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NASA AMES POTENTIAL FLOW ANALYSIS (POTFAN) GEOMETRY PROGRAM (POTGEM) – VERSION 1

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16. Abstract

This document describes a computer program known as POTGEM which has been developed as an independent segment of the NASA Ames Three-Dimensional Linearized, Potential Flow Analysis System (POTFAN) and which is used to generate a panel point description of arbitrary, three-dimensional bodies from convenient engineering descriptions consisting of equations and/or tables. Due to the independent, modular nature of the program, it may be used to generate corner points for other computer programs.

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NASA Ames

Potential Flow Analysis (POTFAN)

Geometry Program (POTGEM).

Version 1

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ABSTRACT

This document describes a computer program known as POTGEM which has been developed as an independent segment of the NASA Ames Three-Dimensional Linearized, Potential Flow Analysis System (POTFAN) and which is used to generate a panel point description of arbitrary, three-dimensional bodies from convenient engineering descriptions consisting of equations and/or tables. Due to the independent, modular nature of the program, it may be used to generate corner points for other computer programs.

1 INTRODUCTION

This document describes Version 1 of a geometry generating code (POTGEM) which computes panel corner points and other geometrical data necessary to run the remaining segments of POTFAN, which is a program system for analyzing three-dimensional, subcritical potential flows about arbitrary configurations. An overview of the POTFAN system is given by Medan (1976). In addition to being the first segment of POTFAN, POTGEM can be used to generate geometrical corner point data for other computer programs.

Some of the important characteristics of the POTGEM program are the following:

1. Complicated components can be handled with a minimum of input. Components that can be handled include complicated aircraft fuselages; thick wings with variable section, twist, and dihedral; wings with control surfaces; wind tunnels; and fan wakes. One or more components considered together constitute a configuration.

2. In addition to computing panel corner points, the program computes position vectors to control points, vortex force sensing locations, and other useful data.

3. Simple panel distributions are easily handled, yet the program does allow complex and non-uniform panel and control point distributions.

4. The program allows components to be decomposed into segments. The geometrical description of the component and the independent variables may be different in each segment.

5. The program has a general rotate, shift, and scale capability.

6. The program runs under a command format which makes the program flexible, easy to use, and easy to modify even though the program is quite complex and versatile.

7. Variable dimensioning is used so that oddly-sized problems can be handled without redimensioning.

8. Machine dependent language features have been generally avoided to make conversions to other computers relatively easy.

9. The program has been liberally documented internally with comment cards to make it easy to modify.

10. The program checks for user input errors in many places. This makes it somewhat difficult to improperly run the program.

11. The program is coded in FORTRAN IV.

12. To date the program has been run on a UNIVAC 1108 computer with 65k words of memory.

13. The program can be executed in either batch or conversational modes.

14. The program is based on a generalized coordinate system that reduces to Cartesian, polar, or spherical in special cases, yet is more flexible than any of these.

One major feature lacking in the program is that because each component of a configuration is considered independently, the program cannot automatically put panel edges along lines of intersection with other components. It is necessary for the user to supply these intersection lines in the form of the VL(S), VU(S), SL(V), or SU(V) curves that are defined in Section 3.2.1. It should be noted, however, that the program produces output (S and V at corner and boundary condition points as described in Section 6.1) that would allow another program to be developed which could automatically calculate the intersection lines. This would allow POTGEM to then be rerun with the correct intersection lines. Therefore, part of the intersection problem has already been solved in POTGEM. It is expected that such a program will be developed in the future.

Another disadvantage of POTGEM is that it cannot automatically distribute panels in relationship to surface curvature (e.g., dense panelling in regions of high curvature). Furthermore, POTGEM cannot be easily modified to do this automatically. However, the output from POTGEM (see Chapter 6) is suitable for driving another program which could redistribute panels based on surface curvature.

Finally, the cross sectional data (Section 3.1.1) that is input to POTGEM is not in parametric form. If the program had initially been designed this way, it would have been somewhat easier to use and, in some cases, multiple segments (Section 3.1.7) would not have been required. This deficiency is expected to be corrected in version 2 of POTGEM.

2 PROBLEM TASK DESCRIPTION

This section describes the basic specifications that guided the development of this program and the basic mathematical problems confronting the authors at the beginning of the task.

The task that the program was required to perform is to produce a file called the geometry file and containing the data described in Section 6. It was required that this file be created from a convenient engineering description of as general a component as possible. Furthermore, it was required that the program be flexible, easy to use, easy to modify, well documented, and easy to convert to other computers.

There are basically two mathematical problems associated with determining a panel corner point description of a component from an engineering description. The first is to devise a method which will give the position vector of any point on the surface given the two independent panelling variables, which are called S and V. The second problem is to divide an appropriate region of the S-V plane into quadrilaterals with the corner points of the quadrilaterals corresponding either to corner points of the panels or to control points of the panels. It is important to realize that these two problems are completely independent. Therefore, the computer program handles these phases separately and the method of solution of either of the problems is independent of the other.

3 METHOD OF SOLUTION

This section describes the solutions of the two mathematical problems posed in the previous section.

3.1 SURFACE REPRESENTATION

As shown in Figure 3.1-1, the surface is described in part by a set of cross sections, an arbitrarily curved axis (which is not necessarily perpendicular to the cross sections), and the angular orientation of the cross sections. This data together with a method for interpolating between cross sections completely defines the surface. Each of these subjects is discussed in detail below. Following this there are explanations of how the pieces are fit together to make a working algorithm and of the multiple segment capability.

3.1.1 Cross Sections

The set of cross sections defining the component consists of one or more members. Each member of the set may consist of an open or closed curve, but the curves are restricted to lie in a plane.

The independent variable in the cross section is V and the dependent variable is V2. V may be either y', z', or θ and V2 may be either z', y' or R, respectively, where R = SQRT(y'**2 + z'**2), θ = ATAN(z'/y'), and where y' = Y'/YPSCAL(S) and z' = Z'/ZPSCAL(S). Here Y' and Z' are defined by Figure 3.1-1 and YPSCAL and ZPSCAL are arbitrary scaling factors. These scaling factors are functions of the other independent variable, S.

The choice of which pair of cross section variables that may be used is restricted only by the requirement that V2(V) be a single valued curve. If none of the three choices yields a convenient, single valued curve, then the component must be broken into two or more segments such that for each segment V2(V) is single valued. The multiple segment capability will be discussed further in Section 3.1.7. The choice of V and V2 cannot vary from cross section to cross section within the same segment, but may vary from segment to segment.

Once an appropriate set of cross section variables has been chosen, it is necessary to consider how the cross sections can be mathematically described. Each cross section may be described either by the coefficients of a series expansion (e.g., V2(V)=R(Θ)=A0*COS(Θ) + A1*COS(Θ)+B1*SIN(Θ)+...) or by a set of data points together with a specification of an interpolation method. In the latter case, the data points need not be (V,V2) pairs, but can be (y',z'), (z',y'), or (Θ,R) pairs since the program can internally convert whatever is given to it into (V,V2) pairs. The method used to describe any cross section is independent of the methods used to describe other cross sections (i.e., a table may be used for one cross section and a series expansion for another). More details on the mathematical description of these curves are given in Section 3.1.4.

The maximum number of cross sections allowed is governed by the variable MXD05 as explained in subroutine GEOM.

3.1.2 Arbitrary Axis

The axis equation has been chosen to be the following parametric form:

XAXIS = XAXIS(S)
YAXIS = YAXIS(S)
ZAXIS = ZAXIS(S)

The functions XAXIS(S), YAXIS(S), and ZAXIS(S) can be described using the same methods used for the cross sections. These methods are described in Section 3.1.4. Each of the three functions can be defined independently.

In view of the general form of the axis equation, the independent variable S can be identified with several physical quantities. If, for example, XAXIS(S) = S, then S is the value of X along the axis. S could also be Y or Z or the arc length. Furthermore, if XAXIS = YAXIS = ZAXIS = 0, S may even be an angle (see Section 7.5 for an example). Usually, however, S is the value of X along the axis.

3.1.3 Orientation of Cross Sections

It is well known (Euler's rigid body theorem) that the rotation of any rigid body can be effected by a single rotation about some axis. In the present case, the body is to be identified with the cross section and the rotation refers to the angle through which the Y, Z plane must be rotated to make it parallel to the Y', Z' plane.

If the amount of rotation is denoted by PHI, and the axis of rotation has the components EX, EY, and EZ, then the rotation can be defined by a 3-by-3 matrix, T, whose equation is the following:

$$T(PHI) = COS(PHI)\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} + \qquad (3.1.3\text{-}1)$$

$$SIN(PHI)\begin{bmatrix} 0 & -EZ' & EY' \\ EZ' & 0 & -EX' \\ -EY' & EX' & 0 \end{bmatrix} +$$

$$(1-COS(PHI))\begin{Bmatrix} EX' \\ EY' \\ EZ' \end{Bmatrix} \lfloor EX' \quad EY' \quad EZ' \rfloor$$

where

$$EX' = EX/SQRT(EX**2 + EY**2 + EZ**2) \qquad (3.1.3\text{-}2a)$$

$$EY' = EY/SQRT(EX**2 + EY**2 + EZ**2) \qquad (3.1.3\text{-}2b)$$

$$EZ' = EZ/SQRT(EX**2 + EY**2 + EZ**2) \qquad (3.1.3\text{-}2c)$$

Each of the quantities PHI, EX, EY,and EZ is considered to be a function of S and can be described using the methods discussed in Section 3.1.4.

If the matrix T is known, but PHI, EX, EY, and EZ are not known, then PHI, EX, EY, and EZ must be calculated since the program works only with PHI, EX, EY, and EZ and not with the individual components of T. To calculate these quantities in the general case, one must first determine the eigenvalues and eigenvectors of T. One of these eigenvalues must equal one. The components of the eigenvector corresponding to the unit eigenvalue can be defined to be EX, EY, and EZ. PHI can then be determined by working backwards through equations 3.1.3-2 and 3.1.3-1.

This cross section rotation is usually nonzero only in three types of problems. The first consists of a wing with a twist distribution; the second consists of a highly cambered fuselage whose cross sections perpendicular to the axis are much easier to obtain than those parallel to the Y-Z plane; and the third consists of an axisymmetric, but otherwise arbitrary, body. In the first case the axis of rotation is the spanwise axis and PHI is the twist angle. In the second case the axis of rotation is perpendicular to the plane in which the cambered body axis lies and PHI is the arctangent of the derivative of the camber. In the third case the axis degenerates to a point and PHI becomes a spherical polar angle (see Section 7.5 for an example).

3.1.4 Representation of Functions

In the previous three sections a number of functions were introduced, but no mention was made of how these various functions can be described to the computer program. This will now be explained.

To begin with, all of the various functions will be treated in the same way and will be referenced with the same variable names. Therefore each of the functions requires an index to uniquely identify it. This index is the integer variable IC. Table 3.1.4-1 lists the correspondence between IC and the various functions defining the surface. This table also shows in parenthesis the defaults of the various curves.

As just mentioned, all of the functions described in the previous three sections will be referenced by the same names. In particular, VAR1 will stand for S or V (depending on the value of IC), and VAR2 will stand for XAXIS, YAXIS, ZAXIS, PHI, EX, EY, EZ, YPSCAL, ZPSCAL, or V2 at any input cross section (depending on the value of IC).

In addition to the index, there is an integer function option, COPT, which identifies the basic type of description to be used. For example, COPT=1 implies that the function will be determined by linear interpolation from an input table and COPT= -2 implies that the function will be determined by a power series expansion from an input set of coefficients. The above types of function definitions as well as others are implemented in subroutine INTRP3 and associated subroutines. Table 3.1.4-2 lists the correspondence between the function option number and the types of functions available in INTRP3. Note the following correspondence between INTRP3 variables and the variables associated with the functions introduced in the previous three sections:

```
IOPT       =  COPT(IC)
XIN(*)     =  VAR1(*,IC)
YIN(*)     =  VAR2(*,IC)
PARAM(*)   =  PARAM(*,IC)
NIN        =  NTAB(IC)
```

Therefore, in order to describe to the computer what any of the functions in the previous sections is, basically what one needs to do is to input the value of IC and the variables COPT(IC) and NTAB(IC) and the arrays (VAR1(*,IC)), (VAR2(*,IC)), and (PARAM(*,IC)). Then the program will determine the function, when required, using subroutine INTRP3.

The above variables are frequently all that one needs to consider when inputting any of the curves discussed in the previous section. However, in certain applications involving tables, some additional data manipulation capability is useful or required. This capability consists of three transformations that may be performed on the arrays (VAR1) and/or (VAR2). The first transformation consists of the following general affine transformation:

VAR1' = AFTRAN(1)*VAR1 + AFTRAN(3)*VAR2 + AFTRAN(5)

VAR2' = AFTRAN(2)*VAR1 + AFTRAN(4)*VAR2 + AFTRAN(6)

This has obvious usefulness for scaling and shifting tables.

The second transformation is a more general transformation of the arrays (VAR1) and (VAR2) and includes an affine transformation as a general case. However, the most typical use of this second transformation is when the curve is a cross section curve (i.e. IC $\geq$11) and (VAR1) and (VAR2) constitute a table. In this case the second transformation is used to transform (VAR1) and (VAR2) so that (VAR1) will be an array of V values and (VAR2) will be an array of V2 values. This second transformation would thus be very useful if, for example, it were necessary to use polar coordinates for V and V2 and the available data were in Cartesian coordinates. Both the first and second transformations are effected by subroutine TRAN2 as called by subroutines SRFIN1 and/or SRFIN2.

The third, and final transformation is somewhat different than the first two. In the first place it only affects the array (VAR1). In the second place it has no effect on the meaning of the variables V and V2. That is (VAR1) does not become an array of V values until after the first two transformations while the third transformation, although changing (VAR1), does not have an effect on the significance of V. Another way of stating this is if a certain set of program input data that did not specify the third transformation were used to describe a component, then the same input data only with the third transformation invoked would describe the same component. Thus the use of the third transformation does not require changes in the remaining input data. Also the third transformation will not affect the S and V values at corner points or boundary condition points. The only affect that the third transformation has is on the quality of interpolated values. To clarify how this is possible, consider a two-dimensional blunt airfoil in the Y'-Z' plane with the nose at the origin. The upper surface of this component can be described as

Z'(Y') = A*Y'**.5 + B*Y' + C*Y'**1.5 + ...

Obviously an interpolation using polynominal spline fits would require many points near the nose to be accurate. Now let Y" = SQRT(Y'). Then

Z'(Y") = A + B*Y" + CY"**2 + ...

This curve does not require a large number of points to result in an accurate interpolation. This is the function of the third transformation, namely to effect a pre-interpolation transformation of the independent variable to result in a much more accurate curve fit.

The main situation in which this transformation would be used is on cross sections (i.e. V2(V) curves) when such cross sections are blunt nosed airfoils. See Section 7.6 for an example. This transformation is effected by subroutine TRAN1.

In summary, each of the curves required to define the surface can be input either as tables or coefficients and there are transformations available to manipulate tables and improve the accuracy of table interpolations. The input of these curves is accomplished with the SRI1 and SRI2 commands discussed in Section 5.2. It should be noted that each of the curves may be input in a completely independent manner (e.g., PHI(S) may be described by a power series, YPSCAL by linear interpolation from a table containing five data pairs, V2(V) at SCS(1) by CODIM interpolation from a table containing ten data pairs, V2(V) at SCS(2) by a Fourier series, etc.).

3.1.5 Interpolation Between Cross Sections

A typical set of cross sections at which data is given is shown in Figure 3.1.5-1. Each of the vertical lines in the S-V plane is a cross section and, therefore, by using the methods indicated in the previous section, each is a line upon which the dependent variable, V2, can be determined. Now the methods used to determine V2(S,V) in the remainder of the S-V plane will be described.

Consider an arbitrary point, P, in the S-V plane and a horizontal line drawn through this point. The horizontal line intersects the given cross sections and at each intersection the value of V2 can be calculated. These V2 values together with the corresponding values of S constitute a table. Interpolation from this table is used to determine the value of V2 at the point P.

This interpolation in the S-wise direction is done using subroutine INTRP3 and, therefore, all of the methods available in INTRP3 are available for this interpolation. The method actually used is governed by the variable IOPTS and the array (PARAMS) that are entered with the PANL command (see Section 5.2). These variables are the same as IOPT and (PARAM) in subroutine INTRP3, respectively.

As is the case for the various functions described in Sections 3.1.1 - 3.1.3, there is a pre-interpolation transformation that can be invoked to increase the quality of the interpolation. As mentioned in the previous section, this transformation can be used with no other changes required to the input. This transformation is governed by STOPT and (PARST) that are entered with the PANL command. These variables correspond to IOPT and (PARAM) in subroutine TRAN1, which performs the transformation. The most typical use of this transformation in this instance would be for a fuselage with both ends blunt and located at S1 and S2. For this case, STOPT should be 4 and PARST(3) = (S1 + S2)/2 and PARST(4) = (S2 - S1)/2.

It should be noted that the interpolation between cross sections is done <u>prior</u> to rotating the cross sections, <u>prior</u> to putting the cross sections on the arbitrary axis, and <u>prior</u> to scaling the cross sections. This is consistent with the way in which aeronautical structures are generally defined and, therefore, this results in an easy to use method.

3.1.6 Summary of Geometry Algorithm

In the previous sections various aspects of the method were explained. This section explains how these pieces are combined to make a working algorithm.

There are two major phases. The first is the geometry input phase and the second is the actual calculation phase.

In the geometry input phase the functions XAXIS(S), YAXIS(S), ZAXIS(S), PHI(S), EX(S), EY(S), EZ(S), YPSCAL(S), ZPSCAL(S), and a set of cross section curves, V2(V), are defined according to the method described in Section 3.1.4 and using the SRI1 and SRI2 commands. (Commands are described in Section 5.) Also the definitions of V and V2 are established by one of the commands POLR, CARY, or CARZ.

Next comes the calculation phase in which values of X, Y, and Z on the body surface are determined for given values of S and V. This phase is performed mainly in subroutine SURFAS. The determination of the actual values of S and V for which calculations will be made is independent of the geometry definition method and is discussed in Section 3.2.

