K)
      ZTLL(J)=ZTLL(K)
      FTLXR(J)=FTLXR(K)
      FTLZR(J)=FTLZR(K)
      FTLXL(J)=FTLXL(K)
      FTLZL(J)=FTLZL(K)
      ELAREA(J)=ELAREA(K)
      CONBR(J)=CONBR(K)
      CONBL(J)=CONBL(K)
      ALPHAL(J)=ALPHAL(K)
      ALPHAL(K)=0.0
      IF (K.GT.NCWSUM) GO TO 62
   63 NCWI(IM)=NCWI(IM)+NCW
      TLRY=Y(IM)
      TLLY=Y(I)
      TLRZ=TLRY*TPHIW
      TLLZ=TLLY*TPHIW
      BLX=(XTE(I)+XTE(IM))*0.5
      TPSILE=TAN(PSIWTE(I)*DTOR)
      TPSITE=TAN(TESWP*DTOR)
      PSIWTE(I)=TESWP
      DPSI=TPSILE-TPSITE
      DY=TLLY-TLRY
      CTLR=CTLL
      CTLL=CTLR+DY*DPSI
      CBL=(CTLR+CTLL)*0.5
      DCRD=CBL/FNCW
      CHRDLW(IM)=CHRDLW(IM)+CBL
      TLRX=XTE(IM)
      TLLX=XTE(I)
      XTER(IM)=XTE(IM)-CTLR
      XTEL(IM)=XTE(I)-CTLL
      TCONBR=DUMA*CTLR
      TCONBL=DUMA*CTLL
      IF (NTCW.NE.0.AND.I.EQ.IBEG) READ (5,702) (XBL(M),M=1,NCW)
      IF (NTCW.NE.0.AND.I.GT.IBEG.AND.NUNI.EQ.0) READ (5,702) (XBL(M),
     1 M=1,NCW)
C
C     LOOP OVER VORTICES IN THIS ROW
C
      JJ=NCWSUM-1
      DO 70 J=1,NCW
      IV=JJ+J
      FJ=J
      FACB=(FJ-0.75)/FNCW
      FACC=(FJ-0.25)/FNCW
      XCP(IV)=BLX-FACC*CBL
      XTLR(IV)=TLRX-FACB*CTLR
      YTLR(IV)=TLRY
      ZTLR(IV)=TLRZ
      XTLL(IV)=TLLX-FACB*CTLL
      YTLL(IV)=TLLY
      ZTLL(IV)=TLLZ
      FTLXR(IV)=TLRX-FACC*CTLR
      FTLZR(IV)=TLRZ
      FTLXL(IV)=TLLX-FACC*CTLL
      FTLZL(IV)=TLLZ
      ELAREA(IV)=DCRD
      CONBR(IV)=TCONBR
      CONBL(IV)=TCONBL
      ALPHAL(IV)=0.0
      IF (NTCW.GT.0) ALPHAL(IV)=XBL(J)
   70 CONTINUE
   60 CONTINUE
   50 CONTINUE
C
C     CALCULATE OTHER WING VORTEX QUANTITIES
C
  100 DUM=0.5/CPHIW
      DO 101 J=1,MW
      XBL(J)=(XTLL(J)+XTLR(J))*0.5
      YBL(J)=(YTLL(J)+YTLR(J))*0.5
      ZBL(J)=(ZTLL(J)+ZTLR(J))*0.5
      YCP(J)=YBL(J)
      ZCP(J)=ZBL(J)
      TPSI(J)=(XTLR(J)-XTLL(J))/ (YTLR(J)-YTLL(J))*CPHIW
      SW(J)=DUM*(YTLR(J)-YTLL(J))
      ELAREA(J)=ELAREA(J)*SW(J)*2.0
      CONA(J)=TEMP*SW(J)
  101 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE FLPLAT
C
C     THIS SUBROUTINE READS IN THE FLAP DATA AND LAYS OUT THE FLAP
C          VORTICES INCLUDING THE WING VORTEX SEGMENTS IN THE FLAPS
C
C     COMMON STATEMENTS
C
      COMMON /CPDAT/ ALPHAL(250),XCP(250),YCP(250),ZCP(250),
     1 CALPHL(250),SALPHL(250)
      COMMON /BLDAT/ XBL(250),YBL(250),ZBL(250),TPSI(250),SW(250)
      COMMON / WNGDAT/ Y(30),PSIWLE(30),PSIWTE(30),SPHIW,CPHIW,TPHIW
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /TLDAT/ XTER(30),XTEL(30),XTLR(250),YTLR(250),ZTLR(250),
     1 XTLL(250),YTLL(250),ZTLL(250)
      COMMON / INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /FLPDAT/ SDELXZ(10),CDELXZ(10),YF(30,10),SPHIF(10),
     1CPHIF(10)
      COMMON /WKDATW/ XWKRW(30,3),YWKRW(30,3),ZWKRW(30,3),XWKLW(30,3),
     1YWKLW(30,3),ZWKLW(30,3)
      COMMON /WKDATF/ XWKRF(30,2,10),YWKRF(30,2,10),ZWKRF(30,2,10),
     1XWKLF(30,2,10),YWKLF(30,2,10),ZWKLF(30,2,10)
      COMMON /FTLDAT/ FTLXR(250),FTLXL(250),FTLZR(250),FTLZL(250)
      COMMON /LDCONS/ CONA(250),CONBR(250),CONBL(250),TEMP,TEMR
      COMMON /CHORDS/ CHRDLW(30),CROOTF(10),CTIPF(10)
      COMMON /FLAPLE/XWILE(10),YWILE(10),ZWILE(10),SWPFLE(10)
      COMMON /PRSDAT/NPRESW,NPRESF(10),ELAREA(250),XLE(30)
C
C     FORMAT STATEMENTS
C
  701 FORMAT(1H1,4X,15HFLAP INPUT DATA)
  702 FORMAT(10I5)
  703 FORMAT(/10X,13HREGION NUMBER,I2/15X,9HTHERE ARE,I2,21H FLAPS IN THI
     1S REGION/15X,20HTHEY EXTEND FROM Y =,F10.5,7H TO Y =,F10.5)
  704 FORMAT(8F10.0)
  705 FORMAT(/15X,11HFLAP NUMBER,I3,3X1H(,I2,1H)
     1/20X,21HINBOARD EDGE GAP     =,F10.5/
     120X,21HOUTBOARD EDGE GAP    =,F10.5/20X,21HINBOARD EDGE CHORD   =,
     2F10.5/20X,21HOUTBOARD EDGE CHORD =,F10.5/20X,21HDEFLECTION ANGLE
     3  =,F10.5)
```

```
706 FORMAT(/20XI3,41H VORTICES ARE TO BE LAID OUT ON THIS FLAP/25X,I2,
   112H SPANWISE BY,I3,10H CHORDWISE)
707 FORMAT(/20X,21HSPANWISE LOCATIONS OF/21X,20HTRAILING VORTEX LEGS)
708 FORMAT(25X,F11.5)
709 FORMAT(/20X,41HXF,YF COORDINATES OF FOUR CORNERS OF FLAP/28X,
   1 25H(FLAP LIES IN ZF=0 PLANE)/33X,2HXF,11X,2HYF)
710 FORMAT(25X,2F13.5)
C
C     CONSTANTS
C
      DATA DTOR/0.01745329/
C
      WRITE (6,701)
C
C     LOOP OVER REGIONS
C
      DO 100 NR=1,NFREG
      READ (5,702) NINREG,IIN,IOUT
      WRITE (6,703) NR,NINREG,Y(IIN),Y(IOUT)
      XTEDGI=XTER(IIN)
      YTEDGI=Y(IIN)
      ZTEDGI=YTEDGI*TPHIW
      XTEDGO=XTEL(IOUT-1)
      YTEDGO=Y(IOUT)
      ZTEDGO=YTEDGO*TPHIW
      ANG=0.0
C
C     LOOP OVER FLAPS IN THIS REGION
C
      DO 200 NF=1,NINREG
      NFLAPS=NFLAPS+1
      IDFLAP(NFLAPS,1)=NR
      IDFLAP(NFLAPS,2)=NF
      NFS=NFLAPS
      MSF(NFS)=IOUT-IIN
      NFSEGF(NFS)=NINREG-NF
      READ (5,702) NCF(NFS),          NTCF,NUNI,NPRESF(NFS)
      READ (5,704) GAPIN,CRFIN,GAPOUT,CRFOUT,DELXZ
      WRITE (6,705) NF,NFLAPS,GAPIN,GAPOUT,CRFIN,CRFOUT,DELXZ
      CROOTF(NFS)=CRFIN
      CTIPF(NFS)=CRFOUT
      ANGR=ANG*DTOR
      SANG=SIN(ANGR)
      CANG=COS(ANGR)
      ANG=DELXZ
      XWIN=XTEDGI-GAPIN*CANG
      YWIN=YTEDGI
      ZWIN=ZTEDGI+GAPIN*SANG
      XWILE(NFS)=XWIN
      YWILE(NFS)=YWIN
      ZWILE(NFS)=ZWIN
      XWOUT=XTEDGO-GAPOUT*CANG
      YWOUT=YTEDGO
      ZWOUT=ZTEDGO+GAPOUT*SANG
      DELR=DELXZ*DTOR
      SDELR=SIN(DELR)
      CDELR=COS(DELR)
      SDELXZ(NFS)=SDELR
      CDELXZ(NFS)=CDELR
      XTEDGI=XWIN-CRFIN*CDELR
      ZTEDGI=ZWIN+CRFIN*SDELR
      XTEDGO=XWOUT-CRFOUT*CDELR
      ZTEDGO=ZWOUT+CRFOUT*SDELR
      NV=NCF(NFS)*MSF(NFS)
      MF(NFS)=NV
      MSTART(NFS)=MTOT+1
      MEND(NFS)=MTOT+NV
      MTOT=MEND(NFS)
      WRITE (6,706) NV,MSF(NFS),NCF(NFS)
      MSFP=MSF(NFS)+1
      WRITE (6,707)
      K=IIN-1
      DO 210 J=1,MSFP
      K=K+1
      YF(J,NFS)=Y(K)
210   WRITE (6,708) YF(J,NFS)
      MS=MSTART(NFS)
      ME=MEND(NFS)
      NCFF=NCF(NFS)
      MSFF=MSF(NFS)
      IF (NTCF.NE.0) GO TO 212
      DO 211 K=MS,ME
211   ALPHAL(K)=0.0
      GO TO 216
212   IF (NUNI.NE.0) GO TO 214
      MN=MS-1
      DO 213 JNF=MS,ME,NCFF
      MN=MN+NCFF
213   READ (5,704) (ALPHAL(K),K=JNF,MN)
      GO TO 216
214   NCFL=MS+NCFF-1
      READ (5,704) (ALPHAL(K),K=MS,NCFL)
      MN=MS-1
      DO 215 K=2,MSFF
      KK=(K-1)*NCFF+MN
      DO 215 L=1,NCFF
      LL=KK+L
      LLL=L+MN
215   ALPHAL(LL)=ALPHAL(LLL)
216   CONTINUE
C
C     LAY OUT VORTICES
C
      DXW=XWOUT-XWIN
      DZW=ZWOUT-ZWIN
      XFO=DXW*CDELR-DZW*SDELR
      YFO=YWOUT-YWIN
      ZFO=DXW*SDELR+DZW*CDELR
      TPHIF=ZFO/YFO
      PHIF=ATAN(TPHIF)
      SPHIF(NFS)=SIN(PHIF)
      CPHIF(NFS)=COS(PHIF)
      TPSILE=XFO/YFO
      TPSITE=(XFO-CRFOUT+CRFIN)/YFO
      DPSI=TPSILE-TPSITE
      FNCFF=NCFF
      XLEI=0.0
      CTLL=CRFIN
      CPHI=CPHIF(NFS)
      SWPFLE(NFS)=ATAN(TPSILE *CPHI)
      WRITE (6,709)
      XFF=0.0
      YFF=0.0
      WRITE (6,710) XFF,YFF
      XFF=-CRFIN
      WRITE (6,710) XFF,YFF
      XFF=XFO
      YFF=YFO/CPHI
      WRITE (6,710) XFF,YFF
      XFF=XFO-CRFOUT
      WRITE (6,710) XFF,YFF
      KK=MS-1
C
C     LOOP OVER CHORDWISE ROWS
C
      DO 220 I=2,MSFP
      IM=I-1
      TLRY=YF(IM,NFS)
      TLLY=YF(I,NFS)
      TLRZ=(TLRY-YWIN)*TPHIF
      TLLZ=(TLLY-YWIN)*TPHIF
      DY=TLLY-TLRY
      XLEIM=XLEI
      XLEI=XLEIM+DY*TPSILE
      BLX=(XLEI+XLEIM)*0.5
      CTLR=CTLL
      CTLL=CTLR+DY*DPSI
      CBL=(CTLL+CTLR)*0.5
      DCRD=CBL/FNCFF
      BLZ=(TLRZ+TLLZ)*0.5
      BLY=(TLRY+TLLY)*0.5
      S=-0.5*DY/CPHI
      ELARE=DCRD*S*2.0
      TCONA=TEMP*S
      TCONBL=TEMB*CTLL/FNCFF
```

```
      TCONBR=TEMR*CTLR/FNCFF
C
C     LOOP OVER VORTICES IN THIS ROW
C
      DUMA=BLZ *SDELR+XWIN
      DUMB=TLRZ*SDELR+XWIN
      DUMC=TLLZ*SDELR+XWIN
      DUMD=BLZ *CDELR+ZWIN
      DUME=TLRZ*CDELR+ZWIN
      DUMF=TLLZ*CDELR+ZWIN
      DO 230 K=1,NCFF
      KK=KK+1
      FK=K
      FACB=(FK-0.75)/FNCFF
      FACC=(FK-0.25)/FNCFF
      XCPF=BLX-FACC*CBL
      XTLRF=XLEIM-CTLR*FACB
      XTLLF=XLEI-CTLL*FACB
      FXTLR=XLEIM-CTLR*FACC
      FXTLL=XLEI-CTLL*FACC
      XCP(KK)=XCPF*CDELR+DUMA
      XTLR(KK)=XTLRF*CDELR+DUMB
      XTLL(KK)=XTLLF*CDELR+DUMC
      FTLXR(KK)=FXTLR*CDELR+DUMB
      FTLXL(KK)=FXTLL*CDELR+DUMC
      XBL(KK)=(XTLR(KK)+XTLL(KK))*0.5
      YCP(KK)=BLY
      YTLR(KK)=TLRY
      YTLL(KK)=TLLY
      YBL(KK)=BLY
      ZCP(KK)=-XCPF*SDELR+DUMD
      ZTLR(KK)=-XTLRF*SDELR+DUME
      ZTLL(KK)=-XTLLF*SDELR+DUMF
      FTLZR(KK)=-FXTLR*SDELR+DUME
      FTLZL(KK)=-FXTLL*SDELR+DUMF
      ZBL(KK)=(ZTLR(KK)+ZTLL(KK))*0.5
      SW(KK)=S
      ELAREA(KK)=ELARE
      TPSI(KK)=(TPSILE-FACB*DPSI)*CPHI
      CONA(KK)=TCONA
      CONBR(KK)=TCONBR
      CONBL(KK)=TCONBL
  230 CONTINUE
  220 CONTINUE
C
C     LOCATE INTERSECTION OF WING TRAILING LEGS WITH THIS FLAP
C
      DXW=XWOUT-XWIN
      DYW=YWOUT-YWIN
      DZW=ZWOUT-ZWIN
      IOUTM=IOUT-1
      DO 240 J=IIN,IOUTM
      JP=J+1
      IF (NF.EQ.NINREG) LASTF(J)=NFS
      YY=Y(J)
      FAC=(YY-YWIN)/DYW
      XWKRW(J,NF)=XWIN+FAC*DXW
      YWKRW(J,NF)=YY
      ZWKRW(J,NF)=ZWIN+FAC*DZW
      YY=Y(JP)
      FAC=(YY-YWIN)/DYW
      XWKLW(J,NF)=XWIN+FAC*DXW
      YWKLW(J,NF)=YY
      ZWKLW(J,NF)=ZWIN+FAC*DZW
  240 CONTINUE
C
C     LOCATE INTERSECTION OF UPSTREAM FLAPS TRAILING LEGS WITH THIS FLAP
C
      IF (NF.EQ.1) GO TO 270
      NFF=NF
      JF=NFS-NFF+1
      JFF=NFS-1
C
C     LOOP OVER UPSTREAM FLAPS
C
      DO 250 K=JF,JFF
      MSFU=MSF(K)
      NS=JFF-K+1
C
C     LOOP OVER Y LOCATIONS OF TRAILING LEGS ON THIS UPSTREAM FLAP
C
      DO 260 J=1,MSFU
      JP=J+1
      YY=YF(J,JF)
      FAC=(YY-YWIN)/DYW
      XWKRF(J,NS,K)=XWIN+FAC*DXW
      YWKRF(J,NS,K)=YY
      ZWKRF(J,NS,K)=ZWIN+FAC*DZW
      YY=YF(JP,JF)
      FAC=(YY-YWIN)/DYW
      XWKLF(J,NS,K)=XWIN+FAC*DXW
      YWKLF(J,NS,K)=YY
      ZWKLF(J,NS,K)=ZWIN+FAC*DZW
  260 CONTINUE
  250 CONTINUE
  270 CONTINUE
  200 CONTINUE
  100 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE INFMAT
C
C     CALCULATES INFLUENCE COEFFICIENT MATRIX
C
C     COMMON STATEMENTS
C
      COMMON FVN(1)
      COMMON /FLPDAT/ SDELXZ(10),CDELXZ(10),YF(30,10),SPHIF(10),
     1CPHIF(10)
      COMMON /WKDATW/ XWKRW(30,3),YWKRW(30,3),ZWKRW(30,3),XWKLW(30,3),
     1YWKLW(30,3),ZWKLW(30,3)
      COMMON /WKDATF/ XWKRF(30,2,10),YWKRF(30,2,10),ZWKRF(30,2,10),
     1XWKLF(30,2,10),YWKLF(30,2,10),ZWKLF(30,2,10)
      COMMON / WNGDAT/ Y(30),PSIWLE(30),PSIWTE(30),SPHIW,CPHIW,TPHIW
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /CPDAT/ ALPHAL(250),XCP(250),YCP(250),ZCP(250),
     1 CALPHL(250),SALPHL(250)
      COMMON /TLDAT/ XTER(30),XTEL(30),XTLR(250),YTLR(250),ZTLR(250),
     1 XTLL(250),YTLL(250),ZTLL(250)
      COMMON /FLVPRG/X1,Y1,Z1,X2,Y2,Z2,XP,YP,ZP,FU,FV,FW,AX,AZ
      COMMON / INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /NDIFF/ NIDF,IDF(10)
      COMMON /TOLRNC/ TOL
C
C     LOOP OVER ALL CONTROL POINTS
C
      JFLAP=1
      CPHF=CPHIF(1)
      SPHF=SPHIF(1)
      CDXZB=CDELXZ(1)
      SDXZB=SDELXZ(1)
      DO 200 J=1,MTOT
      XP=XCP(J)
      YP=YCP(J)
      ZP=ZCP(J)
      IBASE=0
      CALF=CALPHL(J)
      SALF=SALPHL(J)
      IF (J.LE.MW) GO TO 40
      IF (J.LE.MEND(JFLAP)) GO TO 30
      JFLAP=JFLAP+1
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```
      CPHF=CPHIF(JFLAP)
      SPHF=SPHIF(JFLAP)
      CDXZB=CDELXZ(JFLAP)
      SDXZB=SDELXZ(JFLAP)
C
C     FLAP BOUNDARY CONDITION FACTORS
C
   30 RW=CPHF*CALF*CDXZB-SALF*SDXZB
      RV=-SPHF*CALF
      RU=SALF*CDXZB+CPHF*CALF*SDXZB
      GO TO 50
C
C     WING BOUNDARY CONDITION FACTORS
C
   40 RV=-SPHIW*CALF
      RW=CPHIW*CALF
      RU=SALF
   50 CONTINUE
C
C     LOOP OVER CHORDWISE ROWS OF WING VORTICES
C
      DO 150 ISW=1,MSW
      AFTU=0.
      AFTV=0.
      AFTW=0.
      LF=LASTF(ISW)
      NAFT=NFSEG(ISW)
      IF(NAFT.EQ.0) GO TO 125
      IF(NAFT.EQ.1) GO TO 122
C
C     CONTRIBUTION OF FINITE TRAILING LEGS IN FLAPS AFT OF THIS ROW,
C
      NAFTM=NAFT-1
      DO 120 IAS=1,NAFTM
      IASP=IAS+1
      X1=XWKRW(ISW,IAS)
      Y1=YWKRW(ISW,IAS)
      Z1=ZWKRW(ISW,IAS)
      X2=XWKRW(ISW,IASP)
      Y2=YWKRW(ISW,IASP)
      Z2=ZWKRW(ISW,IASP)
      CALL FLVF
      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
      X1=XWKLW(ISW,IAS)
      Y1=YWKLW(ISW,IAS)
      Z1=ZWKLW(ISW,IAS)
      X2=XWKLW(ISW,IASP)
      Y2=YWKLW(ISW,IASP)
      Z2=ZWKLW(ISW,IASP)
      CALL FLVF
      AFTU=AFTU-FU
      AFTV=AFTV-FV
      AFTW=AFTW-FW
  120 CONTINUE
C
C     CONTRIBUTION OF SEMI-INFINITE TRAILING LEGS IN LAST AFT FLAP
C
  122 AX=-CDELXZ(LF)
      AZ=SDELXZ(LF)
      X1=XWKRW(ISW,NAFT)
      Y1=YWKRW(ISW,NAFT)
      Z1=ZWKRW(ISW,NAFT)
      IF (NIDF.LE.0) GO TO 231
C      CORRECT POSITION OF WING TRAILING LEGS AT FLAP EDGES
      DO 232 JD=1,NIDF
      K=IDF(JD)
      DY=(Y1-Y(K))**2
      IF (DY.LE.TOL) GO TO 235
  232 CONTINUE
      GO TO 231
  235 AX=-1.0
      AZ=0.0
  231 CONTINUE
C
      CALL SIVF
      AFTU=AFTU-FU
      AFTV=AFTV-FV
      AFTW=AFTW-FW
      X1=XWKLW(ISW,NAFT)
      Y1=YWKLW(ISW,NAFT)
      Z1=ZWKLW(ISW,NAFT)
      IF (NIDF.LE.0) GO TO 241
C      CORRECT POSITION OF WING TRAILING LEGS AT FLAP EDGES
      AX=-CDELXZ(LF)
      AZ= SDELXZ(LF)
      DO 242 JD=1,NIDF
      K=IDF(JD)
      DY=(Y1-Y(K))**2
      IF (DY.LE.TOL) GO TO 245
  242 CONTINUE
      GO TO 241
  245 AX=-1.0
      AZ=0.0
  241 CONTINUE
C
      CALL SIVF
      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
  125 CONTINUE
C
C     LOOP OVER VORTICES IN THIS ROW
C
      NCWC=NCWI(ISW)
      DO 140 ICW=1,NCWC
      I=IBASE+ICW
C
C     CONTRIBUTION OF BOUND LEG
C
      X1=XTLL(I)
      X2=XTLR(I)
      Y1=YTLL(I)
      Y2=YTLR(I)
      Z1=ZTLL(I)
      Z2=ZTLR(I)
      CALL FLVF
      UTOT=FU
      VTOT=FV
      WTOT=FW
      IF(NAFT.NE.0) GO TO 135
C
C     NO SURFACES BEHIND THIS WING ROW - TRAILING LEGS IN WING PLANE
C
      AX=-1.0
      AZ=0.
      CALL SIVF
      UTOT=UTOT+FU
      VTOT=VTOT+FV
      WTOT=WTOT+FW
      X1=X2
      Y1=Y2
      Z1=Z2
      CALL SIVF
      UTOT=UTOT-FU
      VTOT=VTOT-FV
      WTOT=WTOT-FW
      GO TO 136
C
C     THERE ARE FLAPS BEHIND THIS ROW,  COMPUTE INFLUENCE OF
C     FINITE TRAILING LEGS IN THE WING PLANE
C
  135 X1=XTLR(I)
      Y1=YTLR(I)
      Z1=ZTLR(I)
      X2=XWKRW(ISW,1)
      Y2=YWKRW(ISW,1)
      Z2=ZWKRW(ISW,1)
      CALL FLVF
      UTOT=UTOT+FU
      VTOT=VTOT+FV
      WTOT=WTOT+FW
      X1=XTLL(I)
```

```
      Y1=YTLL(I)
      Z1=ZTLL(I)
      X2=XWKLW(ISW,1)
      Y2=YWKLW(ISW,1)
      Z2=ZWKLW(ISW,1)
      CALL FLVF
      UTOT=UTOT-FU
      VTOT=VTOT-FV
      WTOT=WTOT-FW
C
C     ADD CONTRIBUTIONS FROM PANELS AFT OF WING
C
      UTOT=UTOT+AFTU
      VTOT=VTOT+AFTV
      WTOT=WTOT+AFTW
  136 JJ=(I-1)*NTOT+J
      FVN(JJ)=UTOT*RU+VTOT*RV+WTOT*RW
  140 CONTINUE
      IBASE=IBASE+NCWC
  150 CONTINUE
      IF(NFLAPS.EQ.0) GO TO 200
C
C     INFLUENCE OF FLAP VORTICES -- LOOP OVER FLAPS
C
      DO 190 IFL=1,NFLAPS
      NAFT=NFSEGF(IFL)
      LFLP=IFL+NAFT
C
C     LOOP OVER CHORDWISE ROWS ON THIS FLAP
C
      NSFF=NSF(IFL)
      CDX=CDELXZ(IFL)
      SDX=SDELXZ(IFL)
      NCFF=NCF(IFL)
      NST=NSTART(IFL)
      DO 175 ISW=1,NSFF
      AFTU=0.
      AFTV=0.
      AFTW=0.
      IBASS=NST+(ISW-1)*NCFF-1
      IF(NAFT.EQ.0) GO TO 163
      IF(NAFT.EQ.1) GO TO 161
C
C     TWO FLAPS BEHIND THIS ONE -- COMPUTE INFLUENCE OF FINITE
C     TRAILING LEGS ON THE FIRST ONE.
C
      X1=XWKRF(ISW,1,IFL)
      Y1=YWKRF(ISW,1,IFL)
      Z1=ZWKRF(ISW,1,IFL)
      X2=XWKRF(ISW,2,IFL)
      Y2=YWKRF(ISW,2,IFL)
      Z2=ZWKRF(ISW,2,IFL)
      CALL FLVF
      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
      X1=XWKLF(ISW,1,IFL)
      Y1=YWKLF(ISW,1,IFL)
      Z1=ZWKLF(ISW,1,IFL)
      X2=XWKLF(ISW,2,IFL)
      Y2=YWKLF(ISW,2,IFL)
      Z2=ZWKLF(ISW,2,IFL)
      CALL FLVF
      AFTU=AFTU-FU
      AFTV=AFTV-FV
      AFTW=AFTW-FW
C
C     CONTRIBUTION OF SEMI-INFINITE TRAILING LEGS IN LAST FLAP AFT OF
C     THIS ONE
C
  161 X1=XWKRF(ISW,NAFT,IFL)
      Y1=YWKRF(ISW,NAFT,IFL)
      Z1=ZWKRF(ISW,NAFT,IFL)
      AX=-CDELXZ(LFLP)
      AZ=SDELXZ(LFLP)
      CALL SIVF
      AFTU=AFTU-FU
      AFTV=AFTV-FV
      AFTW=AFTW-FW
      X1=XWKLF(ISW,NAFT,IFL)
      Y1=YWKLF(ISW,NAFT,IFL)
      Z1=ZWKLF(ISW,NAFT,IFL)
      CALL SIVF
      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
C
C     LOOP OVER VORTICES IN THIS ROW
C
  163 CONTINUE
      DO 170 ICW=1,NCFF
C
C     INFLUENCE OF BOUND LEG
C
      I=IBASS+ICW
      X1=XTLL(I)
      Y1=YTLL(I)
      Z1=ZTLL(I)
      X2=XTLR(I)
      Y2=YTLR(I)
      Z2=ZTLR(I)
      CALL FLVF
      UTOT=FU
      VTOT=FV
      WTOT=FW
      IF(NAFT.NE.0) GO TO 165
C
C     NO FLAPS BEHIND THIS ONE.  COMPUTE INFLUENCE OF SEMI-INFINITE
C     TRAILING LEGS IN THE PLANE OF THIS FLAP.
C
      AX=-CDX
      AZ=SDX
      CALL SIVF
      UTOT=UTOT+FU
      VTOT=VTOT+FV
      WTOT=WTOT+FW
      X1=X2
      Y1=Y2
      Z1=Z2
      CALL SIVF
      UTOT=UTOT-FU
      VTOT=VTOT-FV
      WTOT=WTOT-FW
      GO TO 167
C
C     THERE ARE FLAPS BEHIND THIS ONE.  COMPUTE THE INFLUENCE OF
C     FINITE TRAILING LEGS INT THIS FLAP
C
  165 X1=XTLR(I)
      Y1=YTLR(I)
      Z1=ZTLR(I)
      X2=XWKRF(ISW,1,IFL)
      Y2=YWKRF(ISW,1,IFL)
      Z2=ZWKRF(ISW,1,IFL)
      CALL FLVF
      UTOT=UTOT+FU
      VTOT=VTOT+FV
      WTOT=WTOT+FW
      X1=XTLL(I)
      Y1=YTLL(I)
      Z1=ZTLL(I)
      X2=XWKLF(ISW,1,IFL)
      Y2=YWKLF(ISW,1,IFL)
      Z2=ZWKLF(ISW,1,IFL)
      CALL FLVF
      UTOT=UTOT-FU
      VTOT=VTOT-FV
      WTOT=WTOT-FW
      UTOT=UTOT+AFTU
      VTOT=VTOT+AFTV
      WTOT=WTOT+AFTW
  167 JJ=(I-1)*NTOT+J
      FVN(JJ)=UTOT*RU+VTOT*RV+WTOT*RW
  170 CONTINUE
```

```
  175 CONTINUE
  190 CONTINUE
  200 CONTINUE
C
C     LOOP OVER FLAP CONTROL POINTS
C
      RETURN
      END
```

```
      SUBROUTINE FLVF
C
C     APPLIES EQUATIONS FOR FINITE LENGTH VORTEX FILAMENT
C     INFLUENCE FUNCTIONS.  TAKE FROM BOEING REPORT D6-9244
C     BY RUBBERT PP. 88-89
C
C
C
C     COMMON STATEMENTS
C
      COMMON /TOLRNC/ TOL
      COMMON /FLVFRG/X1,Y1,Z1,X2,Y2,Z2,XP,YP,ZP,FU,FV,FW,AX,AZ
      COMMON /FTLV/ NVTLF
C
      XPO=XP-X1
      XTO=X2-X1
      XPT=XP-X2
      ZPO=ZP-Z1
      ZTO=Z2-Z1
      ZPT=ZP-Z2
      SPT=XPT*XPT+ZPT*ZPT
      SPO=XPO*XPO+ZPO*ZPO
      B=ZTO*XPO-XTO*ZPO
      BSQ=B*B
      FU=0.0
      FV=0.0
      FW=0.0
      SIGN=1.0
      YPO=YP-Y1
      YTO=Y2-Y1
      YPT=YP-Y2
      ELSQ=XTO*XTO+YTO*YTO+ZTO*ZTO
      EL=SQRT(ELSQ)
      VTL=1.0
      IF (NVTLF.GT.0) VTL=0.0
      DO 100 K=1,2
      A=YTO*ZPO-ZTO*YPO
      C=XTO*YPO-YTO*XPO
      RADCL=SQRT(A*A+BSQ+C*C)
      IF (RADCL.LE.TOL) GO TO 90
      R1SQ=SPO+YPO*YPO
      R2SQ=SPT+YPT*YPT
      R1=SQRT(R1SQ)
      R2=SQRT(R2SQ)
      RSD=R1SQ-R2SQ
      CSTH1=(RSD+ELSQ)/(2.0*EL*R1)
      CSTH2=(RSD-ELSQ)/(2.0*EL*R2)
      RR=R2*SQRT(1.0-CSTH2*CSTH2)
      FAC=SIGN*(CSTH1-CSTH2)/(RR*RADCL)
      FU=FU+A*FAC
      FV=FV+B*FAC*VTL
      FW=FW+C*FAC
   90 YTO=-YTO
      YPO=YP+Y1
      YPT=YP+Y2
  100 SIGN=-1.0
      RETURN
      END
```

```
      SUBROUTINE SIVF
C
C     INFLUENCE FUNCTIONS .  REFERENCE -- RUBBERT PP. 88-89
C     APPLIES EQUATIONS FOR SEMI-INFINITE VORTEX FILAMENT
C
C     COMMON STATEMENTS
      COMMON /TOLRNC/ TOL
      COMMON /FLVFRG/X1,Y1,Z1,X2,Y2,Z2,XP,YP,ZP,FU,FV,FW,AX,AZ
      COMMON /FTLV/ NVTLF
C
      XX=XP-X1
      ZZ=ZP-Z1
      E=AZ*XX-AX*ZZ
      CUP=-(AX*XX+AZ*ZZ)
      XSPZS=XX*XX+ZZ*ZZ
      YY=YP-Y1
      FU=0.0
      FV=0.0
      FW=0.0
      SIGN=1.0
      VTL=1.0
      IF (NVTLF.GT.0) VTL=0.0
      DO 100 K=1,2
      D=-AZ*YY
      F=AX*YY
      RADCL=SQRT(D*D+E*E+F*F)
      IF (RADCL.LE.TOL) GO TO 90
      BIGR=SQRT(YY*YY+XSPZS)
      CSTHT=CUP/BIGR
      SMLR=BIGR*SQRT(1.0-CSTHT*CSTHT)
      FACT=(CSTHT-1.0)/(SMLR*RADCL)*SIGN
      FU=FU+D*FACT
      FV=FV+E*FACT*VTL
      FW=FW+F*FACT
   90 YY=YP+Y1
  100 SIGN=-1.0
      RETURN
      END
```

```
      SUBROUTINE RHSCLC(EXVEL)
C
C     THIS SUBROUTINE CALCULATES THE RIGHT HAND SIDE OF
C     THE EQUATIONS FOR HORSESHOE VORTEX STRENGTHS.
C     THE ARGUMENT EXVEL IS TRUE IF EXTERNALLY INDUCED
C     VELOCITIES ARE TO BE INCLUDED IN THE CALCULATION.
C
      LOGICAL EXVEL
C
C     COMMON STATEMENTS
C
      COMMON / INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /FLPDAT/ SDELXZ(10),CDELXZ(10),YF(30,10),SPHIF(10),
     1CPHIF(10)
      COMMON / WNGDAT/ Y(30),PSI-LE(30),PSI-TE(30),SPHIW,CPHIW,TPHIW
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /CPDAT/ ALPHAL(250),XCP(250),YCP(250),ZCP(250),
     1 CALPHL(250),SALPHL(250)
      COMMON /RSIDE/ CIR(250),UEI(250),VEI(250),WEI(250)
      COMMON /ATAK/SINALF,COSALF
C
C     RIGHT HAND SIDE FOR WING CONTROL POINTS
      IF(EXVEL) GO TO 45
C
C     LOOP OVER WING CONTROL POINTS FOR CASE WITH NO EXTERNALLY
C     INDUCED VELOCITIES
```