Let (S,V) denote one of the given values of S and V. Then the first step is the calculation of the S-wise interpolation table (Section 3.1.5) for the given value of V. Next, the given S and values of S in the table are transformed according to the value of STOPT (Section 3.1.5) to make the interpolation more accurate. Then the interpolation is performed. As a result V2(S,V) is determined. Then y' and z' are calculated from V and V2 according to the definition of V and V2 (Section 3.1.1). This definition is stored in the variable VTYPE, which is established by the POLR, CARY, or CARZ command. Then the values of XAXIS(S), YAXIS(S), ZAXIS(S), PHI(S), EX(S), EY(S), EZ(S), YPSCAL(S), and ZPSCAL(S) are calculated. The variables y' and z' are multiplied by YPSCAL(S) and ZPSCAL(S), respectively, to yield Y' AND Z'. The cross section rotation matrix, T, is calculated from equations 3.1.3-1 and 3.1.3-2 and, finally, X, Y, and Z are calculated from

```
X(S,V) = XAXIS(S) + T(1,2;S)*Y'(S,V) + T(1,3;S)*Z'(S,V)
Y(S,V) = YAXIS(S) + T(2,2;S)*Y'(S,V) + T(2,3;S)*Z'(S,V)
Z(S,V) = ZAXIS(S) + T(3,2;S)*Y'(S,V) + T(3,3;S)*Z'(S,V)
```

The last two terms in the above equations represent the rotation of the cross section to its final orientation.

In addition to being used to find X, Y, and Z values of corner points, the above method is used to determine the X, Y, and Z values of boundary condition points and also to calculate the unit normals. This is in contrast to many existing programs, which determine boundary condition points and unit normals from the corner points. The latter method is generally not as accurate.

The calculation of the unit normals will now be discussed. Consider a point P in the S,V plane. Let the points A, B, C, and D be arranged around P in the manner shown in Figure 3.1.6-1. The program calculates the position vectors (R̲A, R̲B, R̲C, and R̲D) to each of these points, calculates the cross product of R̲C-R̲A with R̲D-R̲B, normalizes the result, and calls it the unit normal. If UNEPSS and UNEPSV are small enough (but not too small), this method is generally more accurate than using the panel corner points. It should be noted that a consistent sign convention has been applied so that the unit normal will lie on the same side of the surface as a vector in the N1-cross-N2 direction. If S and V are either both increasing or both decreasing functions of the N1 and N2 indices, then the unit normals will be in the S-cross-V direction.

3.1.7 Surface Segmentation

A component may be divided into a number of segments. There are several reasons why this is done.

In the first place the geometry may be naturally segmented. For example the NASA Ames 12.2m-by-24.4m (40'x80') wind tunnel has a cross section in the shape of a square with semi-circles on each side. (Figure 7.3-1 shows one side of this configuration.) The top and bottom surfaces can be easily and exactly described in a Cartesian coordinate system and one side can be easily and exactly described in a polar coordinate system with origin coinciding with the center of the corresponding semi-circle. (See Section 7.3 for an example.)

A second reason for segmentation rests in the fact that the cross section curves, V2(V), must be single-valued. An example of where this requirement necessitates segmentation is a thick wing section. In this case two segments are required. One is the upper surface and the other is the lower.

A third reason is that the component may be too complicated to handle as a single segment. That is, there may be too many cross sections and/or table entries to fit in the program at once.

A final reason is that there may be certain lines on the component along which panel edges must be constrained to lie. An example of this is a wing planform with a crank. In modelling such wings it is best to have panel edges at the spanwise location of the crank.

In addition to the above examples, some components may have to be segmented for more than one reason. A thin wing with a deflected control surface, for example, may be easier to describe in segmented form and also panel edges should be made to lie along the hinge line.

Despite the differing reasons for segmentation, the program handles all cases of segmentation in the same manner. Different aspects of this treatment are discussed in the following paragraphs.

The total number of segments and the number of panels in each segment must be established once for each component before any panelling is done. This is accomplished by a DSEGMENTS command (Section 5.2). Note that this command is somewhat different from the geometry definition commands, the SEGMENT command, and the PANL command because it refers to the entire component, whereas the others refer to a segment (except the geometry definition commands need not be repeated if the geometry description remains the same).

Prior to panelling each segment, the segment must be identified (see the SEGMENT command, Section 5.2), the boundaries of the segment in the S,V plane must be defined (see the SL, SU, VL, and VU commands, Sections 3.2 and 5.2), and the distribution of corner points and boundary condition points along the boundaries (see the SLBC, SUBC, VLBC, and VUBC commands, Section 5.2) must be established. Also, prior to panelling each segment, those aspects of the geometry that are different from those of the previous segment must be redefined.

Because of the fact that boundaries between segments may represent situations where the actual geometry is discontinuous (e.g., between a wing and the side edge of a control surface) the program inserts a pseudo row of panels in between each segment. In many cases it is desirable to eliminate these rows. This is accomplished by the NRI1 and NRI2 commands (Section 5.2).

3.2 PANELLING

In the previous section, a method was described for determining the position vector to the surface given the two independent panelling variables, S and V. This section will now describe how the values of S and V are determined. For each segment (Section 3.1.7), the locations of corner points are determined from the boundaries of the segment, the intersections of the corner and boundary condition grid lines with the boundaries of the segment, and a method for constructing grid lines from the boundaries and intersection points. Each of these topics is discussed in detail in the following sections.

3.2.1 Segment Boundaries

All segment boundaries in the S-V plane are in the form of four arbitrary functions SL(V), SU(V), VL(S), and VU(S) as shown in Figure 3.2.1-1. Although in most applications the four curves are straight lines, there are situations where more general curves are desirable or essential (e.g. on a fuselage where a wing intersects).

Each of these four functions can be described to the program in basically the same manner that the functions describing the geometry can (Section 3.1.4). That is, subroutine INTRP3, with all of its varicus options, is used. These functions are input using the commands SL, SU, VL and VU (Section 5.2).

As will be seen later, one of the necessary steps in determining S and V values in the interior of the segment is the calculation of the intersections of the VL and VU curves with the SL and SU curves. The method that the program uses for this calculation is an iterative one that cannot be guaranteed to converge for all cases. This iterative method is described in subroutine GRID. A sufficient condition for convergence at the intersection of the VL(S) and SL(V) curves is that

$$ABS(d(VL)/dS)*ABS(d(SL)/dV) < 1$$

Similar conditions hold for the other three intersections. In the extreme cases for which the above conditions do not hold, the intersections must be determined a priori and input to the program with a PANL command.

The notation for these intersections is defined in Figure 3.2.3-1 (e.g., (SSUVL, VSUVL) is (S,V) at the intersection of SU(V) with VL(S)).

3.2.2 Grid Line Intersections with Boundaries

Grid lines are lines in the S-V plane along which corner points or boundary condition points can be located. More specifically, corner points and boundary condition points are located at the intersections of grid lines extending nominally in the S direction with those extending nominally in the V direction. These grid lines are defined, in part, by their interesections with the boundaries of the segment. This section explains terminology related to these intersections and how the intersections are input.

A nondimensional system is used to describe the grid line and boundary intersections. This system is illustrated in Figure 3.2.2-1 for the VL(S) curve. The intersection of VL(S) with SL(V) is, by definition, at XGP=-1 and the intersection of VL(S) with SU(V) is at XGP=+1. Furthermore, XGP, by definition, varies linearly with S. In the program the intersections of the V-wise corner point grid lines with the VL(S) curve are contained in the array (XGPVLC) and the intersections of the V-wise boundary condition point grid lines with the VL(S) curve are contained in the array (XGPVLB). Similar notation applies to the other grid line boundary intersections (e.g., (XGPSUB) contains the intersections of the SU(V) curve with the S-wise boundary condition point grid lines).

The program does not assume that any of the elements of the XGP arrays are equal to -1 or +1 (i.e., corner points need not lie on the segment boundaries). Also the program allows, for example, XGPSLC(I) to be unequal to XGPSUC(I), although the program will assume that XGPSUC(I) is equal to XGPSLC(I) unless instructed otherwise.

The intersection point arrays (i.e., (XGPSLC). etc.) are defined for the program using the SLBC, SUBC, VLBC, and VUBC commands. Although the arrays may be input explicitly with these commands, the usual procedure is to select one of a set of predefined rules and have the program calculate the values. These details are governed by the variable IOPT that is input with the SLBC, SUBC, VLBC, and VUBC commands. If IOPT is zero, then the intersections are expected as input. Otherwise, the program will calculate the intersections. The correspondence between some valid IOPT values and the intersections calculated is shown in Figure 3.2.2-2 for the case of four panels and IOPT greater than zero. The spacings for IOPT less than zero are reversed from those of positive IOPT. For example, IOPT=-4 gives finer spacing near XGP=+1. For any nonzero IOPT the XGP arrays will always be in ascending order. The computation of corner point and boundary condition control point spacings is done in subroutine XPANCP.

As will be seen in the next section it will be necessary to calculate the S and V values at the intersections of the grid lines with the boundaries. The notation for these intersections is shown in Figure 3.2.3-1. The characters C and B standing for corner points and boundary condition points, respectively, have been dropped because the procedure is identical for both. The intersections of the S-wise grid lines with the SL(V) boundary curve are given by the following equations:

$$\text{VGPSL(K2)}=(1-\text{XGPSL(K2)})*\text{VSLVL}/2 + (1+\text{XGPSL(K2)})*\text{VSLVU}/2 \qquad (3.2.2\text{-}1)$$

$$\text{SGPSL(K2)} = \text{SL(VGPSL(K2))} \qquad (3.2.2\text{-}2)$$

In the above equation SL(VGPSL(K2)) is calculated using subroutine INTRP3 and the data entered with the SL command. Similar equations are used for the other three grid line and boundary intersections.

3.2.3 Intersections of S-Wise and V-Wise Grid Lines

As mentioned in the previous section the nondimensional description of the intersections contained in the arrays (XGPSLC), (XGPSLB), etc., only defines the grid lines in part. Namely, these arrays define the grid line intersections with the boundaries of the segment and they do so nondimensionally. This section completes the definition by explaining how grid lines are extended to the interior of the segment and how their intersections with other grid lines are calculated.

The method used is identical for corner point grid lines and boundary condition point grid lines, and therefore, the characters C and B in the arrays describing the intersections will be dropped for the remainder of this section. The particular value of (S,V) to be determined is denoted by (S(K1,K2),V(K1,K2)) where K1 is an index that varies in the S direction and K2 is an index that varies in the V direction. All of the various symbols introduced to this point are shown in Figure 3.2.3-1.

A simple, yet effective way to determine S(K1,K2) would be to consider it a weighted average of the S values at the intersections of the S-wise grid line with the SL(V) and SU(V) curves. Mathematically this can be stated as

$$\begin{aligned} S(K1,K2) = {} & (1-FS(K1,K2))*SGPSL(K2)/2 \; + \\ & (1+FS(K1,K2))*SGPSU(K2)/2. \end{aligned} \tag{3.2.3-1}$$

FS(K1,K2) is a nondimensional number that is equal to -1 when the V-wise grid line coincides with SL(V) and is equal to +1 when the V-wise grid line coincides with the SU(V) curve. A similar expression is used for V(K1,K2):

$$\begin{aligned} V(K1,K2) = {} & (1-FV(K1,K2))*VGPVL(K1)/2 \; + \\ & (1+FV(K1,K2))*VGPVU(K1)/2. \end{aligned} \tag{3.2.3-2}$$

This raises the question of how to determine FS(K1,K2) and FV(K1,K2). The answer is shown in Figure 3.2.3-2. This figure shows that FS(K1,K2) and FV(K1,K2) are at the intersection of two straight lines drawn from (XGPVL(K1),-1) to (XGPVU(K1),+1) and from (-1,XGPSL(K2)) to (+1,XGPSU(K2)). In other words FS(K1,K2) and FV(K1,K2) are the simultaneous solution to

$$FS(FV(K1,K2)) = FV(FS(K1,K2)).$$

More explicitly, FS(K1,K2) and FV(K1,K2) are the simultaneous solution of

$$\begin{aligned} FV(K1,K2) = {} & (1-FS(K1,K2))*XGPSL(K2)/2 \; + \\ & (1+FS(K1,K2))*XGPSU(K2)/2 \end{aligned} \tag{3.2.3-3}$$

and

$$FS(K1,K2) = (1-FV(K1,K2))*XGPVL(K1)/2 + (1+FV(K1,K2))*XGPVU(K1)/2 \quad (3.2.3\text{-}4)$$

Due to their linearity, the above equations are easily solved analytically. Subroutine GRID contains the actual equations. This completes the description of how S and V values are determined.

In summary, the VL(S), VU(S), SL(V), and SU(V) segment boundary curves are defined by the VL, VU, SL, and SU commands, respectively. The grid line intersections with the boundary curves are defined by the VLBC, VUBC, SLBC, and SUBC commands. Then, when a PANL command is given, the program executes the following: (1) It calculates the boundary curve intersections ((SSLVL,VSLVL), etc.); (2) Using equations 3.2.2-1 and 3.2.2-2 and similar equations, it calculates S and V values on the boundaries; (3) It solves 3.2.3-3 and 3.2.3-4 simultaneously; (4) Finally it calculates S and V from equations 3.2.3-1 and 3.2.3-2. The program executes the preceding (as required, i.e., redundant calculations are avoided) for all of the corner points and all of the boundary conditions points and, also under the PANL command, determines the position vectors to the corner points and boundary condition points and the unit normals at the boundary condition points using the methods described in Section 3.1.

An example of an actual network of grid lines generated by the above method is shown in Figure 3.2.3-3.

4 PROGRAM DESCRIPTION

To a great extent the description of the inner workings of the program has been relegated to comment cards in the FORTRAN source decks. This includes descriptions of the functions of the subroutines and their input and output. The remainder of the section presents relevant descriptive data which could not effectively be placed on comment cards.

4.1 CALLING STRUCTURE

Figure 4.1-1 shows the subroutine calling structure. Table 4.1-1 shows the calling structure in a different format.

4.2 COMMON BLOCKS

Table 4.2-1 shows the common blocks. These common blocks are the same length in every program in which they appear.

4.3 LOGICAL UNITS

Table 4.3-1 summarizes the logical units (tape, disks, or drums) which the program uses.

4.4 MEMORY REQUIREMENTS

Without the 25 arrays dimensioned in the main program and without using overlays, the POTGEM program requires approximately 45,000 decimal words of core storage. This requirement includes all system subroutines and internal symbol dictionaries and was determined on the INFONET Univac 1108 operating system. The size of the 25 arrays must be added to this number to determine the total amount of storage required by the program. An overlay structure and compilation without internal symbol dictionaries can be used to decrease the storage required.

4.5 SYSTEM DEPENDENT SUBROUTINES

Subroutines FILEND, OPENW, and TIMEST all call system dependent subroutines. Therefore, they all generally must be modified when the program is used on a new computer system.

4.6 RESTRICTIONS AND LIMITATIONS

The most important restriction regarding the POTGEM program is the limitation on the total number of corner points. This is limited by the dimensions of the 25 arrays in the main program. If these dimensions are not sufficient, then they must be increased, the main program must be recompiled, and the program must be relinked.

There are also limitations on the maximum number of corner points in the N1 or S direction and in the N2 or V direction, the maximum number of cross sections, the maximum number of table entries, etc. These limitations are discussed in more detail in subroutine GEOM, instructions for changing the maximum limits are also given in GEOM.

The program itself checks for violations of the above restrictions, so there is no a priori need for the user to worry about them.

5 OPERATING INSTRUCTIONS

The purpose of this section is to provide the user with information necessary to execute the program. Instructions for modifying the program are also given.

5.1 GENERAL DATA INPUT CONSIDERATIONS

The program is designed to use commands as the basic form of input to control the program flow. These commands consist of four letters placed in the first four columns and are recognized as keys that cause the program to perform particular operations. These operations consist of reading input, writing output, or calculations, or a combination of all three. After the operations are performed, the program flow returns to the beginning of the program and reads the next command. This continues until a STOP command is encountered, whereby the program terminates. Any command input record whose first four columns are left blank is considered a "comment" command. In the conversational mode, any command that is not recognized by the program is printed and program flow is returned to the next command without any operations being performed. In the batch mode an unrecognizable command causes program termination unless the variable CONTIN has been made .TRUE. by a preceding DATA command. Following each command some data must usually be entered. This data is prescribed in either NAMELIST or regular formats.

In the batch mode each command line that is read in is printed out before any action is taken on it. The entire 80 columns are printed even though only the first four columns comprise the command. This allows the output to be documented with "comment" commands and helps to pinpoint sources of errors.

Aside from commands, most of the input data is in NAMELIST format. The program has been coded to take maximum advantage of the way in which NAMELIST works. In particular, only the specific data that is actually required needs to be input, the data elements can be in any order, and (except where noted otherwise) data that is entered with one command need not be reentered with succeeding commands unless it is to be changed. To effect this last advantage, intermediate arrays are used for some commands (SRI1, VLBC, VUBC, SLBC, SUBC, VL, VU, SL, and SU). These intermediate arrays allow similar curves stored in different core locations to be input with a minimum of data.

Other input data is in regular format form. Integers are always input under a 16I5 format and floating point numbers under an 8F10.0 format.

5.2 INPUT DESCRIPTION

Detailed descriptions of the various available commands are given in the listing of subroutine GEOM. This subroutine is arranged in a number of sections. The first section consists of general commentary and a summary of the available commands. The next section is the specification section (sets data types, dimensions, common blocks, etc.). The next section sets the initial default values for those variables having default values. The next section is the command read and branch section. By examining this section, one can determine to which point control is transferred for specific commands. Each of the following sections contains detailed commentary and code necessary to effect each command. Thus by determining the command transfer point from the command read and branch section, one is led to the place in the listing that contains the detailed description of the command and further input required for the command. Since the listing contains the detailed command and input descriptions, they will not be repeated here.

Instead, the most typical ordering of commands and some general comments will be given:

1. TITLE

2. DSEGMENTS

3. Geometry definition -- SRI1, SRI2, POLR, CARY, and CARZ.

4. SEGMENT. Not required if NSEGS=NSEGV=1 for the first segment to be panelled.

5. Segment boundary definition -- SL, SU, VL, and VU. All four commands are frequently not required for the second and subsequent segments.

6. Corner and control point distribution definition -- SLBC and VLBC commands. Use Figure 3.2.2-2 as a guide to available distributions. SUBC and VUBC are not usually required.

7. GRID. Prints distributions determined in step 6.

8. PANL.

9. Repeat 3 through 8 as required for the remaining segments. The segments may be considered in any order. However, for each specific case, there is generally an optimal order that will minimize the amount of data required. Unless indicated in the detailed instructions, it is not necessary to repeat data that does not change. If all of the data input with any SRI1, SRI2, SL, SU, VL, or VU command remains unchanged, the command may be left out.

10. NRI1 commands if there are multiple segments in V-direction and component is continuous.

11. NRI2 commands if there are multiple segments in S-direction and component is continuous.

12. Singularity Definition -- BCFLAG, DSFLAG, and UVW.

13. ROSS. May be given more than once.

14. FINISH. Enter variables in Section 6.1 that are marked with an asterisk (*).

15. STORE

16. PRINT

17. STOP or compute a new geometry beginning with INITIALIZE followed by steps 1 through 16 or compute a modified geometry starting with an XINIT command followed by a subset of steps 1 through 16.