```
C
      SACP=SINALF*CPHIW
      DO 40 J=1,MW
   40 CIR(J)=   SACP      *CALPHL(J) + COSALF*SALPHL(J)
      GO TO 55
C
C     LOOP OVER WING CONTROL POINTS FOR CASE WITH EXTERNALLY INDUCED
C     VELOCITIES INCLUDED
C
   45 CONTINUE
      DO 50 J=1,MW
   50 CIR(J)=((SINALF-WEI(J))*CPHIW + VEI(J)*SPHIW)*CALPHL(J)
     1 +(COSALF-UEI(J))*SALPHL(J)
   55 IF(NFLAPS.EQ.0) RETURN
C
C     RIGHT HAND SIDE FOR FLAP CONTROL POINTS (IF PRESENT)
C
C     LOOP OVER FLAPS
C
      DO 90 JF=1,NFLAPS
      CPH=CPHIF(JF)
      SPH=SPHIF(JF)
      CDXZ=CDELXZ(JF)
      SDXZ=SDELXZ(JF)
      CADX=CDXZ*COSALF-SDXZ*SINALF
      SADX=CDXZ*SINALF+SDXZ*COSALF
      DA=SADX*CPH
      DC=CPH*CDXZ
      DD=CPH*SDXZ
      MS=MSTART(JF)
      ME=MEND(JF)
      IF(EXVEL) GO TO 75
C
C     LOOP OVER CONTROL POINTS ON FLAP WITHOUT EXTERNALLY INDUCED
C     VELOCITIES
C
      DO 70 J=MS,ME
   70 CIR(J)=DA*CALPHL(J)+CADX*SALPHL(J)
      GO TO 90
C
C     LOOP OVER CONTROL POINTS ON THIS FLAP FOR CASE WITH EXTERNALLY
C     INDUCED VELOCITIES INCLUDED
C
   75 CONTINUE
      DO 80 J=MS,ME
      CAL=CALPHL(J)
      SAL=SALPHL(J)
   80 CIR(J)=DA*CAL+CADX*SAL-WEI(J)*(DC*CAL-SDXZ*SAL)
     1  + VEI(J)*SPH*CAL - UEI(J)*(SAL*CDXZ+DD*CAL)
   90 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE LINEQS(N,A)
      DIMENSION A(N,N),IP(300)
      COMMON /LINSOL/IP
      IP(N)=1
      DO 6 K=1,N
      IF(K.EQ.N)GO TO 5
      KP1=K+1
      M=K
      DO 1 I=KP1,N
    1 CONTINUE
      IP(K)=M
      IF(M.NE.K)IP(N)=-IP(N)
      T=A(M,K)
      A(M,K)=A(K,K)
      A(K,K)=T
      IF(T.EQ.0.)GO TO 5
      DO 2 I=KP1,N
    2 A(I,K)=-A(I,K)/T
      DO 4 J=KP1,N
      T=A(M,J)
      A(M,J)=A(K,J)
      A(K,J)=T
      IF(T.EQ.0.)GO TO 4
      DO 3 I=KP1,N
    3 A(I,J)=A(I,J)+A(I,K)*T
    4 CONTINUE
    5 IF(A(K,K).EQ.0.)IP(N)=0
    6 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SOLVE (B,A,N)
      DIMENSION B(1)
      DIMENSION A(N,N)
      COMMON /LINSOL/IP(300)
      IF(N.EQ.1)GO TO 9
      NM1=N-1
      DO 7 K=1,NM1
      KP1=K+1
      M=IP(K)
      T=B(M)
      B(M)=B(K)
      B(K)=T
      DO 7 I=KP1,N
    7 B(I)=B(I)+A(I,K)*T
      DO 8 KB=1,NM1
      KM1=N-KB
      K=KM1+1
      B(K)=B(K)/A(K,K)
      T=-B(K)
      DO 8 I=1,KM1
    8 B(I)=B(I)+A(I,K)*T
    9 B(1)=B(1)/A(1,1)
      RETURN
      END
```

```
      SUBROUTINE TRLG
C
C       CORRECT TRAILING LEG POSITIONS AT FLAP JUNCTIONS
C
      COMMON / WNGDAT/ Y(30),PSIWLE(30),PSIWTE(30),SPHIW,CPHIW,TPHIW
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /TLDAT/ XTER(30),XTEL(30),XTLR(250),YTLR(250),ZTLR(250),
     1 XTLL(250),YTLL(250),ZTLL(250)
      COMMON / INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /WKDATW/ XWKRW(30,3),YWKRW(30,3),ZWKRW(30,3),XWKLW(30,3),
     1YWKLW(30,3),ZWKLW(30,3)
```

```
      COMMON /NDIFF/ NIDF,IDF(10)
C
      DO 100 J=1,NIDF
      NY=IDF(J)-1
      DO 110 K=1,3
      ZWKLW(NY,K)=0.0
      ZWKRW(NY+1,K)=0.0
  110 CONTINUE
  100 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE LOAD(EXVEL)
C
C     COMMON STATEMENTS
      COMMON /VORFOR/CXBL(250),CYBL(250),CZBL(250),CYTLL(250),CYTLR(250)
     1  ,  CZTLL(250),CZTLR(250)
      COMMON /RVELS/UP,VP,WP
      COMMON /RSIDE/ CIR(250),UEI(250),VEI(250),WEI(250)
      COMMON /BLDAT/ XBL(250),YBL(250),ZBL(250),TPSI(250),SW(250)
      COMMON / WNGDAT/ Y(30),PSIWLE(30),PSIWTE(30),SPHIW,CPHIW,TPHIW
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /TLDAT/ XTER(30),XTEL(30),XTLR(250),YTLR(250),ZTLR(250),
     1 XTLL(250),YTLL(250),ZTLL(250)
      COMMON /ATAK/ SINALF,COSALF
      COMMON / INDEXF/ NFREG,NFLAPS,IOFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /FLPDAT/ SDELXZ(10),CDELXZ(10),YF(30,10),SPHIF(10),
     1CPHIF(10)
      COMMON /FTLDAT/ FTLXR(250),FTLXL(250),FTLZR(250),FTLZL(250)
      COMMON /LDCONS/ CONA(250),CONBR(250),CONBL(250),TEMP,TEMR
      COMMON /JETCIR/ JFLP(150),LJFLP, CIRJ(150),CNJ(150),CAJ(150)
      COMMON /FRCTL/ NTLF
C
      LOGICAL EXVEL
      DIMENSION VL(10),VR(10),WR(10),WL(10),           GAMFWR(30),
     1              GAMFAR(30),GAMSUM(30)
C
C     CALCULATE FORCE COMPONENTS IN -X, Y, AND -Z DIRECTIONS AT
C     BOUND LEG MIDPOINTS ON WING
C
C
      CPSA=CPHIW*SINALF
      SPCA=SPHIW*COSALF
      CPCA=COSALF*CPHIW
      DO 100 JW=1,MW
      TPSJ=TPSI(JW)
      CALL VELSUM(XBL(JW),YBL(JW),ZBL(JW))
      IF(.NOT.EXVEL) GO TO 10
      UP=UP+UEI(JW)
      VP=VP+VEI(JW)
      WP=WP+WEI(JW)
   10 FACT=CONA(JW)*CIR(JW)
      CXBL(JW)=-FACT*(CPSA-WP*CPHIW+VP*SPHIW)
      CYBL(JW)=FACT*(SPCA-UP*SPHIW+(WP-SINALF)*TPSJ)
      CZBL(JW)=FACT*(VP*TPSJ+CPCA-UP*CPHIW)
  100 CONTINUE
      IF(NFLAPS.EQ.0) GO TO 201
C
C     BOUND LEG MIDPOINTS ON FLAPS
C
C     LOOP OVER FLAPS
C
      DO 200 JF=1,NFLAPS
      CDXZ=CDELXZ(JF)
      SDXZ=SDELXZ(JF)
      CSUM=CDXZ*COSALF-SDXZ*SINALF
      SSUM=CDXZ*SINALF+SDXZ*COSALF
      CPH=CPHIF(JF)
      SPH=SPHIF(JF)
      CPSAF=CPH*SSUM
      SPCAF=SPH*CSUM
      CPCAF=CSUM*CPH
      MS=MSTART(JF)
      ME=MEND(JF)
C
C     LOOP OVER BOUND LEG MIDPOINTS ON THIS FLAP
C
      DO 190 JC=MS,ME
      TPSJ=TPSI(JC)
      CALL VELSUM(XBL(JC),YBL(JC),ZBL(JC))
      IF(.NOT.EXVEL) GO TO 110
      UP=UP+UEI(JC)
      VP=VP+VEI(JC)
      WP=WP+WEI(JC)
C
C     ROTATE U AND W TO LIE IN THIS FLAP COORDINATE SYSTEM
C
  110 WU=UP
      WW=WP
      UP=WU*CDXZ-WW*SDXZ
      WP=WW*CDXZ+WU*SDXZ
      FACT=CIR(JC)*CONA(JC)
      CXBL(JC)=FACT*(WP*CPH-CPSAF-VP*SPH)
      CYBL(JC)=FACT*(SPCAF-UP*SPH+(WP-SSUM)*TPSJ)
      CZBL(JC)=FACT*(VP*TPSJ+CPCAF-UP*CPH)
  190 CONTINUE
  200 CONTINUE
      IF (LJFLP.LE.0) GO TO 201
C      CORRECT PANEL LOADING FOR JET TURNING FORCE
      DO 199 JF=1,LJFLP
      JC=JFLP(JF)
      CXBL(JC)=CXBL(JC) + CAJ(JF)
      CZBL(JC)=CZBL(JC) + CNJ(JF)
  199 CONTINUE
  201 CONTINUE
      IF (NTLF.LE.0) GO TO 202
C      ELIMINATE ALL TRAILING LEG FORCES
      DO 191 J=1,MTOT
      CYTLL(J)=0.0
      CYTLR(J)=0.0
      CZTLL(J)=0.0
      CZTLR(J)=0.0
  191 CONTINUE
      RETURN
  202 CONTINUE
C
C     LOADS ON WING TRAILING LEG POINTS
C
      NCWC=NCWI(1)
      DO 50 ICW=1,NCWC
      CALL VELSUM(FTLXR(ICW),YTLR(ICW),FTLZR(ICW))
      IF(.NOT.EXVEL) GO TO 20
      VP=VP+VEI(ICW)
      WP=WP+WEI(ICW)
   20 VR(ICW)=VP
      WR(ICW)=WP
      CALL VELSUM(FTLXL(ICW),YTLL(ICW),FTLZL(ICW))
      IF(.NOT.EXVEL) GO TO 30
      VP=VP+VEI(ICW)
      WP=WP+WEI(ICW)
   30 VL(ICW)=VP
   50 WL(ICW)=WP
C
C     LOOP OVER WING CHORDWISE ROWS
C
      IBASE=0
      DO 1200 ISW=1,MSW
      NCWC=NCWI(ISW)
      IF(ISW.EQ.1) GO TO 95
      NCWM=NCWI(ISW-1)
      JJ=MIN0(NCWC,NCWM)
```

```
      DO 60 J=1,JU
      VR(J)=VL(J)
   60 WR(J)=WL(J)
      IF(NCWC.LE.NCWM) GO TO 66
      JL=NCWM+1
      DO 65 J=JL,NCWC
      I=IBASE+J
      CALL VELSUM(FTLXR(I),YTLR(I),FTLZR(I))
      IF(.NOT.EXVEL) GO TO 62
      VP=VP+VEI(I)
      WP=WP+WEI(I)
   62 VR(J)=VP
   65 WR(J)=WP
   66 CONTINUE
      DO 70 J=1,NCWC
      I=IBASE+J
      CALL VELSUM(FTLXL(I),YTLL(I),FTLZL(I))
      IF(.NOT.EXVEL) GO TO 68
      VP=VP+VEI(I)
      WP=WP+WEI(I)
   68 VL(J)=VP
   70 WL(J)=WP
C
   95 DELGAM=0.0
      DO 1100 ICW=1,NCWC
      I=IBASE+ICW
      CIRR=CIR(I)
      DUMA=DELGAM+0.75*CIRR
      FACL=DUMA*CONBL(I)
      FACR=-DUMA*CONBR(I)
      CYTLL(I)=FACL*(WL(ICW)-SINALF)
      CYTLR(I)=FACR*(WR(ICW)-SINALF)
      IF (ISW.EQ.1) CYTLR(I)=-CYTLL(I)
      CZTLL(I)=FACL*VL(ICW)
      CZTLR(I)=FACR*VR(ICW)
      DELGAM=DELGAM+CIRR
 1100 CONTINUE
      GAMSUM(ISW)=DELGAM
 1200 IBASE=IBASE+NCWC
C
C     TRAILING LEG LOADS ON FLAPS -- LOOP OVER FLAPS
C
      IF(NFLAPS.EQ.0) RETURN
      DO 800 IFL=1,NFLAPS
      IF(IDFLAP(IFL,2).GT.1) GO TO 312
C
C     THIS IS THE FIRST FLAP AFT OF THE WING.  COMPUTE GAMMA
C     CONTRIBUTIONS FROM WING VORTICES AHEAD
C
      MS=MSTART(IFL)
      MSFF=MSF(IFL)
      NCFF=NCF(IFL)
      YSTRTF=YF(1,IFL)
      DO 305 ISWW=1,MSW
      JSW=ISWW
      IF (Y(ISWW).LE.YSTRTF) GO TO 306
  305 CONTINUE
  306 GAMFWR(1)=GAMSUM(JSW)
      DO 307 ISWF=2,MSFF
      JSW=JSW+1
      GAMFWR(ISWF)=GAMSUM(JSW)
  307 CONTINUE
      GO TO 390
C
C     THERE IS A FLAP AHEAD OF THIS ONE.  COMPUTE GAMMA CONTRIBUTIONS
C     FROM THE FLAP AHEAD
C
C     LOOP OVER CHORDWISE ROWS ON THIS FLAP
C
  312 CONTINUE
      NCFF=NCF(IFL)
      MSFF=MSF(IFL)
      MS=MSTART(IFL)
      DO 335 ISWF=1,MSFF
      GAMFWR(ISWF)=GAMFAR(ISWF)
  335 CONTINUE
  390 CONTINUE
C
C     COMPUTE THE TRAILING LEG LOADS ON THIS FLAP
C
      CDXZ=CDELXZ(IFL)
      SDXZ=SDELXZ(IFL)
      SALFP=SINALF*CDXZ+COSALF*SDXZ
C
C     RIGHT AND LEFT VELOCITIES ON FIRST ROW OF THIS FLAP
C
      II=MS-1
      DO 398 ICW=1,NCFF
      I=II+ICW
      CALL VELSUM(FTLXR(I),YTLR(I),FTLZR(I))
      IF(.NOT.EXVEL) GO TO 395
      UP=UP+UEI(I)
      VP=VP+VEI(I)
      WP=WP+WEI(I)
  395 WR(ICW)=WP*CDXZ+UP*SDXZ
      VR(ICW)=VP
      CALL VELSUM(FTLXL(I),YTLL(I),FTLZL(I))
      IF(.NOT.EXVEL) GO TO 396
      UP=UP+UEI(I)
      VP=VP+VEI(I)
      WP=WP+WEI(I)
  396 WL(ICW)=WP*CDXZ+UP*SDXZ
  398 VL(ICW)=VP
C
C     LOOP OVER CHORDWISE ROWS ON THIS FLAP -- LOAD CALCULATION
C
      DO 500 ISW=1,MSFF
      IY=0
      IF (ISW.EQ.1.AND.YTLR(MS).GE.0.0) IY=1
      IF(ISW.EQ.1) GO TO 401
C
C     UPDATE RIGHT AND LEFT VELOCITIES
C
      II=MS+(ISW-1)*NCFF-1
      DO 400 ICW=1,NCFF
      VR(ICW)=VL(ICW)
      WR(ICW)=WL(ICW)
      I=II+ICW
      CALL VELSUM(FTLXL(I),YTLL(I),FTLZL(I))
      IF(.NOT.EXVEL) GO TO 399
      UP=UP+UEI(I)
      VP=VP+VEI(I)
      WP=WP+WEI(I)
  399 WL(ICW)=WP*CDXZ+UP*SDXZ
  400 VL(ICW)=VP
  401 CONTINUE
C
C     LOOP OVER TRAILING LEG POINTS IN THIS ROW
C
      DELGMR=GAMFWR(ISW)
      II=(ISW-1)*NCFF+MS-1
      DO 450 ICW=1,NCFF
      I=II+ICW
      CIRR=CIR(I)
      DUMA=0.75*CIRR
      FACR=-(DELGMR+DUMA)*CONBR(I)
      FACL= (DELGMR+DUMA)*CONBL(I)
      CYTLL(I)=FACL*(WL(ICW)-SALFP)
      CYTLR(I)=FACR*(WR(ICW)-SALFP)
      IF (IY.EQ.1) CYTLR(I)=-CYTLL(I)
      CZTLL(I)=FACL*VL(ICW)
      CZTLR(I)=FACR*VR(ICW)
      DELGMR=DELGMR+CIRR
  450 CONTINUE
      GAMFAR(ISW)=DELGMR
  500 CONTINUE
  800 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE LOADCP (EXVEL)
C        CALCULATE UPPER AND LOWER SURFACE PRESSURE COEFFICIENTS ON
C         EACH PANEL AT ITS CONTROL POINT USING THE BERNOULLI EQUATION.
C
      DIMENSION UCPU(250),VCPU(250),WCPU(250),UCPL(250),VCPL(250),
     1          WCPL(250),CPU(250),CPL(250)
C
      LOGICAL EXVEL
C
      COMMON /REFQUA/ SSPAN,SREF,REFL,XM,ZM
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /CPDAT/ ALPHAL(250),XCP(250),YCP(250),ZCP(250),
     1 CALPHL(250),SALPHL(250)
      COMMON /BLDAT/ XBL(250),YBL(250),ZBL(250),TPSI(250),SW(250)
      COMMON / INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /RSIDE/ CIR(250),UEI(250),VEI(250),WEI(250)
      COMMON /ATAK/ SINALF,COSALF
      COMMON /RVELS/ UP,VP,WP
      COMMON /VORFOR/CXBL(250),CYBL(250),CZBL(250),CYTLL(250),CYTLR(250)
     1  ,  CZTLL(250),CZTLR(250)
      COMMON /FLPDAT/ SDELXZ(10),CDELXZ(10),YF(30,10),SPHIF(10),
     1CPHIF(10)
      COMMON /LDCONS/ CONA(250),CONBR(250),CONBL(250),TEMP,TEMR
      COMMON /XYZCL/ NJET,NCYL(2),XO(2),YO(2),ZO(2),GAMVJ(2),DS(2),
     1 RHO(2),CMU(2),XCLR(2,25),YCLR(2,25),ZCLR(2,25),THETA(2,25),
     2               SCLR(2,25),AJET(2,25),BJET(2,25),DSFACT(2,25),
     3                UCL(2,25), VCL(2,25), WCL(2,25),  CFJ,CFK
      COMMON /CLDAT/ NSS(2),SS(2,11),XSS(2,11),YSS(2,11),ZSS(2,11),
     1               TSS(2,11),BSS(2,11),ASS(2,11),XSN(2,11),YSN(2,11),
     2               ZSN(2,11),XST(2,11),YST(2,11),ZST(2,11),DSS(2,11)
      COMMON /JETCIR/ JFLP(150),LJFLP, CIRJ(150),CNJ(150),CAJ(150)
C
  701 FORMAT (1H1,5X,73HUPPER AND LOWER SURFACE PRESSURE COEFFICIENTS AT
     1 CONTROL POINTS,  ALPHA = ,F6.2)
  702 FORMAT (//8X1HJ,4X6HXCP(J),4X6HYCP(J),4X6HZCP(J),7X2HUU,8X2HUL,
     1          8X3HCPU,7X3HCPL,8X3HDCP)
  703 FORMAT (I5,3F10.4,3(F11.5,F10.5))
C
C       COMPUTE CONTINUOUS VELOCITY COMPONENTS AT WING CONTROL POINTS
C
      RAD=57.2957795
      ALPHA=ASIN(SINALF)*RAD
      WRITE (6,701) ALPHA
      WRITE (6,702)
      DO 20 J=1,MW
      CALL VELSUM (XCP(J),YCP(J),ZCP(J))
      UCPU(J)=UP
      UCPL(J)=UP
      VCPU(J)=VP
      VCPL(J)=VP
      WCPU(J)=WP
      WCPL(J)=WP
   20 CONTINUE
      IF (NFLAPS.EQ.0) GO TO 29
C
C       COMPUTE CONTINUOUS VELOCITY COMPONENTS AT FLAP CONTROL POINTS
C
      DO 28 JF=1,NFLAPS
      MS=MSTART(JF)
      ME=MEND(JF)
      DO 21 J=MS,ME
      CALL VELSUM (XCP(J),YCP(J),ZCP(J))
      UCPU(J)=UP
      UCPL(J)=UP
      VCPU(J)=VP
      VCPL(J)=VP
      WCPU(J)=WP
      WCPL(J)=WP
   21 CONTINUE
   28 CONTINUE
   29 CONTINUE
C
C       COMPUTE DISCONTINUOUS U-VELOCITY AT WING CONTROL POINTS
C                DISCONTINUOUS V-VELOCITIES NEGLECTED
C         NOTE,  DUM=(4*PI)**2/SREF
C
      IF (.NOT.EXVEL) GO TO 32
C       INCLUDE JET CIRCULATION ON FLAPS
      DO 35 J=1,LJFLP
      NJ=JFLP(J)
      CIR(NJ)=CIR(NJ)+CIRJ(J)
   35 CONTINUE
   32 DUM=157.9136706/SREF
      DO 30 J=1,MW
      CAVG=0.5*(CONBR(J)+CONBL(J))
      UP=CIR(J)*DUM/CAVG
      UCPU(J)=UCPU(J)-UP
      UCPL(J)=UCPL(J)+UP
   30 CONTINUE
C
      IF (NFLAPS.EQ.0) GO TO 39
C
C       COMPUTE DISCONTINUOUS VELOCITIES AT FLAP CONTROL POINTS
C
      DO 38 JF=1,NFLAPS
      MS=MSTART(JF)
      ME=MEND(JF)
      CDXZ=CDELXZ(JF)
      SDXZ=SDELXZ(JF)
      DO 31 J=MS,ME
      CAVG=0.5*(CONBR(J)+CONBL(J))
      UP=CIR(J)*DUM/CAVG
      UCPU(J)=UCPU(J)-UP*CDXZ
      UCPL(J)=UCPL(J)+UP*CDXZ
      WCPU(J)=WCPU(J)+UP*SDXZ
      WCPL(J)=WCPL(J)-UP*SDXZ
   31 CONTINUE
   38 CONTINUE
   39 CONTINUE
      IF (.NOT.EXVEL) GO TO 49
C
C       INCLUDE EXTERNALLY INDUCED VELOCITIES AT EACH CONTROL POINT
C
      DO 40 J=1,MTOT
      UCPU(J)=UCPU(J)+UEI(J)
      UCPL(J)=UCPL(J)+UEI(J)
      VCPU(J)=VCPU(J)+VEI(J)
      VCPL(J)=VCPL(J)+VEI(J)
      WCPU(J)=WCPU(J)+WEI(J)
      WCPL(J)=WCPL(J)+WEI(J)
   40 CONTINUE
   49 CONTINUE
C
C       COMPUTE UPPER AND LOWER SURFACE PRESSURE COEFFICIENTS
C
      DO 51 J=1,MTOT
      UU=1.0-2.0*(UCPU(J)*COSALF + WCPU(J)*SINALF) + (UCPU(J)**2)
     1      + (VCPU(J)**2) + (WCPU(J)**2)
      CPU(J)=1.0-UU
      UL=1.0-2.0*(UCPL(J)*COSALF + WCPL(J)*SINALF) + (UCPL(J)**2)
     1      + (VCPL(J)**2) + (WCPL(J)**2)
      CPL(J)=1.0-UL
      UU=SQRT(UU)
      UL=SQRT(UL)
      DCP=CPL(J)-CPU(J)
      WRITE (6,703) J,XCP(J),YCP(J),ZCP(J),UU,UL,CPU(J),CPL(J),DCP
   51 CONTINUE
C
C       COMPUTE NORMAL FORCE COEFFICIENT ON EACH PANEL OF WING AND FLAPS
C
C         INITIALIZE ARRAYS
   52 DO 53 J=1,MTOT
      CXBL(J)=0.0
      CYBL(J)=0.0
      CZBL(J)=0.0
      CYTLL(J)=0.0
      CYTLR(J)=0.0
      CZTLL(J)=0.0
   53 CZTLR(J)=0.0
      DUM=1.0/(TEMR*SREF)
      DO 55 J=1,MTOT
      SPNL=(CONBL(J)+CONBR(J))*DUM*SW(J)
      CZBL(J)=(CPL(J)-CPU(J))*SPNL
   55 CONTINUE
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C
      RETURN
      END
```

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      SUBROUTINE FORCES
C
C     THIS SUBROUTINE CALCULATES THE SPANWISE LOAD DISTRIBUTIONS AND
C          THE FORCES AND MOMENTS FROM THE FORCES ACTING ON THE VORTEX
C          FILAMENTS
C
C     COMMON STATEMENTS
C
      COMMON /ATAK/SINALF,COSALF
      COMMON /BLDAT/ XBL(250),YBL(250),ZBL(250),TPSI(250),SW(250)
      COMMON / WNGDAT/ Y(30),PSIWLE(30),PSIWTE(30),SPHIW,CPHIW,TPHIW
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON / INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /FLPDAT/ SDELXZ(10),CDELXZ(10),YF(30,10),SPHIF(10),
     1CPHIF(10)
      COMMON /FTLDAT/ FTLXR(250),FTLXL(250),FTLZR(250),FTLZL(250)
      COMMON /REFQUA/ SSPAN,SREF,REFL,XM,ZM
      COMMON /CHORDS/ CHRDLW(30),CROOTF(10),CTIPF(10)
      COMMON /VORFOR/CXBL(250),CYBL(250),CZBL(250),CYTLL(250),CYTLR(250)
     1  ,  CZTLL(250),CZTLR(250)
      COMMON /TLDAT/ XTER(30),XTEL(30),XTLR(250),YTLR(250),ZTLR(250),
     1 XTLL(250),YTLL(250),ZTLL(250)
      COMMON /FLAPLE/XWILE(10),YWILE(10),ZWILE(10),SWPFLE(10)
      COMMON /PRSDAT/NPRESW,NPRESF(10),ELAREA(250),XLE(30)
      COMMON /FPNL/ NPRINT,NJPNL,JPNL(30)
C
C     DIMENSION STATEMENT
C
      DIMENSION XC(20),PRES(20)
C
C     FORMAT STATEMENTS
C
  701 FORMAT(1H0,15X,39HAERODYNAMIC LOADING RESULTS FOR ALPHA =,F6.2,
     1  5H DEG.)
  702 FORMAT(//30X,20HREFERENCE QUANTITIES/23X,12HWING SPAN, B,3X,4HAREA
     1  ,6X,6HLENGTH/23X,3F11.5)
  703 FORMAT(//27X,27HSPANWISE LOAD DISTRIBUTIONS/22X37H*********** LEFT
     1WING PANEL **********)
  704 FORMAT(40X,5HLOCAL/19X7HSTATION,3X,7HY/(B/2),3X,8HCHORD, C,2X,
     113HCNORM*C/(2*B),4X,5HCNORM,8X2HCA)
  705 FORMAT(19XI5,F12.5,F11.4,F12.5,2F12.4)
  706 FORMAT(/22X10(1H*),1X,6HREGION,I2,5H FLAP,I2,1X,10(1H*))
  707 FORMAT(///21X,40HWING ALONE FORCE AND MOMENT COEFFICIENTS)
  708 FORMAT(29X,24H(WING COORDINATE SYSTEM))
  709 FORMAT(15X,3HCNW,9X,3HCAW,9X,3HCLW,9X,3HCDW,9X,3HCMW)
  710 FORMAT(9X,5F12.5)
  711 FORMAT(///13X,79HINDIVIDUAL FLAP FORCE AND MOMENT COEFFICIENTS AND
     1 LOCATIONS AT WHICH FORCES ACT/26X,52H(FLAP COORDINATE SYSTEMS - F
     2LAP LIES IN XF,YF PLANE)/1X,11HREGION FLAP,5X,3HCNF,7X,7HXF(CNF),
     35X,7HYF(CNF),7X,3HCAF,7X,7HYF(CAF),7X,3HCYF,7X,7HXF(CYF),7X,3HCMF)
  712 FORMAT(1X,I4,I5,8F12.5)
  713 FORMAT(///14X,52HCOMPLETE CONFIGURATION FORCE AND MOMENT COEFFICIE
     1NTS)
  714 FORMAT(11X,2HCN,10X,2HCA,10X,2HCL,10X,2HCD,10X,2HCM,6X,10HCD/(CL*C
     1L))
  715 FORMAT(4X,6F12.5)
  716 FORMAT(1H1,54X,22HPRESSURE DISTRIBUTIONS/61X,9HDELTA P/Q)
  717 FORMAT(/5X,10(1H*),1X,15HLEFT WING PANEL,1X,10(1H*))
  718 FORMAT(/3X,7HY/(B/2),2X,8HCHORD, C)
  719 FORMAT(2F10.5,7X,4HX/C=,F9.5,9F10.5/30X,10F10.5)
  720 FORMAT(21X,10HDELTA P/Q=,F9.5,9F10.5/30X,10F10.5)
  721 FORMAT(1H )
  722 FORMAT(/5X,10(1H*),1X,6HREGION,I2,5H FLAP,I2,1X,10(1H*))
  723 FORMAT (1H1)
  725 FORMAT (/20X,26HFORCES OMITTED FROM PANELS,10I5/46X,10I5/46X,10I5)
C
  796 FORMAT (14X,4HCXBL,11X,4HCYBL,8X5HCYTLL,7X5HCYTLR,
     1                      10X,4HCZBL,8X5HCZTLL,7X5HCZTLR )
C     CONSTANTS
C
      DATA RTOD/57.2957795/
C
      NTIME=1
  102 SPAN=2.0*SSPAN
      SREFTB=SREF/(2.*SPAN)
      ALF=ASIN(SINALF)*RTOD
      IF (NTIME.GT.1) WRITE (6,723)
      WRITE (6,701) ALF
      IF (NTIME.GT.1) WRITE (6,725) (JPNL(K),K=1,NJPNL)
      WRITE(6,702) SPAN,SREF,REFL
      IF (NTIME.GT.1) GO TO 99
C
C      DISTRIBUTE TRAILING LEG FORCES BETWEEN ADJACENT WING PANELS
C
  103 IBASE1=0
      IBASE2=NCWI(1)
      MSWM=MSW-1
      DO 90 I=1,MSWM
      NCW1=NCWI(I)
      NCW2=NCWI(I+1)
      NTE=NCW1
      IF (NCW1.GT.NCW2) NTE=NCW2
      DO 91 J=1,NTE
      J1=IBASE1+J
      J2=IBASE2+J
      CYS=(CYTLL(J1)+CYTLR(J2))/2.0
      CNS=(CZTLL(J1)+CZTLR(J2))/2.0
      CYTLL(J1)=CYS
      CYTLR(J2)=CYS
      CZTLL(J1)=CNS
      CZTLR(J2)=CNS
   91 CONTINUE
      IBASE1=IBASE1+NCW1
      IBASE2=IBASE2+NCW2
   90 CONTINUE
C
C      DISTRIBUTE TRAILING LEG FORCES BETWEEN ADJACENT FLAP PANELS
C        AND SET TRAILING LEG FORCES EQUAL TO ZERO AT FLAP EDGES
C
      IF (NFLAPS.EQ.0) GO TO 99
      DO 92 N=1,NFLAPS
      NCF1=NCF(N)
      MSWM=MSF(N)-1
      JB =MSTART(N)-1
      IF (MSWM.GT.0) GO TO 94
      DO 98 J=1,NCF1
      JBL=JB+J
      CZTLR(JBL)=0.0
   98 CZTLL(JBL)=0.0
      GO TO 92
   94 CONTINUE
      DO 97 I=1,MSWM
      DO 93 J=1,NCF1
      JBL=JB+J
      JBL2=JBL+NCF1
      IF (I.GT.1) GO TO 95
      CZTLL(JBL)=0.0
      CZTLR(JBL)=0.0
      CZTLR(JBL2)=0.0
      IF (I.EQ.MSWM) CZTLL(JBL2)=0.0
      GO TO 96
   95 IF (I.LT.MSWM) GO TO 96
      CZTLL(JBL2)=0.0
   96 CONTINUE
      CYS=(CYTLL(JBL)+CYTLR(JBL2))/2.0
      CNS=(CZTLL(JBL)+CZTLR(JBL2))/2.0
      CYTLL(JBL )=CYS
      CYTLR(JBL2)=CYS
      CZTLL(JBL )=CNS
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      CZTLR(JBL2)=CNB
   93 CONTINUE
      JB=JB+NCFI
   97 CONTINUE
   92 CONTINUE
   99 CONTINUE
C
      IF (NTIME.LE.1) GO TO 101
C
C       OMIT FORCES ON SELECTED PANELS ACCORDING TO JPNL ARRAY
C
      DO 104 J=1,NJPNL
      JBL=JPNL(J)
      CXBL(JBL)=0.0
      CYBL(JBL)=0.0
      CZBL(JBL)=0.0
      CYTLL(JBL)=0.0
      CYTLR(JBL)=0.0
      CZTLL(JBL)=0.0
  104 CZTLR(JBL)=0.0
  101 CONTINUE
C
C     CALCULATE WING LOADS
C
      WRITE (6,703)
      WRITE(6,704)
      CON=SREFTB/(2.*CPHIW)
C
C     LOOP OVER CHORDWISE ROWS
C
      IBASE=0
      DO 1 I=2,IMAX
      CYS=0.
      CNS=0.
       CAS=0.0
      YBOT=(Y(I)+Y(I-1))/(2.*SSPAN)
      NSTAT=I-1
      CHLOC=CHRDLW(NSTAT)
C
C     LOOP OVER AREA ELEMENTS IN ROW
C
      NCWW=NCWI(NSTAT)
      DO 2 K=1,NCWW
      JJ=IBASE+K
      CYS=CYS+CYBL(JJ)+0.5*(CYTLL(JJ)+CYTLR(JJ))
      CNS=CNS+CZBL(JJ)+0.5*(CZTLL(JJ)+CZTLR(JJ))
       CAS=CAS+CXBL(JJ)
    2 CONTINUE
      TA=CON/SW(JJ)
      CYS=TA*CYS
      CNS=CNS*TA
      CNORM=CNS*CPHIW+CYS*SPHIW
      IBASE=IBASE+NCWW
      CN=CNORM*2.0*SPAN/CHLOC
       CAS=CAS*TA*2.0*SPAN/CHLOC
    1 WRITE(6,705) NSTAT,YBOT,CHLOC,CNORM,CN ,CAS
C
C     CALCULATE FLAP LOADS
C
C     LOOP OVER FLAPS
C
      IF(NFLAPS.EQ.0) GO TO 50
      DO 20 N=1,NFLAPS
      WRITE(6,706) IDFLAP(N,1),IDFLAP(N,2)
      WRITE (6,704)
      NCFF=NCF(N)
      CPHIFF=CPHIF(N)
      SPHIFF=SPHIF(N)
      CON=SREFTB/2.0
      IFM=NSF(N)+1
      CROOT=CROOTF(N)
      DCHORD=CROOT-CTIPF(N)
      JBL=MEND(N)
      YOTBRD=YTLL(JBL)
      YINBRD=YF(1,N)
      FSPAN=YINBRD-YOTBRD
      JBL=MSTART(N)-1
C
C     LOOP OVER CHORDWISE ROWS ON THIS FLAP
C
      DO 30 I=2,IFM
      NSTAT=I-1
      YBOT=(YF(I,N)+YF(NSTAT,N))/(2.*SSPAN)
      CHLOC=CROOT+(YBOT*SSPAN-YINBRD)*DCHORD/FSPAN
      CYS=0.0
      CNS=0.0
       CAS=0.0
C
C     LOOP OVER AREA ELEMENTS IN THIS ROW
C
      DO 40 J=1,NCFF
      JBL=JBL+1
      CYS=CYS+CYBL(JBL)+0.5*(CYTLL(JBL)+CYTLR(JBL))
      CNS=CNS+CZBL(JBL)+0.5*(CZTLL(JBL)+CZTLR(JBL))
      CAS=CAS + CXBL(JBL)
   40 CONTINUE
      TA=CON/SW(JBL)
      CYS=TA*CYS
      CNS=TA*CNS
      CNORM=CNS*CPHIFF+CYS*SPHIFF
      CN=CNORM*2.0*SPAN/CHLOC
       CAS=CAS*TA*2.0*SPAN/CHLOC
   30 WRITE(6,705) NSTAT,YBOT,CHLOC,CNORM,CN ,CAS
   20 CONTINUE
C
C     CALCULATE WING FORCES AND MOMENTS
C
   50 CNW=0.0
      CAW=0.0
      CMW=0.0
      DO 60 J=1,MW
      CXBLW=CXBL(J)
      CZBLW=CZBL(J)
      CZTLRW=CZTLR(J)
      CZTLLW=CZTLL(J)
      IF (J.LE.NCWI(1)) CZTLRW=0.0
      CAW=CAW+CXBLW
      CNW=CNW+CZBLW+CZTLRW+CZTLLW
      CMW=CMW+(XBL(J)-XM)*CZBLW-(ZBL(J)-ZM)*CXBLW+(FTLXR(J)-XM)*CZTLRW
     1 +(FTLXL(J)-XM)*CZTLLW
   60 CONTINUE
      CNW=2.*CNW
      CAW=2.*CAW
      CMW=2.*CMW/REFL
      CLW=CNW*COSALF-CAW*SINALF
      CDW=CNW*SINALF+CAW*COSALF
      WRITE (6,707)
      WRITE (6,708)
      WRITE (6,709)
      WRITE(6,710) CNW,CAW,CLW,CDW,CMW
      CLT=CLW
      CDT=CDW
      CMT=CMW
C
C     CALCULATE FLAP FORCE AND MOMENTS
      IF(NFLAPS.EQ.0) GO TO 100
C
C     LOOP OVER FLAPS
C
      WRITE (6,711)
      DO 70 N=1,NFLAPS
      CNF=0.0
      CAF=0.0
      CYF=0.0
      CMF=0.0
      CMXNF=0.0
      CMYNF=0.0
      CMZAF=0.0
      CMZYF=0.0
      NCFF=NCF(N)
      MS  =MSTART(N)
      ME  =MEND(N)
      CDXZ=CDELXZ(N)
      SDXZ=SDELXZ(N)
      XMLX=XMILE(N)
```

```
      YWL=YWILE(N)
      ZWL=ZWILE(N)
      CPHIFF=CPHIF(N)
      SPHIFF=SPHIF(N)
      SPSD=SPHIFF*SDXZ
      SPCD=SPHIFF*CDXZ
      TPSILE=TAN(SWPFLE(N))
      CPSILE=COS(SWPFLE(N))
      CAPD=COSALF*CDXZ-SINALF*SDXZ
      SAPD=SINALF*CDXZ+COSALF*SDXZ
C
C     LOOP OVER VIRTICES ON THIS FLAP
C
      DO 80 J=MS,ME
      CXBLF=CXBL(J)
      CYBLF=CYBL(J)
      CZBLF=CZBL(J)
      CZTLRF=CZTLR(J)
      CZTLLF=CZTLL(J)
      CYTLRF=CYTLR(J)
      CYTLLF=CYTLL(J)
      K=J-MS+1
      IF (K.GT.NCFF.OR.YF(1,N).NE.0.0) GO TO 81
      CZTLRF=0.0
      CYTLRF=0.0
   81 CONTINUE
      DXWBL=XBL(J)-XWL
      DYWBL=YBL(J)-YWL
      DZWBL=ZBL(J)-ZWL
      DXWTLR=FTLXR(J)-XWL
      DYWTLR=YTLR(J)-YWL
      DZWTLR=FTLZR(J)-ZWL
      DXWTLL=FTLXL(J)-XWL
      DYWTLL=YTLL(J)-YWL
      DZWTLL=FTLZL(J)-ZWL
      DXFBL=DXWBL*CDXZ-DZWBL*SDXZ
      DYFBL=DYWBL*CPHIFF+DXWBL*SPSD+DZWBL*SPCD
      DXFTLR=DXWTLR*CDXZ-DZWTLR*SDXZ
      DYFTLR=DYWTLR*CPHIFF+DXWTLR*SPSD+DZWTLR*SPCD
      DXFTLL=DXWTLL*CDXZ-DZWTLL*SDXZ
      DYFTLL=DYWTLL*CPHIFF+DXWTLL*SPSD+DZWTLL*SPCD
      CNFBL=CZBLF*CPHIFF+CYBLF*SPHIFF
      CYFBL=CYBLF*CPHIFF-CZBLF*SPHIFF
      CNFTLR=CZTLRF*CPHIFF+CYTLRF*SPHIFF
      CYFTLR=CYTLRF*CPHIFF-CZTLRF*SPHIFF
      CNFTLL=CZTLLF*CPHIFF+CYTLLF*SPHIFF
      CYFTLL=CYTLLF*CPHIFF-CZTLLF*SPHIFF
      CAF=CAF+CXBLF
      CNF=CNF+CNFBL+CNFTLR+CNFTLL
      CYF=CYF+CYFBL+CYFTLR+CYFTLL
      CMXNF=CMXNF+DYFBL*CNFBL+DYFTLR*CNFTLR+DYFTLL*CNFTLL
      CMYNF=CMYNF+DXFBL*CNFBL+DXFTLR*CNFTLR+DXFTLL*CNFTLL
      CMZAF=CMZAF+DYFBL*CXBLF
      CMZYF=CMZYF+DXFBL*CYFBL+DXFTLR*CYFTLR+DXFTLL*CYFTLL
      CMF=CMF+(XBL(J)-XM)*(CZBLF*CDXZ-CXBLF*SDXZ)-(ZBL(J)-ZM)
     1 *(CZBLF*SDXZ+CXBLF*CDXZ)
      CMF=CMF+(FTLXR(J)-XM)*CZTLRF*CDXZ-(FTLZR(J)-ZM)*CZTLRF*SDXZ
      CMF=CMF+(FTLXL(J)-XM)*CZTLLF*CDXZ-(FTLZL(J)-ZM)*CZTLLF*SDXZ
   80 CONTINUE
      CNFF=CNF*CPHIFF-CYF*SPHIFF
      CLF=CNFF*CAPD-CAF*SAPD
      CDF=CNFF*SAPD+CAF*CAPD
      XFCNF=999.999
      YFCNF=999.999
      YFCAF=999.999
      XFCYF=999.999
      IF (CNF.NE.0.0) XFCNF=CMYNF/CNF
      IF (CNF.NE.0.0) YFCNF=CMXNF/CNF
      IF (CAF.NE.0.0) YFCAF=CMZAF/CAF
      IF (CYF.NE.0.0) XFCYF=CMZYF/CYF
      CMF=CMF*(XFCNF-YFCNF*TPSILE)*CPSILE/REFL
      CMF=CMF/REFL
      WRITE (6,712) IDFLAP(N,1),IDFLAP(N,2),CNF,XFCNF,YFCNF,CAF,YFCAF,
     1CYF,XFCYF,CMF
      CLT=CLT+2.*CLF
      CDT=CDT+2.*CDF
      CMT=CMT+2.*CMF
   70 CONTINUE
C
C     CALCULATE COMPLETE CONFIGURATION FORCES AND MOMENTS
C
  100 WRITE(6,713)
      WRITE (6,708)
      WRITE (6,714)
      CNT=CLT*COSALF+CDT*SINALF
      CAT=CDT*COSALF-CLT*SINALF
      CDCLS=0.0
      IF (CLT.NE.0.0) CDCLS=CDT/(CLT*CLT)
      WRITE(6,715) CNT,CAT,CLT,CDT,CMT,CDCLS
      IF (NPRINT.LE.1) GO TO 505
      IF (NTIME.GT.1) GO TO 505
C       ***** DEBUG *****
  797 FORMAT (1H )
  798 FORMAT (1H1,10X,27HSUMMARY OF FORCE COMPONENTS )
  799 FORMAT (I5,5X,1PE12.4,2(3X,3E12.4))
      WRITE (6,798)
      WRITE (6,797)
      WRITE (6,796)
      DO 500 J=1,MW
      WRITE (6,799) J,CXBL(J),CYBL(J),CYTLL(J),CYTLR(J),
     1                               CZBL(J),CZTLL(J),CZTLR(J)
  500 CONTINUE
      IF (NFLAPS.LE.0) GO TO 505
      DO 501 N=1,NFLAPS
      WRITE (6,797)
      JS=MSTART(N)
      JE=MEND(N)
      DO 502 J=JS,JE
      WRITE (6,799) J,CXBL(J),CYBL(J),CYTLL(J),CYTLR(J),
     1                               CZBL(J),CZTLL(J),CZTLR(J)
  502 CONTINUE
  501 CONTINUE
  505 CONTINUE
C       ***** DEBUG *****
C
C     CALCULATE PRESSURE DISTRIBUTIONS
C
      IHEAD=0
      IF (NTIME.GT.1) RETURN
C
C     WING PRESSURE DISTRIBUTION
C
      IF (NPRESW.EQ.0) GO TO 300
      WRITE (6,716)
      IHEAD=1
      WRITE (6,717)
      WRITE (6,718)
C
C     LOOP OVER CHORDWISE ROWS
C
      IBASE=0
      DO 200 I=2,IMAX
      IM=I-1
      YBOT=(Y(I)+Y(IM))/(2.0*SSPAN)
      CHLOC=CHRDLW(IM)
      XLEE=(XLE(I)+XLE(IM))/2.0
      NCWW=NCWI(IM)
      DO 210 K=1,NCWW
      JJ=IBASE+K
      XC(K)=(XLEE-XBL(JJ))/CHLOC
      CNS=CZBL(JJ)+CZTLR(JJ)+CZTLL(JJ)
      CYS=CYBL(JJ)+CYTLR(JJ)+CYTLL(JJ)
      CNORM=CNS*CPHIW+CYS*SPHIW
      PRES(K)=CNORM*SREF/ELAREA(JJ)
  210 CONTINUE
      WRITE (6,719) YBOT,CHLOC,(XC(J),J=1,NCWW)
      WRITE (6,720) (PRES(J),J=1,NCWW)
      WRITE (6,721)
      IBASE=IBASE+NCWW
  200 CONTINUE
C
C     FLAP PRESSURE DISTRIBUTIONS
C
  300 IF (NFLAPS.EQ.0) GO TO 350
C
C     LOOP OVER FLAPS
```

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C
      DO 310 N=1,NFLAPS
      IF (NPRESF(N).EQ.0) GO TO 310
      IF (IHEAD.EQ.1) GO TO 320
      WRITE (6,716)
      IHEAD=1
  320 WRITE (6,722) IDFLAP(N,1),IDFLAP(N,2)
      WRITE (6,718)
      NCFF=NCF(N)
      FNCFF=NCFF
      DO 321 J=1,NCFF
      FJ=J
  321 XC(J)=(FJ-0.75)/FNCFF
      IFM=MSF(N)+1
      FSPAN=YF(1,N)-YF(IFM,N)
      YINBRD=YF(1,N)/FSPAN
      CROOT=CROOTF(N)
      DCHORD=CROOT-CTIPF(N)
      JBL=MSTART(N)-1
      CPF=CPHIF(N)
      SPF=SPHIF(N)
C
C     LOOP OVER CHORDWISE ROWS
C
      DO 330 I=2,IFM
      IM=I-1
      YBOT=((YF(I,N)+YF(IM,N))/2.0)/SSPAN
      YFS=YBOT*SSPAN/FSPAN-YINBRD
      CHLOC=CROOT+YFS *DCHORD
      DO 340 K=1,NCFF
      JBL=JBL+1
      CNS=CZBL(JBL)+CZTLL(JBL)+CZTLR(JBL)
      CYS=CYBL(JBL)+CYTLL(JBL)+CYTLR(JBL)
      CNORM=CNS*CPF+CYS*SPF
      PRES(K)=CNORM*SREF/ELAREA(JBL)
  340 CONTINUE
      WRITE (6,719) YBOT,CHLOC,(XC(J),J=1,NCFF)
      WRITE (6,720) (PRES(J),J=1,NCFF)
      WRITE (6,721)
  330 CONTINUE
  310 CONTINUE
  350 CONTINUE
      IF (NJPNL.EQ.0) RETURN
      NTIME=2
      GO TO 102
      END

      SUBROUTINE VELSUM(XX,YY,ZZ)
C
C     CALCULATES VELOCITIES DUE TO VORTICES AND THEIR WAKES AT
C     A FIELDPOINT (XX,YY,ZZ)
C
C     COMMON STATEMENTS
C
      COMMON / WNGDAT/ Y(30),PSIWLE(30),PSIWTE(30),SPHIW,CPHIW,TPHIW
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /TLDAT/ XTER(30),XTEL(30),XTLR(250),YTLR(250),ZTLR(250),
     1 XTLL(250),YTLL(250),ZTLL(250)
      COMMON / INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /FLPDAT/ SDELXZ(10),CDELXZ(10),YF(30,10),SPHIF(10),
     1CPHIF(10)
      COMMON /WKDATW/ XWKRW(30,3),YWKRW(30,3),ZWKRW(30,3),XWKLW(30,3),
     1YWKLW(30,3),ZWKLW(30,3)
      COMMON /WKDATF/ XWKRF(30,2,10),YWKRF(30,2,10),ZWKRF(30,2,10),
     1XWKLF(30,2,10),YWKLF(30,2,10),ZWKLF(30,2,10)
      COMMON /RVELS/UP,VP,WP
      COMMON /FLVFRG/X1,Y1,Z1,X2,Y2,Z2,XP,YP,ZP,FU,FV,FW,AX,AZ
      COMMON /RSIDE/ CIR(250),UEI(250),VEI(250),WEI(250)
      COMMON /TOLRNC/ TOL
      COMMON /NDIFF/ NIDF,IDF(10)
      COMMON /FRCVEL/ NFRC
      COMMON /FTLV/ NVTLF
C
      XP=XX
      YP=YY
      ZP=ZZ
      UP=0.0
      VP=0.0
      WP=0.0
      IBASE=0
      NVTLF=0
C
      IF (NFRC.GT.0) RETURN
C
C     INFLUENCE OF WING VORTICES -- LOOP OVER CHORDWISE ROWS
C
      DO 200 ISW=1,MSW
      NAFT=NFSEG(ISW)
      AFTU=0.
      AFTV=0.
      AFTW=0.
      IF(NAFT.EQ.0) GO TO 133
      IF(NAFT.EQ.1) GO TO 131
C
C     INFLUENCE OF FINITE LENGTH WAKE PIECES BEHIND THIS ROW
C
      NAFTM=NAFT-1
      DO 130 IAS=1,NAFTM
      X1=XWKRW(ISW,IAS)
      Y1=YWKRW(ISW,IAS)
      Z1=ZWKRW(ISW,IAS)
      IASP=IAS+1
      X2=XWKRW(ISW,IASP)
      Y2=YWKRW(ISW,IASP)
      Z2=ZWKRW(ISW,IASP)
      CALL FLVF
      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
      X1=XWKLW(ISW,IAS)
      Y1=YWKLW(ISW,IAS)
      Z1=ZWKLW(ISW,IAS)
      X2=XWKLW(ISW,IASP)
      Y2=YWKLW(ISW,IASP)
      Z2=ZWKLW(ISW,IASP)
      CALL FLVF
      AFTU=AFTU-FU
      AFTV=AFTV-FV
      AFTW=AFTW-FW
  130 CONTINUE
C
C     INFLUENCE OF SEMI-INFINITE TRAILING LEGS IN LAST AFT FLAP
C
  131 CONTINUE
      LF=LASTF(ISW)
      AX=-CDELXZ(LF)
      AZ=SDELXZ(LF)
      X1=XWKRW(ISW,NAFT)
      Y1=YWKRW(ISW,NAFT)
      Z1=ZWKRW(ISW,NAFT)
      IF (NIDF.LE.0) GO TO 231
C      CORRECT POSITION OF WING TRAILING LEGS AT FLAP EDGES
      DO 232 J=1,NIDF
      K=IDF(J)
      DY=(Y1-Y(K))**2
      IF (DY.LE.TOL) GO TO 235
  232 CONTINUE
      GO TO 231
  235 AX=-1.0
      AZ=0.0
  231 CONTINUE
C
      CALL SIVF
      AFTU=AFTU-FU
```

```
      AFTV=AFTV-FV
      AFTW=AFTW-FW
      X1=XWKLW(ISW,NAFT)
      Y1=YWKLW(ISW,NAFT)
      Z1=ZWKLW(ISW,NAFT)
      IF (NIDF.LE.0) GO TO 241
C      CORRECT POSITION OF WING TRAILING LEGS AT FLAP EDGES
      AX=-CDELXZ(LF)
      AZ=SDELXZ(LF)
      DO 242 J=1,NIDF
      K=IDF(J)
      DY=(Y1-Y(K))**2
      IF (DY.LE.TOL) GO TO 245
  242 CONTINUE
      GO TO 241
  245 AX=-1.0
      AZ=0.0
  241 CONTINUE
C
      CALL SIVF
      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
  133 CONTINUE
C
C     LOOP OVER VORTICES IN THIS WING CHORDWISE ROW
C
      NCWC=NCWI(ISW)
      DO 150 ICW=1,NCWC
C
C     INFLUENCE OF BOUND LEG
C
      I=IBASE+ICW
      X1=XTLL(I)
      Y1=YTLL(I)
      Z1=ZTLL(I)
      X2=XTLR(I)
      Y2=YTLR(I)
      Z2=ZTLR(I)
      CALL FLVF
      CU=FU
      CV=FV
      CW=FW
      IF(NAFT.NE.0) GO TO 145
C
C     NO FLAPS BEHIND THIS ROW.  COMPUTE THE INFLUENCE OF INFINITE
C     TRAILING LEGS IN WING PLANE
C
      AX=-1.0
      AZ=0.0
      CALL SIVF
      CU=CU+FU
      CV=CV+FV
      CW=CW+FW
      X1=X2
      Y1=Y2
      Z1=Z2
      CALL SIVF
      CU=CU-FU
      CV=CV-FV
      CW=CW-FW
      GO TO 147
C
C     THERE ARE FLAPS BEHIND THIS ROW.  COMPUTE INFLUENCE OF
C     FINITE TRAILING LEGS IN WING PLANE
C
  145 X1=XTLR(I)
      Y1=YTLR(I)
      Z1=ZTLR(I)
      X2=XWKRW(ISW,1)
      Y2=YWKRW(ISW,1)
      Z2=ZWKRW(ISW,1)
      CALL FLVF
      CU=CU+FU
      CV=CV+FV
      CW=CW+FW
      X1=XTLL(I)
      Y1=YTLL(I)
      Z1=ZTLL(I)
      X2=XWKLW(ISW,1)
      Y2=YWKLW(ISW,1)
      Z2=ZWKLW(ISW,1)
      CALL FLVF
      CU=CU-FU
      CV=CV-FV
      CW=CW-FW
      CU=CU+AFTU
      CV=CV+AFTV
      CW=CW+AFTW
  147 VS=CIR(I)
      UP=UP+CU*VS
      VP=VP+CV*VS
      WP=WP+CW*VS
  150 CONTINUE
  200 IBASE=IBASE+NCWC
C
C     INFLUENCE OF FLAP VORTICES -- LOOP OVER FLAPS
C
      IF(NFLAPS.EQ.0) RETURN
      DO 300 IFL=1,NFLAPS
      NCFF=NCF(IFL)
      NSFF=NSF(IFL)
      CDXZ=CDELXZ(IFL)
      SDXZ=SDELXZ(IFL)
      NAFT=NFSEGF(IFL)
      IBASE=NSTART(IFL)
C
C     LOOP OVER CHORDWISE ROWS OF VORTICES ON THIS FLAP
C
      DO 250 ISW=1,NSFF
      AFTU=0.0
      AFTV=0.0
      AFTW=0.0
      IF(NAFT.EQ.0) GO TO 212
      IF(NAFT.EQ.1) GO TO 210
C
C     INFLUENCE OF FINITE TRAILING LEGS IN FIRST FLAP AFT OF THIS ONE
C
      X1=XWKRF(ISW,1,IFL)
      Y1=YWKRF(ISW,1,IFL)
      Z1=ZWKRF(ISW,1,IFL)
      X2=XWKRF(ISW,2,IFL)
      Y2=YWKRF(ISW,2,IFL)
      Z2=ZWKRF(ISW,2,IFL)
      CALL FLVF
      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
      X1=XWKLF(ISW,1,IFL)
      Y1=YWKLF(ISW,1,IFL)
      Z1=ZWKLF(ISW,1,IFL)
      X2=XWKLF(ISW,2,IFL)
      Y2=YWKLF(ISW,2,IFL)
      Z2=ZWKLF(ISW,2,IFL)
      CALL FLVF
      AFTU=AFTU-FU
      AFTV=AFTV-FV
      AFTW=AFTW-FW
C
C     CONTRIBUTION OF SEMI-INFINITE TRAILING LEGS IN SECOND FLAP
C
  210 X1=XWKRF(ISW,NAFT,IFL)
      Y1=YWKRF(ISW,NAFT,IFL)
      Z1=ZWKRF(ISW,NAFT,IFL)
      NF=IFL+NAFT
      AX=-CDELXZ(NF)
      AZ=SDELXZ(NF)
      CALL SIVF
      AFTU=AFTU-FU
      AFTV=AFTV-FV
      AFTW=AFTW-FW
      X1=XWKLF(ISW,NAFT,IFL)
      Y1=YWKLF(ISW,NAFT,IFL)
      Z1=ZWKLF(ISW,NAFT,IFL)
      CALL SIVF
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      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
C
C     LOOP OVER VORTICES IN THIS CHORDWISE ROW
C
  212 CONTINUE
      II=IBASE+(ISW-1)*NCFF-1
      DO 220 ICW=1,NCFF
C
C     INFLUENCE OF BOUND LEG
C
      I=II+ICW
      X1=XTLL(I)
      Y1=YTLL(I)
      Z1=ZTLL(I)
      X2=XTLR(I)
      Y2=YTLR(I)
      Z2=ZTLR(I)
      CALL FLVF
      CU=FU
      CV=FV
      CW=FW
      IF(NAFT.NE.0) GO TO 214
C
C     NO FLAPS BEHIND THIS ONE.  COMPUTE INFLUENCE OF SEMI-INFINITE
C      TRAILING LEGS IN THE PLANE OF THIS FLAP
C
      AX=-CDXZ
      AZ=SDXZ
      CALL SIVF
      CU=CU+FU
      CV=CV+FV
      CW=CW+FW
      X1=X2
      Y1=Y2
      Z1=Z2
      CALL SIVF
      CU=CU-FU
      CV=CV-FV
      CW=CW-FW
      GO TO 216
C
C      THERE ARE FLAPS BEHIND THIS ONE.  COMPUTE INFLUENCE OF
C      FINITE TRAILING LEGS IN THIS FLAP
C
  214 X1=XTLR(I)
      Y1=YTLR(I)
      Z1=ZTLR(I)
      X2=XWKRF(ISW,1,IFL)
      Y2=YWKRF(ISW,1,IFL)
      Z2=ZWKRF(ISW,1,IFL)
      CALL FLVF
      CU=CU+FU
      CV=CV+FV
      CW=CW+FW
      X1=XTLL(I)
      Y1=YTLL(I)
      Z1=ZTLL(I)
      X2=XWKLF(ISW,1,IFL)
      Y2=YWKLF(ISW,1,IFL)
      Z2=ZWKLF(ISW,1,IFL)
      CALL FLVF
      CU=CU-FU
      CV=CV-FV
      CW=CW-FW
      CU=CU+AFTU
      CV=CV+AFTV
      CW=CW+AFTW
  216 VS=CIR(I)
      UP=UP+CU*VS
      VP=VP+CV*VS
  220 WP=WP+CW*VS
  250 CONTINUE
  300 CONTINUE
      NVTLF=0
      RETURN
      END
```

```
      SUBROUTINE JET (NP,XP,YP,ZP,UP,VP,WP,NTIME)
C
C       USB VERSION,  JET IS REPRESENTED BY A SERIES OF QUADRILATERAL
C                     VORTEX RINGS, LYING ON A PRESCRIBED PATH,
C                     PARALLEL TO WING AND FLAP UPPER SURFACE
C
C      ALL FIELD POINT COORDINATES ARE INPUT IN THE WING SYSTEM AND
C       TRANSFORMED TO THE ENGINE SYSTEM FOR CALCULATIONS
C     JET CENTERLINE COORDINATES ARE INPUT IN ENGINE SYSTEM
C     ALL OUTPUT IS IN THE WING SYSTEM
C
C                NCRCT = 0  CORRECT FIELD POINT POSITIONS
C                           WITH RESPECT TO VORTEX RINGS
C                NCRCT = 1  DO NOT CORRECT FIELD POINT POSITIONS
C
C                NTIME = 0       INPUT AND PRINT INITIAL JET PARAMETERS
C                NTIME .GT. 0    PRINT JET PARAMETERS AND CALCULATE
C                                  INDUCED VELOCITIES
C                                IF CFK = 1.0, PRINT JET PARAMETERS
C                                        (INDUCED VELOCITIES INPUT)
C                NTIME .LT. 0    CALCULATE INDUCED VELOCITIES FROM
C                                  PREVIOUSLY DESCRIBED JETS - NO OUTPUT
C                NVLP = NUMBER OF LATTICE ELEMENT CONTROL POINTS
C                         AT WHICH NO JET VELOCITIES ARE TO BE
C                         COMPUTED  (NVLP.LE.100)
C                CFK.GT.0.0    PRINT INPUT JET PARAMETERS AND
C                              SET UP NPTJ(-,-) ARRAY
C
C       OPTIONAL OUTPUT ...
C                JPRINT = -1      MINIMUM OUTPUT
C                JPRINT = 0       NO OPTIONAL OUTPUT
C                JPRINT = 1       INDIVIDUAL JET INDUCED VELOCITIES
C
      DIMENSION TITLE(8), PJET(2),XP(250),YP(250),ZP(250),
     2          XPR(250),YPR(250),ZPR(250),U(250),V(250),W(250),
     3          UP(250),VP(250),WP(250),CT(2)
C
      COMMON /XYZCL/ NJET,NCYL(2),XO(2),YO(2),ZO(2),GAMVJ(2),DS(2),
     1 RHO(2),CMU(2),XCLR(2,25),YCLR(2,25),ZCLR(2,25),THETA(2,25),
     2                SCLR(2,25),AJET(2,25),BJET(2,25),DSFACT(2,25),
     3                 UCL(2,25), VCL(2,25), WCL(2,25),  CFJ,CFK
      COMMON /CLDAT/ NSS(2),SS(2,11),XSS(2,11),YSS(2,11),ZSS(2,11),
     1                TSS(2,11),BSS(2,11),ASS(2,11),XSN(2,11),YSN(2,11),
     2                ZSN(2,11),XST(2,11),YST(2,11),ZST(2,11),DSS(2,11)
      COMMON /CORNER/ XCRQ(4),YCRQ(4),ZCRQ(4)
      COMMON /PTDAT/ NPTJ(2,250),NCRCT
      COMMON /VLDAT/ NVLP,NVL(101)
      COMMON /NFJCL/ NFJ,NFJN(3)
      COMMON /REFQUA/ SSPAN,SREF,REFL,XM,ZM
C
  700 FORMAT (8F10.5)
  701 FORMAT (16I5)
  702 FORMAT (8A10)
  703 FORMAT (10X,8A10)
  704 FORMAT (1H1,3X,20HINPUT JET PARAMETERS //)
  705 FORMAT (6F10.5,I5)
  706 FORMAT (//5X,48HJET INDUCED VELOCITIES ARE OMITTED ON PANELS... ,
     1            10I5,9(/53X,10I5))
  707 FORMAT (1H1,3X,34HJET PARAMETERS FOR TANGENT USB JET //)
  708 FORMAT (6X,12HINPUT VALUES )
  711 FORMAT(//2H (I1,16H) JET PARAMETERS,10X,3HCT ,7X3HRHO,7X2HXO,
     1 8X2HYO,8X2HZO,8X4HD(S),5X4HNCYL,3X7HGAMMA/V /23X,6F10.4,I8,F10.4/
     2          8X3HXCL,7X3HYCL,7X3HZCL,8X3HSCL,6X5HTHETA,7X1HA,9X1HB
     3         6X6HDSFACT,7X1HP )
  712 FORMAT (3X,3F10.5,4F10.4,3F10.3)
  713 FORMAT (/3X4HNJET,2X4HNVLP,3X2HNP,2X5HNCRCT,2X6HJPRINT)
  714 FORMAT (15I6)
  715 FORMAT ( 4X1HN,7X2HX-,8X2HY-,8X2HZ-5X3HU/V,9X3HV/V,9X3HW/V)
  716 FORMAT (I5,3F10.3,2X,3(1PE12.4),2I5)
  717 FORMAT (/11X,22HWING COORDINATE SYSTEM)
  718 FORMAT (/2X,25HVELOCITIES INDUCED BY JET,I2,24H - JET COORDINATE S
     1YSTEM/4X1HN,7X4HXP  ,6X4HYP  ,6X4HZP  ,3X3HU/V9X3HV/V9X3HW/V)
  719 FORMAT (// 5X,38HSURFACE COORDINATE PARAMETERS FOR JET ,I2, 3X,
     1        24H(WING COORDINATE SYSTEM)  )
  720 FORMAT (/8X2HXS,6X2HYS,6X2HZS,6X2HSS,4X5HTHETA,5X1HA,7X1HB,
     1           9X3HXSN,5X3HYSN,5X3HZSN,7X3HXST,5X3HYST,5X3HZST,5X3HDSS)
  721 FORMAT (///10X, 34HEXECUTION TERMINATED,  ERROR IN DS  )
```

```
  722 FORMAT (3X,7F8.3,2(2X,3F8.5),F8.1)
C
      PI=3.1415926
      RAD=180./PI
C
      IF (NTIME) 193,10,997
C
   10 READ(5,701) NHEAD,NJET,NVLP,NCRCT,JPRINT
      IF (EOF(5)) 999,998
  999 STOP 10
  998 CONTINUE
      NPRINT=JPRINT
      NVLPZ=NVLP
      IF (NPRINT.GT.1) NPRINT=1
      NA=NPRINT
      WRITE (6,704)
      DO 9 J=1,NHEAD
      READ(5,702) TITLE
    9 WRITE (6,703) TITLE
C
C        INPUT INDIVIDUAL JET PARAMETERS
C
      DO 16 J=1,NJET
      READ (5,705)  CT(J),RHO(J),    XQ(J),YQ(J),ZQ(J),DS(J),NCYL(J)
      CMU(J)=CT(J)
      NCY=NCYL(J)
      IF (RHO(J).LE.0.0) RHO(J)=1.0
      DO 11 N=1,NCY
      READ (5,700) XCLR(J,N),YCLR(J,N),ZCLR(J,N),AJET(J,N),BJET(J,N),
     1             THETA(J,N),DSFACT(J,N)
      M=DSFACT(J,N)
      DSFACT(J,N)=M
      IF (DSFACT(J,N).LE.0.0) DSFACT(J,N)=1.0
   11 CONTINUE
      AJ=4.0*AJET(J,1)*BJET(J,1)
      DUM=SQRT(2.0*CMU(J)*SREF/AJ*RHO(J) + 1.0)
      GAMVJ(J)=0.5*(1.0 + DUM) - 1.0
   16 CONTINUE
      IF (NVLP.GT.0) READ (5,701) (NVL(J),J=1,NVLP)
C
  997 CONTINUE
      NPRINT=NA
      IF (NTIME.GT.0) WRITE (6,707)
      IF (CFK.LE.0.0) GO TO 996
      WRITE (6,708)
      NPRINT=0
  996 CONTINUE
C
C        SET UP TABLE OF JET CENTERLINE PARAMETERS
C
      DO 14 J=1,NJET
      SCLR(J,1)=0.0
      NCY=NCYL(J)
      DO 13 N=2,NCY
      SR = (XCLR(J,N)-XCLR(J,N-1))**2 + (YCLR(J,N)-YCLR(J,N-1))**2 +
     1     (ZCLR(J,N)-ZCLR(J,N-1))**2
   13 SCLR(J,N)=SQRT(SR) + SCLR(J,N-1)
   14 CONTINUE
C
C          PRELIMINARY OUTPUT
C
      WRITE (6,713)
      WRITE (6,714)    NJET,NVLP,NP,NCRCT,NPRINT
      DO 45 N=1,NJET
      NCY=NCYL(N)
      PJET(N)=4.0*(AJET(N,1) + BJET(N,1))
      WRITE (6,711) N,CMU(N),RHO(N),XQ(N),YQ(N),ZQ(N),DS(N),NCY,GAMVJ(N)
      DO 15 J=1,NCY
      P=4.0*(AJET(N,J) + BJET(N,J))
   15 WRITE (6,712) XCLR(N,J),YCLR(N,J),ZCLR(N,J),SCLR(N,J),THETA(N,J),
     1              AJET(N,J),BJET(N,J),DSFACT(N,J),P
      IF (NTIME.EQ.0) GO TO 45
C
C          OUTPUT SURFACE COORDINATES OF JET (CALC. IN JETCL)
      NS=NSS(N)
      WRITE (6,719)  N
      WRITE (6,720)
      DO 18 J=1,NS
   18 WRITE (6,722) XSS(N,J),YSS(N,J),ZSS(N,J),SS(N,J),TSS(N,J),
     1   ASS(N,J),BSS(N,J),XSN(N,J),YSN(N,J),ZSN(N,J),XST(N,J),YST(N,J),
     2    ZST(N,J),DSS(N,J)
   45 CONTINUE
      IF (NVLP.GT.0) WRITE(6,706) (NVL(J),J=1,NVLP)
      IF (NTIME.EQ. 0 ) RETURN
      GO TO 194
  193 NPRINT=-1
      IF (NTIME.LT.-1) NVLP=0
  194 CONTINUE
      IF (NTIME.GE.-1) NVL(NVLP+1)=NP+1
C
      IF (CFK.GT.0.0) GO TO 46
      DO 192 J=1,NP
      UP(J)=0.0
      VP(J)=0.0
  192 WP(J)=0.0
C
C          BEGINNING OF LOOP OVER ALL JETS
   46 DO 40 M=1,NJET
      IF (DS(M).LE.0.0) GO TO 90
      NS=NSS(M)
      NCL=NCYL(M)
      NFJ3=NFJ+3
C
C        TRANSFORM SURFACE COORDINATES TO JET SYSTEM
C
      J=M
      DO 62 I=1,NS
      XSS(J,I)=XQ(J)-XSS(J,I)
      XSN(J,I)=XQ(J)-XSN(J,I)
      XST(J,I)=XQ(J)-XST(J,I)
      YSS(J,I)=YSS(J,I)-YQ(J)
      YSN(J,I)=YSN(J,I)-YQ(J)
      YST(J,I)=YST(J,I)-YQ(J)
      ZSS(J,I)=ZQ(J)-ZSS(J,I)
      ZSN(J,I)=ZQ(J)-ZSN(J,I)
      ZST(J,I)=ZQ(J)-ZST(J,I)
      TSS(J,I)=-TSS(J,I)
   62 CONTINUE
      DO 19 J=1,NP
      U(J)=0.0
      V(J)=0.0
   19 W(J)=0.0
      SREND=SCLR(M,NCL)
C
C         TRANSFORM FIELD POINT COORDINATES TO ENGINE SYSTEM
C
  190 DO 191 J=1,NP
      XPR(J)= -XP(J)+XQ(M)
      YPR(J)= YP(J)-YQ(M)
  191 ZPR(J)= -ZP(J)+ZQ(M)
C
C          CORRECT FIELD POINT LOCATIONS IF DESIRED
C            SET UP NPTJ(-,-) ARRAY TO IDENTIFY PANELS NEAR JET
C
      CALL CORECT (NP,XPR,YPR,ZPR,    M,NTIME)
      IF (CFK.GT.0.0) GO TO 51
      SR=-DS(M)/2.0
      FACTOR=DSS(M,1)
      NSR=2
   20 CONTINUE
C
C          BEGINNING OF LOOP OVER ALL RINGS IN JET M
      DSR=DS(M)*FACTOR
      GAMI=GAMVJ(M)*PJET(M)*DSR
      SR=SR+DSR
C
C          USE SURFACE SPECIFICATION TO LOCATE VORTEX RINGS
C
  421 IF (SR-SS(M,NSR)) 423,425,422
  422 NSR=NSR+1
      IF (NSR.GT.NS) GO TO 51
      GO TO 421
  425 BG=BSS(M,NSR)
      AG=ASS(M,NSR)
```