It needs to be stressed that the above outline is not to be considered a rigid one. The commands, except where noted, may be given in a different order. Also not all of the commands need to be given in all applications.

Also it should be noted that segments do not need to be panelled in any specific order.

5.3 SYSTEM CONTROL CARDS

This section describes the control cards that are necessary to run POTGEM on the various computer systems that have or are being used to run it.

5.3.1 INFONET Univac 1108 System

Since this system allows automatic file definition commands determined from the file identification number (Apppendix A) entered after the STORE command, the only control card required is the name of the main program which is POTGEM/POTF. All geometry files created by the STORE command will show up in the user's LIB$ library with names identical to the file identification number and a version identifier of GM. Thus, for example, inputting ID=1023 after the STORE command will create a file named 1023.GM/LIB$. The content of these files is described in Section 6.

In addition to POTGEM/POTF, the user may also want to switch IN$ and OUT$.

5.4 PROGRAM MODIFICATIONS

There are a few modifications that receivers of this program might typically want to change. These are described in the following sections.

5.4.1 Additional Curve Fitting Capability

If the curve fit routines provided are not adequate, it is a simple matter to add new ones. All that is required is that the input can be made compatible with the input to subroutine INTRP3. If it can, then a new option can be inserted into INTRP3. An examination of the INTRP3 listing will make it obvious how this can be easily done. The <u>only</u> changes required to POTGEM are some simple additions of cards in INTRP3.

5.4.2 Additional Types of Panel Distributions

New panel and control point distributions can be easily added by simple modifications to subroutine XPANCP. This subroutine calculates the distributions demanded with any SLBC, VLBC, SUBC, or VUBC command. An examination of the listing of XPANCP will make it obvious how the modifications can be easily done. The <u>only</u> changes required are some simple additions of cards in XPANCP.

5.4.3 Increasing Array Dimensions

See Section 4.6.

5.4.4 Use of POTGEM not in Conjunction with Other POTFAN Modules

Persons wanting to use POTGEM to generate corner point descriptions of geometries for use by their own programs can do so without modifying POTGEM. However, by eliminating unneeded arrays and the code that computes them, savings in CPU time and core memory can be realized. This section will explain how to eliminate the following arrays:

(UVWX), (UVWY), (UVWZ), (BCFLAG), (DSFLAG), (SSFLAG), (UNX), (UNY), (UNZ), (DA), (XS1), (YS1), (ZS1), (XS2), (YS2), and (ZS2).

First of all these arrays should be eliminated in the main program. In the CALL GEOM statement replace each of the array names with XCP(N) where N is an integer larger than the core memory. The purpose of this is to ensure that a fatal execution error occurs in case the program should happen to try to compute one of these arrays. It is not necessary to remove the DIMENSIONS for these arrays in subroutine GEOM.

The next step is to remove the code that calculates these arrays. An examination of a compiler cross reference map of subroutine GEOM will indicate which code can be removed. In particular note that the second CALL PANL2 after a PANL command can be removed and so can the calls to FSENS1 and FSENS2. Furthermore, note that some entire subroutines called by POTGEM can be removed. Also make appropriate modifications to (LOG) (see Section 6.2).

The final step is to remove the code that writes out these arrays. These are written out in subroutine STORGM and PRNTGM. An examination of compiler cross reference listings of these subroutines will indicate clearly what to remove. Note that it is not necessary to eliminate the arrays from the argument lists.

If these changes are made, then like changes must be made in the auxiliary subroutines READGM and RDGMA and in the EDITGM and PLOTGM programs. (see Section 8).

6 PROGRAM OUTPUT

Output from POTGEM consists of line printer output and geometry files. The line printer output is meant to be self explanatory and will not be discussed further.

The geometry files are created according to the procedure in Appendix A and conform to the format in Appendix B. Control cards for managing the geometry files are given in Section 5.3. Each geometry file consists of 8 to 18 binary records (i.e., each is created by 8 to 18 write statements of the form WRITE (NTG) ...data...). The data contained on the geometry file is explained in detail in Section 6.1 and is summarized in Section 6.2.

6.1 Detailed Description of Geometry File

All of the geometry file data on the most general POTFAN geometry file is described in this section. The current POTGEM version cannot determine all of this data because there has not yet been an actual need for it. It should be stressed, however, that other POTFAN programs assume that geometry files they read in may contain any of the data described herein even though POTGEM can not yet put it there.

Data denoted as being default data is only used if not changed by other POTFAN programs. The array notation used is explained in Appendix C. Variables in the first record marked with an asterisk must be entered with a FINISH command. All other variables are determined automatically or as the result of other commands. Variables or records marked with a + are ones that would probably not be of interest unless POTGEM is used with other POTFAN modules (i.e., persons using POTGEM to obtain corner points for their own programs may ignore variables and records marked with a +).

In addition to defining the standard geometry file format, explanations of how some of the data is determined by POTGEM are included.

First Record

(Note--At this point the reader should be familiar with Appendices B and C.)

NCTIME--number of words in (CTIME). $1 \leq NCTIME \leq 5$.

(CTIME(NCTIME))--Time stamp to identify the approximate time of creation of the file. This should be printed out in an A4 format whenever the file is read in by a subsequent program.

NTITL--Number of words in (TITLE). $1 \leq NTITL \leq 20$.

(TITLE(NTITL))--Alphanumeric titling information input with the TITLE command. When required, this information is to be written out under a format such as (1X,20A4).

NRECS--Number of records on the file including the first. $1 \leq NRECS \leq 20$.

(IFORM(NRECS))--An integer describing the format of each record. See Appendix B. NRECS and (IFORM) are on all POTFAN files so that the EDITPF program can be used to list them. In POTGEM the array (IFORM) is computed with a FINISH command.

NID--Number of file identification numbers. $1 \leq NID \leq 10$.

(ID(NID))--Identification number array. In POTGEM NID=1 and ID(1) is the same as ID entered with the STORE command. Note, however, that if the EDITPF or EDITGM program (Section 8.3) is used to modify a geometry file created by POTGEM, then NID on the modified file will be greater than 1.

NLOG--Number of words in (LOG). $1 \leq NLOG \leq 50$.

LOG(1)=BCFLG--This logical variable is .TRUE. iff. there are boundary condition flags stored on a subsequent record of the file. For geometry files created by POTGEM, BCFLAG will be .TRUE. if a BCFLAG command was given or if the null rows of panels between geometrical segments have not been eliminated by NRI1 and/or NRI2 commands.

+LOG(2)--Not used any more.

LOG(3)=UVW--This variable is .TRUE. iff. there are unit wake vectors in the direction of shed wake lines stored on a subsequent record of the file. For geometry files created by POTGEM, UVW will be .TRUE. if a UVW command was given.

**LOG(4)=DANDS--This is .TRUE. iff. both doublet and source singularities are to be placed on the body.

LOG(5)=DSF--This is .TRUE. iff. there are doublet singularity flags on a subsequent record. For geometry files created by POTGEM, DSF will be .TRUE. if a DSFLAG command was given or if the null rows of panels between geometrical segments have not been eliminated by NRI1 and/or NRI2 commands.

LOG(6)=SSF--This is .TRUE. iff. there are source singularity flags on a subsequent record. Currently POTGEM cannot determine these flags, so SSF is always .FALSE. on files created by POTGEM.

LOG(7)=NTOP--This is .TRUE. iff. there are top surface boundary condition vectors stored on a subsequent record. If NTOP is .FALSE., then POTFAN programs use the unit normals instead. Currently POTGEM cannot determine these vectors, so NTOP is always .FALSE. on geometry files created by POTGEM.

LOG(8)=NBOT--This is .TRUE. iff. there are bottom surface boundary condition vectors stored on a subsequent record. If NBOT is .FALSE., then POTFAN programs use the negatives of the unit normals instead. Currently POTGEM cannot determine these vectors, so NBOT is always .FALSE. on files created by POTGEM.

LOG(9)=OTOPL--This is .TRUE. iff. the top surface outflow along the top surface boundary condition vectors at the control points is stored on a subsequent record. If OTOPL is .FALSE., then POTFAN programs assume zero outflow. Currently POTGEM cannot determine the top surface outflow, so OTOPL is always .FALSE. on geometry files created by POTGEM.

LOG(10)=OBOTL--This is .TRUE. iff. the bottom surface outflow along the bottom surface boundary condition vectors at the control points is stored on a subsequent record. If OBOTL is .FALSE., then POTFAN programs assume zero outflow. Currently POTGEM cannot determine the bottom surface outflow, so OBOTL is always .FALSE. on geometry files created by POTGEM.

**LOG(11)--Default value for the variable NOS1 in the VVIM (vortex velocity influence matrix calculator) program. Making the variable .TRUE. if there are no bound vortex legs in the N1 direction (e.g., axisymmetric body in axisymmetric flow) will save significantly on CPU time in VVIM.

+*LOG(12)--Default value for the variable NOS2 in VVIM. Making this variable .TRUE. if there are no bound vortex legs in the N2 direction (e.g., planar wings modelled by horseshoe vortices) will save significantly on CPU time in VVIM.

+*LOG(13)--Default value for the variable SLINE1 in VVIM. If each of the N2 rows of N1 direction vortex legs (i.e., each group of contiguous N1 direction panel edges) contains legs that are of the same length and parallel to those in its own row, then SLINE1 may be set to .TRUE. to save some CPU time in VVIM. This situation usually exists only for certain, simple, planar components.

+*LOG(14)--Default value for the variable SLINE2 in VVIM. This is the same as SLINE1 except it applies in the N2 direction.

+*LOG(15)--Default for the variable SUM1 in VVIM. This should be .TRUE. if the influence of singularities should be summed in the N1 direction (e.g., if the component is a shed wake with N1 being the streamwise direction).

+*LOG(16)--Default for the variable SUM2 in VVIM. This is the same as SUM1 except it applies in the N2 direction.

+*LOG(17)=DBLT--This should be .TRUE. if doublet type singularities will be placed on the component.

+*LOG(18)=SOURCE--This should be .TRUE. if source type singularities will be placed on the component. Note--LOG(4)=LOG(17).AND.LOG(18).

+LOG(19)=RS1--This is .TRUE. iff. the force sensing locations of the N1 direction vortex segments (panel edges of constant doublet singularities) are on a subsequent record of the file. If these are not on the file, then other POTFAN programs use the midpoints determined by averaging corner points. These force sensing locations are only used if vortices model the component and the Kutta-Joukowskii method is used to calculate forces. In POTGEM, RS1 is established by the PANL command.

+LOG(20)=RS2--This is the same as RS1 except it applies to the N2 direction.

NINT--Number of words in (INT). $1 \leq NINT \leq 50$.

+INT(1)=NNBC--Number of null boundary condition flags (i.e., number of words in (BCFLAG) that are equal to 1).

INT(2)=N1--Total number of corner points in the N1 direction.

INT(3)=N2--Total number of corner points in the N2 direction.

INT(4)=N1BC=N1-1--Number of boundary condition points in the N1 direction. This is also the number of panels in the N1 direction.

INT(5)=N2BC=N2-1--Number of boundary condition points or panels in the N2 direction. N1BC*N1BC is thus the total number of panels.

+INT(6)=NNDS--Number of null doublet singularity flags (i.e., number of words in (DSFLAG) that are equal to 1).

+INT(7)=NNSS--Number of null source singularity flags. Currently POTGEM cannot compute these flags, so NNSS is always 0 on geometry files created by POTGEM.

INT(8)--Not used.

INT(9)--Not used.

+*INT(10)=FFISL--This is the default flow field indicator for the I1=1 edge of the component as is required when vortices model the component. In the case of a single segment this is the SL edge. A value of 1 is required when there will be a symmetric image of the component attached at its I1=1 edge. A symmetric image is one which together with the component creates a symmetrical flow field about the plane situated symmetrically between them. A value of 2 is used for an antisymmetrical image. A value of 3 is used when the I1=1 edge is physically coincident with the I1=N1 edge. Any other value indicates no special edge condition.

+*INT(11)=FFISU--This is the same as FFISL except that it applies to the I1=N1 edge.

+*INT(12)=FFIVL--This is the same as FFISL except it applies at the I2=1 edge.

+*INT(13)=FFIVU--This is the same as FFISL except it applies at the I2=N2 edge.

NFLT--Number of words in (FLT). $1 \leq NFLT \leq 50$.

+*FLT(1)=AREF--Component reference area for normalizing forces and moments. In POTGEM this is computed with a FINISH command if it is not input. See the GEOM listing for details.

+*FLT(2)=XLEN1--Reference length for normalizing momemts about the X axis. In POTGEM this is computed with a FINISH command if it is not input. See the GEOM listing for details.

+*FLT(3)=XLEN2--Reference length for normalizing moments about the Y axis. In POTGEM, this is computed with a FINISH command if it is not input. See the GEOM listing for details.

+*FLT(4)=XLEN3--Reference length for normalizing moments about the Z axis. In POTGEM, this is computed with a FINISH command if it is not input. See the GEOM listing for details.

+*FLT(5)=DUVWX--Default for the X component of the unit wake vectors. This is used if the wake vectors are required and LOG(3)=UVW=.FALSE.

+*FLT(6)=DUVWY--Same as DUVWX except that it applies in the Y direction.

+*FLT(7)=DUVWZ--Same as DUVWX except that it applies in the Z direction.

+*FLT(8)--Default value for the variable RDVORT used in VVIM. This is the distance beyond which the divortlet approximation for a vortex segment's influence will be used. In POTGEM this is computed if it is not input. See the GEOM listing for details.

+*FLT(9)--Default value for the variable HCUT used in VVIM. This is the perpendicular distance within which the influence of semiinfinite wake lines is set to zero. In POTGEM this is computed if it is not input. See the GEOM listing for details.

+*FLT(10)--X component of the position about which moments should be computed.

+*FLT(11)--Y component of the position about which moments should be computed.

+*FLT(12)--Z component of the position about which moments should be computed.

Second Record

(Note--Appendix B defines J1, J2, J3, and NW.)

J1=N1--Number of corner points in the N1 direction.

J2=N2--Number of corner points in the N2 direction.

J3=5

NW=N1*N2*5

(XCP(N1,N2))--X components of position vectors to corner points.

(YCP(N1,N2))--Y components of position vectors to corner points.

(ZCP(N1,N2))--Z components of position vectors to corner points.

+(SCP(N1,N2))--Values of S at corner points.

+(VCP(N1,N2))--Values of V at corner points.

+Next Record (if LOG(3)=.TRUE.)

(Note--This record is not present unless LOG(3)=.TRUE..)

J1=N1

J2=N2

J3=3

NW=N1*N2*3

(UVWX(N1,N2))--X components of unit wake vectors along wake elements originating from each corner point.

(UVWY(N1,N2))--Y components of unit wake vectors along wake elements originating from each corner point.

(UVWZ(N1,N2))--Z components of unit wake vectors along wake elements originating from each corner point.

In POTGEM (UVWX), (UVWY), and (UVWZ) are established by the UVW command.

If this record is not present, then other POTFAN programs assumethe following:

UVWX(I1,I2) = FLT(5)
UVWY(I1,I2) = FLT(6)
UVWZ(I1,I2) = FLT(7).

+<u>Next Record</u> (if LOG(1)=.TRUE.)

J1=N1BC--Number of panels in the N1 direction.

J2=N2BC--Number of panels in the N2 direction.

J3=1

NW=N1BC*N2BC

(BCFLAG(N1BC,N2BC))--integer boundary condition flag denoting the type of boundary condition point. Values of 0 indicate a regular boundary condition point. Values of 1 indicate a completely null boundary condition point. For closed surfaces to be modelled by doublet panels at least one panel must have a null boundary condition flag. Any other value indicates that the boundary condition influence of the panel is to be ignored, but the velocity on the panel is to be computed. The latter would be the case if constraint functions with deleted boundary conditions were to be used. If this record is not present, then other POTFAN programs assume BCFLAG(I1,I2)=0. IN POTGEM this array is determined mainly as the result of a BCFLAG command. If, however, the null rows of panels between geometrical segments are left in by not using the NRI1 and/or NRI2 commands, then the elements of (BCFLAG) corresponding to these panels are set to 1. The latter is accomplished with a FINISH command and by looking for elements in (XBP) (X coordinates of boundary condition control points) that are less than or equal to -1.E30.

+<u>Next Record</u> (If LOG(5)=.TRUE.)

J1=N1BC

J2=N2BC

J3=1

NW=N1BC*N2BC

(DSFLAG(N1BC,N2BC))--Integer doublet singularity flags. These are used by the VVIM program to indicate what type of vortex distribution each panel has. These flags could also be used by a module that replaces VVIM. In VVIM a value of 1 implies no singularity; a value of 2 implies a closed quadrilateral vortex; and a value of 30 implies a horseshoe vortex of type 2 (i.e., a type used for wings with I2=1 being the leading edge). There are a large number of other types available. The various types are shown in Figure 6.1-1. Together they allow bodies to be modelled with practically any combination of vortex segments on panel edges in the N1 direction, vortex segments in the N2 direction, and semi-infinite vortices shed from any corner points. If this array is not present, VVIM assumes DSFLAG(I1,I2)=30. In POTGEM these flags are determined in the same ways that (BCFLAG) is determined, except that the DSFLAG command is used instead of the BCFLAG command.

+Next Record (If LOG(6)=.TRUE.)

J1=N1BC

J2=N2BC

J3=1

NW=N1BC*N2BC

(SSFLAG(N1BC,N2BC))--Integer source singularity flags. Currently POTGEM cannot determine these flags.

+Next Record

J1=N1BC

J2=N2BC

J3=5

NW=N1BC*N2BC*5

(XBC(N1BC,N2BC))--X components of position vectors to control points.

(YBC(N1BC,N2BC))--Y components of position vectors to control points.

(ZBC(N1BC,N2BC))--Z components of position vectors to control points.

(SBC(N1BC,N2BC))--Values of S at control points.

(VBC(N1BC,N2BC))--Values of V at control points.

+Next Record

J1=N1BC

J2=N2BC

J3=4

NW=N1BC*N2BC*4

(UNX(N1BC,N2BC))--X components of "outward" unit normals at control points.

(UNY(N1BC,N2BC))--Y components of "outward" unit normals at control points.

(UNZ(N1BC,N2BC))--Z components of "outward" unit normals at control points.

The "outward" direction is defined as being on that side of the surface on which a vector in the N1-cross-N2 direction lies. This may give unit vectors that actually point inward. If the boundary condition is one of zero inflow or outflow, the direction of the unit normals makes no difference. For POTGEM generated geometry files, the direction may be reversed by switching the SL and SU curves or the VL and VU curves.