```
      THG=TSS(M,NSR)/RAD
      XG=XSS(M,NSR)-BG*SIN(THG)
      YG=YSS(M,NSR)
      ZG=ZSS(M,NSR)+BG*COS(THG)
      XGN=XSN(M,NSR)
      YGN=YSN(M,NSR)
      ZGN=ZSN(M,NSR)
      XGT=XST(M,NSR)
      YGT=YST(M,NSR)
      ZGT=ZST(M,NSR)
      FACTOR=DSS(M,NSR)
      GO TO 430
  423 DELTA=(SR-SS(M,NSR-1))/(SS(M,NSR)-SS(M,NSR-1))
      IF (NSR-NFJ3) 424,424,427
  427 THG=TSS(M,NSR-1)+(TSS(M,NSR)-TSS(M,NSR-1))*DELTA
      THG=THG/RAD
      GO TO 426
  424 THG=TSS(M,NSR)/RAD
  426 BG=BSS(M,NSR-1)+(BSS(M,NSR)-BSS(M,NSR-1))*DELTA
      AG=ASS(M,NSR-1)+(ASS(M,NSR)-ASS(M,NSR-1))*DELTA
      XG=XSS(M,NSR-1)+(XSS(M,NSR)-XSS(M,NSR-1))*DELTA - BG*SIN(THG)
      ZG=ZSS(M,NSR-1)+(ZSS(M,NSR)-ZSS(M,NSR-1))*DELTA + BG*COS(THG)
      YG=YSS(M,NSR-1)+(YSS(M,NSR)-YSS(M,NSR-1))*DELTA
      XGN=XSN(M,NSR-1)+(XSN(M,NSR)-XSN(M,NSR-1))*DELTA
      YGN=YSN(M,NSR-1)+(YSN(M,NSR)-YSN(M,NSR-1))*DELTA
      ZGN=ZSN(M,NSR-1)+(ZSN(M,NSR)-ZSN(M,NSR-1))*DELTA
      XGT=XST(M,NSR-1)+(XST(M,NSR)-XST(M,NSR-1))*DELTA
      YGT=YST(M,NSR-1)+(YST(M,NSR)-YST(M,NSR-1))*DELTA
      ZGT=ZST(M,NSR-1)+(ZST(M,NSR)-ZST(M,NSR-1))*DELTA
      FACTOR=DSS(M,NSR-1)
  430 CONTINUE
   30 CONTINUE
C        CALCULATE INFLUENCE OF THIS RING ON ALL FIELD POINTS
      SNTH=SIN(THG)
      CSTH=COS(THG)
      THG=THG*RAD
      PGAM=4.0*(AG+BG)
   31 GAMMA=GAMI/PGAM
      NL=1
      DO 38 N=1,NP
      IF (NTIME.LT.-1) GO TO 138
      IF (NVLP.LE.0) GO TO 138
  338 IF (N-NVL(NL)) 138,38,238
  238 NL=NL+1
      IF (NL.LE.NVLP) GO TO 338
      NL=NVLP+1
  138 CONTINUE
      XIPR=(XPR(N)-XG)*CSTH + (ZPR(N)-ZG)*SNTH
      ETAR= (YPR(N)-YG)
      ZETAR=-(XPR(N)-XG)*SNTH + (ZPR(N)-ZG)*CSTH
C
C          COMPUTE VELOCITY INDUCED BY A QUADRILATERAL RING
C
   35 CONTINUE
C          SET UP CORNER POINTS OF RING
      XCRQ(1)=XGT
      YCRQ(1)=YGT
      ZCRQ(1)=ZGT
      XCRQ(2)=XGT-2.*BG*SNTH
      YCRQ(2)=YGT
      ZCRQ(2)=ZGT+2.*BG*CSTH
      XCRQ(3)=XGN-2.*BG*SNTH
      YCRQ(3)=YGN
      ZCRQ(3)=ZGN+2.*BG*CSTH
      XCRQ(4)=XGN
      YCRQ(4)=YGN
      ZCRQ(4)=ZGN
      X=XPR(N)
      Y=YPR(N)
      Z=ZPR(N)
      CALL QRING (X,Y,Z,UG,VG,WG)
      UGAM=UG*GAMMA
      VGAM=VG*GAMMA
      WGAM=WG*GAMMA
C
   37 U(N)=U(N)+UGAM
      W(N)=W(N)+WGAM
      V(N)=V(N)+VGAM
   38 CONTINUE
C
C         NOTE.. U(N),V(N),W(N) ARE VELOCITIES INDUCED IN ENGINE SYSTEM
C
      IF (SR.LT.SPEND) GO TO 20
   51 CONTINUE
C
C         TRANSFORM SURFACE COORDINATES BACK TO WING SYSTEM
C
      J=M
      DO 63 I=1,NS
      XSS(J,I)=XQ(J)-XSS(J,I)
      XSN(J,I)=XQ(J)-XSN(J,I)
      XST(J,I)=XQ(J)-XST(J,I)
      YSS(J,I)=YSS(J,I)+YQ(J)
      YSN(J,I)=YSN(J,I)+YQ(J)
      YST(J,I)=YST(J,I)+YQ(J)
      ZSS(J,I)=ZQ(J)-ZSS(J,I)
      ZSN(J,I)=ZQ(J)-ZSN(J,I)
      ZST(J,I)=ZQ(J)-ZST(J,I)
      TSS(J,I)=-TSS(J,I)
   63 CONTINUE
      IF (CFK.GT.0.0) GO TO 40
      DO 52 N=1,NP
      UP(N)=UP(N)+U(N)
      VP(N)=VP(N)+V(N)
   52 WP(N)=WP(N)+W(N)
      IF (NPRINT) 40,40,92
C
C          OPTIONAL OUTPUT
C
   92 WRITE (6,718) M
      DO 50 N=1,NP
   50 WRITE (6,716) N,XPR(N),YPR(N),ZPR(N),U(N),V(N),W(N)
   40 CONTINUE
      IF (CFK.GT.0.0) RETURN
   91 DO 41 N=1,NP
      UP(N)=-UP(N)
      WP(N)=-WP(N)
   41 CONTINUE
      NVLP=NVLPZ
      IF (NPRINT.LT.0) RETURN
C
C         OUTPUT INDUCED VELOCITIES IN WING SYSTEM
C
      WRITE (6,717)
      WRITE (6,715)
      DO 42 N=1,NP
   42 WRITE (6,716)N,XP(N),YP(N),ZP(N),UP(N),VP(N),WP(N),
     1                  (NPTJ(J,N),J=1,NJET)
      RETURN
   90 WRITE (6,721)
      STOP
      END
```

```
      SUBROUTINE JETCL
C        CALCULATE THE CENTERLINE POSITIONS FOR USB JETS TANGENT
C          TO THE UPPER SURFACES OF THE WING AND FLAPS
C        MODIFIED TO SET UP SURFACE COORDINATE SPECIFICATION OF JET
C
      DIMENSION XCL(25), YCL(25),ZCL(25),A(25),B(25),TH(25),DF(25)
C
      COMMON /WNGDAT/ Y(30),PSIWLE(30),PSIWTE(30),SPHIW,CPHIW,TPHIW
      COMMON /NFJCL/ NFJ,NFJN(3)
      COMMON /INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),NF(10),
```

```
     1                    MSTART(10),MEND(10),NFSEGF(10)
      COMMON /BLDAT/ XBL(250),YBL(250),ZBL(250),TPST(250),SW(250)
      COMMON /CPDAT/ ALPHAL(250),XCP(250),YCP(250),ZCP(250),
     1               CALPHL(250),SALPHL(250)
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /XYZCL/ NJET,NCYL(2),XQ(2),YQ(2),ZQ(2),GAMVJ(2),DS(2),
     1 RHO(2),CMU(2),XCLR(2,25),YCLR(2,25),ZCLR(2,25),THETA(2,25),
     2               SCLR(2,25),AJET(2,25),BJET(2,25),DSFACT(2,25),
     3                UCL(2,25), VCL(2,25), WCL(2,25),  CFJ,CFK
      COMMON /CLDAT/ NSS(2),SS(2,11),XSS(2,11),YSS(2,11),ZSS(2,11),
     1               TSS(2,11),BSS(2,11),ASS(2,11),XSN(2,11),YSN(2,11),
     2               ZSN(2,11),XST(2,11),YST(2,11),ZST(2,11),DSS(2,11)
C
      ENTRP(XL,XU,YL,YU,X)=YL+(X-XL)*(YU-YL)/(XU-XL)
C
C
  701 FORMAT (/10X,3HJET,I3,2X,20HOUTBOARD OF WING TIP)
  702 FORMAT (/10X,3HJET,I3,2X,16HOUTBOARD OF FLAP,I3//)
C
      RAD=180.0/3.1415926
C
C     LOOP OVER TOTAL NUMBER OF JETS
C
      DO 100 J=1,NJET
      NCL=NCYL(J)
C
C      TRANSFORM JET TO WING COORDINATE SYSTEM
C
      DO 6 K=1,NCL
      XCLR(J,K)=XQ(J)-XCLR(J,K)
      YCLR(J,K)=YQ(J)+YCLR(J,K)
    6 ZCLR(J,K)=ZQ(J)-ZCLR(J,K)
      NCW=MW/MSW
      SS(J,1)=0.0
      XSS(J,1)=XCLR(J,1)
      YSS(J,1)=YCLR(J,1)
      TSS(J,1)=0.0
      BSS(J,1)=BJET(J,1)
      ASS(J,1)=AJET(J,1)
      DSS(J,1)=DSFACT(J,1)
      XSS(J,2)=XCLR(J,2)
      YSS(J,2)=YCLR(J,2)
      TSS(J,2)=0.0
      BSS(J,2)=BJET(J,2)
      ASS(J,2)=AJET(J,2)
      DSS(J,2)=DSFACT(J,2)
      NSS(J)=2
C
C     LOCATE INTERSECTION OF WING T.E. AND FLAP 1 L.E.
C
      MST=NCW+1
      DO 10 I=MST,MW,NCW
      IW=I
      IWM1=I-NCW
      IF (YCP(IW)-YQ(J)) 11,12,10
   10 CONTINUE
      WRITE (6,701) J
      GO TO 100
C
C      COORDINATES XB,ZB AND XC,ZC ARE ON WING
C
   12 XB=XBL(IW)
      ZB=ZBL(IW)
      XC=XCP(IW)
      ZC=ZCP(IW)
      GO TO 15
   11 XB=ENTRP(YCP(IWM1),YCP(IW),XBL(IWM1),XBL(IW),YQ(J))
      ZB=ENTRP(YCP(IWM1),YCP(IW),ZBL(IWM1),ZBL(IW),YQ(J))
      XC=ENTRP(YCP(IWM1),YCP(IW),XCP(IWM1),XCP(IW),YQ(J))
      ZC=ENTRP(YCP(IWM1),YCP(IW),ZCP(IWM1),ZCP(IW),YQ(J))
   15 MFJ=NFJN(1)
      ZSS(J,1)=ENTRP(XB,XC,ZB,ZC,XSS(J,1))
      ZSS(J,2)=ENTRP(XB,XC,ZB,ZC,XSS(J,2))
      SS(J,2)=SS(J,1) + SQRT((XSS(J,2)-XSS(J,1))**2
     1            + (YSS(J,2)-YSS(J,1))**2 + (ZSS(J,2)-ZSS(J,1))**2)
      ZD=ZSS(J,1)-BSS(J,1)
      ZH=ABS(ZD-ZQ(J))
      IF (ZH.LE.1.0E-04) GO TO 14
      DO 13 K=1,NCL
   13 ZCLR(J,K)=ZCLR(J,K)-ZQ(J)+ZD
      ZQ(J)=ZD
   14 MI=NCF(MFJ)
      MST=MSTART(MFJ)
      MND=HEND(MFJ)
      DO 16  I=MST,MND,MI
      IF=I
      IFM1=I-MI
      IF (YCP(IF)-YQ(J)) 21,22,16
   16 CONTINUE
      WRITE (6,702) J,MFJ
      STOP 16
C
C     COORDINATES XE, ZE, AND XF,ZF ARE ON FLAP 1
C
   22 XE=XBL(IF)
      ZE=ZBL(IF)
      XF=XCP(IF)
      ZF=ZCP(IF)
      GO TO 25
   21 XE=ENTRP(YCP(IFM1),YCP(IF),XBL(IFM1),XBL(IF),YQ(J))
      ZE=ENTRP(YCP(IFM1),YCP(IF),ZBL(IFM1),ZBL(IF),YQ(J))
      XF=ENTRP(YCP(IFM1),YCP(IF),XCP(IFM1),XCP(IF),YQ(J))
      ZF=ENTRP(YCP(IFM1),YCP(IF),ZCP(IFM1),ZCP(IF),YQ(J))
   25 CONTINUE
      ZCB=(ZC-ZB)/(XC-XB)
      ZFE=(ZF-ZE)/(XF-XE)
      DF1=ATAN(-ZFE)
      XD=(ZE-ZB + XB*ZCB - XE*ZFE)/(ZCB-ZFE)
      ZD=ZB + (XD-XB)*ZCB
      XFBLA=XE
      ZFBLA=ZE
      XFCPA=XF
      ZFCPA=ZF
      NSS(J)=3
      XSS(J,3)=XD
      YSS(J,3)=YSS(J,2)
      ZSS(J,3)=ZD
      TSS(J,3)=0.0
      SS(J,3)=SS(J,2)+SQRT((XSS(J,3)-XSS(J,2))**2
     1            + (YSS(J,3)-YSS(J,2))**2 + (ZSS(J,3)-ZSS(J,2))**2)
C
C       XD,YQ(J),ZD  ARE COORDINATES OF WING-FLAP INTERSECTION
C
C      SET UP NEW CENTERLINE OVER WING, FIRST TWO POINTS ARE UNCHANGED
C
      DO 26 I=1,2
      XCL(I)=XCLR(J,I)
      YCL(I)=YCLR(J,I)
      ZCL(I)=ZCLR(J,I)
      TH(I)=0.0
      DF(I)=DSFACT(J,I)
      A(I)=AJET(J,I)
   26 B(I)=BJET(J,I)
      L=3
      LR=3
   27 IF (XCLR(J,LR)-XD) 29,29,28
   28 XCL(L)=XCLR(J,LR)
      YCL(L)=YQ(J)
      ZCL(L)=ZSS(J,3)-BJET(J,LR)
      A(L)=AJET(J,LR)
      B(L)=BJET(J,LR)
      TH(L)=0.0
      DF(L)=DSFACT(J,LR)
      L=L+1
      LR=LR+1
      IF (LR.GT.NCL .OR.L.GT.25) STOP 27
      GO TO 27
   29 XCL(L)=XD
      YCL(L)=YQ(J)
      A(L)=ENTRP(XCLR(J,LR-1),XCLR(J,LR),AJET(J,LR-1),AJET(J,LR),XD)
      B(L)=ENTRP(XCLR(J,LR-1),XCLR(J,LR),BJET(J,LR-1),BJET(J,LR),XD)
      TH(L)=0.0
      DF(L)=DSFACT(J,LR-1)
      ZCL(L)=ZSS(J,3)-B(L)
      BSS(J,3)=B(L)
      ASS(J,3)=A(L)
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```
      DSS(J,3)=DF(L)
      LD=L+1
      L=LD+1
C
C      JET OVER WING COMPLETED, START ON FLAP 1
C           (POINT LD IN TRANSITION REGION BETWEEN WING AND FLAP)
C
C      THE FOLLOWING POINT (L) CORRESPONDS TO THE L.E. OF FLAP 1
C
      NFK=1
      XCL(L)=XD-B(L-2)*SIN(DF1)
      YCL(L)=YQ(J)
      ZCL(L)=ZD-B(L-2)*COS(DF1)
      TH(L)= DF1*RAD
      DF(L)=DF(L-2)
      A(L)=A(L-2)
      B(L)=B(L-2)
      L=L+1
C
C      THE FOLLOWING POINT (L) CORRESPONDS TO THE T.E. OF FLAP 1
C
      F=NCF(MFJ)
      IF (NFJ.LE.1) F=F*2.0
      CF1=2.0*F*SQRT((XE-XF)**2 + (ZE-ZF)**2)
      XD=XD-CF1*COS(DF1)
      ZD=ZD+CF1*SIN(DF1)
      NSS(J)=4
      XSS(J,4)=XD
      YSS(J,4)=YSS(J,3)
      ZSS(J,4)=ZD
      TSS(J,4)=DF1*RAD
      SS(J,4)=SS(J,3)+SQRT((XSS(J,4)-XSS(J,3))**2 +
     1               (YSS(J,4)-YSS(J,3))**2 +  (ZSS(J,4)-ZSS(J,3))**2)
   32 IF (XCLR(J,LR)-XD) 30,30,31
   31 LR=LR+1
      IF (LR.GT.NCL)  STOP 32
      GO TO 32
   30 A(L)=ENTRP(XCLR(J,LR-1),XCLR(J,LR),AJET(J,LR-1),AJET(J,LR),XD)
      B(L)=ENTRP(XCLR(J,LR-1),XCLR(J,LR),BJET(J,LR-1),BJET(J,LR),XD)
      XCL(L)=XD-B(L)*SIN(DF1)
      YCL(L)=YQ(J)
      ZCL(L)=ZD-B(L)*COS(DF1)
      TH(L)= DF1*RAD
      DF(L)=DSFACT(J,LR-1)
      BSS(J,4)=B(L)
      ASS(J,4)=A(L)
      DSS(J,4)=DF(L)
      L=L+1
C
C      NOW COMPUTE POINT LD IN TRANSITION REGION
C
      XF=XCL(L-1)
      ZF=ZCL(L-1)
      XE=XCL(L-2)
      ZE=ZCL(L-2)
      XC=XCL(L-4)
      ZC=ZCL(L-4)
      XB=XCL(L-5)
      ZB=ZCL(L-5)
      ZCB=(ZC-ZB)/(XC-XB)
      ZFE=(ZF-ZE)/(XF-XE)
      XCL(LD)=(ZE - ZB + XB*ZCB - XE*ZFE)/(ZCB-ZFE)
      ZCL(LD)=ZB+(XCL(LD)-XB)*ZCB
      YCL(LD)=YQ(J)
      A(LD)=A(L-4)
      B(LD)=B(L-4)
      TH(LD)=0.5*(TH(LD-1)+TH(LD+1))
      DF(LD)=DF(L-4)
      IF (XCL(LD)-XC) 34,34,33
   33 XCL(LD)=(XC+XE)/2.0
      ZCL(LD)=(ZC+ZE)/2.0
   34 IF(NFJ-NFK) 50,50,35
   35 NFK=NFK+1
      LD=L
      L=L+1
      XB=XE
      ZB=ZE
      XC=XF
      ZC=ZF
C
C      COMPUTE INTERSECTION OF TWO FLAPS
C           (POINT LD IS IN TRANSITION REGION BETWEEN FLAPS)
C
      MFJ=NFJN(NFK)
      MI=NCF(MFJ)
      MST=MSTART(MFJ)
      MND=MEND(MFJ)
      DO 36 I=MST,MND,MI
      IF=I
      IFM1=I-MI
      IF(YCP(IF)-YQ(J)) 41,42,36
   36 CONTINUE
      WRITE (6,702) J,MFJ
      STOP 36
   42 XFBLB=XBL(IF)
      ZFBLB=ZBL(IF)
      XFCPB=XCP(IF)
      ZFCPB=ZCP(IF)
      GO TO 45
   41 XFBLB=ENTRP(YCP(IFM1),YCP(IF),XBL(IFM1),XBL(IF),YQ(J))
      ZFBLB=ENTRP(YCP(IFM1),YCP(IF),ZBL(IFM1),ZBL(IF),YQ(J))
      XFCPB=ENTRP(YCP(IFM1),YCP(IF),XCP(IFM1),XCP(IF),YQ(J))
      ZFCPB=ENTRP(YCP(IFM1),YCP(IF),ZCP(IFM1),ZCP(IF),YQ(J))
   45 CONTINUE
      ZCB=(ZFCPA-ZFBLA)/(XFCPA-XFBLA)
      ZFE=(ZFCPB-ZFBLB)/(XFCPB-XFBLB)
      DF2=ATAN(-ZFE)
      XD=(ZFBLB-ZFBLA+XFBLA*ZCB-XFBLB*ZFE)/(ZCB-ZFE)
      ZD=ZFBLA + (XD-XFBLA)*ZCB
C
C      XD,YQ(J),ZD ARE COORDINATES OF INTERSECTION OF FLAPS
C           FOLLOWING POINT (L) CORRESPONDS TO AFT FLAP L.E.
C
      XCL(L)=XD-B(L-2)*SIN(DF2)
      YCL(L)=YQ(J)
      ZCL(L)=ZD-B(L-2)*COS(DF2)
      TH(L)= DF2*RAD
      DF(L)=DF(L-2)
      A(L)=A(L-2)
      B(L)=B(L-2)
C
C        FOLLOWING POINT (L) CORRESPONDS TO AFT FLAP T.E.
C
      L=L+1
      F=NCF(MFJ)
      IF (NFJ.EQ.NFK) F=F*2.0
      CF2=2.0*F*SQRT((XFBLB-XFCPB)**2 + (ZFBLB-ZFCPB)**2)
      XD=XD-CF2*COS(DF2)
      ZD=ZD+CF2*SIN(DF2)
      M=NSS(J)+1
      NSS(J)=M
      XSS(J,M)=XD
      ZSS(J,M)=ZD
      YSS(J,M)=YSS(J,M-1)
      TSS(J,M)=DF2*RAD
      SS(J,M)=SS(J,M-1)+SQRT((XSS(J,M)-XSS(J,M-1))**2 +
     1                           (ZSS(J,M)-ZSS(J,M-1))**2)
   52 IF (XCLR(J,LR)-XD) 53,53,51
   51 LR=LR+1
      IF (LR.GT.NCL)  STOP 52
      GO TO 52
   53 A(L)=ENTRP(XCLR(J,LR-1),XCLR(J,LR),AJET(J,LR-1),AJET(J,LR),XD)
      B(L)=ENTRP(XCLR(J,LR-1),XCLR(J,LR),BJET(J,LR-1),BJET(J,LR),XD)
      BSS(J,M)=B(L)
      ASS(J,M)=A(L)
      XCL(L)=XD-B(L)*SIN(DF2)
      YCL(L)=YQ(J)
      ZCL(L)=ZD-B(L)*COS(DF2)
      TH(L)= DF2*RAD
      DF(L)=DSFACT(J,LR-1)
      DSS(J,M)=DF(L)
      L=L+1
C
C      NOW COMPUTE POINT LD IN TRANSITION REGION BETWEEN FLAPS
C
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```
      XF=XCL(L-1)
      ZF=ZCL(L-1)
      XE=XCL(L-2)
      ZE=ZCL(L-2)
      ZCB=(ZC-ZB)/(XC-XB)
      ZFE=(ZF-ZE)/(XF-XE)
      XCL(LD)=(ZE-ZB+XB*ZCB-XE*ZFE)/(ZCB-ZFE)
      ZCL(LD)=ZB+(XCL(LD)-XB)*ZCB
      YCL(LD)=YQ(J)
      A(LD)=A(L-4)
      B(LD)=B(L-4)
      TH(LD)=0.5*(TH(LD-1)+TH(LD+1))
      DF(LD)=DF(LD-1)
      XFBLA=XFBLB
      ZFBLA=ZFBLB
      XFCPA=XFCPB
      ZFCPA=ZFCPB
      IF (XCL(LD)-XCL(LD-1)) 54,54,54
   54 XCL(LD)=(XCL(LD-1)+XCL(LD+1))/2.0
      ZCL(LD)=(ZCL(LD-1)+ZCL(LD+1))/2.0
      GO TO 34
   50 IF (L.GT.25) STOP 50
C
C      FINISH CENTERLINE SPECIFICATION WITH A PARABOLIC ARC
C         POINTS H AND I ARE LAST COMPUTED CENTERLINE POINTS ABOVE LAST
C         FLAP.     POINT S IS THE END OF THE JET.
C
      XH=XCL(L-2)
      XI=XCL(L-1)
      ZH=ZCL(L-2)
      ZI=ZCL(L-1)
      TTHI=(ZH-ZI)/(XI-XH)
      THI=ATAN(TTHI)*RAD
      XS=XCLR(J,NCL)
      ZS=ZI+(XS-XI)*TTHI*1.078*EXP(-0.0395*THI)
C
C      CALCULATE COEFFICIENTS OF PARABOLA
C
      SA=((XS-XI)/(ZS-ZI)-(XI-XH)/(ZI-ZH))/((ZS*ZS-ZI*ZI)/(ZS-ZI)
     1     -2.0*ZI)
      SB=(XI-XH)/(ZI-ZH) - 2.0*ZI*SA
      SC=XI - SA*ZI*ZI - SB*ZI
      KL=5
      DX=(XS-XCL(L-1))/5.0 + 0.0001
      IF (L.LE.20) GO TO 56
      KL=25-L
      AKL=KL
      DX=(XS-XCL(L-1))/AKL + 0.0001
   56 CONTINUE
      AKL=0.5
      DO 55 I=1,KL
      IF (I.GT.1) AKL=1.0
      IF (I.EQ.KL) AKL=1.5
      XCL(L)=XCL(L-1)+DX*AKL
      YCL(L)=YQ(J)
      ZCL(L)=(-SB-SQRT(SB*SB-4.0*SA*(SC-XCL(L))))/(2.0*SA)
   57 IF (XCLR(J,LR)-XCL(L)) 58,58,60
   60 LR=LR+1
      IF (LR.GT.NCL)  STOP 60
      GO TO 57
   58 A(L)=ENTRP(XCLR(J,LR-1),XCLR(J,LR),AJET(J,LR-1),AJET(J,LR),XCL(L))
      B(L)=ENTRP(XCLR(J,LR-1),XCLR(J,LR),BJET(J,LR-1),BJET(J,LR),XCL(L))
      TTH=1.0/(2.0*SA*ZCL(L)+SB)
      TH(L)=-ATAN(TTH)*RAD
      DF(L)=DSFACT(J,LR-1)
      IF (ABS(TH(L)).GT.ABS(TH(L-1))) TH(L)=TH(L-1)
      L=L+1
   55 CONTINUE
      L=L-1
      NCYL(J)=L
C
C      LOCATE THE INTERSECTION OF THE EDGES OF THE JET WITH THE
C        TRAILING EDGES OF THE LIFTING SURFACES
C
C        XSN(J,-), ETC. : INBOARD SIDE OF JET
C        XST(J,-), ETC. : OUTBOARD SIDE OF JET
C
      TPHIW=SPHIW/CPHIW
      XSN(J,1)=XSS(J,1)
      XSN(J,2)=XSS(J,2)
      XST(J,1)=XSS(J,1)
      XST(J,2)=XSS(J,2)
      YSN(J,1)=YSS(J,1) + AJET(J,1)
      YST(J,1)=YSS(J,1) - AJET(J,1)
      ZSN(J,1)=ZSS(J,1) + AJET(J,1)*TPHIW
      ZST(J,1)=ZSS(J,1) - AJET(J,1)*TPHIW
      ZSN(J,2)=ZSS(J,2) +  ASS(J,2)*TPHIW
      ZST(J,2)=ZSS(J,2) -  ASS(J,2)*TPHIW
      YSN(J,2)=YSS(J,2) + ASS(J,2)
      YSN(J,3)=YSS(J,3) + ASS(J,3)
      YST(J,2)=YSS(J,2) - ASS(J,2)
      YST(J,3)=YSS(J,3) - ASS(J,3)
C
      DO 500 KG=1,2
      YQEDG=YSN(J,3)
      IF (KG.EQ.2) YQEDG=YST(J,3)
C
C     LOCATE INTERSECTION OF WING T.E. AND FLAP 1 L.E.
C
      MST=NCW+1
      DO 510 I=MST,MW,NCW
      IW=I
      IWM1=I-NCW
      IF (YCP(IW)-YQEDG) 511,512,510
  510 CONTINUE
      GO TO 511
C
C      COORDINATES XB,ZB AND XC,ZC ARE ON WING
C
  512 XB=XBL(IW)
      ZB=ZBL(IW)
      XC=XCP(IW)
      ZC=ZCP(IW)
      GO TO 515
  511 XB=ENTRP(YCP(IWM1),YCP(IW),XBL(IWM1),XBL(IW),YQEDG)
      ZB=ENTRP(YCP(IWM1),YCP(IW),ZBL(IWM1),ZBL(IW),YQEDG)
      XC=ENTRP(YCP(IWM1),YCP(IW),XCP(IWM1),XCP(IW),YQEDG)
      ZC=ENTRP(YCP(IWM1),YCP(IW),ZCP(IWM1),ZCP(IW),YQEDG)
  515 MFJ=NFJN(1)
      MI=NCF(MFJ)
      MST=MSTART(MFJ) + MI
      MND=MEND(MFJ)
      DO 516 I=MST,MND,MI
      IF=I
      IFM1=I-MI
      IF (YCP(IF)-YQEDG) 521,522,516
  516 CONTINUE
      GO TO 521
C
C     COORDINATES XE, ZE, AND XF,ZF ARE ON FLAP 1
C
  522 XE=XBL(IF)
      ZE=ZBL(IF)
      XF=XCP(IF)
      ZF=ZCP(IF)
      GO TO 525
  521 XE=ENTRP(YCP(IFM1),YCP(IF),XBL(IFM1),XBL(IF),YQEDG)
      ZE=ENTRP(YCP(IFM1),YCP(IF),ZBL(IFM1),ZBL(IF),YQEDG)
      XF=ENTRP(YCP(IFM1),YCP(IF),XCP(IFM1),XCP(IF),YQEDG)
      ZF=ENTRP(YCP(IFM1),YCP(IF),ZCP(IFM1),ZCP(IF),YQEDG)
  525 CONTINUE
      ZCB=(ZC-ZB)/(XC-XB)
      ZFE=(ZF-ZE)/(XF-XE)
      DF1=ATAN(-ZFE)
      XD=(ZE-ZB + XB*ZCB - XE*ZFE)/(ZCB-ZFE)
      ZD=ZB + (XD-XB)*ZCB
      IF (KG-1) 504,504,505
  504 XSN(J,3)=XD
      ZSN(J,3)=ZD
      GO TO 506
  505 XST(J,3)=XD
      ZST(J,3)=ZD
  506 CONTINUE
      N=3
C
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C        LOCATE INTERSECTION OF JET SIDES WITH FLAP T.E.
C
  555 N=N+1
C
      YQEDG=YSS(J,N) + ASS(J,N)
      IF (KS.EQ.2) YQEDG=YSS(J,N) - ASS(J,N)
      IF (NFJ.EQ.N-3) GO TO 556
      DO 520 I=MST,MND,MI
      IF=I
      IFM1=I-MI
      IF (YCP(IF)-YQEDG) 526,527,520
  520 CONTINUE
  527 XB=XBL(IF)
      ZB=ZBL(IF)
      XC=XCP(IF)
      ZC=ZCP(IF)
      GO TO 528
  526 XB=ENTRP(YCP(IFM1),YCP(IF),XBL(IFM1),XBL(IF),YQEDG)
      ZB=ENTRP(YCP(IFM1),YCP(IF),ZBL(IFM1),ZBL(IF),YQEDG)
      XC=ENTRP(YCP(IFM1),YCP(IF),XCP(IFM1),XCP(IF),YQEDG)
      ZC=ENTRP(YCP(IFM1),YCP(IF),ZCP(IFM1),ZCP(IF),YQEDG)
  528 CONTINUE
      GO TO 558
  556 MFJ=NFJN(NFJ)
      GO TO 559
  558 MFJ=NFJN(N-2)
  559 MI=NCF(MFJ)
      MST=MSTART(MFJ) + MI
      MND=MEND(MFJ)
      DO 550 I=MST,MND,MI
      IF=I
      IFM1=I-MI
      IF (YCP(IF)-YQEDG) 551,552,550
  550 CONTINUE
      GO TO 551
  552 XE=XBL(IF)
      ZE=ZBL(IF)
      XF=XCP(IF)
      ZF=ZCP(IF)
      GO TO 553
  551 XE=ENTRP(YCP(IFM1),YCP(IF),XBL(IFM1),XBL(IF),YQEDG)
      ZE=ENTRP(YCP(IFM1),YCP(IF),ZBL(IFM1),ZBL(IF),YQEDG)
      XF=ENTRP(YCP(IFM1),YCP(IF),XCP(IFM1),XCP(IF),YQEDG)
      ZF=ENTRP(YCP(IFM1),YCP(IF),ZCP(IFM1),ZCP(IF),YQEDG)
  553 CONTINUE
      ZCB=(ZC-ZB)/(XC-XB)
      ZFE=(ZF-ZE)/(XF-XE)
      DF2=ATAN(-ZFE)
      IF (NFJ.EQ.N-3) GO TO 557
      XD=(ZE-ZB + XB*ZCB - XE*ZFE)/(ZCB-ZFE)
      ZD=ZB + (XD-XB)*ZCB
      IF (KG-1) 529,529,530
  529 XSN(J,N)=XD
      ZSN(J,N)=ZD
      YSN(J,N)=YQEDG
      GO TO 531
  530 XST(J,N)=XD
      ZST(J,N)=ZD
      YST(J,N)=YQEDG
  531 CONTINUE
      GO TO 555
  557 F=NCF(MFJ)
      F=F+2.0
      CF2=2.0*F*SQRT((XE-XF)**2 + (ZE-ZF)**2)
      XD=XD-CF2*COS(DF2)
      ZD=ZD+CF2*SIN(DF2)
      IF (KG-1) 546,546,547
  546 XSN(J,N)=XD
      ZSN(J,N)=ZD
      YSN(J,N)=YQEDG
      GO TO 548
  547 XST(J,N)=XD
      ZST(J,N)=ZD
      YST(J,N)=YQEDG
  548 CONTINUE
  500 CONTINUE
C
C        COMPLETE SURFACE SPECIFICATION OF JET BOUNDARY
C
      M=NSS(J)
      THG=TSS(J,M)/RAD
      XE=XSS(J,M)-BSS(J,M)*SIN(THG)*1.05
      DO 63 I=1,L
      IF=I
      IF (XE-XCL(I)) 63,63,64
   63 CONTINUE
   64 DO 65 I=IF,L
      M=M+1
      THG=TH(I)/RAD
      XSS(J,M)=XCL(I) + B(I)*SIN(THG)
      ZSS(J,M)=ZCL(I) + B(I)*COS(THG)
      YSS(J,M)=YCL(I)
      TSS(J,M)=TH(I)
      SS(J,M)=SS(J,M-1) + SQRT((XSS(J,M)-XSS(J,M-1))**2 +
     1                         (ZSS(J,M)-ZSS(J,M-1))**2 )
      NSS(J)=M
      ASS(J,M)=A(I)
      BSS(J,M)=B(I)
      DSS(J,M)=DF(I)
      XSN(J,M)=XSS(J,M)
      ZSN(J,M)=ZSS(J,M)
      YSN(J,M)=YSS(J,M) + ASS(J,M)
      XST(J,M)=XSS(J,M)
      YST(J,M)=YSS(J,M) - ASS(J,M)
      ZST(J,M)=ZSS(J,M)
   65 CONTINUE
C
C        CHECK SURFACE COORDINATES FOR IRREGULARITIES
C
      NFJ3=NFJ+3
   74 DO 70 I=NFJ3,M
      II=I
      IF (XSN(J,I).GE.XSN(J,I-1)) GO TO 71
      IF (XST(J,I).GE.XST(J,I-1)) GO TO 71
   70 CONTINUE
      GO TO 75
   71 M=M-1
      NSS(J)=M
      DO 73 I=II,M
      XSS(J,I)=XSS(J,I+1)
      YSS(J,I)=YSS(J,I+1)
      ZSS(J,I)=ZSS(J,I+1)
      TSS(J,I)=TSS(J,I+1)
       SS(J,I)= SS(J,I+1)
      ASS(J,I)=ASS(J,I+1)
      BSS(J,I)=BSS(J,I+1)
      DSS(J,I)=DSS(J,I+1)
      XSN(J,I)=XSN(J,I+1)
      YSN(J,I)=YSN(J,I+1)
      ZSN(J,I)=ZSN(J,I+1)
      XST(J,I)=XST(J,I+1)
      YST(J,I)=YST(J,I+1)
      ZST(J,I)=ZST(J,I+1)
   73 CONTINUE
      GO TO 74
   75 CONTINUE
C
C        RAISE JET ABOVE SURFACE OF WING AND FLAPS
C
      H=DS(J)*0.5
      ZQ(J)=ZQ(J)-H
      DO 81 I=1,M
      DHX=H*SIN(TSS(J,I)/RAD)
      DHZ=H*COS(TSS(J,I)/RAD)
      XSS(J,I)=XSS(J,I)-DHX
      XSN(J,I)=XSN(J,I)-DHX
      XST(J,I)=XST(J,I)-DHX
      ZSS(J,I)=ZSS(J,I)-DHZ
      ZSN(J,I)=ZSN(J,I)-DHZ
      ZST(J,I)=ZST(J,I)-DHZ
   81 CONTINUE
      DO 82 I=1,L
      DHX=H*SIN(TH(I)/RAD)
      DHZ=H*COS(TH(I)/RAD)
      XCL(I)=XCL(I)-DHX
```