(DA(N1BC,N2BC))--Areas of the individual panels. POTGEM determines these areas with a FINISH command, which in turn calls subroutine AREAS.

+Next Record (If LOG(7)=.TRUE.)

J1=N1BC

J2=N2BC

J3=3

NW=N1BC*N2BC*3

(NTOPX(N1BC,N2BC))--X components of top surface boundary condition vectors.

(NTOPY(N1BC,N2BC))--Y components of top surface boundary condition vectors.

(NTOPZ(N1BC,N2BC)--Z components of top surface boundary condition vectors.

The NTOP vectors are not necessarily perpendicular to the surface. If this record is absent, subsequent POTFAN programs use the unit normals as the top surface boundary condition vectors.

This record is not found on POTGEM generated geometry files.

↑Next Record (if LOG(8)=.TRUE.)

J1=N1BC

J2=N2BC

J3=3

NW=N1BC*N2BC*3

(NBOTX(N1BC,N2BC))--X components of bottom surface boundary condition vectors.

(NBOTY(N1BC,N2BC))--Y components of bottom surface boundary condition vectors.

(NBOTZ(N1BC,N2BC))--Z components of bottom surface boundary condition vectors.

If this record is absent, subsequent POTFAN programs use the negatives of the unit normals as the bottom surface boundary condition vectors.

This record is not found on POTGEM generated geometry files.

↑Next Record (if LOG(9)=.TRUE.)

J1=N1BC

J2=N2BC

J3=1

NW=N1BC*N2BC

(OTOP(N1BC,N2BC))--Desired values of net velocity along the top surface boundary condition vectors. If this record is not present, then subsequent POTFAN programs assume zero net velocity. This record is not found on geometry files created by POTGEM.

+Next_Record (if LOG(10)=.TRUE.)

J1=N1BC

J2=N2BC

J3=1

NW=N1BC*N2BC

(OBOT(N1BC*N2BC))--Desired values of net velocity along the bottom surface boundary condition vectors. If this record is not present, then subsequent POTFAN programs assume zero net velocity. This record is not found on geometry files created by POTGEM.

+Next_Record

This record and the following three records define the outside boundaries of the component. This definition is necessary because panels need not extend up to the boundaries.

J1=N1

J2=10

J3=1

NW=N1*10

(XVLC(N1)--X values at the intersection of the I1=1 boundary (VL(S) curve in POTGEM) with the corner point grid lines extending nominally in the V or N2 direction. If the panels extend to the boundaries of the component, then XVLC(I2)=XCP(1,I2), but panels need not extend to the component boundaries (e.g., the panels at leading edges of thin wings to be modelled with vortices are set back from the edge).

The significance of most of the arrays on this and the next three records should be clear from the explanation of (XVLC), therefore, they will not be defined.

(XVUC(N1))
(YVLC(N1))
(YVUC(N1))
(ZVLC(N1))

(ZVUC(N1))
(SVLC(N1))
(SVUC(N1))
(VVLC(N1))
(VVUC(N1))

+Next Record

J1=N1BC

J2=12

J3=1

NW=N1BC*12

(XVLB(N1BC))--Same as (XVLC) except that boundary condition point grid lines are involved.

(XVUB(N1BC))
(YVLB(N1BC))
(YVUB(N1BC))
(ZVLB(N1BC))
(ZVUB(N1BC))
(SVLB(N1BC))
(SVUB(N1BC))
(VVLB(N1BC))
(VVUB(N1BC))

(CORD1(N1BC))--Reference chord lengths in the N2 direction. These are used in PCTFOR, which is the program that computes span loads. In POTGEM this array is computed after a FINISH command.

(SPAN1(N1BC))--Reference widths of rows of singularities extending in the N2 direction. These widths are some measure of lengths in the N1 direction and are used in determining sectional aerodynamic properties such as section lift coefficient. In POTGEM this array is computed after a FINISH command.

+Next Record

J1=N2

J2=10

J3=1

NW=N2*10

(XSLC(N2))
(XSUC(N2))
(YSLC(N2))
(YSUC(N2))
(ZSLC(N2))
(ZSUC(N2))
(SSLC(N2))
(SSUC(N2))
(VSLC(N2))
(VSUC(N2))

+Next Record

J1=N2BC

J2=12

J3=1

NW=N2BC*12

(XSLB(N2BC))
(XSUB(N2BC))
(YSLB(N2BC))
(YSUB(N2BC))
(ZSLB(N2BC))
(ZSUB(N2BC))
(SSLB(N2BC))
(SSUB(N2BC))
(VSLC(N2BC))
(VSUB(N2BC))
(CORD1(N2BC))
(SPAN2(N2BC))

+Next Record (if LOG(19)=.TRUE.)

J1=N1BC

J2=N2

J3=3

NW=N1BC*N2*3

(XS1(N1BC,N2))--X components of force sensing locations on the N1 direction vortex segments.

(YS1(N1BC,N2))--Y components of force sensing locations on the N1 direction vortex segments.

(ZS1(N1BC,N2))--Z components of force sensing locations on the N1 direction vortex segments.

These arrays are used only if vortices are used to model the component and then only if the Kutta Joukowskii theorem is used to determine the forces. If this record is absent, subsequent POTFAN programs requiring the N1 force sensing locations assume the midpoints of the N1 segments. In POTGEM these arrays are computed if the variable RS1 is entered as .TRUE. on a PANL command.

+<u>Next Record</u> (if LOG(20)=.TRUE.)

J1=N1

J2=N2BC

J3=3

NW=N1*N2BC*3

(XS2(N1,N2BC))--X components of force sensing locations on the N2 direction vortex segments.

(YS2(N1,N2BC))--Y components of force sensing locations on the N2 direction vortex segments.

(ZS2(N1,N2BC))--Z components of force sensing locations on the N2 direction vortex segments.

These arrays serve the same function for the N2 vortex segments that (XS1), (YS1), and (ZS1) do for the N1 vortex segments. In POTGEM these arrays are calculated if the variable RS2 is entered as .TRUE. on a PANL=COMMAND

6.2 SUMMARY OF GEOMETRY FILE DATA

This section summarizes the geometry data by presenting in pseudo-FORTRAN form the statements that could be used to create a geometry file. They are as follows:

```
CALL OPENW(NTG,1,ID(NED),1)

WRITE (NTG) NCTIME,(CTIME),NTITL,(TITL),
#NRECS,(IFORM),NID,(ID),
#NLOG,(LOG),NINT,(INT),NFLT,(FLT)

N1=INT(2)
N2=INT(3)
N1BC=INT(4)
N2BC=INT(5)

WRITE (NTG) N1,N2,5,N1*N2*5,(XCP),(YCP),(ZCP),(SCP),(VCP)
```

```
 IF  (LOG(3))  WRITE  (NTG)N1,N3,2,N1*N2*3,(UVWX),(UVWY),(UVWZ)

 IF  (LOG(1))  WRITE  (NTG)N1BC,N2BC,1,N1BC*N2BC,(BCFLAG)

 IF  (LOG(5))  WRITE  (NTG)N1BC,N2BC,1,N1BC*N2BC,(DSFLAG)

 IF  (LOG(6))  WRITE  (NTG)N1BC,N2BC,1,N1BC*N2BC,(SSFLAG)

 WRITE  (NTG)N1BC,N2BC,5,N1BC*N1BC*5,
#(XBC),(YBC),(ZBC),(SBC),(VBC)

 WRITE  (NTG)N1BC,N2BC,4,N1BC*N2BC*4
#(UNX),(UNY),(UNZ),(DA)

 IF  (LOG(7))  WRITE(NTG)N1BC,N2BC,3,N1BC*N2BC*3,
#(NTOPX),(NTOPY),(NTOPZ)

 IF(LOG(8))  WRITE(NTG)N1BC,N2BC,3,N1BC*N2BC*3,
#(NBOTX),(NBOTY),(NBOTZ)

 IF  (LOG(9))  WRITE(NTG)N1BC,N2BC,1,N1BC*N2BC,(OTOP)

 IF  (LOG(10))  WRITE(NTG)N1BC,N2BC,1,N1BC*N2BC,(OBOT)

 WRITE(NTG)N1,10,1,N1*10,(XVLC),(XVUC),(YVLC),(YVUC),
#(ZVLC),(ZVUC),(SVLC),(SVUC),(VVLC),(VVUC)

 WRITE(NTG)N1BC,12,1,N1BC*12,(XVLB),(XVUB),(YVLB),(YVUB),
#(ZVLB),(ZVUB),(SVLB),(SVUB),(VVLB),(VVUB),(CORD2),(SPAN1)

 WRITE(NTG)N2,10,1,N2*10,(XSLC),(XSUC),(YSLC),(YSUC),
#(ZSLC),(ZSUC),(SSLC),(SSUC),(VSLC),(VSUC)

 WRITE(NTG)N2BC,12,1,N2BC*12,(XSLB),(XSUB),(YSLB),(YSUB),
#(ZSLB),(ZSUB),(SSLB),(SSUB),(VSLB),(VSUB),(CORD1),(SPAN2)

 IF  (LOG(19))  WRITE(NTG)N1BC,N2,3,N1BC*N2*3,
#(XS1),(YS1),(ZS1)

 IF  (LOG(20))  WRITE(NTG)N1,N2BC,3,N1*N2BC*3,
#(XS2),(YS2),(ZS2)
```

In POTGEM the geometry file is written by subroutine STORGM.

7 SAMPLE CASES

This section presents a number of sample cases. These cases were not only devised to test the program, but to serve as the basis of a tutorial guide for assisting users in learning how to use the program. This tutorial proceeds from simple cases to more complex ones with each new facet of the program being explained the first time it is introduced. Potential users are therefore advised to study every sample case.

7.1 TEST CASE NO. 1 - THIN, SYMMETRICAL, SWEPT, FLAT WING

The so-called Warren 12 planform shown in Figure 7.1-1 has been chosen as the first test case. Note the SL(V), SU(V), VL(S), and VU(S) curves. This wing consists of a single segment, which is the right hand half of the wing, and only half the wing needs to be considered due to the symmetry. The spanwise direction has been chosen as the S or N1 direction and the chordwise direction as the V or N2 direction. These could have been reversed, but for more complicated wings this is generally the best way to choose the directions. This wing can be handled most simply by using the WING command or else by inputting the SL, SU, VL, and VU curves explicitly. The former method is the subject of this section, while the latter is discussed in Section 7.2.

The input deck illustrating the use of the WING command is shown in Figure 7.1-2. Comments concerning some cards are given below:

Card 7--This card specifies that there should be 10 panels in the S direction (spanwise in this case) and 4 in the V direction (chordwise).

Card 9--Uniform spacing of the vortices in the S direction is requested.

Card 11--IOPT=2 specifies the typical (1/4 and 3/4) spacing of vortices and control points in the V direction.

Card 13--RS1 is .TRUE. because it is intended that loads should be determined using the Kutta-Joukowskii law. There will be no load-carrying vortex segments in the N2 direction.

Cards 14-17--These cards cause all panels to have a type 30 doublet singularity on them. This type of singularity is a horseshoe vortex with bound portion in the N1 direction. The -1 values on cards 15 and 16 signal the program to use the number of panels in the N1 and N2 directions, respectively, as the upper limits.

Card 19--LOG(12) is .TRUE. because there are no bound vortex legs in the N2 direction.

LOG(13) is .TRUE. because the vortex legs along each panel line in the N1 direction are all parallel and of the same length.

INT(10) is 1 because the SL edge (i.e., the centerline) is in a symmetry plane.

FLT(5), FLT(6), and FLT(7) are the components of the unit wake vectors. In this case the wake vectors are all identical (if the angles vary from corner point to corner point the UVW command should be used) and parallel to the X AXIS.

The printed output for this case is shown in Figure 7.1-3. Figure 7.1-4 shows the arrangement of panels, wing outline (dashed), and wake vectors. This figure was generated using the PLOTGM program (Section 8.4). The input to PLOTGM is shown in Figure 7.1-5.

7.2 TEST CASE NO. 2

The results from this test case are identical to case no. 1. The only difference is that this case was run using a different input method. With this method, which is more complicated, but more general, it is necessary to explicitly consider the component axis, the cross sectional planes, and the VL, VU, SL, and SU curves. The component's axis is taken to be the Y axis. The Y' axis is the X axis and the Z' axis is the Z axis. Thus the Y-Z plane must be rotated by -90 degrees about the Z axis in order to become parallel to the Y'-Z' plane. The SL, SU, VL, and VU curves are shown in Figure 7.1-1. The input is shown in Figure 7.2-1. Specific comments on the input deck follow:

Card 6--COPT=0 causes the corresponding function to be zero. Thus XAXIS(S)=0.

Card 8--COPT=2 implies YAXIS(S)=S.

Card 10--Causes PHI(S) to equal -90.

Card 12--Causes EX(S) to equal 0.

Card 14--Causes EY(S) to equal 1. Note that NTAB =1 does not have to be entered because it was given on Card 10.

Card 16--This is the only cross section. Since there is only one cross section, SCS does not have to be entered. COPT=0 then implies that V2(S,V)=0 or Z(Y,X)=0.

Cards 23-30--These define the SL, SU, VL, and VU curves shown in Figure 7.1-1.

The output from this case is shown in Figure 7.2-2.

This same wing could have been done by a somewhat different procedure. Namely the default axis and cross sections could have been used initially and, after panelling, the entire component could have been rotated by 90 degrees and about the Z axis. If this were to be done, cards 5 through 14 would be deleted and a ROSS command and appropriate data would be inserted after card 32 or 37.

7.3 TEST CASE NO. 3 - NASA AMES 12.192-by-24.384 METER WIND TUNNEL

A cross section view of the right half of the 12.192-by-24.384 (40'x80') test section is shown in Figure 7.3-1. It can be described analytically as follows:

Section A-B: $Z'(Y') = -6.096$ for $-6.096 \leq Y' \leq 0$
Section B-C: $r(\theta) = 6.096$ for -90 degrees $\leq \theta \leq 90$ degrees
Section C-D: $Z'(y') = 6.096$ for $0 \geq Y' \geq 06.096$.

The most accurate method of describing this geometry to the program is to take advantage of the multiple segment capability with the segments being the sections A-B, B-C, and C-D. The V variable is y' in sections A-B and C-D and is θ in section B-C. The S variable is chosen to be X. The equations for the axis are the following:

$$XAXIS(S) = S$$
$$YAXIS(S) = 6.096$$
$$ZAXIS(S) = 0.$$

In the first segment (A-B) the equations for V2, VL(S), and VU(S) are:

$$V2 = -6.096$$
$$VL = -6.096$$
$$VU = 0$$

In the second segment (B-C) the equations for V2, VL(S), and VU(S) are:

$$V2 = 6.096$$
$$VL = -90$$
$$VU = 90$$

In the third segment (C-D) the equations for V2, VL(S), and VU(S) are:

$$V2 = 6.096$$
$$VL = 0$$
$$VU = -6.096$$

Note that VU(S) may be less than VL(S).

If the longitudinal extent of the portion of the tunnel to be modelled is from X = -10 to X = +20, then SL(V) and SU(V) are:

$$SL = -10$$
$$SU = 20$$

The input which implements the description just given is shown in Figure 7.3-2. Comments on certain of the input cards are given below:

<u>Cards 4-5</u>--Define YAXIS(S) as 6.096.

<u>Card 6</u>--Defines V2 as y'.

<u>Card 10</u>--NSEGVT is the total number of segments in the V direction. NBPV = 3,10,3 causes 3 panels in the first segment (A-B), 10 panels in the second segment (B-C), and 3 panels in the third segment (C-D).

<u>Card 23</u>--Panels the first segment.

<u>Card 25</u>--Defines V2 as θ.

<u>Cards 28-29</u>--Name the next segment to be panelled.

<u>Cards 36-37</u>--Panel the second segment. Note that the VLBC command was not required for this segment.

<u>Cards 47-48</u>--Panel the third segment. Note that the VLBC command was not required for this segment and also it was not necessary to give an SRI1 command for IC=11 because V2 is numerically the same as in the previous segment (even though its basic definition has been changed by the CARY command on card 38).

<u>Cards 53-56</u>--Set all doublet singularity flags to type 2.

<u>Cards 57-59</u>--Set the doublet singularity flags along the trailing edge to type 4. See Figure 6.1-1.

The output from the program is shown in Figure 7.3-3. Figure 7.3-4 shows various views of the resultant panel distributions, control points and shed wakes. Figure 7.3-5 shows the PLOTGM input that generated Figure 7.3-4.

7.4 TEST CASE NO. 4 - THIN, SWEPT, UNCAMBERED, UNTWISTED WING WITH DIHEDRAL

Top and rear views of the subject wing are shown in Figure 7.4-1.

The first step in treating this wing is to rotate it by 90 degrees around the Z axis. The resultant plan view is shown in Figure 7.4-2. Note the SL, SU, VL and VU curves and that S = -X and V = y' = Y. Also V2 = z' = Z. Two cross sections which are sufficient to complete the geometry description are:

V2 = z' = 0 at S = 0

and

V2 = z' = .5 at S = 2

After the wing is input to the program via the above description, it is rotated by 90 degrees about the -Z axis so that it conforms to Figure 7.4-1 and then it is rotated by 45 degrees about the Y axis to put it at 45 degrees angle of attack. This final rotation is not necessary to obtain a solution for the wing at 45 degrees angle of attack, but has been done for testing purposes.

A schematic of the vortex singularity model used for this wing together with the doublet singularity flags is shown in Figure 7.4-3.

The input deck for this case is shown in Figure 7.4-4. Comments on some cards are given below:

Card 6--COPT=3 defines XAXIS(S) as being equal to -S.

Cards 7-10--These cards define the two cross sections.

Cards 28-29--These cards rotate the wing so that the YAXIS is the spanwise direction.

Cards 32-42--These cards define the doublet singularities shown in Figure 7.4-3.

Card 44--LOG(13) is .TRUE. because the N1 vortex segments for any given value of N2 are all of the same length and parallel.

The output from the program is shown in Figure 7.4-5. Figure 7.4-6 shows top and side views of the wing outline (dashed), panels, and shed wakes.

7.5 TEST CASE NO. 5 - SPHERE WITH S THE CIRCUMFERENTIAL VARIABLE

Figure 7.5-1 shows the choice of the S and V variables and the y'-z' plane, which varies with S. Note that as S varies, the origin of the y'-z' plane remains fixed. Therefore, it is necessary that

XAXIS(S) = YAXIS(S) = ZAXIS(S) = 0.

The variable PHI in this case is identical to S and the -Y axis is the rotation axis of the cross section. Hence,

PHI(S) = S
EX(S) = 0
EY(S) = -1
EZ(S) = 0.

Also the variable V2 in this case is just the radius of the sphere and is taken equal to 1.

Figure 7.5-2 shows the input deck for this case. A total of 5 panels are laid out in the S direction with S varying from 1 to 90 degrees (i.e., only 1/4 of the sphere is panelled). The panel corners occur at equal increments in S. In the V direction 10 panels are laid out at equal increments with the first corner points being moved back from the nose (V = 0), which is necessary for the sphere to be modelled with doublet singularities. Type 19 and type 27 doublet singularities are selected due to the axisymmetry (see Figure 6.1-1). Finally the component is rotated so that the nose is on the negative X axis.

Figure 7.5-3 shows the output from POTGEM for this case.

7.6 TEST CASE NO. 6 - TWO DIMENSIONAL AIRFOIL

The purpose of this test case is to show how cross sections of typical thick wings can be handled. The cross section is decomposed into two segments. The first segment is the lower surface starting at the trailing edge and ending at the nose. The second segment is the upper surface beginning at the nose and ending at the trailing edge. For both cases the V-variable is X.

In both the first and second segments the input data is proportional to SQRT(V) near V = 0. The interpolation routines provided in the program are not able to fit curves to such data accurately. To overcome this difficulty one of the transformation capabilities of the program is invoked so that the independent variable for interpolation is SQRT(V). In terms of this variable the input data is now linear near V = 0, and, therefore, interpolation is much more accurate. See Section 3.1.4 for more details.

The program deals with three-dimensional bodies, therefore the airfoil section is considered to be of unit thickness and centered at the origin. Thus the S variable is Y and SL(V) = -.5 and SU(V) = .5. Also there is one panel in the S direction.

The section is input as if it were parallel to the Y-Z plane and after the section is panelled, it is rotated so that it is parallel to the X-Z plane. This is the typical procedure that is followed for all wings when the usual aerodynamicist's coordinate system is used.

The input deck for this case is shown in Figure 7.6-1 and the program output is shown in Figure 7.6-2. Specific comments on the input deck are given below:

Card 6--COPT=6 specifies that the controlled deviation interpolation method be used for interpolation within the cross section. IOPT1=1 specifies that the independent variable for this interpolation will be SQRT(V) instead of V.

Card 29--IOPT=6 gives dense panels near the nose.

Cards 73-80--When modelling closed bodies with doublet panels, a hole must be left somewhere in the body. These cards make the first panel null and thus the hole will be at the trailing edge on the bottom surface. These cards also define the remaining panels as type 32 (see Fig. 6.1-1).

Cards 81-88--These cards create a null boundary condition point at the null panel so that the resulting influence matrices will be square.

Cards 89-95--In order to make the flow field two dimensional, the wake vectors on the I1 = 1 edge must be directed in the +Y direction while the vectors on the I1 = 2 edge must be directed in the -Y direction.

Figure 7.6-3 shows the resulting corner point model of this airfoil.

7.7 TEST CASE NO. 7 - THIN WING WITH TWIST, CAMBER, AND DIHEDRAL

The purpose of this test case is to show how complicated, thin wings can be handled.

The planform of the subject wing *prior* to the addition of the twist is shown in Figure 7.7-1. At Y = 0.0 the mean camber line is Z/c = 0.0 where c is the wing chord. At Y = 15.479 the camber line is the parabolic arc given by

$$Z/c = x(1-x)$$

where x is the linear function of X that is equal to 0.0 at the leading edge and 1.0 at the trailing edge. At Y = 25.0 the camber line is derived from Table 7.7-1 by multiplying the Z/c values by a factor of 12.0. Note that the table entries extend beyond the leading edge. This is done in order to control the interpolation near the leading edge. Also it should be noted that between X = .2025 and X = 1.0 the camber line is exactly straight. At Y = 35.107 the camber line is also derived from Table 7.7-1, only the factor to be applied is 15.0. Between the given stations the mean camber surface varies linearly with Y along the lines x = constant.

The twist in degrees is equal to -.0097363*Y**2. The twist center is the trailing edge of the wing and the twist axis is everywhere parallel to the Y axis. The vertical displacement of the trailing edge of the wing is given by Z = .25Y.

If the cross sections are initally chosen to be parallel to the Y-Z plane, the above description of the geometry can be accomodated by the following:

```
             S = X
      YAXIS(S) = -Xte(Y)              (Fig. 7.7-1)
      ZAXIS(S) = .25*S
        PHI(S) = -.0097636*S**2
         EX(S) = 1
         EY(S) = 0
     YPSCAL(S) = c(Y)
     V = 1 - x = (Xte - X)/c(Y)
         VL(S) = 1
         VU(S) = 0
```

In addition V2 will be the value of Z on the surface *prior* to adding in the twist or dihedral.

The wing is modelled with quadrilateral vortices. These are placed in the typical manner chordwise and in both the root segment and tip segment they are evenly spaced spanwise. A wake is shed from the trailing edge and the rearward half of the tip edge and trails back at an angle of 10 degrees.

This wing is treated in a manner similar to test case no. 4. The primary differences are the addition of camber and twist, the dihedral is handled somewhat differently, and the presence of the break in the trailing edge creates the need to assure that panel edges occur also at the break.

The input deck for this case is shown in Figure 7.7-2. Specific comments on some of the cards are given below:

Card 35--COPT=6 and PARAM(1)=0 cause the controlled deviation interpolation method with linear interpolation in the end intervals to be used for this cross section. Linear interpolation in the last interval is ideal because the rear portion of the camber line is exactly straight. Linear interpolation near the leading edge would not be very good, however, so the table has been extended beyond the leading edge.

Card 42--The table (Cards 36-39) does not have to be entered again even though it was transformed by the previous command. This is because the transformations are not done on the intermediate arrays (see subroutine SRFIN1).

Card 68--Note that the SL(V) curve does not have to be entered for the second segment. This is because it is identical to the SU(V) curve from the previous segment.

Cards 81, 84, 87, and 90--See Figure 6.6-1 for a schematic of these vortex models.

The output from this case is shown in Figure 7.7-3. Various views of the panels, boundary condition points, and shed wakes are shown in Figure 7.7-4.

8 RELATED PROGRAMS

This chapter describes programs and subroutines related to POTGEM and which are also available.

8.1 SUBROUTINE READGM

This subroutine reads a geometry file in a straightforward manner. The principal drawbacks are that all of the data on the file is read in whether necessary or not and the program does not supply the data defaults discussed in Section 6.1.

8.2 SUBROUTINE RDGMA

This subroutine also reads in a geometry file. It differs from READGM on three counts. First of all, it does not read in any data that is not required. Secondly, if some data is not available on the file, but is requested, RDGMA will compute it according to established conventions (see Section 6.1). Finally RDGMA packs all of the requested data solidly into a single array and computes the addresses of the individual arrays. Thus RDGMA is compatible with calling programs using dynamic memory allocation.

8.3 EDITGM

EDITGM is a separate program that can be used to manipulate POTFAN geometry files in various ways. It operates in the same way that all POTFAN programs do. That is, it operates using commands as the basic form of logic control. The commands in EDITGM allow geometry files to be read in, printed out, edited, compared with other geometry files, and, after editing, to be stored. Also, EDITGM can be used to rotate, shift, and scale the component.

The EDIT command has been found to be very useful for changing flags ((BCFLAG) and (DSFLAG)) and parts of the introductory record that should have been entered with a FINISH command but were not.

The PRINT command is another useful command. It is frequently used to print out geometry file data that, for whatever reason, was not printed out when POTGEM was run.

The ROSS command can be used to rotate, shift, and scale the component. This command works in the identical way that ROSS works in POTGEM.

The listing of EDITGM contains all of the necessary instructions to run the program.

8.4 PLOTGM

PLOTGM is an independent and separate program that can be used to graphically display a component described by any POTFAN geometry file. This display consists mainly of the corner points connected by straight line segments in either or both directions. Optionally the boundary condition points, unit normals, unit wake vectors, and component outline can be displayed. The display can be from any viewing angle and to any desired scale.

PLOTGM is currently set up to run a Zeta plotter, but can be easily converted to use a Calcomp plotter.

PLOTGM works on a command basis in the same way that all other POTFAN programs do. These commands and all necessary user instructions are contained in the PLOTGM listing. PLOTGM was used to prepare figures for this report. In some cases the input decks have been shown to serve as examples since no separate documentation will be available for this program (see Chapter 7).

9 REFERENCES

Medan, R. C. (1976): Overview of the NASA-Ames Three-Dimensional Potential Flow Analysis System (POTFAN). To be published.

APPENDIX A

A--STANDARDIZED FILE HANDLING PROCEDURES FOR POTFAN PROGRAMS

Standardized FORTRAN procedures and subroutines for opening and closing files have been developed to facilitate using and coding POTFAN programs and the conversion of these codes to different computer systems.

A.1 FILE CREATION

This section describes actions taken before and after any POTFAN program attempts to write a POTFAN file.

Prior to writing any permanent file onto a unit, all POTFAN programs call a system dependent subroutine as follows:

```
CALL OPENW (NT,IFTYP,ID,IR)
```

If IR is not zero, then NT and ID are considered subroutine inputs. NT is the logical unit number on which the file will be written and ID is the file creation identifier, which should also be the primary file identification number. If IR is zero, then ID is nct considered a subroutine input and NT is only the default unit number. In this case the program reads in ID and NT from a card via 2I5 format. If the value of NT on the card is zero, the subroutine replaces NT with the default value.

If the value of ID determined in either case is then still zero and if it is possible on the computer system being used, the program will replace ID with the current number on the identification number file and also update the identification number file.

In addition to NT, ID, and IR, IFTYP is also input to the program. IFTYP defines the type of file being created according to the following table:

IFTYP	TYPE OF FILE
1	Geometry
2	Boundary condition
3	Influence matrix
4	Velocity matrix
5	Solutions
6	Velocity at force sensing location of N1 segments
7	Velocity at force sensing location of N2 segments
8	Constraint function transformation matrix
9	Zeta plot file
10	Constrained influence matrix
12	Preset solution
15	Inverse or decomposition of influence matrix
16	External velocity
17	Surface pressures
18	Surface velocity

Once ID and NT have been determined, the program opens (if possible on the system being used) the file for writing using a file name determined from ID and IFTYP. On IBM systems, opening a file consists of issuing a DDEF to the operating system. On the INFONET UNIVAC 1108 system, an EQUATE command is involved. This feature eliminates the need for job control cards to handle files on those systems for which FORTRAN programs can open files.

The program then rewinds the file and writes a message indicating which unit has been opened and the value of ID and IFTYP.

After the file has been opened and written upon, it is released by calling another system dependent subroutine as follows:

```
CALL ENDFIL(NT)
```

This subroutine writes an end-of-file mark on the unit and (if required by the system being used), releases the unit. The subroutine also writes a message indicating that unit NT has been closed.

A.2 FILE ACCESSING

This section describes actions taken before and after any POTFAN program attempts to read any POTFAN file.

Prior to reading any permanent file from a unit all POTFAN programs call a system dependent subroutine as follows:

CALL OPENR(NT,IFTYP,ID,IR)

If IR is not zero, then NT and ID are considered subroutine inputs. NT is the logical unit number from which the file is read and ID is the file access identifier, which should also be the primary file identification number. If IR is zero, then ID is not considered a subroutine input and NT is only the default unit number. In this case, the program reads in ID and NT from a card via 2I5 format. If the value of NT on the card is zero, the subroutine replaces NT with the default value.

In addition to NT, ID, and IR, IFTYP is also input to the program. IFTYP defines the type of file being read according to the table in the previous section.

Once ID and NT have been determined, the program attempts to open the file using a file name determined from ID and IFTYP. The capability to open a file from a FORTRAN program depends on the system being used. As explained in the previous section, this may involve a DDEF or EQUATE command and can eliminate the need for job control cards to handle files.

The program rewinds the file and writes a message indicating which unit has been opened and the value of ID and IFTYP.

After control is returned to the calling program and the first record of the file has been read, all POTFAN programs check to see if the access identifier is equal to the actual primary file identification number existing on the first record. If not equal, the program writes an informational diagnostic message and proceeds. This feature is meant to be a helpful filekeeping technique for those systems that do not permit automated file control.

After the file has been read and there is no further use for it, it is released by calling another system dependent subroutine as follows:

CALL FILEND(NT)

This subroutine rewinds unit NT and (if required by the system being used) releases the unit.

APPENDIX B

B STANDARDIZED FORMAT OF POTFAN FILES

A standard format has been developed for POTFAN files. This format is applicable to all files except scratch files and plot files. This standard has been developed for the following reasons:

1. to minimize the effects of changes in one POTFAN segment on other POTFAN segments;

2. to allow a program to be developed (EDITPF) which can list and/or edit the contents of any POTFAN file; and

3. to promote consistency among POTFAN programs.

Briefly, the standardized POTFAN file consist of one or more records. The first record is called the introductory record and contains miscellaneous data including the primary identification number, a title, and real, integer, and logical parameters reflecting how the data on the remaining records was calculated and/or how it is to be used. The second and subsequent records generally contain the bulk of the data and are called data records. The latter records contain one or more arrays which are always either integer or floating point numbers (i.e. integer and floating point numbers are not mixed on a single record). A detailed description is given below.

First Record (Introductory Record)

This record is created by an unformatted write statement such as the following:

```
WRITE(NT) NCTIME, (CTIME(N),N=1,NCTIME), NTITL,
#(TITL(N),N=1,NTITL),NRECS, (IFORM(N),N=1,NRECS),
#NID, (ID(N),N=1,NID), NLOG, (LOG(N),N=1,NLOG),
#NINT, (INT(N),N=1,NINT), NFLT, (FLT(N),N=1,NFLT)
```

The values of NCTIME, NRECS, NID, NLOG, NINT, and NFLT are all at least one and can vary from file to file even for files of the same type (e.g. NINT may be different on two different geometry files). An explanation of these variables is given below:

NCTIME	Number of words in (CTIME)
(CTIME)	Creation time in A4 alphanumeric format. Whether or not this array can be filled out depends on the availability of a system dependent subroutine to compute it. This array is used only as a filekeeping aid. It is printed out whenever a file is created or read.
NTITL	The number of words in (TITL). Generally NTITL is a multiple of 20.
(TITL)	Alphanumeric titling information (e.g. "Delta wing with flaps"). This array is to be written under a format such as (1x,20A4/).
NRECS	The number of records (including the first) comprising the file. NRECS is also the number of words in (IFORM).
(IFORM)	An integer array indicating the kind of numbers on each record. A value of zero implies an integer and a value of one implies a floating point number. IFORM(1) has no significance.
NID	The number of words in (ID)
(ID)	Identification number array. ID(NID) is the primary file identification number. In order to keep track of files ID(NID) should be unique for each file. This number is printed out whenever the file is created or read.
NLOG	The number of words in (LOG)
(LOG)	An array of logical parameters
NINT	Number of words in (INT)
(INT)	An array of integer parameters
NFLT	Number of words in (FLT)
(FLT)	An array of floating point parameters. If the remaining data on the file is dependent on Mach number, then FLT(1) is the Mach number.

Second and Subsequent Records (Data Records)

The remaining records of POTFAN files contain one or more arrays. If the data record contains more than one array, then all arrays on the record must be of the same type (i.e. either integers or real numbers, but not both) and all arrays must have the same number of words. The records also contain array dimensions (J1, J2, and J3) and the total number of words in all arrays on the record (NW). Following are some examples of code used to create data records:

```
  NW = J1*J2*J3
  WRITE(NT) J1,J2,J3,NW,(((A(I,J,K),I=1,J1),J=1,J2),K=1,J3)
```

```
  J3 = 2
  NW = J1*J2*J3
  WRITE(NT) J1,J2,J3,NW,((A(I,J),I=1,J1),J=1,J2),
 #((B(I,J),I=1,J1),J=1,J2)
```

```
  J2 = 1
  J3 = 1
  NW = J1
  WRITE(NT) J1,J2,J3,NW,(A(I),I=1,NW)
```

```
  J2 = 3
  J3 = 1
  NW = 3*J1
  WRITE(NT) J1,J2,J3,NW,(A(I),I=1,J1),(B(I),I=1,J1),
 #(C(I),I=1,J1)
```

Note that in the above examples all dimensions with multiple arrays were written with the leftmost indices varying most rapidly. This practice is always followed unless it is strictly necessary to do otherwise.

No matter how a data record was created, it can be read in by either of the following:

```
  READ(NT) J1,J2,J3,NW,(A(I),I=1,NW)
  READ(NT) J1,J2,J3,NW,(((A(I,J,K),I=1,J1),J=1,J2),K=1,J3)
```

In the former case, the data is packed solidly into core. In the latter case, some a priori knowledge of J1, J2, and

J3 or their maximum allowable values must have been available in order to properly dimension (A). Such a priori knowledge is generally contained as elements of (INT).

Different data records may contain data of different types and may have differing values of J1, J2, J3, and NW.

APPENDIX C

C ARRAY NOTATION

A shorthand notation for referring to arrays in the internal and external documentation of POTFAN programs has been developed. This notation is illustrated by the following examples:

(A)	This implies that A is an array.
(A(N))	This refers to all the words in (A) from 1 through N.
A(N)	This refers only to the Nth word of (A).
(A(I,J))	This refers to all the words in the doubly dimensioned array A for which the first index varies from 1 to I and the second from 1 to J.
A(I,J)	This refers to the element in (A) for which the first index is I and the second is J.
(A(I,J),J=3,K)	This refers to the words of (A) for which the first index is I and the second index varies from 3 to K.
(A(I,*))	This refers to those elements of (A) for which the first index varies from 1 to I and the second index varies from 1 to some value which for some reason cannot be defined.

TABLE 3.1.4-1--The correspondence between IC and various functions defining the surface and default values of the functions.

IC	FUNCTION
1	XAXIS(S) (XAXIS(S)=S)*
2	YAXIS(S) (YAXIS=0)*
3	ZAXIS(S) (ZAXIS=0)*
4	PHI(S) (PHI=0)*
5	EX(S) (EX=1)*
6	EY(S) (EY=0)*
7	EZ(S) (EZ=0)*
8	YPSCAL(S) (YPSCAL=1)*
9	ZPSCAL(S) (ZPSCAL=1)*
10	Not used
11	V2(V) at S = SCS(1) (V2=1)*
12	V2(V) at S = SCS(2) (V2=1)*
.	.
.	.
.	.