```
      ZCL(I)=ZCL(I)-DHZ
   82 CONTINUE
C
C      TRANSFORM JET BACK TO JET COORDINATE SYSTEM
C
      DO 61 I=1,L
      XCLR(J,I)=XQ(J)-XCL(I)
      YCLR(J,I)=YCL(I)-YQ(J)
      ZCLR(J,I)=ZQ(J)-ZCL(I)
      AJET(J,I)=A(I)
      BJET(J,I)=B(I)
      THETA(J,I)=-TH(I)
      DSFACT(J,I)=DF(I)
   61 CONTINUE
  100 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE CORECT (NP,XPR,YPR,ZPR,   M,NTIME)
C
C       CORRECT FIELD POINT LOCATIONS TO AVOID VORTEX RING SINGULARITIES
C         MODIFIED FOR SURFACE SPECIFICATION OF QUADRILATERAL RINGS
C
C        FIELD POINT IDENTIFICATION....
C          NPTJ = 0   POINT OUTSIDE JET, NOT CORRECTED
C               = 1   POINT NEAR JET, CORRECTED
C               = 1+M POINT INSIDE JET M, CORRECTED
C
      DIMENSION XPR(250),YPR(250),ZPR(250)
      COMMON /XYZCL/ NJET,NCYL(2),XQ(2),YQ(2),ZQ(2),GAMVJ(2),DS(2),
     1 RHO(2),CHU(2),XCLR(2,25),YCLR(2,25),ZCLR(2,25),THETA(2,25),
     2               SCLR(2,25),AJET(2,25),BJET(2,25),DSFACT(2,25),
     3                UCL(2,25), VCL(2,25), WCL(2,25),  CFJ,CFK
      COMMON /CLDAT/ NSS(2),SS(2,11),XSS(2,11),YSS(2,11),ZSS(2,11),
     1               TSS(2,11),BSS(2,11),ASS(2,11),XSN(2,11),YSN(2,11),
     2               ZSN(2,11),XST(2,11),YST(2,11),ZST(2,11),DSS(2,11)
      COMMON /PTDAT/ NPTJ(2,250),NCRCT
      COMMON /NFJCL/ NFJ,NFJN(3)
C
C       INITIALIZATION
C
      RAD=57.2957795
      IF (NTIME.LT.-1) GO TO 19
      DO 2 J=1,NP
    2 NPTJ(M,J)=0
      INJET=1+M
C
C       SEARCH ARRAY FOR POINTS TO BE CORRECTED
      NSR=1
      KL=NSS(M)
      DO 3 J=1,NP
      X=XPR(J)
      Y=YPR(J)
      DO 4 K=1,KL
      KS=K
      IF (X-XSS(M,K)) 12,13,4
    4 CONTINUE
      GO TO 3
   13 IF (KS.EQ.1 .OR. KS.EQ.KL) GO TO 3
      YG=YSS(M,KS)
      BG=BSS(M,KS)
      AG=ASS(M,KS)
      GO TO 9
   12 IF (KS.EQ.1) GO TO 3
      DELTA=(X-XSS(M,KS-1))/(XSS(M,KS)-XSS(M,KS-1))
      YG=YSS(M,KS-1) + (YSS(M,KS)-YSS(M,KS-1))*DELTA
      AG=ASS(M,KS-1) + (ASS(M,KS)-ASS(M,KS-1))*DELTA
      BG=BSS(M,KS-1) + (BSS(M,KS)-BSS(M,KS-1))*DELTA
    9 YI=YG+AG
      YO=YG-AG
      IF (Y.LE.YI .AND. Y.GE.YO) GO TO 14
      YI=YI+BG
      YO=YO-BG
      IF (Y.LE.YI .AND. Y.GE.YO) GO TO 15
      GO TO 3
   14 NPTJ(M,J)=INJET
      GO TO 3
   15 NPTJ(M,J)=1
    3 CONTINUE
C
   19 IF (NCRCT.GT.3) RETURN
      NFJ3=NFJ+3
      DO 38 N=1,NP
      IF (NTIME.LT.-1) GO TO 21
      IF (NPTJ(M,N).LT.1)  GO TO 38
   21 JSA=0
      NSR=2
      FACTOR=DSFACT(M,1)
      NS=NSS(M)
      SR=-DS(M)/2.0
      DSR=DS(M)*FACTOR
   20 SR=SR+DSR
  521 IF (SR.GT.SS(M,NS)) GO TO 38
C
C         USE SURFACE SPECIFICATION TO LOCATE VORTEX RINGS
C
  421 IF (SR-SS(M,NSR)) 423,425,422
  422 NSR=NSR+1
      IF (NSR.GT.NS) STOP 1422
      GO TO 421
  425 BG=BSS(M,NSR)
      THG=TSS(M,NSR)/RAD
      XG=XSS(M,NSR)-BG*SIN(THG)
      XGN=XSN(M,NSR)
      YGN=YSN(M,NSR)
      ZGN=ZSN(M,NSR)
      XGT=XST(M,NSR)
      YGT=YST(M,NSR)
      ZGT=ZST(M,NSR)
      FACTOR=DSS(M,NSR)
      GO TO 30
  423 DELTA=(SR-SS(M,NSR-1))/(SS(M,NSR)-SS(M,NSR-1))
      IF (NSR-NFJ3) 424,424,427
  427 THG=TSS(M,NSR-1)+(TSS(M,NSR)-TSS(M,NSR-1))*DELTA
      THG=THG/RAD
      GO TO 426
  424 THG=TSS(M,NSR   )/RAD
  426 BG=BSS(M,NSR-1)+(BSS(M,NSR)-BSS(M,NSR-1))*DELTA
      XG=XSS(M,NSR-1)+(XSS(M,NSR)-XSS(M,NSR-1))*DELTA - BG*SIN(THG)
      XGN=XSN(M,NSR-1)+(XSN(M,NSR)-XSN(M,NSR-1))*DELTA
      YGN=YSN(M,NSR-1)+(YSN(M,NSR)-YSN(M,NSR-1))*DELTA
      ZGN=ZSN(M,NSR-1)+(ZSN(M,NSR)-ZSN(M,NSR-1))*DELTA
      XGT=XST(M,NSR-1)+(XST(M,NSR)-XST(M,NSR-1))*DELTA
      YGT=YST(M,NSR-1)+(YST(M,NSR)-YST(M,NSR-1))*DELTA
      ZGT=ZST(M,NSR-1)+(ZST(M,NSR)-ZST(M,NSR-1))*DELTA
      FACTOR=DSS(M,NSR-1)
   30 CONTINUE
      IF (JSA.GT.0) GO TO 25
      X=AMAX1(XGN,XGT,XG)
      X=X+2.*DSR
      IF (XPR(N).GT.X) GO TO 20
      JSA=1
      X2=XGT-2.*BG*SIN(THG)
      Y2=YGT
      Z2=ZGT+2.*BG*COS(THG)
      AYZ=(YGN-YGT)*(Z2-ZGT) - (Y2-YGT)*(ZGN-ZGT)
      AXZ=-(XGN-XGT)*(Z2-ZGT) + (X2-XGT)*(ZGN-ZGT)
      AXY=(XGN-XGT)*(Y2-YGT) - (X2-XGT)*(YGN-YGT)
      RTA=SQRT(AYZ**2 + AXZ**2 + AXY**2)
      D1=((XPR(N)-XGT)*AYZ + (YPR(N)-YGT)*AXZ + (ZPR(N)-ZGT)*AXY)/RTA
      GO TO 20
   25 CONTINUE
      SNTH=SIN(THG)
```

```
      CSTH=COS(THG)
      X2=XGT-2.*BG*SNTH
      Y2=YGT
      Z2=ZGT+2.*BG*CSTH
      AYZ=(YGN-YGT)*(Z2-ZGT) - (Y2-YGT)*(ZGN-ZGT)
      AXZ=-(XGN-XGT)*(Z2-ZGT) + (X2-XGT)*(ZGN-ZGT)
      AXY=(XGN-XGT)*(Y2-YGT) - (X2-XGT)*(YGN-YGT)
      RTA=SQRT(AYZ**2 + AXZ**2 + AXY**2)
      D2=((XPR(N)-XGT)*AYZ + (YPR(N)-YGT)*AXZ + (ZPR(N)-ZGT)*AXY)/RTA
      IF (D2) 35,35,36
   36 D1=D2
      GO TO 20
   35 DBAR=0.5*(D1-D2)
      XPR(N)=XPR(N) + (DBAR-D1)*CSTH
      ZPR(N)=ZPR(N) + (DBAR-D1)*SNTH
   38 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE QRING (XP,YP,ZP,U,V,W)
C
C      COMPUTE THE VELOCITY INDUCED BY A QUADRILATERAL VORTEX RING
C
C        XCRQ,YCRQ,ZCRQ  ARE  COORDINATES OF CORNER POINTS IN JET SYSTEM
C
C        XP,YP,ZP  ARE FIELD POINT COORDINATES IN JET SYSTEM
C        U,V,W  ARE INDUCED VELOCITY COMPONENTS IN X,Y,Z DIRECTIONS
C               NORMALIZED WITH RESPECT TO RING STRENGTH
C
      COMMON/CORNER/XCRQ(4),YCRQ(4),ZCRQ(4)
      FPI=12.5663706
      U=0.0
      V=0.0
      W=0.0
      XBP=XCRQ(1)-XP
      YBP=YCRQ(1)-YP
      ZBP=ZCRQ(1)-ZP
      B=SQRT(XBP**2 + YBP**2 + ZBP**2)
      DO 20 N=1,4
      XAP=XBP
      YAP=YBP
      ZAP=ZBP
      A=B
      M=N+1
      IF(M.GT.4) M=1
      XBP=XCRQ(M)-XP
      YBP=YCRQ(M)-YP
      ZBP=ZCRQ(M)-ZP
      B=SQRT(XBP**2 + YBP**2 + ZBP**2)
      AYZ=YAP*ZBP-YBP*ZAP
      AXZ=XBP*ZAP-XAP*ZBP
      AXY=XAP*YBP-XBP*YAP
      AXB2=AYZ**2 + AXZ**2 + AXY**2
      ADB=XAP*XBP + YAP*YBP + ZAP*ZBP
      GK=-(A+B)*(1.0 - ADB/(A*B))/(AXB2*FPI)
      U=U+GK*AYZ
      V=V+GK*AXZ
      W=W+GK*AXY
   20 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE JETVEL (MTIME)
C
C        MTIME=1,  CALCULATE ADDITIONAL CIRCULATION ON FLAP TO ACCOUNT
C                  FOR JET TURNING AND CALCULATE VELOCITIES INDUCED
C                  BY THIS ADDITIONAL CIRCULATION
C        MTIME=2,  CALCULATE INDUCED VELOCITY FIELD FOR FORCE CALC.
C                  CFJ=-1.0 , JET MODEL AND JET CIRCULATION VELOCITIES
C                             NOT USED IN FORCE CALC.
C                  CFJ= 0.0 , ALL JET VELOCITIES USED IN FORCE CALC.
C                  CFJ= 1.0 , JET MODEL VELOCITIES USED IN FORCE CALC.
C
      DIMENSION AP(150),UJ(250),VJ(250),WJ(250)
C
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSER(30),LASTF(30)
      COMMON / INDEXF/ NFREG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /CPDAT/ ALPHAL(250),XCP(250),YCP(250),ZCP(250),
     1 CALPHL(250),SALPHL(250)
      COMMON /RVELS/UP,VP,WP
      COMMON /RSIDE/ CIR(250),UEI(250),VEI(250),WEI(250)
      COMMON /XYZCL/ NJET,NCYL(2),XO(2),YO(2),ZO(2),GAMVJ(2),DS(2),
     1 RHO(2),CMU(2),XCLR(2,25),YCLR(2,25),ZCLR(2,25),THETA(2,25),
     2               SCLR(2,25),AJET(2,25),BJET(2,25),DSFACT(2,25),
     3                UCL(2,25), VCL(2,25), WCL(2,25),  CFJ,CFK
      COMMON /CLDAT/ NSS(2),SS(2,11),XSS(2,11),YSS(2,11),ZSS(2,11),
     1               TSS(2,11),BSS(2,11),ASS(2,11),XSN(2,11),YSN(2,11),
     2               ZSN(2,11),XST(2,11),YST(2,11),ZST(2,11),DSS(2,11)
      COMMON /PTDAT/ NPTJ(2,250),NCRCT
      COMMON /VLDAT/ NVLP,NVL(101)
      COMMON /REFQUA/ SSPAN,SREF,REFL,XM,ZM
      COMMON /BLDAT/ XBL(250),YBL(250),ZBL(250),TPSI(250),SW(250)
      COMMON /ATAK/ SINALF,COSALF
      COMMON /NFJCL/ NFJ,NFJN(3)
      COMMON /JETCIR/ JFLP(150),LJFLP, CIRJ(150),CNJ(150),CAJ(150)
      COMMON /FLPDAT/ SDELXZ(10),CDELXZ(10),YF(30,10),SPHIF(10),
     1               CPHIF(10)
      COMMON /FPNL/NPRINT,NJPNL,JPNL(30)
      COMMON /JETEFF/ ETAJ
C
  797 FORMAT (//10X,29HSUMMARY OF JET TURNING FORCES /
     1          9X1HN,5X7HAREA(N),7X5HGAM/V,6X3HCNJ,9X3HCAJ)
  798 FORMAT (1H1,15X,43HSUMMARY OF TOTAL JET INDUCED VELOCITY FIELD  /
     A /20X,66HUEI,VEI,WEI = VELOCITY COMPONENTS INDUCED BY VORTEX RING
     BJET MODEL  / 20X,76HUJ,VJ,WJ    = VELOCITY COMPONENTS INDUCED BY J
     CET DEFLECTION LOADING ON FLAPS   //
     1   7X3HNCP,7X3HXCP,9X3HYCP,9X3HZCP,9X2HUJ,10X2HVJ,10X2HWJ,
     2   10X3HUEI,9X3HVEI,9X3HWEI)
  799 FORMAT (5X,I5,10F12.5)
      DATA FOURPI/12.56637062/
      NP=MTOT
      IF (MTIME-2) 10,50,50
   10 CONTINUE
      LJFLP=0
      IF (NJET.LE.0) RETURN
C
C      ADD CIRCULATION ON FLAPS TO ACCOUNT FOR JET TURNING
C
      IF (NFREG.LE.0 .OR. NFJ.EQ.0) RETURN
C      IDENTIFY REGIONS OF JET INFLUENCE ON EACH FLAP
      L=0
      L1=1
      DO 19 J=1,NJET
      DO 20 N=1,NFJ
      SDEL1=0.0
      NF=NFJN(N)
      SDEL=SDELXZ(NF)
      CDEL=CDELXZ(NF)
      IF (N.GT.1) SDEL1=SDELXZ(NF-1)
      MS=MSTART(NF)
      ME=MEND(NF)
      AJ=0.0
      DO 21 K=MS,ME
      IF (NPTJ(J,K).LT.1) GO TO 21
      L=L+1
      AP(L)=SW(K)*4.0*SQRT((XCP(K)-XBL(K))**2 + (ZCP(K)-ZBL(K))**2)
      JFLP(L)=K
      AJ=AJ+AP(L)
```

```
   21 CONTINUE
      SNDEL=SDFL-SDEL1
      GVS=CMU(J)*SNDEL*SREF/(2.0*COSALF*FOURPI)*ETAJ
      CNT=CMU(J)*SNDEL*ETAJ
C      CALCULATE ADDITIONAL CIRCULATION ON FLAP PANELS
C            (NOTE...S=PANEL HALF WIDTH)
      DO 22 K=L1,L
      JK=JFLP(K)
      CIRJ(K) =GVS*AP(K)/(2.0*AJ*SW(JK))
      CNJ(K)=CNT*AP(K)/AJ*CDEL
      CAJ(K)=-CNT*AP(K)/AJ*SDEL
C      NOTE... CNJ(K) IS NORMAL FORCE COEF. IN FLAP COORDINATE SYSTEM
C              CAJ(K) IS AXIAL  FORCE COEF. IN FLAP COORDINATE SYSTEM
   22 CONTINUE
      L1=L+1
   20 CONTINUE
   19 CONTINUE
      LJFLP=L
C
C      CALCULATE INFLUENCE OF THE ADDITIONAL CIRCULATION
C
      NL=1
      IF (NPRINT.GT.0) WRITE (6,798)
      DO 25 N=1,MTOT
      UJ(N)=0.0
      VJ(N)=0.0
      WJ(N)=0.0
      IF (NVLP.LE.0) GO TO 125
   28 IF (N-NVL(NL)) 125,25,225
  225 NL=NL+1
      IF (NL.LE.NVLP) GO TO 28
      NL=NVLP+1
  125 CONTINUE
      XX=XCP(N)
      YY=YCP(N)
      ZZ=ZCP(N)
      CALL JTCIRV (XX,YY,ZZ,N)
      IF (NPRINT.GT.0) WRITE (6,799) N,XX,YY,ZZ,UP,VP,WP,
     1                               UEI(N),VEI(N),WEI(N)
      UEI(N)=UEI(N)+UP
      VEI(N)=VEI(N)+VP
      WEI(N)=WEI(N)+WP
      UJ(N)=UP
      VJ(N)=VP
      WJ(N)=WP
   25 CONTINUE
      IF (NPRINT.LE.0) RETURN
      WRITE (6,797)
      DO 26 J=1,LJFLP
      N=JFLP(J)
      DUM=CIRJ(J)*FOURPI
   26 WRITE (6,799) N,AP(J),DUM,CNJ(J),CAJ(J)
C
      RETURN
C
   50 CONTINUE
C
C      SET UP JET ASSOCIATED VELOCITY FIELD FOR USE IN FORCE CALC.
C
      IF (CFJ) 62,63,60
C      REMOVE ALL JET INDUCED VELOCITIES FROM FORCE CALC.
   62 DO 51 N=1,NP
      UEI(N)=0.0
      VEI(N)=0.0
      WEI(N)=0.0
   51 CONTINUE
      RETURN
C
C      USE JET MODEL INDUCED VELOCITIES ONLY
   60 DO 61 N=1,NP
      UEI(N)=UEI(N)-UJ(N)
      VEI(N)=VEI(N)-VJ(N)
      WEI(N)=WEI(N)-WJ(N)
   61 CONTINUE
      RETURN
   63 CONTINUE
C      INCLUDE JET CIRCULATION INDUCED VELOCITIES IN FORCE CALC.
      RETURN
      END
```

```
      SUBROUTINE JTCIRV (XX,YY,ZZ,N)
C
C       CALCULATE INDUCED VELOCITIES AT POINT XX,YY,ZZ DUE TO
C        JET CIRCULATION VORTICES         (N=PANEL NUMBER)
C
C
C     COMMON STATEMENTS
      COMMON /TLDAT/ XTER(30),XTEL(30),XTLR(250),YTLR(250),ZTLR(250),
     1 XTLL(250),YTLL(250),ZTLL(250)
      COMMON / INDEXF/ NFRFG,NFLAPS,IDFLAP(10,2),NCF(10),MSF(10),MF(10),
     1MSTART(10),MEND(10),NFSEGF(10)
      COMMON /FLPDAT/ SDELXZ(10),CDELXZ(10),YF(30,10),SPHIF(10),
     1CPHIF(10)
      COMMON /WKDATF/ XWKRF(30,2,10),YWKRF(30,2,10),ZWKRF(30,2,10),
     1               XWKLF(30,2,10),YWKLF(30,2,10),ZWKLF(30,2,10)
      COMMON /RVFLS/UP,VP,WP
      COMMON /FLVFRG/X1,Y1,Z1,X2,Y2,Z2,XP,YP,ZP,FU,FV,FW,AX,AZ
      COMMON /NFJCL/ NFJ,NFJN(3)
      COMMON /JETCIR/ JFLP(150),LJFLP, CIRJ(150),CNJ(150),CAJ(150)
C
      XP=XX
      YP=YY
      ZP=ZZ
      UP=0.0
      VP=0.0
      WP=0.0
C
      IFLAG=0
      IF (LJFLP.LE.0) RETURN
      JS=NFJN(1)
      JE=NFJN(NFJ)
      MS=MSTART(JS)
      ME=MEND(JE)
      IF (N.GE.MS .AND. N.LE.ME) IFLAG=1
      JPN=0
      IF (IFLAG.EQ.0) GO TO 100
C      IDENTIFY FLAP NUMBER (JPN) CONTAINING PANEL N
      DO 155 K=1,NFJ
      JPN=NFJN(K)
      MS=MSTART(JPN)
      ME=MEND(JPN)
      IF (N.GE.MS .AND. N.LE.ME) GO TO 100
  155 CONTINUE
       STOP 14
  100 CONTINUE
C
      DO 220 J=1,LJFLP
      JP=J
      I=JFLP(J)
      IF (I.EQ.N) GO TO 220
C      IDENTIFY FLAP NUMBER (JFI) CONTAINING PANEL I
      DO 150 K=1,NFJ
      JFI=NFJN(K)
      MS=MSTART(JFI)
      ME=MEND(JFI)
      IF (I.GE.MS .AND. I.LE.ME) GO TO 152
  150 CONTINUE
       STOP 13
  152 CDXZ=CDELXZ(JFI)
      SDXZ=SDELXZ(JFI)
      IFL=JFI
      NAFT=NFSEGF(JFI)
      MSFF=MSF(JFI)
```

```
      NCFF=NCF(JFI)
C         LOCATE SPANWISE ROW (ISW) CONTAINING PANEL I
      DO 157 ISWF=1,NSFF
      ISW=ISWF
      MSL=MS+(ISW-1)*NCFF
      MST=MSL+NCFF-1
      IF (I.GE.MSL .AND. I.LE.MST) GO TO 158
  157 CONTINUE
      STOP 15
  158 CONTINUE
C
C         INFLUENCE OF BOUND LEG
  160 X1=XTLL(I)
      Y1=YTLL(I)
      Z1=ZTLL(I)
      X2=XTLR(I)
      Y2=YTLR(I)
      Z2=ZTLR(I)
      CALL FLVF
      CU=FU
      CV=FV
      CW=FW
C
      IF (NAFT.NE.0) GO TO 214
C
C     NO FLAPS BEHIND THIS ONE.  COMPUTE INFLUENCE OF SEMI-INFINITE
C     TRAILING LEGS IN THE PLANE OF THIS FLAP
C
      AX=-COXZ
      AZ=SDXZ
      CALL SIVF
      CU=CU+FU
      CV=CV+FV
      CW=CW+FW
      X1=X2
      Y1=Y2
      Z1=Z2
      CALL SIVF
      CU=CU-FU
      CV=CV-FV
      CW=CW-FW
      GO TO 216
C
C     THERE ARE FLAPS BEHIND THIS ONE.  COMPUTE INFLUENCE OF
C     FINITE TRAILING LEGS IN THIS FLAP
C
  214 X1=XTLR(I)
      Y1=YTLR(I)
      Z1=ZTLR(I)
      X2=XWKRF(ISW,1,IFL)
      Y2=YWKRF(ISW,1,IFL)
      Z2=ZWKRF(ISW,1,IFL)
      CALL FLVF
      CU=CU+FU
      CV=CV+FV
      CW=CW+FW
      X1=XTLL(I)
      Y1=YTLL(I)
      Z1=ZTLL(I)
      X2=XWKLF(ISW,1,IFL)
      Y2=YWKLF(ISW,1,IFL)
      Z2=ZWKLF(ISW,1,IFL)
      CALL FLVF
      CU=CU-FU
      CV=CV-FV
      CW=CW-FW
      AFTU=0.0
      AFTV=0.0
      AFTW=0.0
      IF(NAFT.EQ.1) GO TO 210
C
C     INFLUENCE OF FINITE TRAILING LEGS IN FIRST FLAP AFT OF THIS ONE
C
      X1=XWKRF(ISW,1,IFL)
      Y1=YWKRF(ISW,1,IFL)
      Z1=ZWKRF(ISW,1,IFL)
      X2=XWKRF(ISW,2,IFL)
      Y2=YWKRF(ISW,2,IFL)
      Z2=ZWKRF(ISW,2,IFL)
      CALL FLVF
      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
      X1=XWKLF(ISW,1,IFL)
      Y1=YWKLF(ISW,1,IFL)
      Z1=ZWKLF(ISW,1,IFL)
      X2=XWKLF(ISW,2,IFL)
      Y2=YWKLF(ISW,2,IFL)
      Z2=ZWKLF(ISW,2,IFL)
      CALL FLVF
      AFTU=AFTU-FU
      AFTV=AFTV-FV
      AFTW=AFTW-FW
C
C     CONTRIBUTION OF SEMI-INFINITE TRAILING LEGS IN SECOND FLAP
C
  210 X1=XWKRF(ISW,NAFT,IFL)
      Y1=YWKRF(ISW,NAFT,IFL)
      Z1=ZWKRF(ISW,NAFT,IFL)
      NF=IFL+NAFT
      AX=-CDFLXZ(NF)
      AZ=SDFLXZ(NF)
      CALL SIVF
      AFTU=AFTU-FU
      AFTV=AFTV-FV
      AFTW=AFTW-FW
      X1=XWKLF(ISW,NAFT,IFL)
      Y1=YWKLF(ISW,NAFT,IFL)
      Z1=ZWKLF(ISW,NAFT,IFL)
      CALL SIVF
      AFTU=AFTU+FU
      AFTV=AFTV+FV
      AFTW=AFTW+FW
C
      CU=CU+AFTU
      CV=CV+AFTV
      CW=CW+AFTW
  216 VS= CIRJ(JP)
      UP=UP+CU*VS
      VP=VP+CV*VS
      WP=WP+CW*VS
  220 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE FVNOUT (A,N,NUNIT,IP)
      DIMENSION A(N,N),IP(N)
      WRITE (NUNIT) A,IP
      RETURN
      END
```

```
      SUBROUTINE FVNIN (A,N,NUNIT,IP)
      DIMENSION A(N,N),IP(N)
      READ (NUNIT) A,IP
      RETURN
      END
```

```
      SUBROUTINE UVWOUT
C
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /RSIDE/ CIR(250),UEI(250),VEI(250),WEI(250)
      COMMON /XYZCL/ NJET,NCYL(2),XO(2),YO(2),ZO(2),GAMVJ(2),DS(2),
     1 RHO(2),CMU(2),XCLR(2,25),YCLR(2,25),ZCLR(2,25),THETA(2,25),
     2               SCLR(2,25),AJET(2,25),BJET(2,25),DSFACT(2,25),
     3                UCL(2,25), VCL(2,25), WCL(2,25),  CFJ,CFK
      COMMON /CLDAT/ NSS(2),SS(2,11),XSS(2,11),YSS(2,11),ZSS(2,11),
     1               TSS(2,11),BSS(2,11),ASS(2,11),XSN(2,11),YSN(2,11),
     2               ZSN(2,11),XST(2,11),YST(2,11),ZST(2,11),DSS(2,11)
      COMMON /VLDAT/ NVLP,NVL(101)
C
      WRITE (4) NJET,NCYL,NSS,XO,YO,ZO,GAMVJ,DS,RHO,CMU,UEI,VEI,WEI,
     1          UCL,VCL,WCL,SS,XSS,YSS,ZSS,TSS,BSS,ASS,DSS,
     2          XSN,YSN,ZSN,XST,YST,ZST,XCLR,YCLR,ZCLR,THETA,
     3          AJET,BJET,DSFACT,SCLR,NVLP,NVL
      RETURN
      END
```