* denotes that this is the default function

TABLE 3.1.4-2--Current Valid Values of IOPT and the Corresponding Types of Function

IOPT	Definition of Function Y(X)
0	y(x) = 0
1	Linear interpolation from the table (XIN(NIN)), (YIN(NIN))
2	y(x)=x
3	y(x)=-x
4	y=YIN(1)=constant
6	y(x) determined by controlled deviation interpolation method in subroutine CODIM.
7	y(x) determined by modified cubic spline fit in subroutine CRVFT2
-1	y(x) = Fourier series = YIN(1) + YIN(2)*COS(x) + YIN(3)*COS(2*x) +...+ XIN(2)*SIN(x) + XIN(3)*SIN(2*x) + ...
-2	y(x) = power series in z=x-PARAM(2) XIN(1)+XIN(2)*z+XIN(3)*z**2 + ...

TABLE 4.1-1. Subprogram Call Structure

PROGRAM	CALLED BY	CALLS
ADJUST	GEOM	None
AREAS	GEOM	None
CFLAG	STORGM	None
CHORD1	GEOM	None
CHORD2	GEOM	None
CODIM	INTRP3	None
CRVFT2	INTRP3	None
FILEND	STORGM	None
FREAD3	GEOM	None
FROT	GEOM	TRANS
FSENS1	GEOM	None
FSENS2	GEOM	None
GEOM	POTGEM	AREAS, CHORD1, CHORD2 FREAD3, FSENS1, FSENS2, NRI1, NRI2, NULLP, OBEY, PANL2, PRNTGM, RDFLGS, RTSHFT, SETNRC, SPN1, SPN2, SRFIN1, SRFIN2, SRFSET, STORGM, TRAN1, ADJUST, FROT, TRAN2, XPANCP
GRID	PANL2	INTRP3
INTRP3	GRID, SURFAS	CODIM, CRVFT2, STRAT2
NRI1	GEOM	None
NRI2	GEOM	None
NULLP	GEOM	None

OPENW	STORGM	None
PANL2	GEOM	GRID, SURFAS
POTGEM	None	GEOM, TIMEST
PRNTGM	GEOM	None
RDFLGS	GEOM	None
RTSHFT	GEOM	TRANS
SETNN	STORGM	None
SETNRC	GEOM	None
SPN1	GEOM	None
SPN2	GEOM	None
SRFIN1	GEOM	TRAN1, TRAN2
SRFIN2	GEOM	TRAN1, TRAN2
SRFSET	GEOM	None
STORGM	GEOM	CFLAG, FILEND, OPENW, SETNN, TIMEST,
STRAT2	INTRP3	None
SURFAS	PANL2	INTRP3, TRAN1, TRAN2, TRANS
TIMEST	STORGM, POTGEM	None
TRANS	RTSHFT,FROT,SURFAS	None
TRAN1	GEOM, SRFIN1, SRFIN2, SURFAS	None
TRAN2	GEOM, SRFIN1, SRFIN2, SURFAS	None
XPANCP	GEOM	None

TABLE 4.2-1 Common Block Usage

COMMON BLOCK NAME	USING SUBPROGRAMS
COM1	GEOM, GRID, PANL2
COM2	GEOM, PANL2
COM3	GEOM, PRNTGM, STORGM
COM4	GEOM, RTSHFT
CONST	POTGEM, GEOM, CFLAG, CHORD1, CHORD2, CRVFT2, FILEND, FREAD3, GRID, INTRP3, CPENW, PRNTGM, RDFLGS, SPN1, SPN2, SRFIN1, SRFIN2, STORGM, SURFAS, TRAN1, TRAN2, XPANCP, ADJUST, FROT
SRFDAT	GEOM, SRFIN1, SRFIN2, SRFSET, SURFAS

TABLE 4.3-1 Logical Units Used by POTGEM

FORTRAN VARIABLE	LOGICAL UNIT DESCRIPTION	DEFAULT VALUE
NTCP	Output device for conversational prompts and error messages	6
NTP	Output device for normal printout	6
NTR	Card input device	5
NTS	Device for storing geometry file	1

TABLE 7.7-1 Values of the Mean Camber Line of the NACA 5-Digit 230 Airfoil

X	Z/c
-.0200	-.0067692
0.0000	0.0000000
.0200	.0054767
.0400	.0097886
.0600	.0130632
.0800	.0154283
.1000	.0170115
.1200	.0179405
.1400	.0183864
.1500	.0183864
.1600	.0183463
.1800	.0189785
.2000	.0176670
.2025	.0176119
1.0000	0.0000000

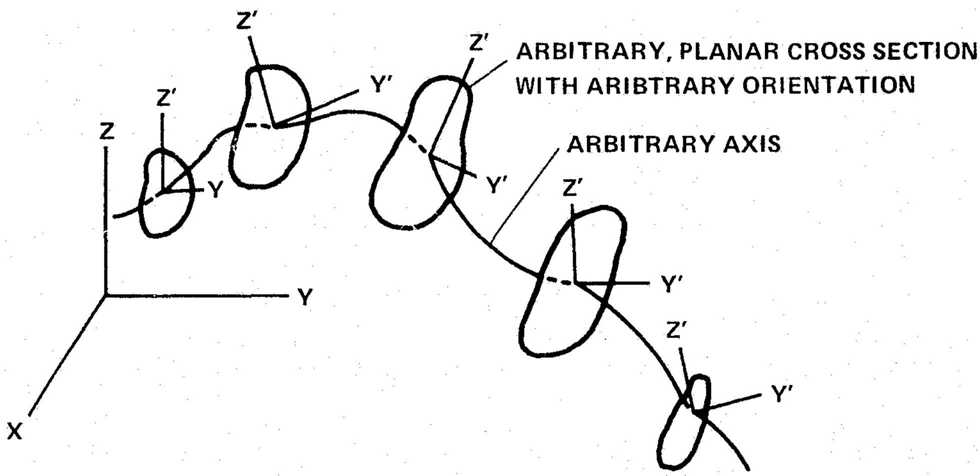


FIGURE 3.1-1. Data Needed to Define an Arbitrary Surface.

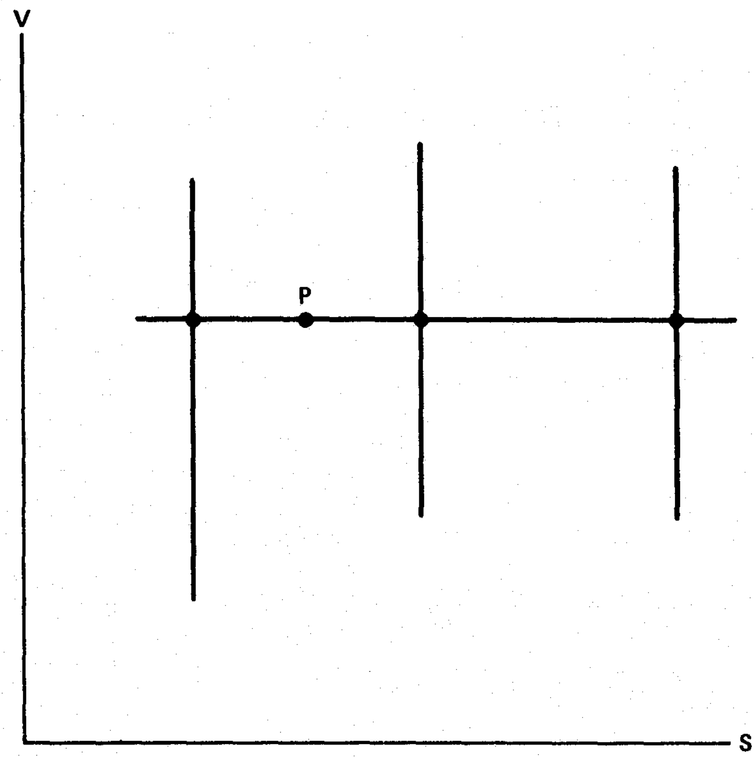


FIGURE 3.1.5-1. Illustration of Interpolation Between Cross Sections.

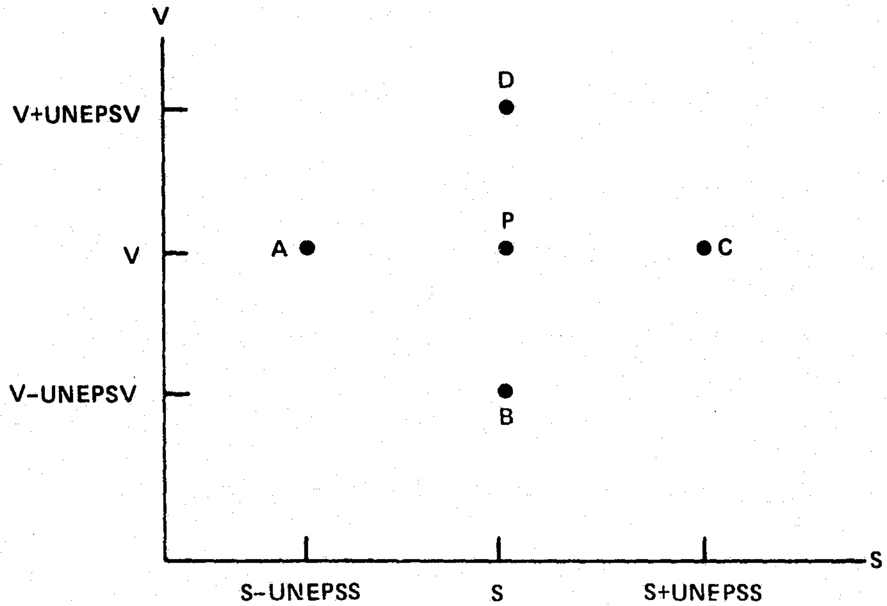


FIGURE 3.1.6-1. Method of Calculating Unit Normals.

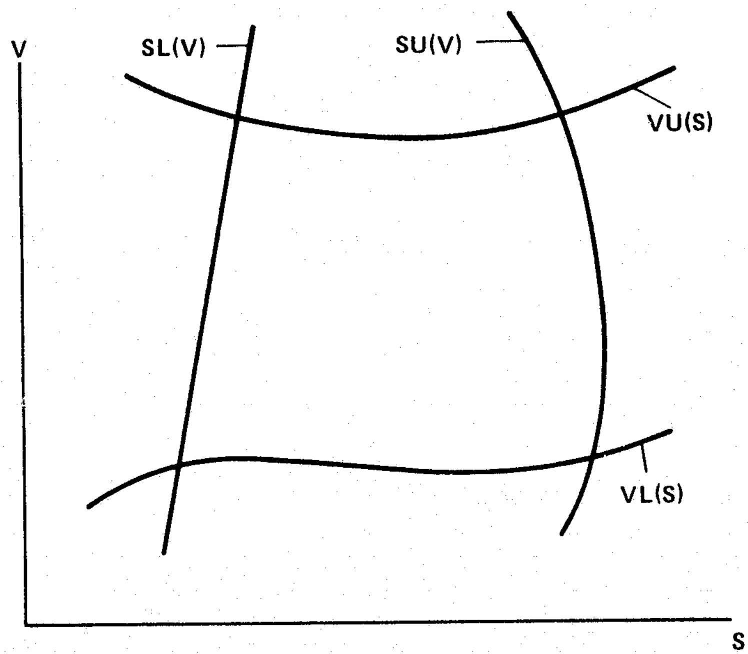


FIGURE 3.2.1-1. Segment Boundaries.

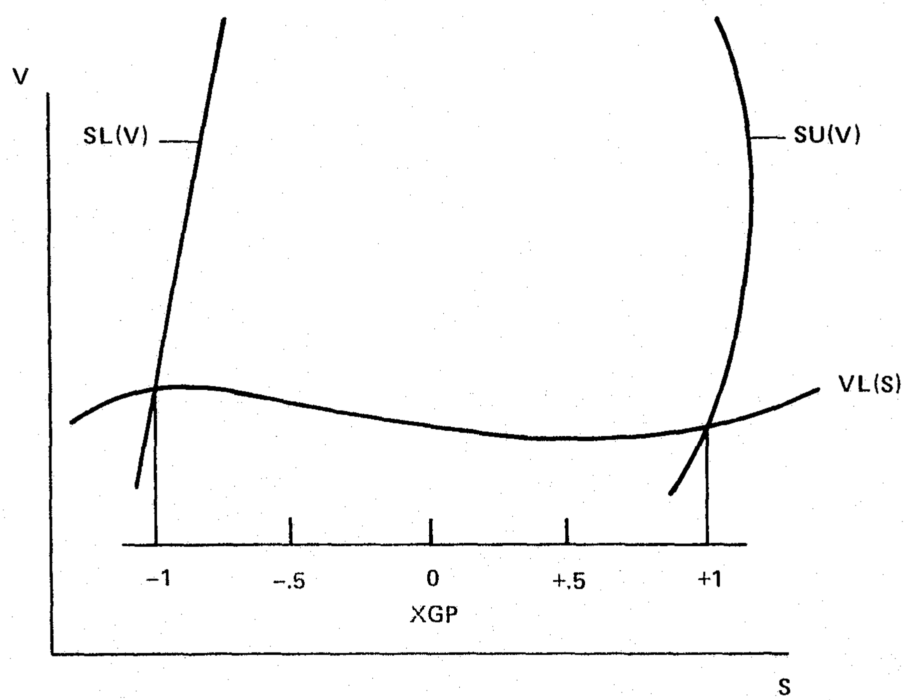


FIGURE 3.2.2-1. Nondimensional Scale for Grid Line Intersections With VL(S) Boundary Curve.

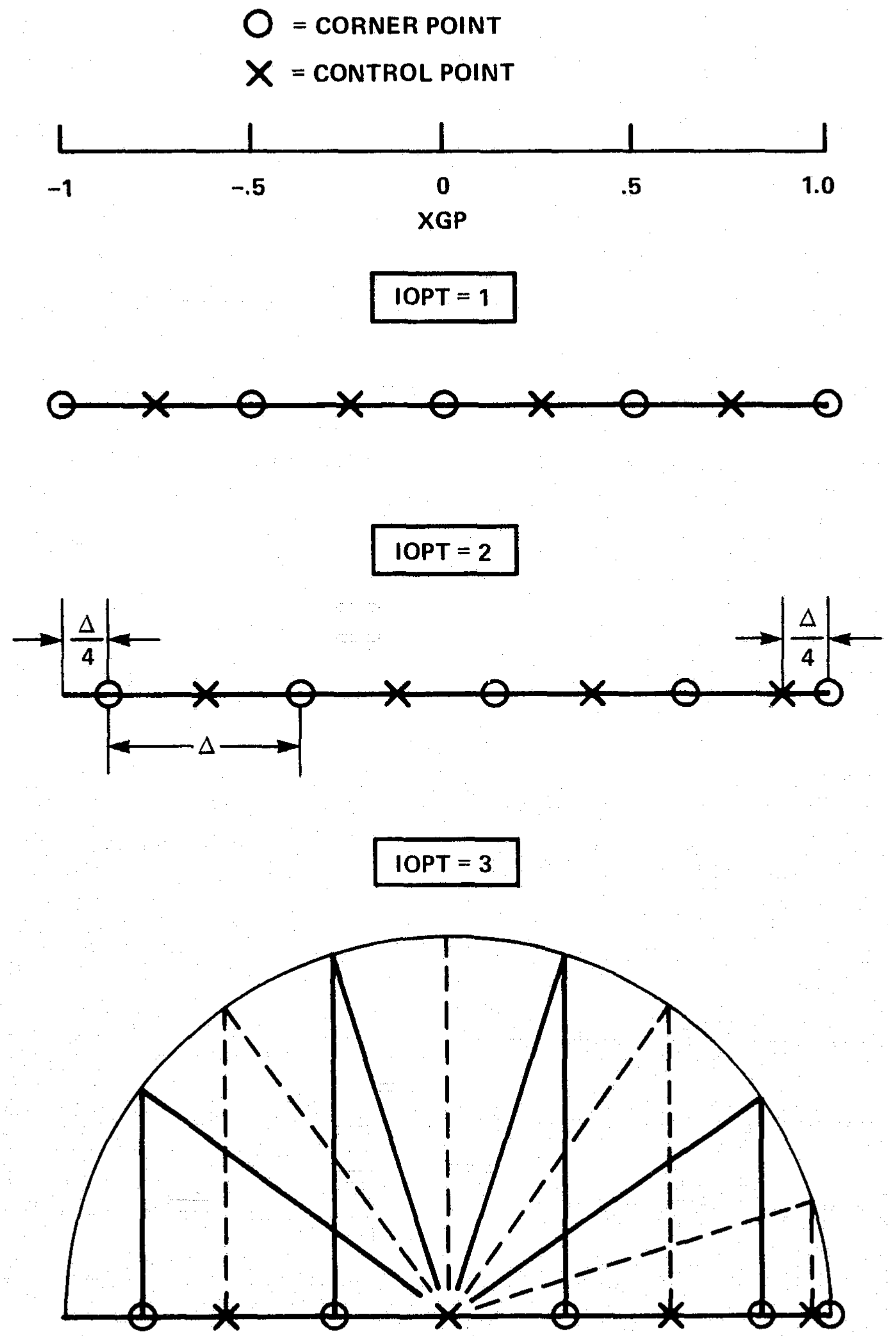


FIGURE 3.2.2-2. Some Panel Spacing Options Available with the SLBC, SUBC, VLBC, and VUBC Commands.

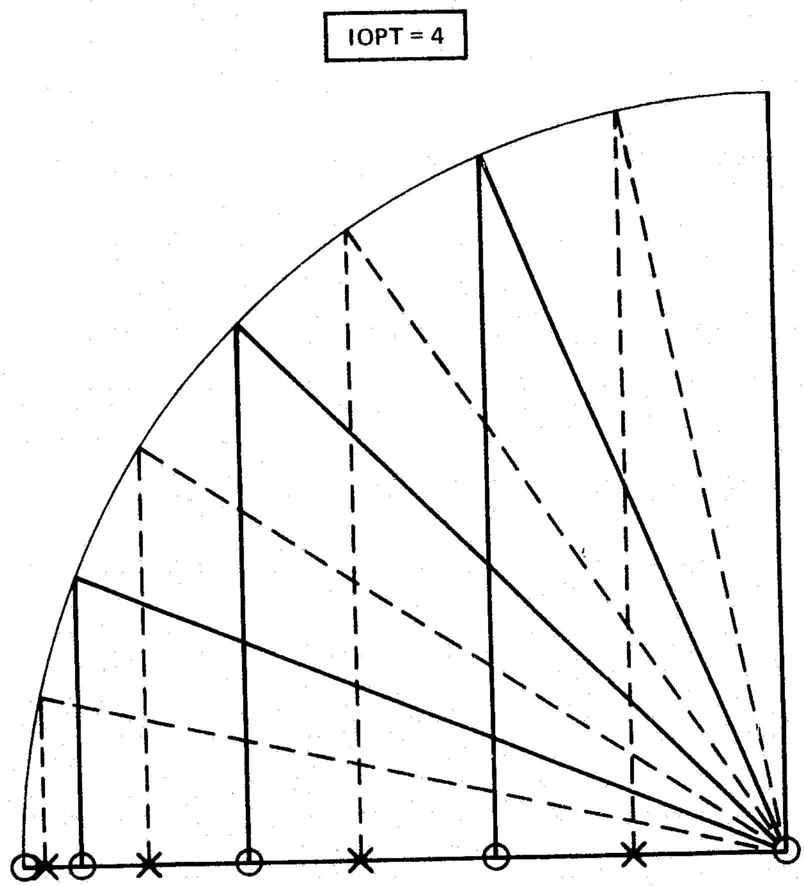


FIGURE 3.2.2-2. Continued.

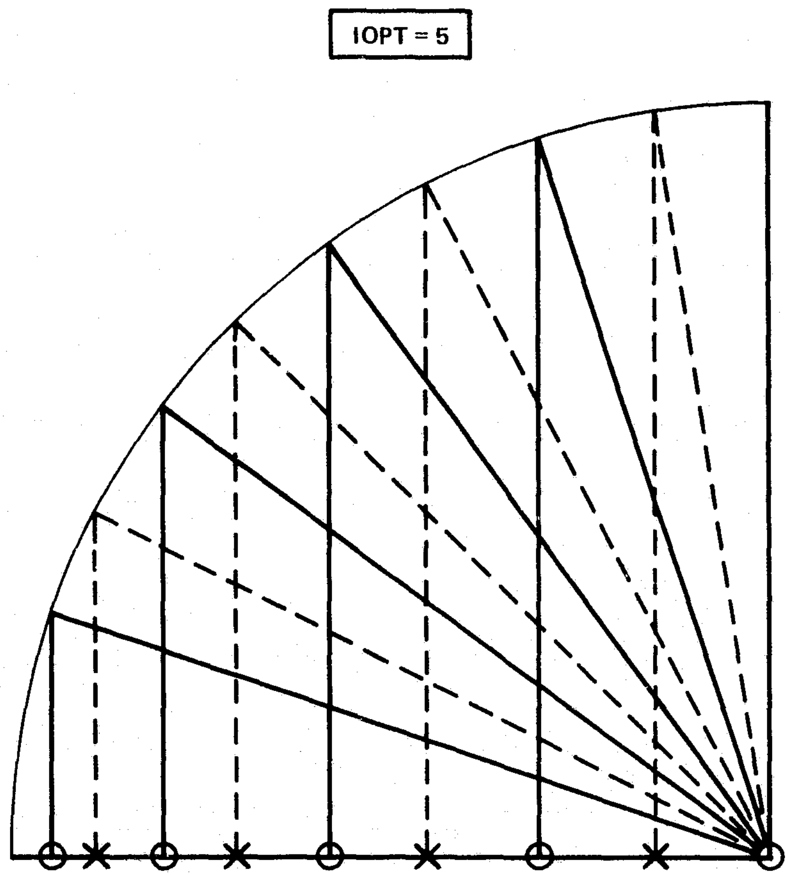
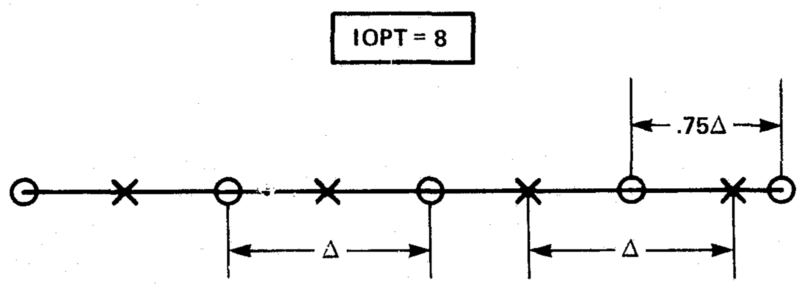


FIGURE 3.2.2-2. Continued.



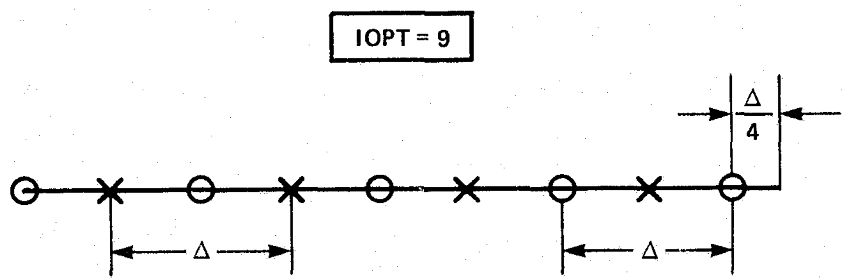


FIGURE 3.2.2-2. Concluded.

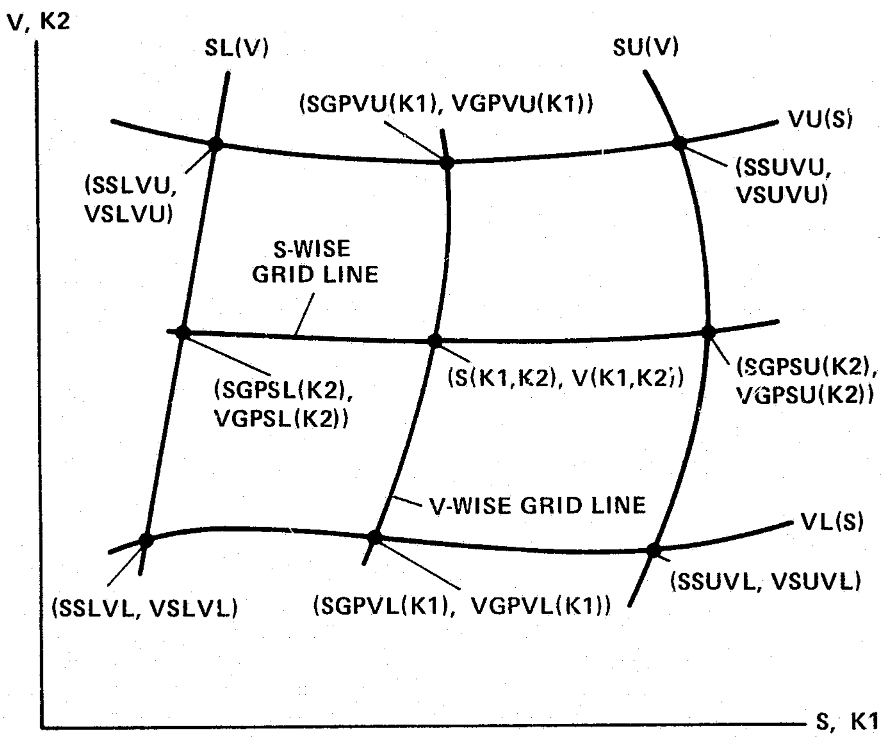


FIGURE 3.2.3-1. Definition of Various Quantities Required in the Calculation of (S,V) Values in the Interior of a Segment.

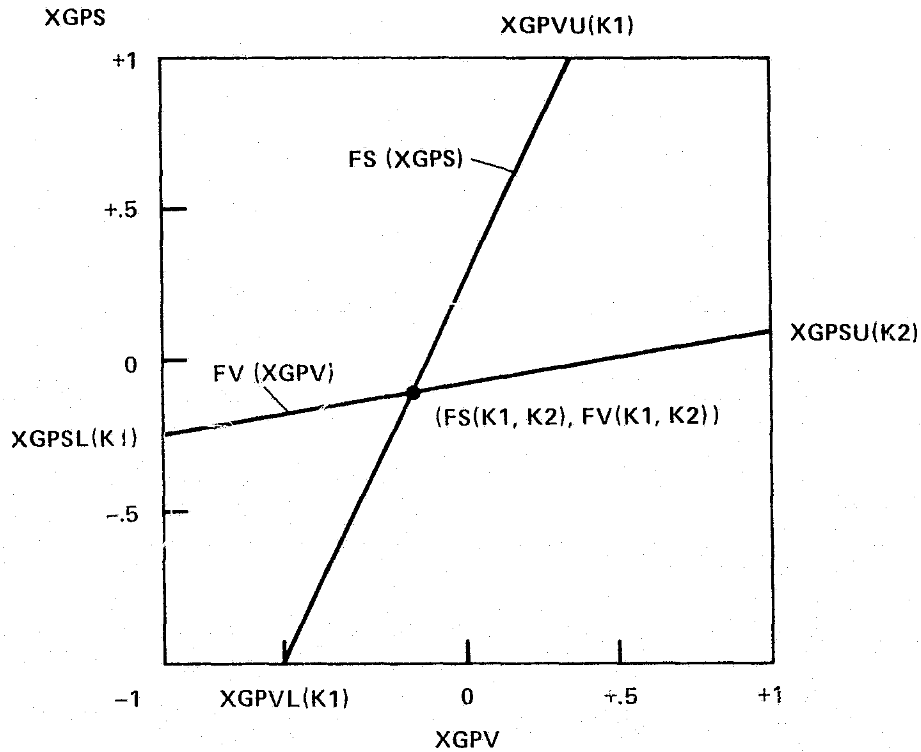


FIGURE 3.2.3-2. Determination of FS(K1,K2) and FV(K1,K2) from the Non-dimensional Description of the Grid Line and Segment Boundary Intersections.

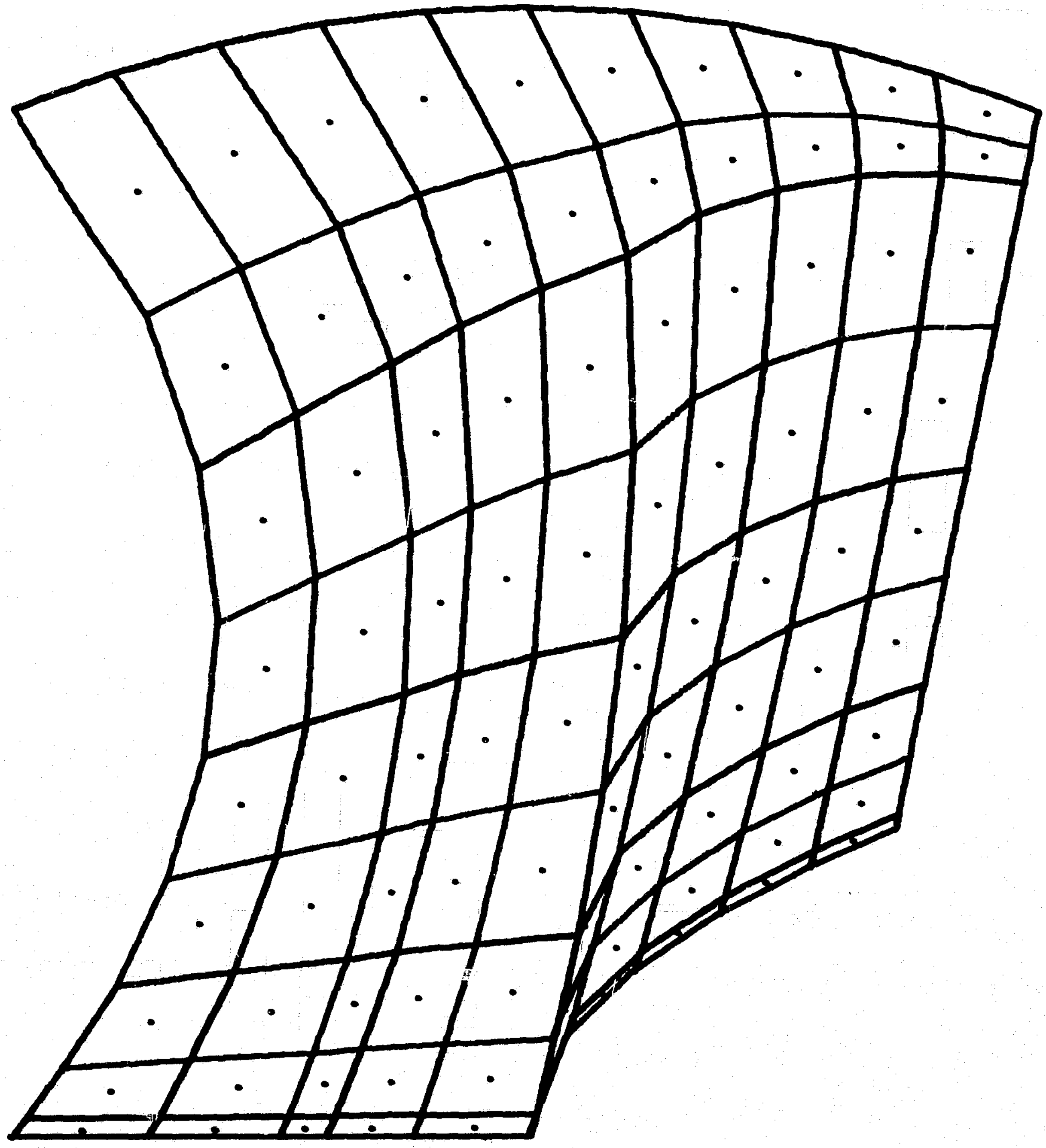


FIGURE 3.2.3-3. Example of Nonuniform Network of Corner Point (Connected by Line Segments) and Boundary Condition Point (shown as dots) Grid Lines.

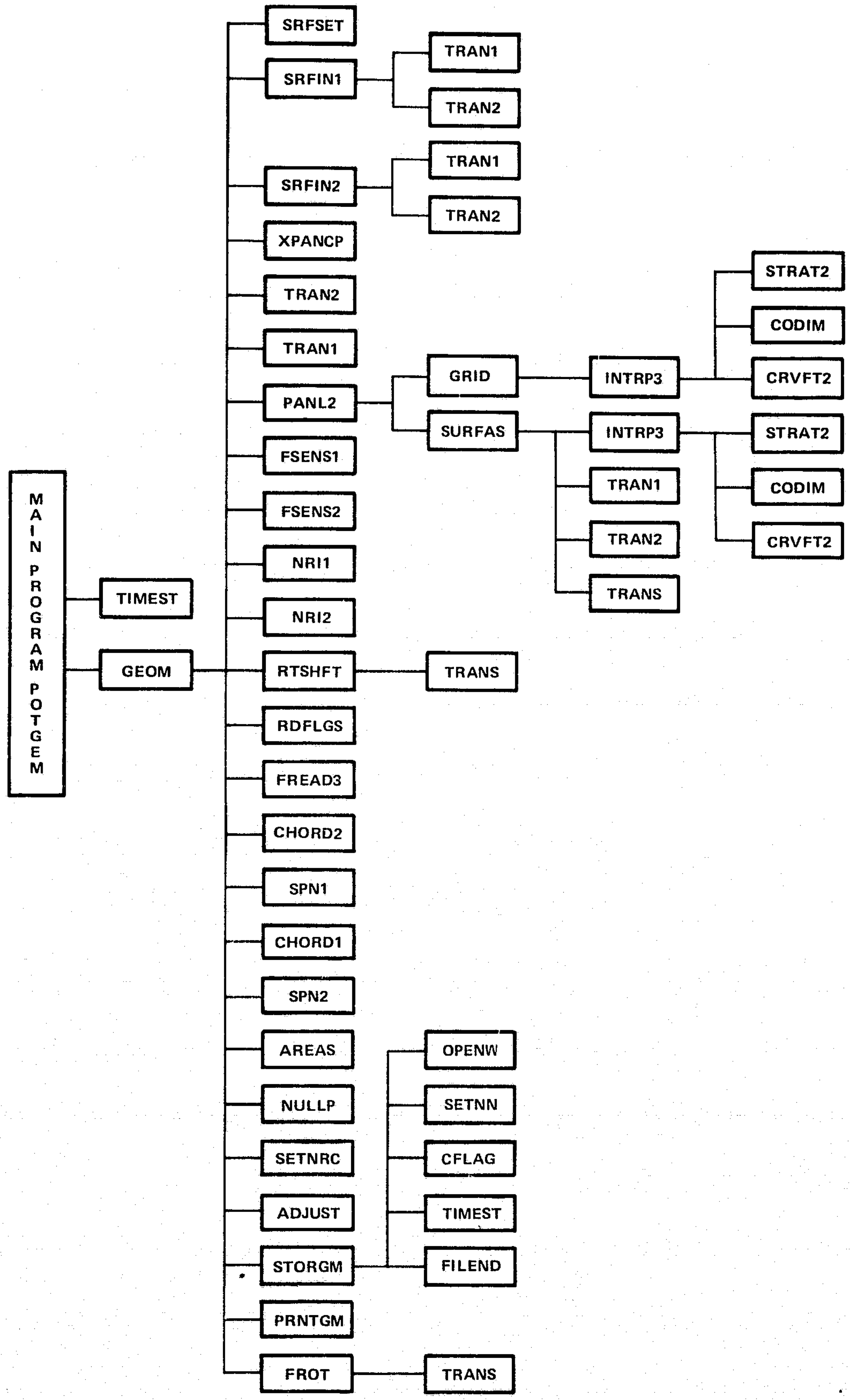


FIGURE 4.1-1. POTGEM Program Subroutine Structure.