```
      SUBROUTINE UVWIN (KEI)
C
      COMMON /INDEX/ MSW,MW,MTOT,NCWI(30),IMAX,NFSEG(30),LASTF(30)
      COMMON /RSIDE/ CIR(250),UEI(250),VEI(250),WEI(250)
      COMMON /XYZCL/ NJET,NCYL(2),XO(2),YO(2),ZO(2),GAMVJ(2),DS(2),
     1 RHO(2),CMU(2),XCLR(2,25),YCLR(2,25),ZCLR(2,25),THETA(2,25),
     2               SCLR(2,25),AJET(2,25),BJET(2,25),DSFACT(2,25),
     3                UCL(2,25), VCL(2,25), WCL(2,25),  CFJ,CFK
      COMMON /CLDAT/ NSS(2),SS(2,11),XSS(2,11),YSS(2,11),ZSS(2,11),
     1               TSS(2,11),BSS(2,11),ASS(2,11),XSN(2,11),YSN(2,11),
     2               ZSN(2,11),XST(2,11),YST(2,11),ZST(2,11),DSS(2,11)
      COMMON /VLDAT/ NVLP,NVL(101)
C
      READ  (4) NJET,NCYL,NSS,XO,YO,ZO,GAMVJ,DS,RHO,CMU,UEI,VEI,WEI,
     1          UCL,VCL,WCL,SS,XSS,YSS,ZSS,TSS,BSS,ASS,DSS,
     2          XSN,YSN,ZSN,XST,YST,ZST,XCLR,YCLR,ZCLR,THETA,
     3          AJET,BJET,DSFACT,SCLR,NVLP,NVL
      RETURN
      END
```

REFERENCES

1. Mendenhall, M. R. and Spangler, S. B.: Calculation of the Longitudinal Aerodynamic Characteristics of Upper-Surface-Blown Wing-Flap Configurations. NASA CR-3004, 1978.

2. Mendenhall, M. R., Perkins, S. C., Jr., Goodwin, F. K., and Spangler, S. B.: Calculation of Static Longitudinal Aerodynamic Characteristics of STOL Aircraft with Upper-Surface-Blown Flaps. NASA CR-137646, April, 1975.

3. Mendenhall, M. R., Goodwin, F. K., and Spangler, S. B.: A Computer Program to Calculate the Longitudinal Aerodynamic Characteristics of Wing-Flap Configurations with Externally Blown Flaps. NASA CR-2706, September, 1976.

4. Mendenhall, M. R., Spangler, S. B., Nielsen, J. N., and Goodwin, F. K.: Calculation of the Longitudinal Aerodynamic Characteristics of Wing-Flap Configurations with Externally Blown Flaps. NASA CR-2705, September, 1976.

5. Dillenius, M. F. E., Mendenhall, M. R., and Spangler, S. B.: Calculation of the Longitudinal Aerodynamic Characteristics of STOL Aircraft with Externally-Blown Jet-Augmented Flaps. NASA CR-2358, February, 1974.

6. Staff of the Langley Research Center: Wind-Tunnel Investigation of Aerodynamic Performance, Steady and Vibratory Loads, Surface Temperatures, and Acoustic Characteristics of a Large-Scale Twin-Engine Upper-Surface Blown Jet-Flap Configuration. NASA TN D-8235, November, 1976.

7. Bloom, A. M., Hohlweg, W. C., and Sleeman, W. C., Jr.: Wing-Surface-Jet Interaction Characteristics of an Upper-Surface Blown Model with Rectangular Exhaust Nozzles and a Radius Flap. NASA TN D-8187, December, 1976.

TABLE I.- TYPICAL EXECUTION TIMES FOR USB PREDICTION PROGRAM

WING-FLAP PARAMETERS						JET PARAMETERS				
Vortex Lattice Panels	Input Option	FORCE OPTIONS				Input Option	Length/DS	Number of JETS		Execution Time in Seconds, CDC-6600
	NFVN	MFRC	NCFJ	NTLF	NLOAD	KJET		NJET	NRHS	
94	0	0	0	0	1	0	-	0	3	55
	0	1	-1	1	1	1	640	2	3	55
	1	1	-1	1	1	1	640	2	3	46
	1	1	-1	1	1	1	375	2	3	31
136	0	0	0	0	0	0	-	0	1	78
	0	0	0	0	1	0	-	0	2	95
	0	0	0	0	2	0	-	0	1	40
	1	0	0	0	0	0	-	0	2	110
	1	0	0	0	1	0	-	0	4	150
	0	1	-1	1	1	1	200	1	1	38
	0	1	-1	1	1	2	200	1	1	27
	0	1	-1	1	0	1	200	1	4	55
	1	1	-1	1	0	1	185	1	4	35
	1	1	-1	1	0	1	185	1	5	40
166	0	0	0	0	1	0	-	0	3	205
	1	1	-1	1	1	1	650	2	3	130
	1	1	-1	1	1	2	650	2	1	42
	1	1	-1	1	1	1	385	2	3	100
	1	1	-1	1	1	1	385	2	2	80
	1	1	-1	1	1	1	385	2	1	64
175	0	0	0	0	1	0	-	0	1	97
	1	1	-1	1	1	1	250	1	3	52

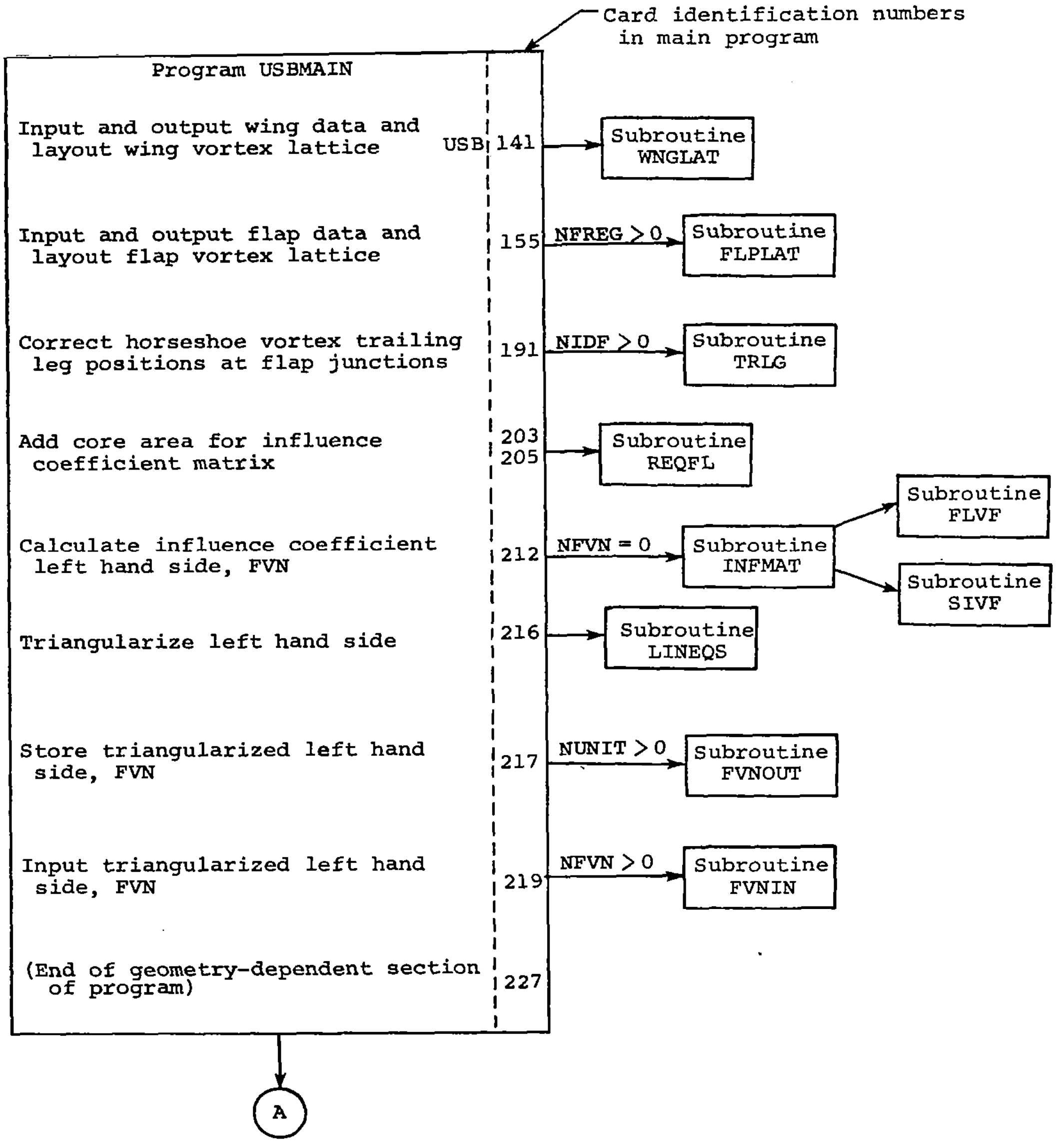


Figure 1.- General flow chart of program USBMAIN.

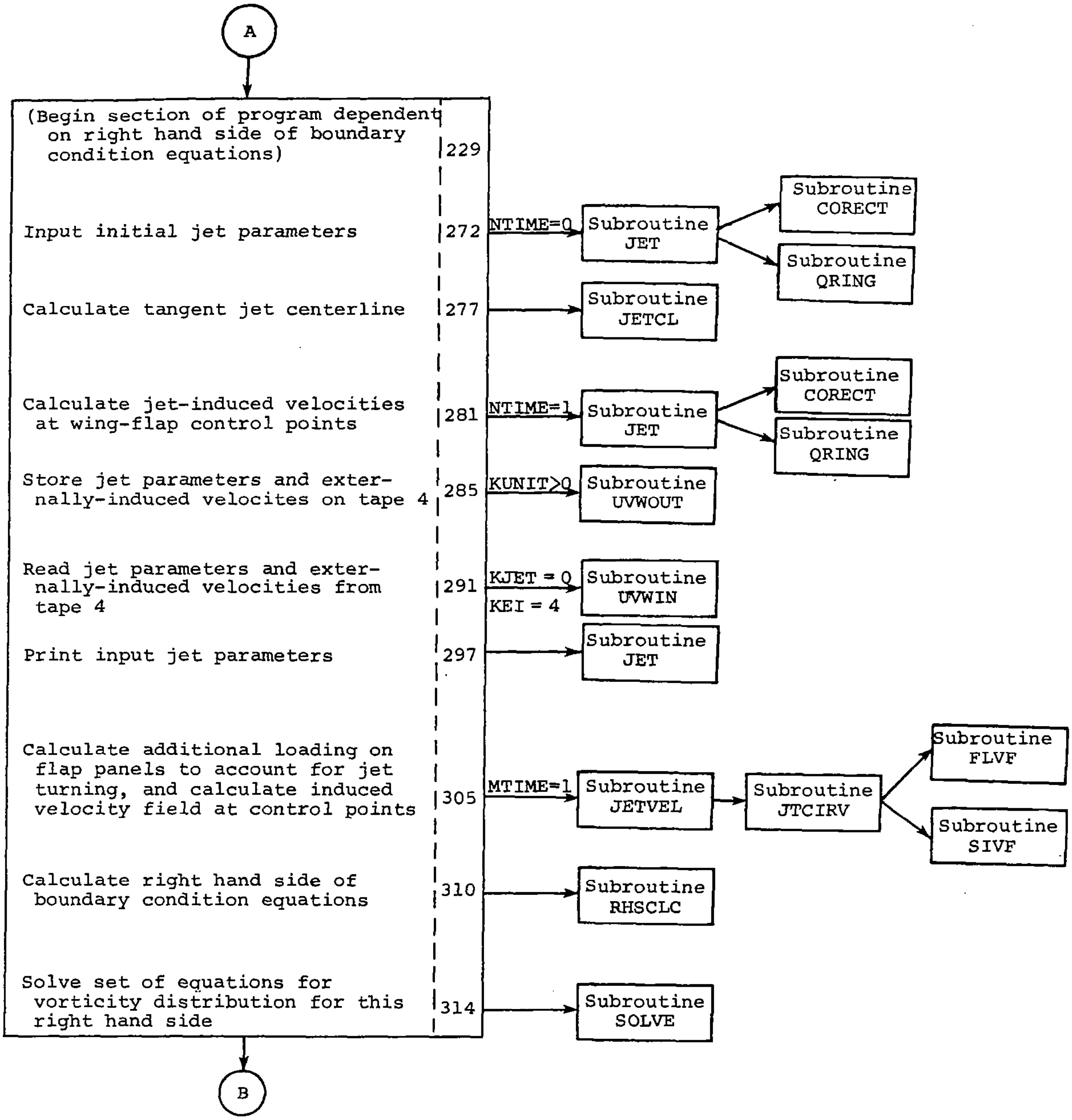


Figure 1.- Continued.

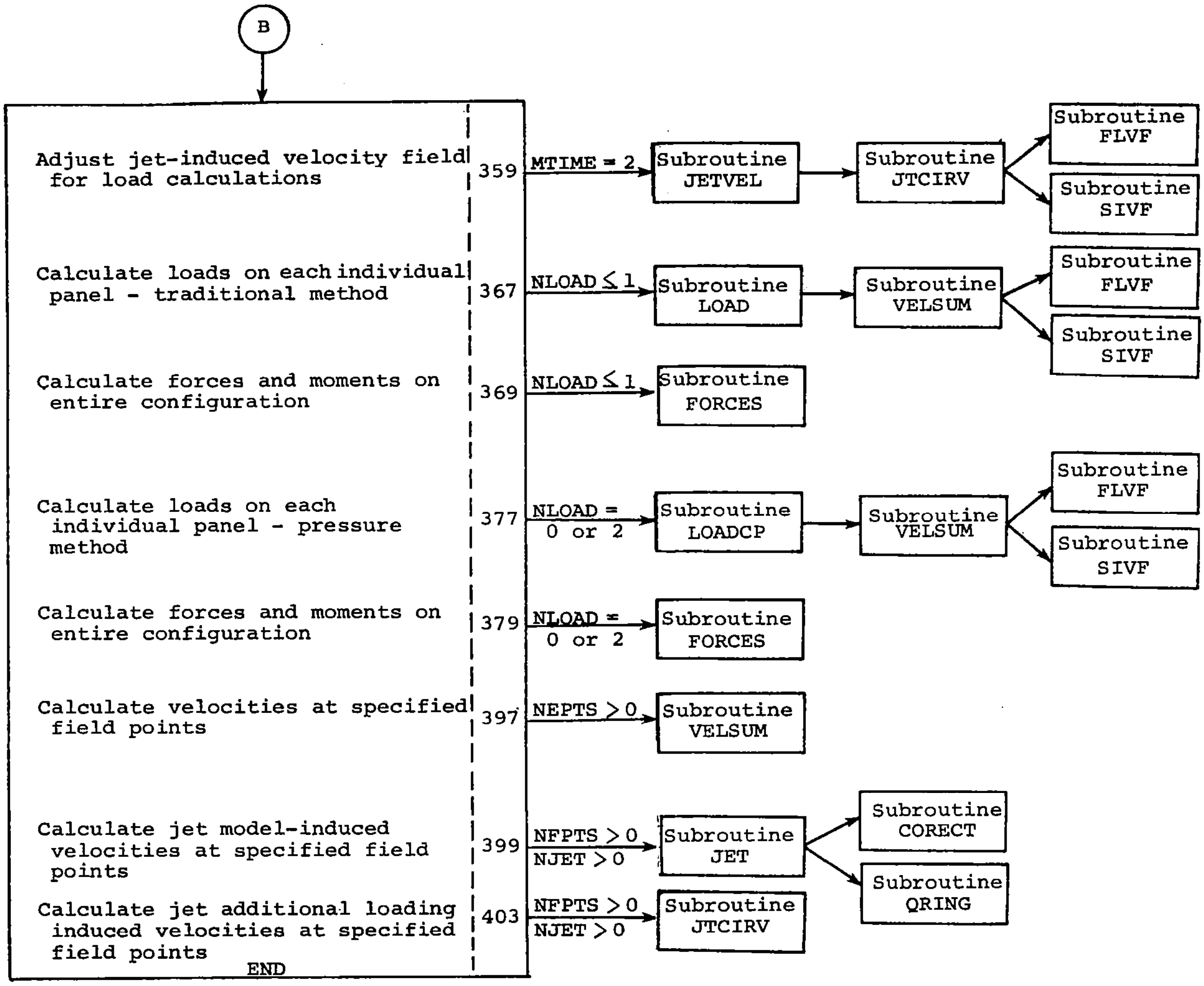


Figure 1.- Concluded.

```
      PROGRAM USBMAIN(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE4,TAPE8) USB 001
      COMMON FVN(18496)                                                 USB 002
      CALL USB                                                          USB 003
      STOP                                                              USB 004
      END                                                               USB 005
```

```
      SUBROUTINE USB                                                    USB 001

              . . .

C*********************************************************************** USB 195
C                                                                       USB 196
C       ADD CORE AREA FOR INFLUENCE COEFFICIENT MATRIX                  USB 197
C      IF REQFL IS NOT AVAILABLE , REMOVE THIS SECTION AND INCREASE     USB 198
C      THE DIMENSIONS OF FVN IN BLANK COMMON, ABOVE, TO MTOT*MTOT       USB 199
C         WHERE MTOT = TOTAL NUMBER OF VORTEX PANELS ON WING AND FLAP   USB 200
C                                                                       USB 201
C      IFLB=0                                                           USB 202
C      CALL REQFL(IFLB)                                                 USB 203
C      LFL=IFLB+MTOT*MTOT-1                                             USB 204
C      CALL REQFL(LFL)                                                  USB 205
C                                                                       USB 206
C*********************************************************************** USB 207

              . . .

      RETURN                                                            USBA421
      END                                                               USB 422
```

Figure 2.- Alternate card decks defining program USBMAIN and subroutine USB.

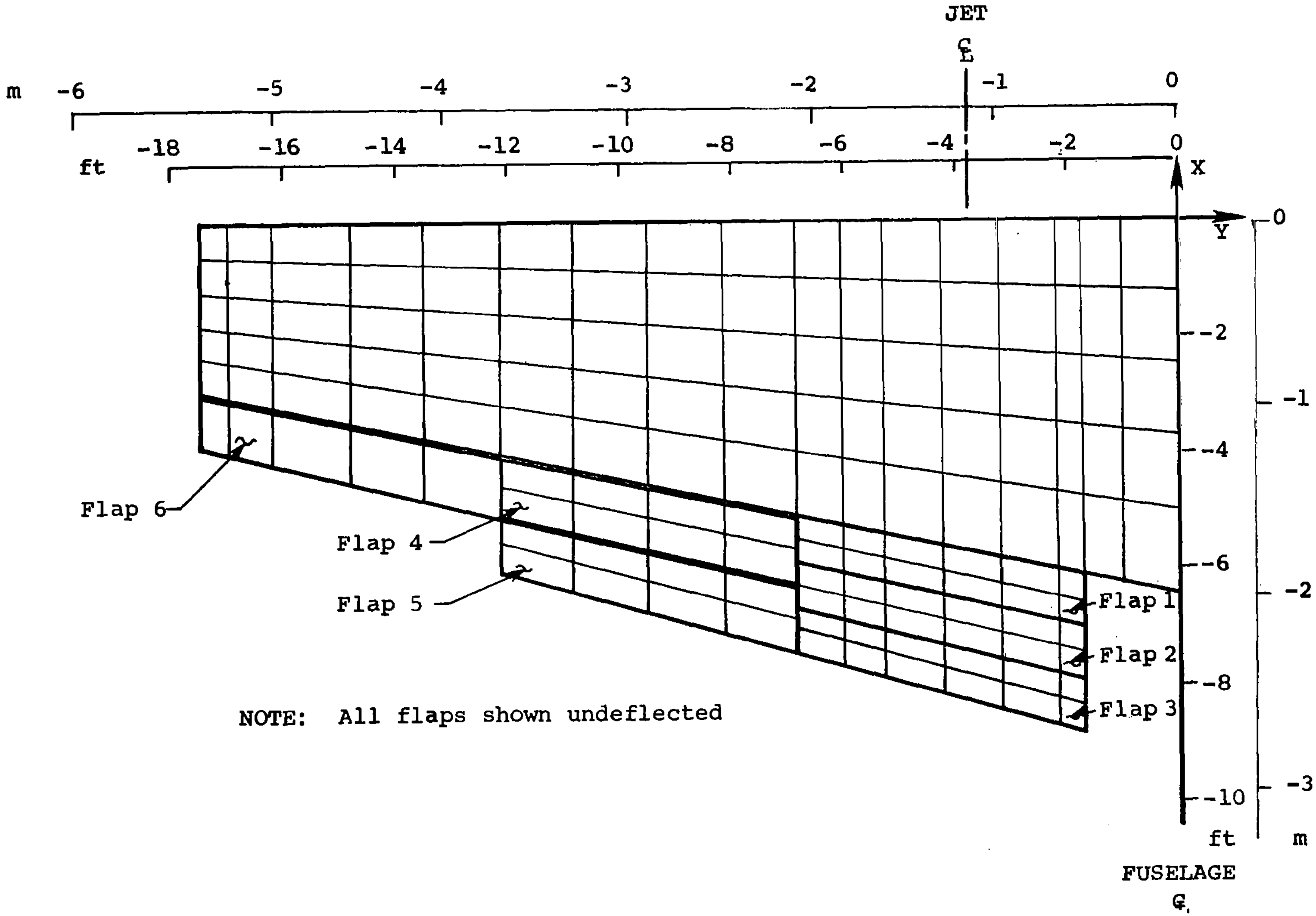
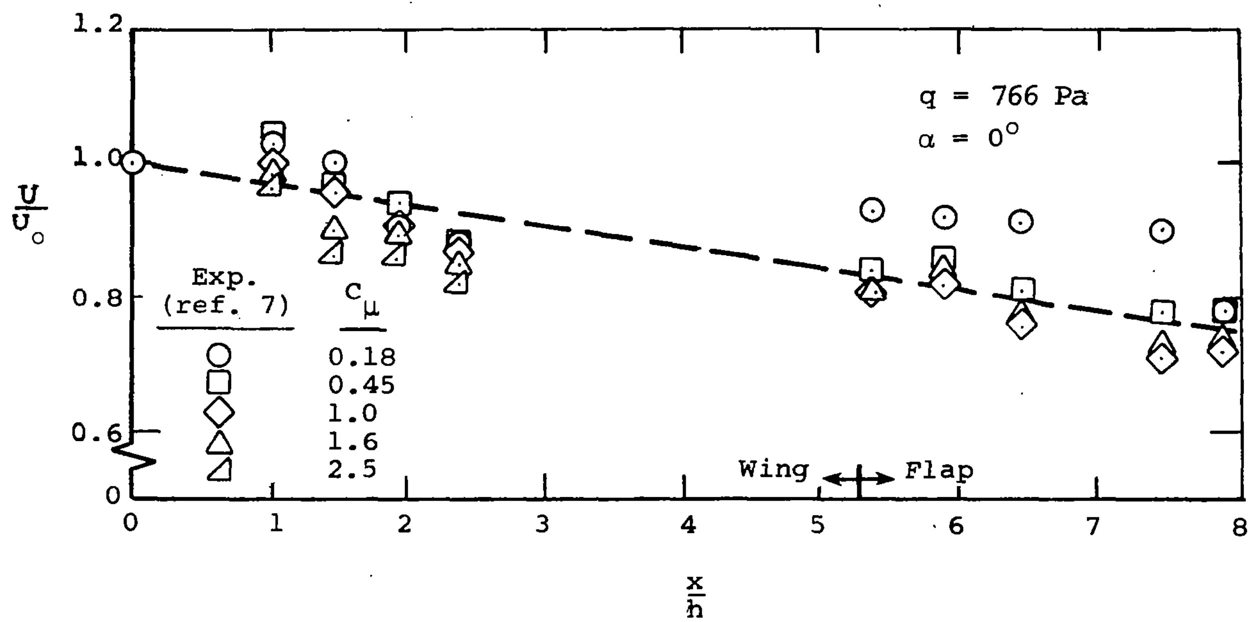


Figure 3.- Vortex-lattice arrangement for the two-engine USB configuration of reference 6.



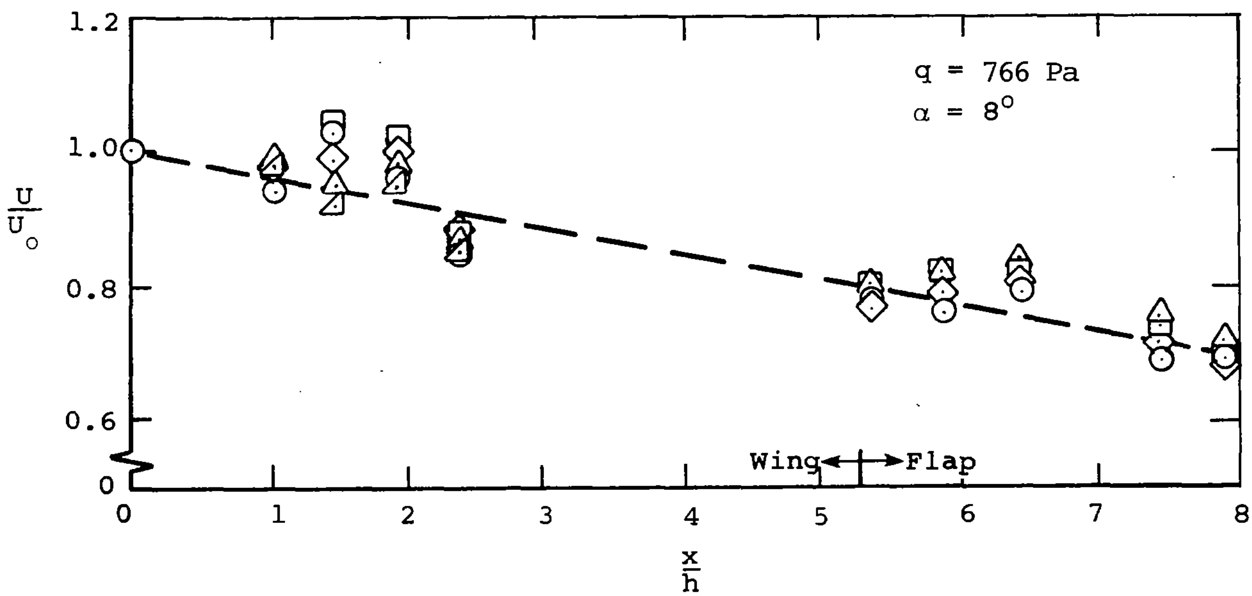


Figure 4.- Decay of the average velocity in an USB jet.

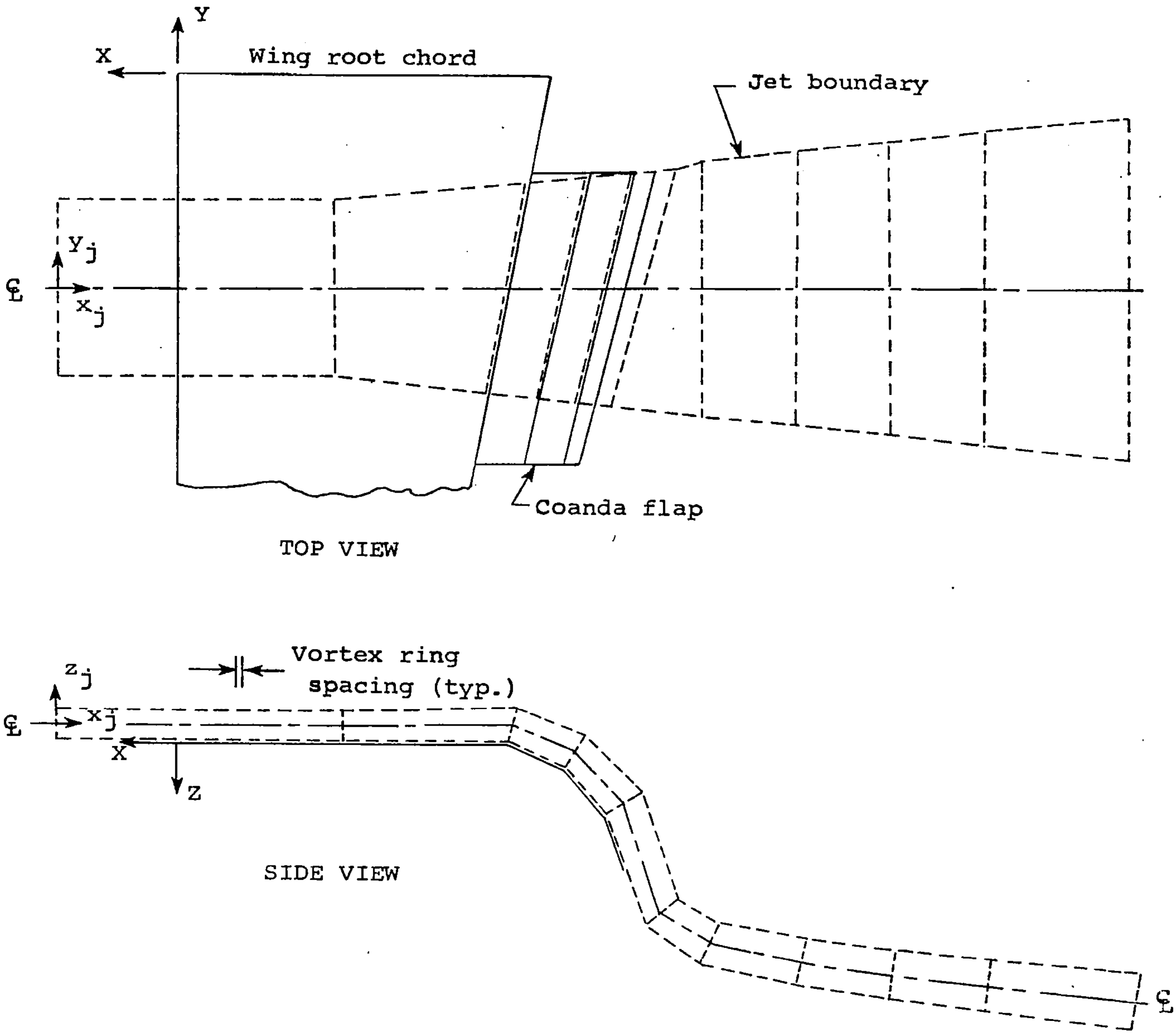


Figure 5.- USB configuration with aspect ratio 6 rectangular jet model.

ITEM 1 FORMAT (I5), 1 card

(MAIN)

NHEAD (5)	NFVN (10)	NUNIT (15)	NFPTS (20)	NPRINT (25)
I	I	I	I	I

ITEM 2 FORMAT (20A4), NHEAD cards

(MAIN)

1 TITLE

ITEM 3 FORMAT (6F10.0), 1 card

(MAIN)

1 SREF	11 REFL	21 XM	31 ZM	41 ETAJ
F	F	F	F	F

ITEM 4 FORMAT (I5), 1 card

(WNGLAT)

NWREG (5)
I

ITEM 5 FORMAT (3F10.0), 1 card

(WNGLAT)

1 CRW	11 SSPAN	21 PHID 31
F	F	F

ITEM 6 FORMAT (5I5), 1 card

(WNGLAT)

NCW (5)	MSW (10)	NTCW (15)	NUNI (20)	NPRESW (25)
I	I	I	I	I

ITEM 7 FORMAT (3F10.0,I5), MSW + 1 cards

(WNGLAT)

1 Y(I)	11 PSIWLE(I)	21 PSIWTE(I)	31 NFSEG(I) 36
F	F	F	I

I = 1, MSW + 1 (MSW + 1 CARDS)

(a) Page 1.

Figure 6.- Input forms for USB prediction program.

OMIT ITEM 8 IF NTCW = 0

ITEM 8 FORMAT (8F10.0), NCW values, eight per card.

(WNGLAT)

1 ALPHAL(1)	11 ALPHAL(2)	21 . . .	31 ALPHAL(NCW)
F	F	F	F

NCW values per card.
1 card if NTCW = 1 and NUNI = 1
MSW cards if NTCW = 1 and NUNI = 0

OMIT ITEMS 9, 10, AND 11 IF NWREG = 1

If NWREG > 1, repeat items 9, 10, and 11 in sequence NWREG - 1 times.

ITEM 9 FORMAT (2I5)

(WNGLAT)

IIN 5	IOUT 10
I	I

ITEM 10 FORMAT (3I5, 2F10.0)

(WNGLAT)

NCW 5	NTCW 10	NUNI 15	16 CIN	26 TESWP 36
I	I	I	F	F

OMIT ITEM 11 IF NTCW = 0

ITEM 11 FORMAT (8F10.0), NCW values, eight per card. { IOUT - IIN sets of cards if NTCW = 1 and NUNI = 0; One set of cards if NTCW = 1 and NUNI = 1.

(WNGLAT)

1 ALPHAL(1)	11 ALPHAL(2)	21 ...	31 ALPHAL(NWC)	41
F	F	F	F	

NCW values per card.
1 card if NTCW = 1 and NUNI = 1
IOUT - IIN cards if NTCW = 1 and NUNI = 0

ITEM 12 FORMAT (I5), 1 card $(0 \leq NIDF \leq 3)$

(MAIN)

NFREG 5	NIDF 10	IDF(I), 15	I = 1, 20	NIDF 25
I	I	I	I	I

If NFREG = 0, omit items 13, 14, 15, and 16.

NFREG > 0, repeat items 13, 14, 15, and 16 NFREG times $(0 \leq NFREG \leq 10)$

(b) Page 2.

Figure 6.- Continued.

ITEM 13 FORMAT (3I5), 1 card

(FLPLAT)

NINREG (5)	IIN (10)	IOUT (15)
I	I	I

ITEM 14 FORMAT (4I5), 1 card

NOTE: More than one set of items 14,15, and 16 may be required by NINREG on item 13.

(FLPLAT)

NCF (5)	NTCF (10)	NUNI (15)	NPRESF (20)
I	I	I	I

ITEM 15 FORMAT (5F10.0), 1 card

(FLPLAT)

1 GAPIN	11 CRFIN	21 GAPOUT	31 CRFOUT	41 DELXZ 51
F	F	F	F	F

OMIT ITEM 16 IF NTCF =0

ITEM 16 FORMAT (8F10.0), NCF values, eight to a card. {IOUT - IIN sets of cards if NTCF = 1 and NUNI = 0; One set of cards if NTCF = 1 and NUNI = 1}

(FLPLAT)

1 ALPHAL(1)	11 ALPHAL(2)	21 . . .	31 ALPHAL(NCF)	41
F	F	F	F	

NCF values per card.
1 card if NTCF = 1 and NUNI = 1
IOUT - IIN cards if NTCF = 1 and NUNI = 0

OMIT ITEM 17 IF NFPTS = 0

ITEM 17 FORMAT (3F10.0), NFPTS cards

(MAIN)

1 XFPT	11 YFPT	21 ZFPT 31
F	F	F

NFPTS cards $(0 \leq NFPTS \leq 50)$

ITEM 18 FORMAT (I5), 1 card

(MAIN)

NRHS (5)
I

(c) Page 3.

Figure 6.- Continued.

Item 19 through end repeated NRHS times.

ITEM 19 FORMAT (F10.0,6I5), 1 card

(MAIN)

1	15	20	25	30	35	40	45	50	55	60	65	70
ALFA	KJET	KEI	KUNIT	NLOAD	NJPNL	MFRC	NCFJ	NTLF	NFJ	NFJN(1)	NFJN(2)	NFJN(3)
F	I	I	I	I	I	I	I	I	I	I	I	I

OMIT ITEM 20 IF NJPNL = 0

ITEM 20

(MAIN) (NJPNL ≤ 30)

5	10	15	20	25	30	35	40	
JPNL(1)	JPNL(2)	. . .	JPNL(NJPNL)					
I	I	I	I	I	I	I	I	

If KJET = 1, include items 21 through 25.

ITEM 21

(JET)

5	10	15	20	25
NHEAD	NJET	NVLP	NCRCT	JPRINT
I	I	I	I	I

ITEM 22 FORMAT (8A10), NHEAD cards

(JET)

TITLE
A

Items 23 and 24 are repeated NJET times.

ITEM 23

(JET)

1	11	21	31	41	51	61 65
CMU(J)	RHO(J)	XO(J)	YO(J)	ZO(J)	DS(J)	NCYL(J)
F	F	F	F	F	F	I

(d) Page 4.

Figure 6.- Continued.

ITEM 24 FORMAT (7F10.5), NCYL cards

	XCLR(J,N) 10	YCLR(J,N) 20	ZCLR(J,N) 30	AJET(J,N) 40	BJET(J,N) 50	THETA(J,N) 60	DSFACT(J,N) 70	
(JET)	F	F	F	F	F	F	F	NCYL(J) cards

OMIT ITEM 25 IF NVLP = 0

ITEM 25

	1 NVL(J) 5	, J = 1, 10	NVLP 15	20	25	30	35	
(JET)	I	I	I	I	I	I	I	

END OF DATA

(e) Page 5.

Figure 6.- Concluded.

```
(ITEM)

 (1)        4     0     8    12     0
        {                 2-ENGINE USB CONFIGURATION , COANDA PLATE DEFLECTED 32 DEG.
 (2)    {                    REF. NASA TN D-8235   BY LANGLEY STAFF    NOV. 1976
        {                    DELTA(A) = 20 ,  PHI = 0  ,   I(ROOT) = 3 , I(TIP) = -.17
        {   SAMPLE RUN L32    C(MU)=2.0      ALPHA = 0 , 8.5 , 20
 (3)        212.5      6.42       -2.48      1.37       1.0
 (4)          1
 (5)        6.25       17.5         .0
 (6)          5    16     1     0     1
        {   0.         0.0        -10.71       0
        {  -1.         0.0        -10.71       0
        {  -1.75       0.0        -10.71       0
        {  -2.19       0.0        -10.71       3
        {  -3.220      0.0        -10.71       3
        {  -4.240      0.0        -10.71       3
        {  -5.27       0.0        -10.71       3
        {  -6.05       0.0        -10.71       3
 (7)    {  -6.830      0.0        -10.71       3
        {  -8.160      0.0        -10.71       2
        {  -9.500      0.0        -10.71       2
        { -10.830      0.0        -10.71       2
        { -12.160      0.0        -10.71       2
        { -13.5        0.0        -10.71       1
        { -14.8        0.0        -10.71       1
        { -16.2        0.0        -10.71       1
        { -17.5        0.0        -10.71       1
        {  0.0508     0.0508     0.0508     0.0508     0.0508
        {  0.0480     0.0480     0.0480     0.0480     0.0480
        {  0.0460     0.0460     0.0460     0.0460     0.0460
        {  0.0440     0.0440     0.0440     0.0440     0.0440
        {  0.0405     0.0405     0.0405     0.0405     0.0405
        {  0.0375     0.0375     0.0375     0.0375     0.0375
        {  0.0350     0.0350     0.0350     0.0350     0.0350
        {  0.0320     0.0320     0.0320     0.0320     0.0320
 (8)    {  0.0287     0.0287     0.0287     0.0287     0.0287
        {  0.0244     0.0244     0.0244     0.0244     0.0244
        {  0.0202     0.0202     0.0202     0.0202     0.0202
        {  0.0160     0.0160     0.0160     0.0160     0.0160
        {  0.0118     0.0118     0.0118     0.0118     0.0118
        {  0.0076     0.0076     0.0076     0.0076     0.0076
        {  0.0033     0.0033     0.0033     0.0033     0.0033
        { -0.0009    -0.0009    -0.0009    -0.0009    -0.0009
(12)          3     3     3     9    13
(13)          3     3     9
(14)          2     0     0     1
(15)        0.0        1.026      0.0        0.86       12.0
(14)          2     0     0     1
(15)         0.0       1.026      0.0        0.86       22.0
(14)          2     0     0     1
(15)        0.0        1.026      0.0        0.86       32.0
(13)          2     9    13
(14)          2     0     0     1
(15)        0.11       1.19       0.088      0.95       15.0
(14)          2     0     0     1
(15)        0.083      1.16       0.066      0.92       32.0
(13)          1    13    17
(14)          1     0     0     1
(15)        0.03       1.05       0.03       0.78       20.0
        {  -3.12      -3.73      -.025
        {  -3.12      -3.73      -.05
        {  -3.12      -3.73      -.10
        {  -3.12      -3.73      -.20
        {  -3.12      -3.73      -.30
        {  -3.12      -3.73      -.40
(17)    {  -3.12      -3.73      -.50
        {  -3.12      -3.73      -.55
        {  -3.12      -3.73      -.575
        {  -3.12      -3.73      -.60
        {  -3.12      -3.73      -.70
        {  -3.12      -3.73      -.80
(18)          3
(19)        0.0          1     0     1     1    10     1    -1     1     3     1     2     3
(20)         11    12    16    17    21    22    26    27    31    32
(21)          1     1    10     0    -1
(22)        AR=4 RECTANGULAR JET ON LEFT WING PANEL - VELOCITY DECAY FROM TN D-8187
(23)        1.0        1.25       2.         -3.73      -.26       .05        5
        {   0.         0.         0.         1.542      .26        0.         1.
        {   4.6        0.         0.         1.542      .26        0.         1.
(24)    {   11.0       0.         0.         2.21       .37        0.         1.
        {   14.5       0.         0.         2.605      .435       0.         2.
        {   18.0       0.         0.         3.0        .50        0.         2.
(25)          1     2     3     4     5     6     7     8     9    10
(19)    {   8.5          2     1     0     1     0     1    -1     1     3     1     2     3
        {   20.          2     1     0     1     0     1    -1     1     3     1     2     3
```

(a) Sample case 1.

Figure 7.- Sample input decks for USB prediction program.

```
(ITEM)
 (1)        4      0      8      0      0
                               2-ENGINE USB CONFIGURATION , COANDA PLATE DEFLECTED 72 DEG.
 (2)                              REF. NASA TN D-8235   BY LANGLEY STAFF     NOV. 1976
                                  DELTA(A) = 53 ,  PHI = 0  ,    I(ROOT) = 3 ,  I(TIP) = -.17
         SAMPLE RUN L72     C(MU)=0         ALPHA = 8.5
 (3)     212.5       6.42       -2.48       1.37        0.9
 (4)        1
 (5)     6.25        17.5         .0
 (6)        5    16      1      0      1
         0.          0.0        -10.71       0
        -1.          0.0        -10.71       0
        -1.75        0.0        -10.71       0
        -2.19        0.0        -10.71       3
        -3.220       0.0        -10.71       3
        -4.240       0.0        -10.71       3
        -5.27        0.0        -10.71       3
        -6.05        0.0        -10.71       3
 (7)    -6.830       0.0        -10.71       3
        -8.160       0.0        -10.71       2
        -9.500       0.0        -10.71       2
       -10.830       0.0        -10.71       2
       -12.160       0.0        -10.71       2
       -13.5         0.0        -10.71       1
       -14.8         0.0        -10.71       1
       -16.2         0.0        -10.71       1
       -17.5         0.0        -10.71       1
        0.0508      0.0508      0.0508      0.0508      0.0508
        0.0480      0.0480      0.0480      0.0480      0.0480
        0.0460      0.0460      0.0460      0.0460      0.0460
        0.0440      0.0440      0.0440      0.0440      0.0440
        0.0405      0.0405      0.0405      0.0405      0.0405
        0.0375      0.0375      0.0375      0.0375      0.0375
        0.0350      0.0350      0.0350      0.0350      0.0350
        0.0320      0.0320      0.0320      0.0320      0.0320
 (8)    0.0287      0.0287      0.0287      0.0287      0.0287
        0.0244      0.0244      0.0244      0.0244      0.0244
        0.0202      0.0202      0.0202      0.0202      0.0202
        0.0160      0.0160      0.0160      0.0160      0.0160
        0.0118      0.0118      0.0118      0.0118      0.0118
        0.0076      0.0076      0.0076      0.0076      0.0076
        0.0033      0.0033      0.0033      0.0033      0.0033
       -0.0009     -0.0009     -0.0009     -0.0009     -0.0009
(12)        3      3      3      9     13
(13)        3      3      4
(14)        2      0      0      1
(15)     0.0         1.105       0.0         0.926       25.
(14)        2      0      0      1
(15)      0.0        1.105       0.0         0.926       49.
(14)        2      0      0      1
(15)     0.0         1.105       0.0         0.926       72.
(13)        2      9     13
(14)        2      0      0      1
(15)     0.102       1.19        0.081       0.95        40.0
(14)        2      0      0      1
(15)     0.083       1.16        0.066       0.92        72.0
(13)        1     13     17
(14)        1      0      0      1
(15)     0.03        1.05        0.03        0.78        50.0
(18)        1
(19)     8.5          0      0      0      1     10      0      0      0      3      1      2      3

(20)       11     12     16     17     21     22     26     27     31     32
```

(b) Sample case 2.

Figure 7.- Concluded.

```
                   USB AERODYNAMIC PREDICTION PROGRAM

               2-ENGINE USB CONFIGURATION , COANDA PLATE DEFLECTED 32 DEG.
                  REF.  NASA TN D-8235   BY LANGLEY STAFF    NOV. 1976
                  DELTA(A) = 20 ,  PHI = 0  ,   I(ROOT) = 3 ,  I(TIP) = -.17
SAMPLE RUN L32    C(MU)=2.0     ALPHA = 0 , 8.5 , 20

 REFERENCE QUANTITIES USED IN FORCE AND MOMENT CALCULATION
      AREA           =  212.50000
      LENGTH         =    6.42000
      MOMENT CENTER
           XM        =   -2.48000
           ZM        =    1.37000

 WING INPUT DATA

      REGION NUMBER  1
           INBOARD EDGE CHORD =   6.25000
           SEMISPAN           =  17.50000
           DIHEDRAL ANGLE     =   0.00000

            80 VORTICES ARE TO BE LAID OUT IN THIS REGION
                16 SPANWISE BY  5 CHORDWISE

           SPANWISE LOCATIONS OF TRAILING VORTEX LEGS, SWEEP ANGLES OF
                WING SECTION TO THE RIGHT AND NUMBER OF FLAPS BEHIND THIS SECTION

                 SPANWISE       LE SWEEP       TE SWEEP       NUMBER
                 LOCATION                                     OF FLAPS
                   0.00000
                  -1.00000       0.00000      -10.71000          0
                  -1.75000       0.00000      -10.71000          0
                  -2.19000       0.00000      -10.71000          3
                  -3.22000       0.00000      -10.71000          3
                  -4.24000       0.00000      -10.71000          3
                  -5.27000       0.00000      -10.71000          3
                  -6.05000       0.00000      -10.71000          3
                  -6.83000       0.00000      -10.71000          3
                  -8.16000       0.00000      -10.71000          2
                  -9.50000       0.00000      -10.71000          2
                 -10.83000       0.00000      -10.71000          2
                 -12.16000       0.00000      -10.71000          2
                 -13.50000       0.00000      -10.71000          1
                 -14.80000       0.00000      -10.71000          1
                 -16.20000       0.00000      -10.71000          1
                 -17.50000       0.00000      -10.71000          1
```

(a) Page 1.

Figure 8.- Sample output from USB aerodynamic prediction program.

```
FLAP INPUT DATA

    REGION NUMBER 1
         THERE ARE 3 FLAPS IN THIS REGION
         THEY EXTEND FROM Y =  -1.75000 TO Y =  -6.83000

         FLAP NUMBER  1    ( 1)
              INBOARD EDGE GAP       =     0.00000
              OUTBOARD EDGE GAP      =     0.00000
              INBOARD EDGE CHORD     =     1.02600
              OUTBOARD EDGE CHORD    =      .86000
              DEFLECTION ANGLE       =    12.00000

               12 VORTICES ARE TO BE LAID OUT ON THIS FLAP
                    6 SPANWISE BY  2 CHORDWISE

              SPANWISE LOCATIONS OF
               TRAILING VORTEX LEGS
                     -1.75000
                     -2.19000
                     -3.22000
                     -4.24000
                     -5.27000
                     -6.05000
                     -6.83000

              XF,YF COORDINATES OF FOUR CORNERS OF FLAP
                     (FLAP LIES IN ZF=0 PLANE)
                         XF             YF
                      0.00000        0.00000
                     -1.02600        0.00000
                       .93980       -5.08393
                       .07980       -5.08393

         FLAP NUMBER  2    ( 2)
              INBOARD EDGE GAP       =     0.00000
              OUTBOARD EDGE GAP      =     0.00000
              INBOARD EDGE CHORD     =     1.02600
              OUTBOARD EDGE CHORD    =      .86000
              DEFLECTION ANGLE       =    22.00000

               12 VORTICES ARE TO BE LAID OUT ON THIS FLAP
                    6 SPANWISE BY  2 CHORDWISE

              SPANWISE LOCATIONS OF
               TRAILING VORTEX LEGS
                     -1.75000
                     -2.19000
                     -3.22000
                     -4.24000
                     -5.27000
                     -6.05000
                     -6.83000

              XF,YF COORDINATES OF FOUR CORNERS OF FLAP
                     (FLAP LIES IN ZF=0 PLANE)
                         XF             YF
                      0.00000        0.00000
                     -1.02600        0.00000
                      1.05431       -5.09485
                       .19431       -5.09485

         FLAP NUMBER  3    ( 3)
              INBOARD EDGE GAP       =     0.00000

              OUTBOARD EDGE GAP      =     0.00000
              INBOARD EDGE CHORD     =     1.02600
              OUTBOARD EDGE CHORD    =      .86000
              DEFLECTION ANGLE       =    32.00000

               12 VORTICES ARE TO BE LAID OUT ON THIS FLAP
                    6 SPANWISE BY  2 CHORDWISE

              SPANWISE LOCATIONS OF
               TRAILING VORTEX LEGS
                     -1.75000
                     -2.19000
                     -3.22000
                     -4.24000
                     -5.27000
                     -6.05000
                     -6.83000

              XF,YF COORDINATES OF FOUR CORNERS OF FLAP
                     (FLAP LIES IN ZF=0 PLANE)
                         XF             YF
                      0.00000        0.00000
                     -1.02600        0.00000
                      1.13427       -5.11470
                       .27427       -5.11470

    REGION NUMBER 2
         THERE ARE 2 FLAPS IN THIS REGION
         THEY EXTEND FROM Y =  -6.83000 TO Y = -12.16000

         FLAP NUMBER  1    ( 4)
              INBOARD EDGE GAP       =      .11000
              OUTBOARD EDGE GAP      =      .08800
              INBOARD EDGE CHORD     =     1.19000
              OUTBOARD EDGE CHORD    =      .95000
              DEFLECTION ANGLE       =    15.00000

                8 VORTICES ARE TO BE LAID OUT ON THIS FLAP
                    4 SPANWISE BY  2 CHORDWISE

              SPANWISE LOCATIONS OF
               TRAILING VORTEX LEGS
                     -6.83000
                     -8.16000
                     -9.50000
                    -10.83000
                    -12.16000

              XF,YF COORDINATES OF FOUR CORNERS OF FLAP
                     (FLAP LIES IN ZF=0 PLANE)
                         XF             YF
                      0.00000        0.00000
                     -1.19000        0.00000
                       .99498       -5.33666
                       .04498       -5.33666

         FLAP NUMBER  2    ( 5)
              INBOARD EDGE GAP       =      .08300
              OUTBOARD EDGE GAP      =      .06600
              INBOARD EDGE CHORD     =     1.16000
              OUTBOARD EDGE CHORD    =      .92000
              DEFLECTION ANGLE       =    32.00000

                8 VORTICES ARE TO BE LAID OUT ON THIS FLAP
                    4 SPANWISE BY  2 CHORDWISE

              SPANWISE LOCATIONS OF
               TRAILING VORTEX LEGS
                     -6.83000
                     -8.16000
                     -9.50000
                    -10.83000
                    -12.16000

              XF,YF COORDINATES OF FOUR CORNERS OF FLAP
                     (FLAP LIES IN ZF=0 PLANE)
                         XF             YF
                      0.00000        0.00000
                     -1.16000        0.00000
                      1.11933       -5.36605
                       .19933       -5.36605

    REGION NUMBER 3
         THERE ARE 1 FLAPS IN THIS REGION
         THEY EXTEND FROM Y = -12.16000 TO Y = -17.50000

         FLAP NUMBER  1    ( 6)
              INBOARD EDGE GAP       =      .03000
              OUTBOARD EDGE GAP      =      .03000
              INBOARD EDGE CHORD     =     1.05000
              OUTBOARD EDGE CHORD    =      .78000
              DEFLECTION ANGLE       =    20.00000

                4 VORTICES ARE TO BE LAID OUT ON THIS FLAP
                    4 SPANWISE BY  1 CHORDWISE

              SPANWISE LOCATIONS OF
               TRAILING VORTEX LEGS
                    -12.16000
                    -13.50000
                    -14.80000
                    -16.20000
                    -17.50000

              XF,YF COORDINATES OF FOUR CORNERS OF FLAP
                     (FLAP LIES IN ZF=0 PLANE)
                         XF             YF
                      0.00000        0.00000
                     -1.05000        0.00000
                       .94906       -5.35116
                       .16906       -5.35116
```

(b) Page 2.

Figure 8.- Continued.

HORSESHOE VORTEX PROPERTIES

********** WING DATA **********

VORTEX NUMBER J	-COORDINATES OF BOUND LEG MIDPOINT XBL(J)	YBL(J)	ZBL(J)	---COORDINATES OF CONTROL POINT--- XCP(J)	YCP(J)	ZCP(J)	B.L. SWEEP PSI(J)	HALF-WIDTH SW(J)	SURFACE SLOPE ALPHAL(J)
1	-.30777	-.50000	0.00000	-.92332	-.50000	0.00000	-.54181	.50000	.05080
2	-1.53886	-.50000	0.00000	-2.15440	-.50000	0.00000	-2.70711	.50000	.05080
3	-2.76995	-.50000	0.00000	-3.38549	-.50000	0.00000	-4.86470	.50000	.05080
4	-4.00103	-.50000	0.00000	-4.61658	-.50000	0.00000	-7.00856	.50000	.05080
5	-5.23212	-.50000	0.00000	-5.84766	-.50000	0.00000	-9.13289	.50000	.05080
6	-.29950	-1.37500	0.00000	-.89849	-1.37500	0.00000	-.54181	.37500	.04800
7	-1.49749	-1.37500	0.00000	-2.09648	-1.37500	0.00000	-2.70711	.37500	.04800
8	-2.69547	-1.37500	0.00000	-3.29447	-1.37500	0.00000	-4.86470	.37500	.04800
9	-3.89346	-1.37500	0.00000	-4.49246	-1.37500	0.00000	-7.00856	.37500	.04800
10	-5.09145	-1.37500	0.00000	-5.69045	-1.37500	0.00000	-9.13289	.37500	.04800
11	-.29387	-1.97000	0.00000	-.88161	-1.97000	0.00000	-.54181	.22000	.04600
12	-1.46935	-1.97000	0.00000	-2.05709	-1.97000	0.00000	-2.70711	.22000	.04600
13	-2.64483	-1.97000	0.00000	-3.23257	-1.97000	0.00000	-4.86470	.22000	.04600
14	-3.82032	-1.97000	0.00000	-4.40806	-1.97000	0.00000	-7.00856	.22000	.04600
15	-4.99580	-1.97000	0.00000	-5.58354	-1.97000	0.00000	-9.13289	.22000	.04600
16	-.28692	-2.70500	0.00000	-.86076	-2.70500	0.00000	-.54181	.51500	.04400
17	-1.43460	-2.70500	0.00000	-2.00844	-2.70500	0.00000	-2.70711	.51500	.04400
18	-2.58228	-2.70500	0.00000	-3.15612	-2.70500	0.00000	-4.86470	.51500	.04400
19	-3.72996	-2.70500	0.00000	-4.30380	-2.70500	0.00000	-7.00856	.51500	.04400
20	-4.87764	-2.70500	0.00000	-5.45148	-2.70500	0.00000	-9.13289	.51500	.04400
21	-.27723	-3.73000	0.00000	-.83168	-3.73000	0.00000	-.54181	.51000	.04050
22	-1.38615	-3.73000	0.00000	-1.94059	-3.73000	0.00000	-2.70711	.51000	.04050
23	-2.49504	-3.73000	0.00000	-3.04949	-3.73000	0.00000	-4.86470	.51000	.04050
24	-3.60395	-3.73000	0.00000	-4.15840	-3.73000	0.00000	-7.00856	.51000	.04050
25	-4.71285	-3.73000	0.00000	-5.26731	-3.73000	0.00000	-9.13289	.51000	.04050
26	-.26753	-4.75500	0.00000	-.80260	-4.75500	0.00000	-.54181	.51500	.03750
27	-1.33767	-4.75500	0.00000	-1.87274	-4.75500	0.00000	-2.70711	.51500	.03750
28	-2.40780	-4.75500	0.00000	-2.94287	-4.75500	0.00000	-4.86470	.51500	.03750
29	-3.47794	-4.75500	0.00000	-4.01301	-4.75500	0.00000	-7.00856	.51500	.03750
30	-4.54807	-4.75500	0.00000	-5.08314	-4.75500	0.00000	-9.13289	.51500	.03750
31	-.25898	-5.66000	0.00000	-.77693	-5.66000	0.00000	-.54181	.39000	.03500
32	-1.29488	-5.66000	0.00000	-1.81283	-5.66000	0.00000	-2.70711	.39000	.03500
33	-2.33078	-5.66000	0.00000	-2.84873	-5.66000	0.00000	-4.86470	.39000	.03500
34	-3.36668	-5.66000	0.00000	-3.88463	-5.66000	0.00000	-7.00856	.39000	.03500
35	-4.40258	-5.66000	0.00000	-4.92053	-5.66000	0.00000	-9.13289	.39000	.03500
36	-.25160	-6.44000	0.00000	-.75480	-6.44000	0.00000	-.54181	.39000	.03200
37	-1.25800	-6.44000	0.00000	-1.76119	-6.44000	0.00000	-2.70711	.39000	.03200
38	-2.26439	-6.44000	0.00000	-2.76759	-6.44000	0.00000	-4.86470	.39000	.03200
39	-3.27079	-6.44000	0.00000	-3.77399	-6.44000	0.00000	-7.00856	.39000	.03200
40	-4.27719	-6.44000	0.00000	-4.78039	-6.44000	0.00000	-9.13289	.39000	.03200
41	-.24162	-7.49500	0.00000	-.72487	-7.49500	0.00000	-.54181	.66500	.02870
42	-1.20811	-7.49500	0.00000	-1.69136	-7.49500	0.00000	-2.70711	.66500	.02870
43	-2.17460	-7.49500	0.00000	-2.65785	-7.49500	0.00000	-4.86470	.66500	.02870
44	-3.14109	-7.49500	0.00000	-3.62434	-7.49500	0.00000	-7.00856	.66500	.02870
45	-4.10758	-7.49500	0.00000	-4.59083	-7.49500	0.00000	-9.13289	.66500	.02870
46	-.22900	-8.83000	0.00000	-.68699	-8.83000	0.00000	-.54181	.67000	.02440
47	-1.14499	-8.83000	0.00000	-1.60299	-8.83000	0.00000	-2.70711	.67000	.02440
48	-2.06098	-8.83000	0.00000	-2.51898	-8.83000	0.00000	-4.86470	.67000	.02440
49	-2.97697	-8.83000	0.00000	-3.43497	-8.83000	0.00000	-7.00856	.67000	.02440
50	-3.89296	-8.83000	0.00000	-4.35096	-8.83000	0.00000	-9.13289	.67000	.02440
51	-.21637	-10.16500	0.00000	-.64912	-10.16500	0.00000	-.54181	.66500	.02020
52	-1.08187	-10.16500	0.00000	-1.51461	-10.16500	0.00000	-2.70711	.66500	.02020
53	-1.94736	-10.16500	0.00000	-2.38011	-10.16500	0.00000	-4.86470	.66500	.02020
54	-2.81285	-10.16500	0.00000	-3.24560	-10.16500	0.00000	-7.00856	.66500	.02020
55	-3.67835	-10.16500	0.00000	-4.11109	-10.16500	0.00000	-9.13289	.66500	.02020
56	-.20380	-11.49500	0.00000	-.61139	-11.49500	0.00000	-.54181	.66500	.01600
57	-1.01898	-11.49500	0.00000	-1.42657	-11.49500	0.00000	-2.70711	.66500	.01600
58	-1.83416	-11.49500	0.00000	-2.24176	-11.49500	0.00000	-4.86470	.66500	.01600
59	-2.64935	-11.49500	0.00000	-3.05694	-11.49500	0.00000	-7.00856	.66500	.01600
60	-3.46453	-11.49500	0.00000	-3.87212	-11.49500	0.00000	-9.13289	.66500	.01600
61	-.19117	-12.83000	0.00000	-.57351	-12.83000	0.00000	-.54181	.67000	.01180
62	-.95586	-12.83000	0.00000	-1.33820	-12.83000	0.00000	-2.70711	.67000	.01180
63	-1.72054	-12.83000	0.00000	-2.10289	-12.83000	0.00000	-4.86470	.67000	.01180
64	-2.48523	-12.83000	0.00000	-2.86757	-12.83000	0.00000	-7.00856	.67000	.01180
65	-3.24991	-12.83000	0.00000	-3.63226	-12.83000	0.00000	-9.13289	.67000	.01180

(c) Page 3.

Figure 8.- Continued.

66	-.17869	-14.15000	0.00000	-.53607	-14.15000	0.00000	-.54181	.65000	.00760
67	-.89344	-14.15000	0.00000	-1.25082	-14.15000	0.00000	-2.70711	.65000	.00760
68	-1.60820	-14.15000	0.00000	-1.96557	-14.15000	0.00000	-4.86470	.65000	.00760
69	-2.32295	-14.15000	0.00000	-2.68033	-14.15000	0.00000	-7.00856	.65000	.00760
70	-3.03771	-14.15000	0.00000	-3.39508	-14.15000	0.00000	-9.13289	.65000	.00760
71	-.16592	-15.50000	0.00000	-.49777	-15.50000	0.00000	-.54181	.70000	.00330
72	-.82961	-15.50000	0.00000	-1.16146	-15.50000	0.00000	-2.70711	.70000	.00330
73	-1.49330	-15.50000	0.00000	-1.82514	-15.50000	0.00000	-4.86470	.70000	.00330
74	-2.15699	-15.50000	0.00000	-2.48883	-15.50000	0.00000	-7.00856	.70000	.00330
75	-2.82068	-15.50000	0.00000	-3.15252	-15.50000	0.00000	-9.13289	.70000	.00330
76	-.15316	-16.85000	0.00000	-.45947	-16.85000	0.00000	-.54181	.65000	-.00090
77	-.76578	-16.85000	0.00000	-1.07209	-16.85000	0.00000	-2.70711	.65000	-.00090
78	-1.37840	-16.85000	0.00000	-1.68471	-16.85000	0.00000	-4.86470	.65000	-.00090
79	-1.99102	-16.85000	0.00000	-2.29734	-16.85000	0.00000	-7.00856	.65000	-.00090
80	-2.60365	-16.85000	0.00000	-2.90996	-16.85000	0.00000	-9.13289	.65000	-.00090

**********REGION 1 FLAP 1 DATA ********** (1)

VORTEX NUMBER J	-COORDINATES OF BOUND LEG MIDPOINT XBL(J)	YBL(J)	ZBL(J)	---COORDINATES OF CONTROL POINT--- XCP(J)	YCP(J)	ZCP(J)	B.L. SWEEP PSI(J)	HALF-WIDTH SW(J)	SURFACE SLOPE ALPHAL(J)
81	-6.00198	-1.97000	.02648	-6.25111	-1.97000	.07943	-10.69925	.22017	0.00000
82	-6.50025	-1.97000	.13239	-6.74939	-1.97000	.18534	-11.59966	.22017	0.00000
83	-5.86003	-2.70500	.02585	-6.10329	-2.70500	.07756	-10.69925	.51540	0.00000
84	-6.34656	-2.70500	.12927	-6.58982	-2.70500	.18098	-11.59966	.51540	0.00000
85	-5.66207	-3.73000	.02498	-5.89714	-3.73000	.07495	-10.69925	.51039	0.00000
86	-6.13222	-3.73000	.12492	-6.36729	-3.73000	.17488	-11.59966	.51039	0.00000
87	-5.46412	-4.75500	.02411	-5.69100	-4.75500	.07234	-10.69925	.51540	0.00000
88	-5.91788	-4.75500	.12056	-6.14476	-4.75500	.16879	-11.59966	.51540	0.00000
89	-5.28933	-5.66000	.02334	-5.50899	-5.66000	.07003	-10.69925	.39030	0.00000
90	-5.72864	-5.66000	.11672	-5.94829	-5.66000	.16341	-11.59966	.39030	0.00000
91	-5.13869	-6.44000	.02268	-5.35211	-6.44000	.06805	-10.69925	.39030	0.00000
92	-5.56553	-6.44000	.11341	-5.77895	-6.44000	.15877	-11.59966	.39030	0.00000

**********REGION 1 FLAP 2 DATA ********** (2)

VORTEX NUMBER J	-COORDINATES OF BOUND LEG MIDPOINT XBL(J)	YBL(J)	ZBL(J)	---COORDINATES OF CONTROL POINT--- XCP(J)	YCP(J)	ZCP(J)	B.L. SWEEP PSI(J)	HALF-WIDTH SW(J)	SURFACE SLOPE ALPHAL(J)
93	-6.99203	-1.97000	.25953	-7.22819	-1.97000	.35494	-11.91515	.22064	0.00000
94	-7.46435	-1.97000	.45036	-7.70050	-1.97000	.54577	-12.80576	.22064	0.00000
95	-6.82675	-2.70500	.25341	-7.05733	-2.70500	.34658	-11.91515	.51651	0.00000
96	-7.28792	-2.70500	.43974	-7.51851	-2.70500	.53290	-12.80576	.51651	0.00000
97	-6.59624	-3.73000	.24488	-6.81907	-3.73000	.33491	-11.91515	.51149	0.00000
98	-7.04189	-3.73000	.42493	-7.26472	-3.73000	.51496	-12.80576	.51149	0.00000
99	-6.36574	-4.75500	.23635	-6.58080	-4.75500	.32324	-11.91515	.51651	0.00000
100	-6.79586	-4.75500	.41013	-7.01092	-4.75500	.49702	-12.80576	.51651	0.00000
101	-6.16222	-5.66000	.22881	-6.37042	-5.66000	.31293	-11.91515	.39114	0.00000
102	-6.57863	-5.66000	.39706	-6.78684	-5.66000	.48118	-12.80576	.39114	0.00000
103	-5.98681	-6.44000	.22232	-6.18911	-6.44000	.30405	-11.91515	.39114	0.00000
104	-6.39140	-6.44000	.38579	-6.59370	-6.44000	.46752	-12.80576	.39114	0.00000

(c) Page 3, continued.

Figure 8.- Continued.

**********REGION 1 FLAP 3 DATA ********** (3)

VORTEX NUMBER J	-COORDINATES OF BOUND LEG MIDPOINT XBL(J)	YBL(J)	ZBL(J)	---COORDINATES OF CONTROL POINT--- XCP(J)	YCP(J)	ZCP(J)	B.L. SWEEP PSI(J)	HALF-WIDTH SW(J)	SURFACE SLOPE ALPHAL(J)
105	-7.92658	-1.97000	.66096	-8.14258	-1.97000	.79593	-12.72527	.22150	0.00000
106	-8.35858	-1.97000	.93091	-8.57458	-1.97000	1.06588	-13.60679	.22150	0.00000
107	-7.73926	-2.70500	.64538	-7.95017	-2.70500	.77717	-12.72527	.51852	0.00000
108	-8.16108	-2.70500	.90896	-8.37199	-2.70500	1.04075	-13.60679	.51852	0.00000
109	-7.47803	-3.73000	.62365	-7.68184	-3.73000	.75100	-12.72527	.51348	0.00000
110	-7.88565	-3.73000	.87836	-8.08945	-3.73000	1.00571	-13.60679	.51348	0.00000
111	-7.21680	-4.75500	.60192	-7.41351	-4.75500	.72484	-12.72527	.51852	0.00000
112	-7.61021	-4.75500	.84775	-7.80692	-4.75500	.97067	-13.60679	.51852	0.00000
113	-6.98616	-5.66000	.58274	-7.17659	-5.66000	.70173	-12.72527	.39266	0.00000
114	-7.36703	-5.66000	.82073	-7.55747	-5.66000	.93973	-13.60679	.39266	0.00000
115	-6.78737	-6.44000	.56620	-6.97240	-6.44000	.68182	-12.72527	.39266	0.00000
116	-7.15743	-6.44000	.79740	-7.34247	-6.44000	.91306	-13.60679	.39266	0.00000

**********REGION 2 FLAP 1 DATA ********** (4)

VORTEX NUMBER J	-COORDINATES OF BOUND LEG MIDPOINT XBL(J)	YBL(J)	ZBL(J)	---COORDINATES OF CONTROL POINT--- XCP(J)	YCP(J)	ZCP(J)	B.L. SWEEP PSI(J)	HALF-WIDTH SW(J)	SURFACE SLOPE ALPHAL(J)
117	-5.07977	-7.49500	.03753	-5.35990	-7.49500	.11259	-10.87204	.66583	0.00000
118	-5.64004	-7.49500	.18765	-5.92017	-7.49500	.26271	-12.10921	.66583	0.00000
119	-4.81451	-8.83000	.03559	-5.08013	-8.83000	.10676	-10.87204	.67084	0.00000
120	-5.34574	-8.83000	.17793	-5.61136	-8.83000	.24910	-12.10921	.67084	0.00000
121	-4.54925	-10.16500	.03364	-4.80035	-10.16500	.10092	-10.87204	.66583	0.00000
122	-5.05145	-10.16500	.16821	-5.30255	-10.16500	.23549	-12.10921	.66583	0.00000
123	-4.28498	-11.49500	.03170	-4.52162	-11.49500	.09511	-10.87204	.66583	0.00000
124	-4.75826	-11.49500	.15852	-4.99490	-11.49500	.22192	-12.10921	.66583	0.00000

**********REGION 2 FLAP 2 DATA ********** (5)

VORTEX NUMBER J	-COORDINATES OF BOUND LEG MIDPOINT XBL(J)	YBL(J)	ZBL(J)	---COORDINATES OF CONTROL POINT--- XCP(J)	YCP(J)	ZCP(J)	B.L. SWEEP PSI(J)	HALF-WIDTH SW(J)	SURFACE SLOPE ALPHAL(J)
125	-6.25815	-7.49500	.39603	-6.49774	-7.49500	.54574	-12.08921	.66950	0.00000
126	-6.73732	-7.49500	.69545	-6.97691	-7.49500	.84516	-13.30854	.66950	0.00000
127	-5.93160	-8.83000	.37539	-6.15844	-8.83000	.51714	-12.08921	.67453	0.00000
128	-6.38528	-8.83000	.65888	-6.61212	-8.83000	.80063	-13.30854	.67453	0.00000
129	-5.60505	-10.16500	.35475	-5.81914	-10.16500	.48853	-12.08921	.66950	0.00000
130	-6.03324	-10.16500	.62231	-6.24733	-10.16500	.75609	-13.30854	.66950	0.00000
131	-5.27972	-11.49500	.33418	-5.48112	-11.49500	.46003	-12.08921	.66950	0.00000
132	-5.68252	-11.49500	.58588	-5.88392	-11.49500	.71173	-13.30854	.66950	0.00000

**********REGION 3 FLAP 1 DATA ********** (6)

VORTEX NUMBER J	-COORDINATES OF BOUND LEG MIDPOINT XBL(J)	YBL(J)	ZBL(J)	---COORDINATES OF CONTROL POINT--- XCP(J)	YCP(J)	ZCP(J)	B.L. SWEEP PSI(J)	HALF-WIDTH SW(J)	SURFACE SLOPE ALPHAL(J)
133	-4.09214	-12.83000	.08688	-4.56956	-12.83000	.26065	-10.75631	.67140	0.00000
134	-3.82680	-14.15000	.08118	-4.27287	-14.15000	.24353	-10.75631	.65136	0.00000
135	-3.55544	-15.50000	.07534	-3.96943	-15.50000	.22602	-10.75631	.70146	0.00000
136	-3.28407	-16.85000	.06950	-3.66600	-16.85000	.20851	-10.75631	.65136	0.00000

WING TRAILING LEGS CORRECTED AT Y(I), I = 3 9 13

ALPHA	NFVN	NUNIT	NFPTS	NPRINT	KJET	KEI	KUNIT	NLOAD	NJPNL	NFRC	NCFJ	NTLF	NFJ
0.000	0	8	12	0	1	0	1	1	10	1	-1	1	3

JET INTERFERENCE ON FLAPS 1 2 3

JET TURNING EFFICIENCY = 1.00

(c) Page 3, concluded.

Figure 8.- Continued.

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INPUT JET PARAMETERS

       AR=6 RECTANGULAR JET ON LEFT WING PANEL - VELOCITY DECAY FROM TN D-8187

 NJET  NVLP   NP  NCRCT  JPRINT
   1    10   136     0     -1

(1) JET PARAMETERS          CT        RHO        XO         YO         ZO         D(8)      NCYL   GAMMA/V
                          1.0000     1.2500    2.0000    -3.7300     -.2600      .0500       5     8.6141
      XCL        YCL        ZCL        SCL      THETA        A           B       DSFACT       P
    0.00000    0.00000    0.00000     0.0000    0.0000     1.5420      .2600      1.000      7.208
    4.60000    0.00000    0.00000     4.6000    0.0000     1.5420      .2600      1.000      7.208
   11.00000    0.00000    0.00000    11.0000    0.0000     2.2100      .3700      1.000     10.320
   14.50000    0.00000    0.00000    14.5000    0.0000     2.6050      .4350      2.000     12.160
   18.00000    0.00000    0.00000    18.0000    0.0000     3.0000      .5000      2.000     14.000

    JET INDUCED VELOCITIES ARE OMITTED ON PANELS...     1    2    3    4    5    6    7    8    9   10
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(d) Page 4.

Figure 8.- Continued.

JET PARAMETERS FOR TANGENT USB JET

NJET	NVLP	NP	NCPCT	JPRINT
1	10	136	0	-1

(1) JET PARAMETERS

CT	RHO	XQ	YQ	ZQ	D(8)	NCYL	GAMMA/V
1.0000	1.2500	2.0000	-3.7300	-.2850	.0500	17	8.0141

XCL	YCL	ZCL	SCL	THETA	A	B	DSFACT	P
0.00000	0.00000	0.00000	0.0000	0.0000	1.5420	.2600	1.000	7.208
4.60000	0.00000	0.00000	4.6000	0.0000	1.5420	.2600	1.000	7.208
7.54454	0.00000	.05061	7.5450	0.0000	1.8493	.3106	1.000	8.640
7.57452	0.00000	.05094	7.5750	-6.0000	1.8493	.3106	1.000	8.640
7.61431	0.00000	.04328	7.6155	-12.0000	1.8493	.3106	1.000	8.640
8.55796	0.00000	-.14078	8.5769	-12.0000	1.9475	.3268	1.000	9.097
8.58291	0.00000	-.14578	8.6024	-17.0000	1.9475	.3268	1.000	9.097
8.61660	0.00000	-.15871	8.6384	-22.0000	1.9475	.3268	1.000	9.097
9.51364	0.00000	-.50461	9.5999	-22.0000	2.0405	.3421	1.000	9.530
9.53872	0.00000	-.51442	9.6268	-27.0000	2.0405	.3421	1.000	9.530
9.57066	0.00000	-.53366	9.6641	-32.0000	2.0405	.3421	1.000	9.530
11.21597	0.00000	-1.52871	11.5869	-32.0000	2.2107	.3701	1.000	10.323
11.88825	0.00000	-1.75973	12.2977	-13.5396	2.3096	.3864	1.000	10.784
13.24539	0.00000	-2.00748	13.6773	-8.3636	2.4630	.4116	1.000	11.499
14.60397	0.00000	-2.18302	15.0472	-6.5743	2.6164	.4369	2.000	12.213
15.96290	0.00000	-2.32690	16.4137	-5.5922	2.7698	.4621	2.000	12.928
18.00155	0.00000	-2.50915	18.4605	-4.7016	2.9999	.5000	2.000	14.000

SURFACE COORDINATE PARAMETERS FOR JET 1 (WING COORDINATE SYSTEM)

XS	YS	ZS	SS	THETA	A	B	XSN	YSN	ZSN	XST	YST	ZST	DSS
2.000	-3.730	-.025	0.000	0.000	1.542	.260	2.000	-2.188	-.025	2.000	-5.272	-.025	1.0
-2.600	-3.730	-.025	4.600	0.000	1.542	.260	-2.600	-2.188	-.025	-2.600	-5.272	-.025	1.0
-5.545	-3.730	-.025	7.545	0.000	1.849	.311	-5.894	-1.881	-.025	-5.195	-5.579	-.025	1.0
-6.490	-3.730	.175	8.506	12.000	1.947	.327	-6.921	-1.783	.189	-6.059	-5.677	.162	1.0
-7.385	-3.730	.537	9.467	22.000	2.041	.342	-7.898	-1.689	.576	-6.873	-5.771	.498	1.0
-9.020	-3.730	1.558	11.390	32.000	2.211	.370	-9.655	-1.519	1.673	-8.384	-5.941	1.442	1.0
-9.798	-3.730	1.850	12.229	13.540	2.310	.386	-9.798	-1.420	1.850	-9.798	-6.040	1.850	1.0
-11.186	-3.730	2.130	13.647	8.364	2.463	.412	-11.186	-1.267	2.130	-11.186	-6.193	2.130	1.0
-12.554	-3.730	2.332	15.031	6.574	2.616	.437	-12.554	-1.114	2.332	-12.554	-6.346	2.332	2.0
-13.918	-3.730	2.502	16.406	5.592	2.770	.462	-13.918	-.960	2.502	-13.918	-6.500	2.502	2.0
-15.961	-3.730	2.722	18.461	4.702	3.000	.500	-15.961	-.730	2.722	-15.961	-6.730	2.722	2.0

JET INDUCED VELOCITIES ARE OMITTED ON PANELS... 1 2 3 4 5 6 7 8 9 10

(e) Page 5.

Figure 8.- Continued.

HORSESHOE VORTEX STRENGTHS FOR ALPHA = 0.0 DEGREES

********** WING DATA **********

VORTEX NUMBER J	XCP(J)	YCP(J)	ZCP(J)	UEI(J)	VEI(J)	WEI(J)	GAMMA/V	
	-----CONTROL POINT COORDINATES-----			---EXTERNALLY INDUCED VELOCITIES---				
1	-.92332	-.50000	0.00000	0.00000	0.00000	0.00000	2.14482	0
2	-2.15440	-.50000	0.00000	0.00000	0.00000	0.00000	1.24285	0
3	-3.38549	-.50000	0.00000	0.00000	0.00000	0.00000	1.04368	0
4	-4.61658	-.50000	0.00000	0.00000	0.00000	0.00000	.87788	0
5	-5.84766	-.50000	0.00000	0.00000	0.00000	0.00000	.56110	0
6	-.89849	-1.37500	0.00000	0.00000	0.00000	0.00000	2.18091	0
7	-2.09648	-1.37500	0.00000	0.00000	0.00000	0.00000	1.28732	0
8	-3.29447	-1.37500	0.00000	0.00000	0.00000	0.00000	1.15232	0
9	-4.49246	-1.37500	0.00000	0.00000	0.00000	0.00000	1.09840	0
10	-5.69045	-1.37500	0.00000	0.00000	0.00000	0.00000	.89126	0
11	-.88161	-1.97000	0.00000	.09692	-.04619	-.12005	2.31207	1
12	-2.05709	-1.97000	0.00000	.04731	-.01000	-.16630	1.36961	1
13	-3.23257	-1.97000	0.00000	-.06477	-.14485	-.44157	1.42433	1
14	-4.40806	-1.97000	0.00000	-.04557	-.18497	-.96773	1.64642	1
15	-5.58354	-1.97000	0.00000	-.45701	.36564	-1.80221	1.92570	2
16	-.86076	-2.70500	0.00000	-.23548	-.03705	-.12117	2.38377	2
17	-2.00844	-2.70500	0.00000	-.26177	-.00913	-.15661	1.41173	2
18	-3.15612	-2.70500	0.00000	-.41720	.08221	-.25853	1.41504	2
19	-4.30380	-2.70500	0.00000	-.30719	.13632	-.50292	1.69922	2
20	-5.45148	-2.70500	0.00000	-.38344	.16354	-1.48416	2.50434	2
21	-.83168	-3.73000	0.00000	-.22515	-.01320	-.11974	2.36952	2
22	-1.94059	-3.73000	0.00000	-.27207	-.03130	-.16555	1.42707	2
23	-3.04949	-3.73000	0.00000	-.26526	-.02620	-.22419	1.37441	2
24	-4.15840	-3.73000	0.00000	-.21572	.02580	-.45139	1.73034	2
25	-5.26731	-3.73000	0.00000	-.30974	.04257	-1.45977	2.67786	2
26	-.80260	-4.75500	0.00000	-.24048	.01628	-.11349	2.29208	2
27	-1.87274	-4.75500	0.00000	-.31366	-.01167	-.16665	1.39571	2
28	-2.94287	-4.75500	0.00000	-.10768	-.08048	-.25520	1.34602	2
29	-4.01301	-4.75500	0.00000	-.12871	-.04321	-.38805	1.56466	2
30	-5.08314	-4.75500	0.00000	-.20803	-.01774	-1.29912	2.49574	2
31	-.77693	-5.66000	0.00000	.08947	.03274	-.10300	2.15876	0
32	-1.81283	-5.66000	0.00000	.04535	.02130	-.14311	1.30398	0
33	-2.84873	-5.66000	0.00000	.07532	.08909	-.26389	1.28398	0
34	-3.88463	-5.66000	0.00000	.14964	-.04186	-.35334	1.37055	1
35	-4.92053	-5.66000	0.00000	.10375	-.27137	-.98164	2.04085	1
36	-.75480	-6.44000	0.00000	.06635	.03325	-.09240	2.02142	0
37	-1.76119	-6.44000	0.00000	.05036	.01532	-.12035	1.19434	0
38	-2.76759	-6.44000	0.00000	.05275	.00614	-.17044	1.11173	0
39	-3.77399	-6.44000	0.00000	.06074	-.04334	-.25896	1.19502	0
40	-4.78039	-6.44000	0.00000	-.01764	-.13720	-.51742	1.53478	0
41	-.72487	-7.49500	0.00000	.04067	.02354	-.07878	1.84486	0
42	-1.69136	-7.49500	0.00000	.03569	.00613	-.09813	1.06388	0
43	-2.65785	-7.49500	0.00000	.02943	-.01065	-.12765	.94745	0
44	-3.62434	-7.49500	0.00000	.01487	-.03365	-.17394	.95917	0
45	-4.59083	-7.49500	0.00000	-.03110	-.05663	-.24951	1.02915	0
46	-.68699	-8.83000	0.00000	.01987	.01152	-.06418	1.61792	0
47	-1.60299	-8.83000	0.00000	.01720	.00105	-.07642	.91243	0
48	-2.51898	-8.83000	0.00000	.01048	-.00922	-.09251	.78453	0
49	-3.43497	-8.83000	0.00000	-.00240	-.01862	-.11343	.75997	0
50	-4.35096	-8.83000	0.00000	-.02537	-.02366	-.13951	.78206	0
51	-.64912	-10.16500	0.00000	.00846	.00464	-.05249	1.39351	0
52	-1.51461	-10.16500	0.00000	.00610	-.00080	-.06017	.77253	0
53	-2.38011	-10.16500	0.00000	.00112	-.00592	-.06928	.65054	0
54	-3.24560	-10.16500	0.00000	-.00709	-.00982	-.07986	.61877	0
55	-4.11109	-10.16500	0.00000	-.01913	-.01100	-.09163	.63588	0
56	-.61139	-11.49500	0.00000	.00237	.00128	-.04333	1.18051	0
57	-1.42657	-11.49500	0.00000	.00034	-.00142	-.04821	.64593	0
58	-2.24176	-11.49500	0.00000	-.00311	-.00381	-.05365	.53677	0
59	-3.05694	-11.49500	0.00000	-.00814	-.00540	-.05957	.50556	0
60	-3.87212	-11.49500	0.00000	-.01483	-.00556	-.06579	.52036	0
61	-.57351	-12.83000	0.00000	-.00086	-.00029	-.03613	.97919	0
62	-1.33820	-12.83000	0.00000	-.00249	-.00159	-.03930	.53020	0
63	-2.10289	-12.83000	0.00000	-.00486	-.00265	-.04269	.43667	0
64	-2.86757	-12.83000	0.00000	-.00801	-.00324	-.04625	.40834	0
65	-3.63226	-12.83000	0.00000	-.01192	-.00310	-.04988	.41477	0

(f) Page 6.

Figure 8.- Continued.

66	-.53607	-14.15000	0.00000	-.00251	-.00099	-.03053	.76845	0
67	-1.25082	-14.15000	0.00000	-.00378	-.00160	-.03265	.42299	0
68	-1.96557	-14.15000	0.00000	-.00543	-.00204	-.03487	.34757	0
69	-2.68033	-14.15000	0.00000	-.00748	-.00221	-.03714	.32753	0
70	-3.39508	-14.15000	0.00000	-.00991	-.00198	-.03942	.34062	0
71	-.49777	-15.50000	0.00000	-.00334	-.00129	-.02599	.59620	0
72	-1.16146	-15.50000	0.00000	-.00430	-.00155	-.02743	.31535	0
73	-1.82514	-15.50000	0.00000	-.00547	-.00169	-.02891	.25937	0
74	-2.48883	-15.50000	0.00000	-.00684	-.00168	-.03040	.24983	0
75	-3.15252	-15.50000	0.00000	-.00841	-.00146	-.03189	.27241	0
76	-.45947	-16.85000	0.00000	-.00370	-.00139	-.02236	.38248	0
77	-1.07209	-16.85000	0.00000	-.00443	-.00148	-.02336	.19140	0
78	-1.68471	-16.85000	0.00000	-.00527	-.00149	-.02437	.15561	0
79	-2.29734	-16.85000	0.00000	-.00622	-.00141	-.02539	.15439	0
80	-2.90996	-16.85000	0.00000	-.00727	-.00122	-.02639	.18390	0

**********REGION 1 FLAP 1 DATA ********** (1)

VORTEX NUMBER J	-----CONTROL POINT	COORDINATES-----		---EXTERNALLY	INDUCED VELOCITIES--			
	XCP(J)	YCP(J)	ZCP(J)	UEI(J)	VEI(J)	WEI(J)	GAMMA/V	
81	-6.25111	-1.97000	.07943	-1.04315	.24002	-3.73474	4.12804	2
82	-6.74939	-1.97000	.18534	-.69586	.40877	-.78168	1.10883	2
83	-6.10329	-2.70500	.07756	-.83825	.08058	-2.97140	3.98030	2
84	-6.58982	-2.70500	.18098	-.84256	.05923	-1.35745	1.44610	2
85	-5.89714	-3.73000	.07495	-.83871	-.03877	-3.05872	4.06127	2
86	-6.36729	-3.73000	.17488	-.88588	-.05621	-1.56274	1.58677	2
87	-5.69100	-4.75500	.07234	-.75803	-.08237	-2.84060	3.91051	2
88	-6.14476	-4.75500	.16879	-.77643	-.07538	-1.32764	1.55584	2
89	-5.50899	-5.66000	.07003	-.31653	-.26844	-2.02688	3.49021	1
90	-5.94829	-5.66000	.16341	-.18290	-.17169	-.04156	1.34044	1
91	-5.35211	-6.44000	.06805	-.20179	-.18937	-1.01604	1.17206	0
92	-5.77895	-6.44000	.15877	-.44316	-.24477	-1.55583	.94563	0

**********REGION 1 FLAP 2 DATA ********** (2)

VORTEX NUMBER J	-----CONTROL POINT	COORDINATES-----		---EXTERNALLY	INDUCED VELOCITIES--			
	XCP(J)	YCP(J)	ZCP(J)	UEI(J)	VEI(J)	WEI(J)	GAMMA/V	
93	-7.22819	-1.97000	.35494	.27008	.54887	1.49612	.50257	2
94	-7.70050	-1.97000	.54577	.98304	.71504	3.52857	.34916	2
95	-7.05733	-2.70500	.34658	-.57877	.11113	-.63377	.87792	2
96	-7.51851	-2.70500	.53290	-.42745	.11927	.33741	.53311	2
97	-6.81907	-3.73000	.33491	-.66823	-.01011	-.97603	1.00555	2
98	-7.26472	-3.73000	.51496	-.59078	.00843	-.10999	.61875	2
99	-6.58080	-4.75500	.32324	-.50923	-.00889	-.74599	1.00768	2
100	-7.01092	-4.75500	.49702	-.39188	.04024	.13767	.62269	2
101	-6.37042	-5.66000	.31293	.22091	.08638	1.07398	.85926	2
102	-6.78684	-5.66000	.48118	.74761	.20341	2.13528	.63168	2
103	-6.18911	-6.44000	.30405	-.79931	-.36075	-2.06404	.92379	0
104	-6.59370	-6.44000	.46752	-1.18207	-.41403	-2.53475	.70103	0

**********REGION 1 FLAP 3 DATA ********** (3)

VORTEX NUMBER J	-----CONTROL POINT	COORDINATES-----		---EXTERNALLY	INDUCED VELOCITIES--			
	XCP(J)	YCP(J)	ZCP(J)	UEI(J)	VEI(J)	WEI(J)	GAMMA/V	
105	-8.14258	-1.97000	.79593	2.34550	.95196	4.87413	.43369	2
106	-8.57458	-1.97000	1.06588	3.50057	1.10241	7.05222	.23918	2
107	-7.95017	-2.70500	.77717	-.11331	.20125	.85590	.68150	2
108	-8.37199	-2.70500	1.04075	.49023	.40375	2.17079	.34456	2
109	-7.68184	-3.73000	.75100	-.29221	.08855	.27407	.71028	2
110	-8.08945	-3.73000	1.00571	.58708	.31909	1.47026	.33371	2
111	-7.41351	-4.75400	.72484	-.02571	.13087	.50002	.69819	2
112	-7.80692	-4.75500	.97067	.94351	.36176	1.68856	.31467	2
113	-7.17659	-5.66000	.70173	1.43965	.47521	2.80425	.64650	2
114	-7.55747	-5.66000	.93973	2.55207	.71987	4.17819	.32442	2
115	-6.97240	-6.44000	.68182	-1.66008	-.57315	-2.87095	.61090	0
116	-7.34247	-6.44000	.91306	-1.94671	-.60995	-3.21932	.31370	0

(f) Page 6, continued.

Figure 8.- Continued.

***********REGION 2 FLAP 1 DATA *********** (4)

VORTEX NUMBER	-----CONTROL POINT COORDINATES----			---EXTERNALLY INDUCED VELOCITIES--				
J	XCP(J)	YCP(J)	ZCP(J)	UEI(J)	VEI(J)	WEI(J)	GAMMA/V	
117	-5.35990	-7.49500	.11259	-.09863	-.06963	-.34251	1.06147	0
118	-5.92017	-7.49500	.26271	-.16736	-.07328	-.42598	.67494	0
119	-5.08013	-8.83000	.10676	-.04940	-.02562	-.16531	.85405	0
120	-5.61136	-8.83000	.24910	-.06964	-.02610	-.18691	.54383	0
121	-4.80035	-10.16500	.10092	-.03010	-.01136	-.10257	.73514	0
122	-5.30255	-10.16500	.23549	-.03861	-.01163	-.11152	.46170	0
123	-4.52162	-11.49500	.09511	-.02051	-.00566	-.07146	.63827	0
124	-4.99490	-11.49500	.22192	-.02473	-.00593	-.07607	.39313	0

***********REGION 2 FLAP 2 DATA *********** (5)

VORTEX NUMBER	-----CONTROL POINT COORDINATES----			---EXTERNALLY INDUCED VELOCITIES--				
J	XCP(J)	YCP(J)	ZCP(J)	UEI(J)	VEI(J)	WEI(J)	GAMMA/V	
125	-6.49774	-7.49500	.54574	-.24400	-.09938	-.52135	.78389	0
126	-6.97691	-7.49500	.84516	-.30767	-.13415	-.59526	.33704	0
127	-6.15844	-8.83000	.51714	-.08993	-.03262	-.21295	.70232	0
128	-6.61212	-8.83000	.80063	-.10654	-.04236	-.23547	.30890	0
129	-5.81914	-10.16500	.48853	-.04670	-.01460	-.12242	.62150	0
130	-6.24733	-10.16500	.75609	-.05313	-.01888	-.13216	.27004	0
131	-5.48112	-11.49500	.46003	-.02861	-.00768	-.08169	.56404	0
132	-5.88392	-11.49500	.71173	-.03162	-.01009	-.08676	.24258	0

***********REGION 3 FLAP 1 DATA *********** (6)

VORTEX NUMBER	-----CONTROL POINT COORDINATES----			---EXTERNALLY INDUCED VELOCITIES--				
J	XCP(J)	YCP(J)	ZCP(J)	UEI(J)	VEI(J)	WEI(J)	GAMMA/V	
133	-4.56956	-12.83000	.26065	-.01639	-.00422	-.05553	.79760	0
134	-4.27287	-14.15000	.24353	-.01258	-.00270	-.04297	.71568	0
135	-3.96943	-15.50000	.22602	-.01007	-.00192	-.03422	.62741	0
136	-3.66600	-16.85000	.20851	-.00835	-.00152	-.02797	.51096	0

(f) Page 6, concluded.

Figure 8.- Continued.

TRADITIONAL METHOD

AERODYNAMIC LOADING RESULTS FOR ALPHA = 0.00 DEG.

REFERENCE QUANTITIES

WING SPAN, B	AREA	LENGTH
35.00000	212.50000	6.42000

SPANWISE LOAD DISTRIBUTIONS

********** LEFT WING PANEL **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.02857	6.1554	.16772	1.9074	0.0000
2	-.07857	5.9899	.18886	2.2071	0.0000
3	-.11257	5.8774	.24795	2.9530	0.0000
4	-.15457	5.7384	.26912	3.2828	0.0000
5	-.21314	5.5445	.27369	3.4554	0.0000
6	-.27171	5.3507	.25983	3.3993	0.0000
7	-.32343	5.1795	.23309	3.1502	0.0000
8	-.36800	5.0320	.20164	2.8050	0.0000
9	-.42829	4.8325	.16699	2.4189	0.0000
10	-.50457	4.5800	.13877	2.1209	0.0000
11	-.58086	4.3275	.11632	1.8816	0.0000
12	-.65686	4.0759	.09683	1.6630	0.0000
13	-.73314	3.8234	.07912	1.4485	0.0000
14	-.80857	3.5738	.06363	1.2464	0.0000
15	-.88571	3.3184	.04838	1.0205	0.0000
16	-.96286	3.0631	.03051	.6972	0.0000

********** REGION 1 FLAP 1 **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.11257	1.0188	.14625	10.0487	-2.1375
2	-.15457	.9948	.15154	10.6632	-2.2682
3	-.21314	.9613	.15772	11.4847	-2.4430
4	-.27171	.9278	.15264	11.5165	-2.4497
5	-.32343	.8982	.13490	10.5131	-2.2363
6	-.36800	.8727	.05909	4.7391	-1.0082

********** REGION 1 FLAP 2 **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.11257	1.0188	.02286	1.5705	-.6339
2	-.15457	.9948	.03756	2.6432	-1.0690
3	-.21314	.9613	.04316	3.1429	-1.2716
4	-.27171	.9278	.04331	3.2673	-1.3221
5	-.32343	.8982	.03962	3.0879	-1.2495
6	-.36800	.8727	.04275	3.4291	-1.3908

********** REGION 1 FLAP 3 **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.11257	1.0188	.01703	1.1704	-.7239
2	-.15457	.9948	.02543	1.7891	-1.1144
3	-.21314	.9613	.02582	1.8802	-1.1719
4	-.27171	.9278	.02505	1.8896	-1.1778
5	-.32343	.8982	.02402	1.8716	-1.1665
6	-.36800	.8727	.02203	1.7667	-1.1152

(g) Page 7.

Figure 8.- Continued.

*********** REGION 2 FLAP 1 ***********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.42829	1.1601	.04779	2.8839	-.7738
2	-.50457	1.0999	.03847	2.4485	-.6570
3	-.58086	1.0398	.03294	2.2176	-.5951
4	-.65686	.9799	.02839	2.0278	-.5441

*********** REGION 2 FLAP 2 ***********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.42829	1.1301	.02673	1.6555	-1.0442
2	-.50457	1.0699	.02411	1.5774	-.9949
3	-.58086	1.0098	.02126	1.4735	-.9294
4	-.65686	.9499	.01923	1.4172	-.8939

*********** REGION 3 FLAP 1 ***********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.73314	1.0161	.02132	1.4686	-.5358
2	-.80857	.9494	.01913	1.4104	-.5146
3	-.88571	.8811	.01677	1.3323	-.4861
4	-.96286	.8129	.01366	1.1761	-.4291

WING ALONE FORCE AND MOMENT COEFFICIENTS
(WING COORDINATE SYSTEM)

CNW	CAW	CLW	CDW	CMW
1.69265	0.00000	1.69265	0.00000	.10334

INDIVIDUAL FLAP FORCE AND MOMENT COEFFICIENTS AND LOCATIONS AT WHICH FORCES ACT
(FLAP COORDINATE SYSTEMS - FLAP LIES IN XF,YF PLANE)

REGION	FLAP	CNF	XF(CNF)	YF(CNF)	CAF	YF(CAF)	CYF	XF(CYF)	CMF
1	1	.22742	.17156	-2.29472	-.04838	-2.29475	.00883	.18182	-.00880
1	2	.06661	.24951	-2.67411	-.02696	-2.67536	.00397	.35126	-.00309
1	3	.04037	.29310	-2.56522	-.02519	-2.57043	.00189	.74495	-.00169
2	1	.06487	.09902	-2.38046	-.01741	-2.38048	.00349	.08451	-.00343
2	2	.04036	.23147	-2.49709	-.02546	-2.49709	.00562	.22009	-.00178
3	1	.03125	.20063	-2.43794	-.01140	-2.43794	.00217	.20063	-.00111

COMPLETE CONFIGURATION FORCE AND MOMENT COEFFICIENTS
(WING COORDINATE SYSTEM)

CN	CA	CL	CD	CM	CD/(CL*CL)
2.69428	-.00000	2.69428	-.00000	-.41548	-.00000

(g) Page 7, concluded.

Figure 8.- Continued.

PRESSURE DISTRIBUTIONS
DELTA P/Q

********** LEFT WING PANEL **********

Y/(B/2)	CHORD, C						
-.02857	6.15543	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	5.48445	2.01911	1.69554	1.42619	.91156
-.07857	5.98994	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	3.64095	2.14914	1.92376	1.85374	1.48793
-.11257	5.87741	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	3.95382	2.33030	2.42340	2.00127	3.27645
-.15457	5.73840	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	4.15407	2.46014	2.46592	2.96114	4.37289
-.21314	5.54454	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	4.27362	2.57384	2.47886	3.12081	4.82972
-.27171	5.35067	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	4.28371	2.60848	2.51560	2.92423	4.66434
-.32343	5.17951	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	4.16788	2.51757	2.47897	2.64611	5.94028
-.36800	5.03199	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	4.01713	2.37350	2.20933	2.37484	3.05005
-.42829	4.83245	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	3.81764	2.20154	1.96061	1.98486	2.12946
-.50457	4.57996	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	3.53262	1.99222	1.71295	1.65933	1.70756
-.58086	4.32747	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	3.22016	1.78519	1.50328	1.42987	1.46939
-.65686	4.07592	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	2.89630	1.58476	1.31692	1.24036	1.27667
-.73314	3.82343	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	2.56101	1.38670	1.14209	1.06800	1.08482
-.80857	3.57377	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	2.20620	1.18358	.97255	.91647	.95311
-.88571	3.31844	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	1.79662	.95028	.78161	.75287	.82091
-.96286	3.06311	X/C=	.05000	.25000	.45000	.65000	.85000
		DELTA P/Q=	1.24867	.62486	.50802	.50402	.60036

********** REGION 1 FLAP 1 **********

Y/(B/2)	CHORD, C			
-.11257	1.01881	X/C=	.12500	.62500
		DELTA P/Q=	15.83655	4.26090
-.15457	.99479	X/C=	.12500	.62500
		DELTA P/Q=	15.63857	5.68777
-.21314	.96130	X/C=	.12500	.62500
		DELTA P/Q=	16.51220	6.45717
-.27171	.92781	X/C=	.12500	.62500
		DELTA P/Q=	16.47323	6.55968
-.32343	.89823	X/C=	.12500	.62500
		DELTA P/Q=	15.18743	5.83870
-.36800	.87274	X/C=	.12500	.62500
		DELTA P/Q=	5.24616	4.23209

(h) Page 8.

Figure 8.- Continued.

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*********** REGION 1 FLAP 2 ***********

Y/(B/2)  CHORD, C
-.11257   1.01881         X/C=    .12500     .62500
                   DELTA P/Q=  1.84620    1.29472

-.15457    .99479         X/C=    .12500     .62500
                   DELTA P/Q=  3.28031    2.00618

-.21314    .96130         X/C=    .12500     .62500
                   DELTA P/Q=  3.88282    2.40305

-.27171    .92781         X/C=    .12500     .62500
                   DELTA P/Q=  4.03042    2.50424

-.32343    .89823         X/C=    .12500     .62500
                   DELTA P/Q=  3.55335    2.62249

-.36800    .87274         X/C=    .12500     .62500
                   DELTA P/Q=  3.90010    2.95818

*********** REGION 1 FLAP 3 ***********

Y/(B/2)  CHORD, C
-.11257   1.01881         X/C=    .12500     .62500
                   DELTA P/Q=  1.48539     .85542

-.15457    .99479         X/C=    .12500     .62500
                   DELTA P/Q=  2.35085    1.22736

-.21314    .96130         X/C=    .12500     .62500
                   DELTA P/Q=  2.53040    1.22995

-.27171    .92781         X/C=    .12500     .62500
                   DELTA P/Q=  2.57590    1.20333

-.32343    .89823         X/C=    .12500     .62500
                   DELTA P/Q=  2.46658    1.27671

-.36800    .87274         X/C=    .12500     .62500
                   DELTA P/Q=  2.33549    1.19784

*********** REGION 2 FLAP 1 ***********

Y/(B/2)  CHORD, C
-.42829   1.16006         X/C=    .12500     .62500
                   DELTA P/Q=  3.52626    2.24150

-.50457   1.09994         X/C=    .12500     .62500
                   DELTA P/Q=  2.99227    1.90479

-.58086   1.03983         X/C=    .12500     .62500
                   DELTA P/Q=  2.72453    1.71063

-.65686    .97994         X/C=    .12500     .62500
                   DELTA P/Q=  2.51010    1.54559

*********** REGION 2 FLAP 2 ***********

Y/(B/2)  CHORD, C
-.42829   1.13006         X/C=    .12500     .62500
                   DELTA P/Q=  2.31661     .99441

-.50457   1.06994         X/C=    .12500     .62500
                   DELTA P/Q=  2.19217     .96260

-.58086   1.00983         X/C=    .12500     .62500
                   DELTA P/Q=  2.05538     .89158

-.65686    .94994         X/C=    .12500     .62500
                   DELTA P/Q=  1.98295     .85141

*********** REGION 3 FLAP 1 ***********

Y/(B/2)  CHORD, C
-.73314   1.01612         X/C=    .25000
                   DELTA P/Q=  1.46862

-.80857    .94938         X/C=    .25000
                   DELTA P/Q=  1.41043

-.88571    .88112         X/C=    .25000
                   DELTA P/Q=  1.33225

-.96286    .81287         X/C=    .25000
                   DELTA P/Q=  1.17610
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(h) Page 8, concluded.

Figure 8.- Continued.

AERODYNAMIC LOADING RESULTS FOR ALPHA = 0.00 DEG.

FORCES OMITTED FROM PANELS 11 12 16 17 21 22 26 27 31 32

REFERENCE QUANTITIES

WING SPAN, B	AREA	LENGTH
35.00000	212.50000	6.42000

SPANWISE LOAD DISTRIBUTIONS

********** LEFT WING PANEL **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.02857	6.1554	.16772	1.9074	0.0000
2	-.07857	5.9899	.18886	2.2071	0.0000
3	-.11257	5.8774	.14276	1.7002	0.0000
4	-.15457	5.7384	.16067	1.9600	0.0000
5	-.21314	5.5445	.16522	2.0859	0.0000
6	-.27171	5.3507	.15447	2.0208	0.0000
7	-.32343	5.1795	.13415	1.8131	0.0000
8	-.36800	5.0320	.20164	2.8050	0.0000
9	-.42829	4.8325	.16699	2.4189	0.0000
10	-.50457	4.5800	.13877	2.1209	0.0000
11	-.58086	4.3275	.11632	1.8816	0.0000
12	-.65686	4.0759	.09683	1.6630	0.0000
13	-.73314	3.8234	.07912	1.4485	0.0000
14	-.80857	3.5738	.06363	1.2464	0.0000
15	-.88571	3.3184	.04838	1.0205	0.0000
16	-.96286	3.0631	.03051	.6972	0.0000

********** REGION 1 FLAP 1 **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.11257	1.0188	.14625	10.0487	-2.1375
2	-.15457	.9948	.15154	10.6632	-2.2682
3	-.21314	.9613	.15772	11.4847	-2.4430
4	-.27171	.9278	.15264	11.5165	-2.4497
5	-.32343	.8982	.13490	10.5131	-2.2363
6	-.36800	.8727	.05909	4.7391	-1.0082

********** REGION 1 FLAP 2 **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.11257	1.0188	.02286	1.5705	-.6339
2	-.15457	.9948	.03756	2.6432	-1.0690
3	-.21314	.9613	.04316	3.1429	-1.2716
4	-.27171	.9278	.04331	3.2673	-1.3221
5	-.32343	.8982	.03962	3.0879	-1.2493
6	-.36800	.8727	.04275	3.4291	-1.3908

********** REGION 1 FLAP 3 **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.11257	1.0188	.01703	1.1704	-.7239
2	-.15457	.9948	.02543	1.7891	-1.1144
3	-.21314	.9613	.02582	1.8802	-1.1719
4	-.27171	.9278	.02505	1.8896	-1.1778
5	-.32343	.8982	.02402	1.8716	-1.1665
6	-.36800	.8727	.02203	1.7667	-1.1152

(i) Page 9.

Figure 8.- Continued.

********** REGION 2 FLAP 1 **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.42829	1.1601	.04779	2.8839	-.7738
2	-.50457	1.0999	.03847	2.4485	-.6570
3	-.58086	1.0398	.03294	2.2176	-.5951
4	-.65686	.9799	.02839	2.0278	-.5441

********** REGION 2 FLAP 2 **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.42829	1.1301	.02673	1.6555	-1.0442
2	-.50457	1.0699	.02411	1.5774	-.9949
3	-.58086	1.0098	.02126	1.4735	-.9294
4	-.65686	.9499	.01923	1.4172	-.8939

********** REGION 3 FLAP 1 **********

STATION	Y/(B/2)	LOCAL CHORD, C	CNORM*C/(2*B)	CNORM	CA
1	-.73314	1.0161	.02132	1.4686	-.5358
2	-.80857	.9494	.01913	1.4104	-.5146
3	-.88571	.8811	.01677	1.3323	-.4861
4	-.96286	.8129	.01366	1.1761	-.4291

WING ALONE FORCE AND MOMENT COEFFICIENTS
(WING COORDINATE SYSTEM)

CNW	CAW	CLW	CDW	CMW
1.39334	0.00000	1.39334	0.00000	.01989

INDIVIDUAL FLAP FORCE AND MOMENT COEFFICIENTS AND LOCATIONS AT WHICH FORCES ACT
(FLAP COORDINATE SYSTEMS - FLAP LIES IN XF,YF PLANE)

REGION	FLAP	CNF	XF(CNF)	YF(CNF)	CAF	YF(CAF)	CYF	XF(CYF)	CMF
1	1	.22742	.17156	-2.29472	-.04838	-2.29475	.00883	.18182	-.00880
1	2	.06661	.24951	-2.67411	-.02696	-2.67536	.00397	.35126	-.00309
1	3	.04037	.29310	-2.56522	-.02519	-2.57043	.00189	.74495	-.00169
2	1	.06487	.09902	-2.38048	-.01741	-2.38048	.00349	.08451	-.00343
2	2	.04036	.23147	-2.49709	-.02546	-2.49709	.00562	.22009	-.00178
3	1	.03125	.20063	-2.43794	-.01140	-2.43794	.00217	.20063	-.00111

COMPLETE CONFIGURATION FORCE AND MOMENT COEFFICIENTS
(WING COORDINATE SYSTEM)

CN	CA	CL	CD	CM	CD/(CL*CL)
2.39496	-.00000	2.39496	-.00000	-.49894	-.00000

(i) Page 9, concluded.

Figure 8.- Continued.

INDUCED VELOCITIES AT SPECIFIED FIELD POINTS

			I-------- WING/FLAP	PERTURBATION VELOCITIES	----------I	--- WING/FLAP+JET+VINF	------I	
X	Y	Z	U/VINF	V/VINF	W/VINF	U/VINF	V/VINF	W/VINF
-3.12000	-3.73000	-.02500	.03105	-.02037	-.09951	-5.10382	-.16240	-.09347
-3.12000	-3.73000	-.05000	-.02021	-.02243	-.09688	-8.97772	-.30706	-.09861
-3.12000	-3.73000	-.10000	-.11858	-.02635	-.08676	-9.42103	-.32430	-.11068
-3.12000	-3.73000	-.20000	-.28675	-.03285	-.05301	-9.59207	-.33206	-.12144
-3.12000	-3.73000	-.30000	-.40719	-.03718	-.01395	-9.71448	-.33769	-.12768
-3.12000	-3.73000	-.40000	-.48396	-.03960	.02005	-9.79262	-.34144	-.14028
-3.12000	-3.73000	-.50000	-.52862	-.04065	.04572	-9.83410	-.34388	-.16348
-3.12000	-3.73000	-.55000	-.54248	-.04082	.05562	-8.36898	-.28994	-.18978
-3.12000	-3.73000	-.57500	-.54781	-.04083	.05994	-2.92109	-.08679	.12452
-3.12000	-3.73000	-.60000	-.55223	-.04081	.06388	-1.60829	-.03712	.12054
-3.12000	-3.73000	-.70000	-.56285	-.04038	.07651	-1.54860	-.03177	.12382
-3.12000	-3.73000	-.80000	-.56563	-.03957	.08539	-1.55117	-.02855	.13197

(j) Page 10.

Figure 8.- Concluded.

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16. Abstract This document is a user's manual for the computer program developed to calculate the longitudinal aerodynamic characteristics of upper surface blown (USB) wing-flap combinations. A vortex-lattice lifting-surface method is used to model the wing and multiple flaps, and the engine wake model consists of a series of closely spaced vortex rings with rectangular cross sections. The jet wake is positioned such that the lower boundary of the jet is tangent to the wing and flap upper surfaces. The two potential flow models are used to calculate the wing-flap loading distribution including the influence of the wakes from up to two engines on the semispan. The method is limited to the condition where the flow and geometry of the configurations are symmetric about the vertical plane containing the wing root chord. The results available from the program include total configuration forces and moments, individual lifting-surface load distributions, pressure distributions, flap hinge moments, and flow field calculation at arbitrary field points.

This program manual contains a description of the use of the program, instructions for preparation of input, a description of the output, program listing, and sample cases.

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