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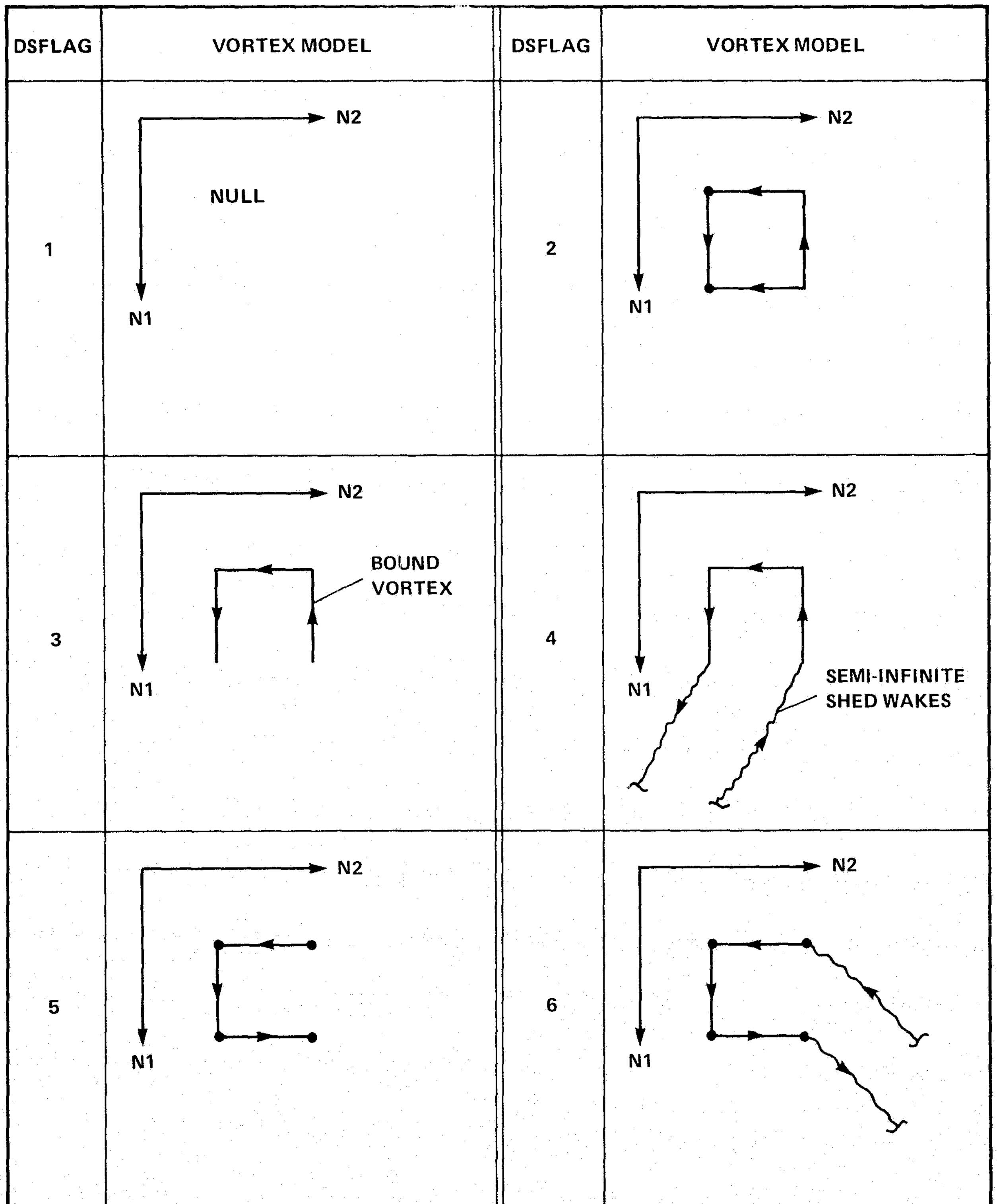


FIGURE 6.1-1. Vortex Models Available in VVIM

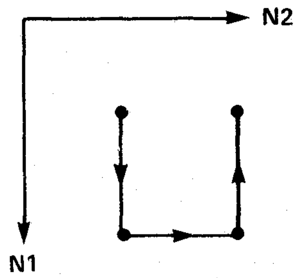
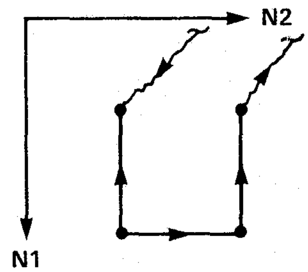
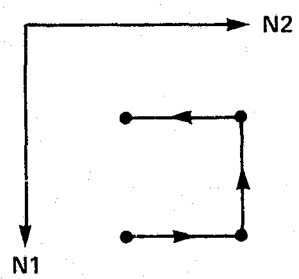
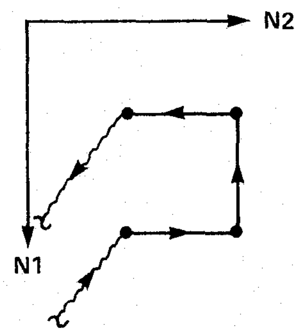
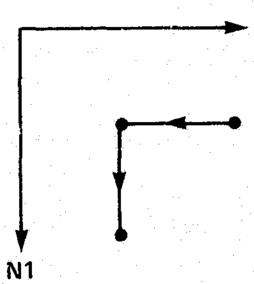
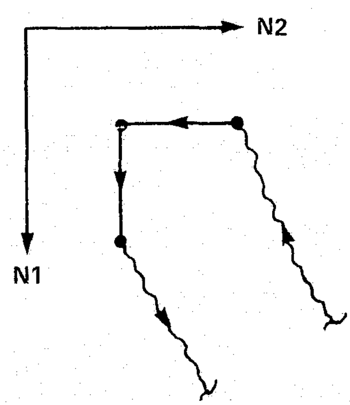
DSFLAG	VORTEX MODEL	DSFLAG	VORTEX MODEL
7		8	
9		10	
11		12	

FIGURE 6.1-1. Vortex Models Available in VVIM (Cont'd).

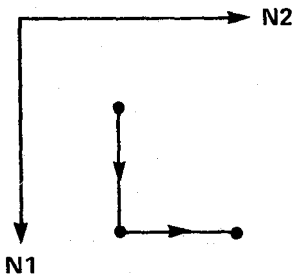
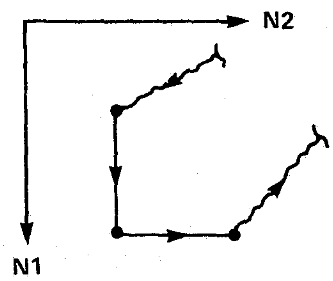
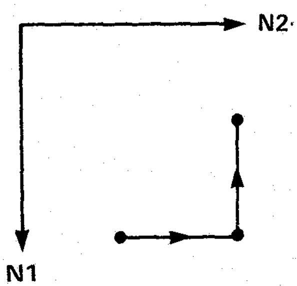
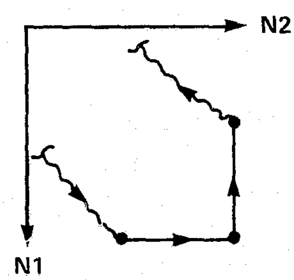
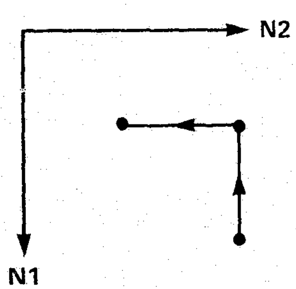
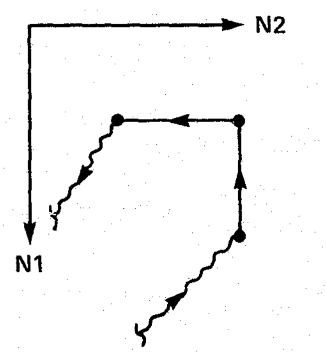
DSFLAG	VORTEX MODEL	DSFLAG	VORTEX MODEL
13		14	
15		16	
17		18	

FIGURE 6.1-1. Vortex Models Available in VVIM (Cont'd).

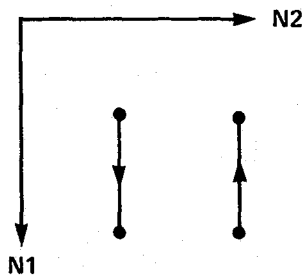
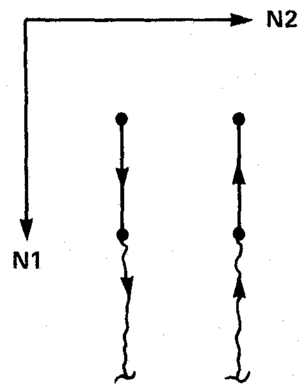
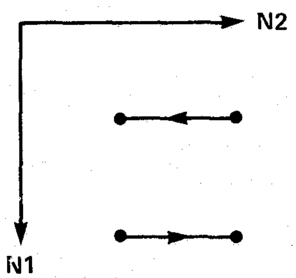
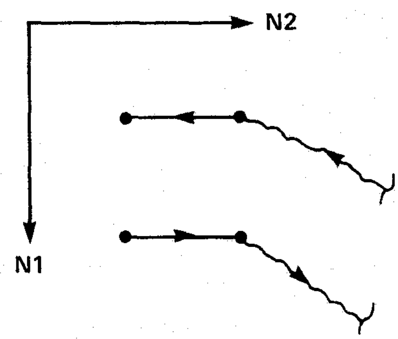
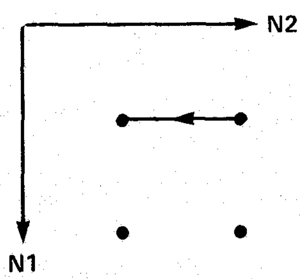
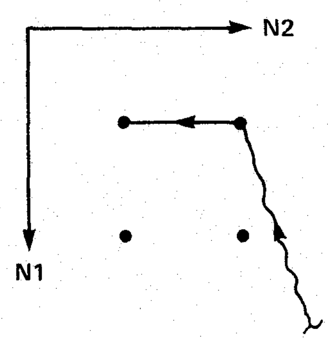
DSFLAG	VORTEX MODEL	DSFLAG	VORTEX MODEL
19		20	
21		22	
23		24	

FIGURE 6.1-1. Vortex Models Available in VVIM (Cont'd).

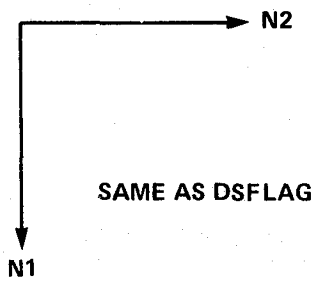
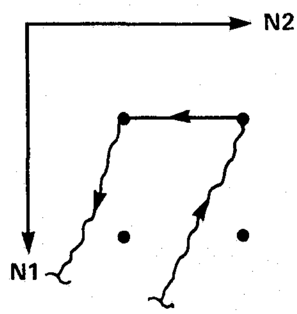
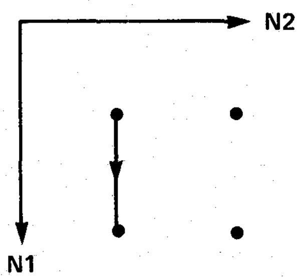
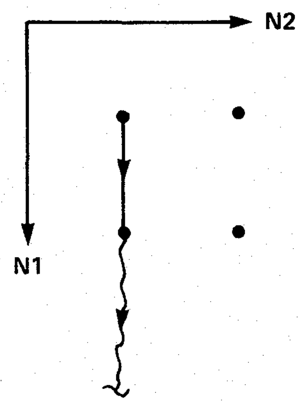
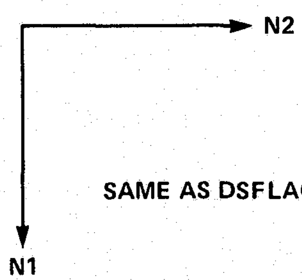
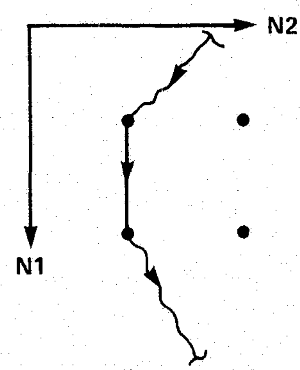
DSFLAG	VORTEX MODEL	DSFLAG	VORTEX MODEL
25	 SAME AS DSFLAG = 23	26	
27		28	
29	 SAME AS DSFLAG = 27	30	

FIGURE 6.1-1. Vortex Models Available in VVIM (Cont'd).

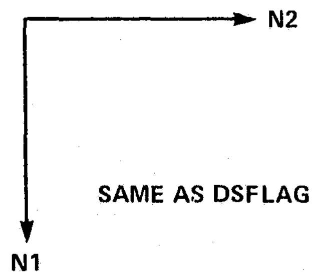
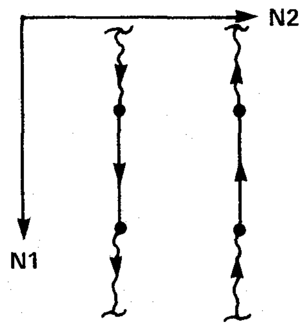
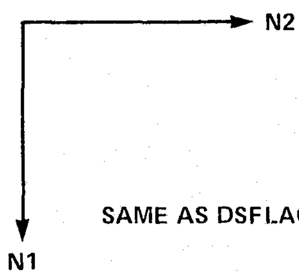
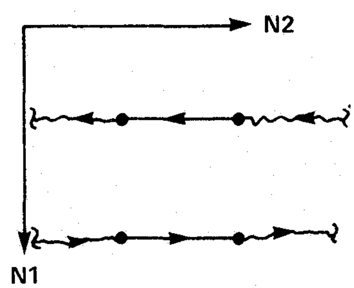
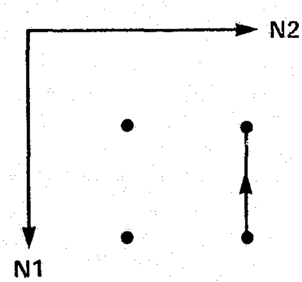
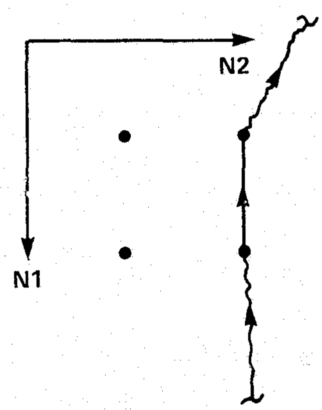
DSFLAG	VORTEX MODEL	DSFLAG	VORTEX MODEL
31	 SAME AS DSFLAG = 19	32	
33	 SAME AS DSFLAG = 21	34	
35		36	

FIGURE 6.1-1. Vortex Models Available in VVIM (Concluded).

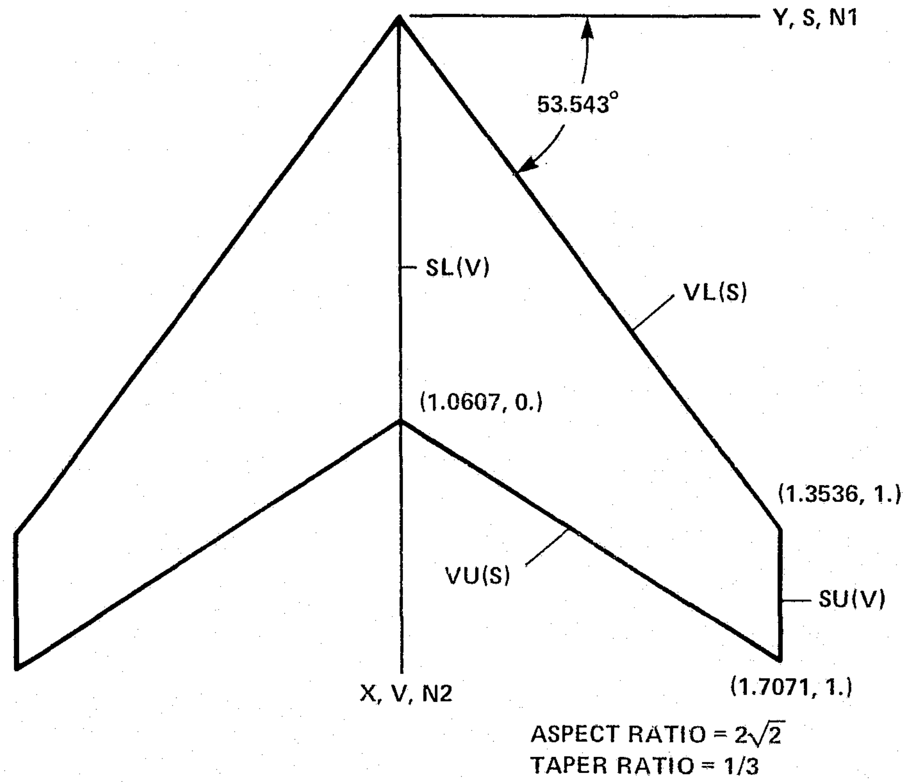


FIGURE 7.1-1. Thin, Symmetrical, Swept, Flat Wing (Warren 12 Planform).

```
T
TITLE
TEST CASE 1 - WARREN 12 WING
WING
 $DATA CROOT=1.0607,CTIP=.3536,LAMLE=53.543,R2=1.0 $END
DSEGMENTS
 $DATA NBPS=10,NBPV=4 $END
VLBC
 $DATA $END
SLBC
 $DATA IOPT=2 $END
PANI
 $DATA RSI=T $END
DSFL
    1    -1
    1    -1
   30
0
FINISH
 $DATA LOG(12)=T,T,INT(10)=1,FLT(5)=1.0,0.0,0.0 $END
STORE
 $DATA ID=1 $END
PRINT
 $DATA PRINT=18*T $END
STOP
```

FIGURE 7.1-2. Input for POTGEM Test Case 1.

```
POTFAN GEOMETRY PROGRAM,  VERSION 1.3
*************************************

TIME = 08/09/76    02:23:58

ENTER BATCH
+TITLE

TEST CASE 1 - WARREN 12 WING


+WING
+DSEGMENTS
+VLBC
+SLBC
+PANL
+DSFL
+FINISH
+STORE
FILE 1.GM-PNC/LIB$         HAS BEEN OPENED FOR WRITING ON UNIT  1
CREATION TIME = 08/09/76    02:24:05

CREATION OF GEOMETRY FILE
-------------------------

TITLE =  TEST CASE 1 - WARREN 12 WING

(LOG) =  F F F F T F F F F F F T T F F F T F T F
(INT) =    0  11   5  10   4   0    0    0    0    1    0    0    0
(FLT) =   .70715000     1.0000000     .70715000     1.0000000     1.0000000          0.          0.      13.296146
          .13296146E-02     0.           0.           0.
+PRINT

PRINTOUT OF GEOMETRY FILE DATA
------------------------------
TITLE = TEST CASE 1 - WARREN 12 WING

CREATION TIME = 08/09/76    02:24:05
(IFORM) = 1101111111
```

FIGURE 7.1-3. Output for POTGEM Test Case 1.

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```
(ID)  =   1
(LOG) =   F F F F T F F F F F T T F F F T F T F
(INT) =   0  11  5  10  4  0  0  0  0  1  0  0  0
(FLT) =        .7071500     1.0000000      .7071500     1.0000000     1.0000000     0.     0.
             13.2961460      .0013296     0.            0.            0.
```

PANEL CORNER POINTS

I	J	X(I,J)	Y(I,J)	Z(I,J)	S(I,J)	V(I,J)
1	1	.0662937	-.0000000	0.	0.	.0662938
2	1	.1972289	.1000000	0.	.1000000	.1972289
3	1	.3281641	.2000000	0.	.2000000	.3281641
4	1	.4590993	.3000000	0.	.3000000	.4590993
5	1	.5900345	.4000000	0.	.4000000	.5900345
6	1	.7209697	.5000000	0.	.5000000	.7209697
7	1	.8519049	.6000000	0.	.6000000	.8519049
8	1	.9828401	.7000000	0.	.7000000	.9828401
9	1	1.1137753	.8000000	0.	.8000000	1.1137753
10	1	1.2447104	.9000000	0.	.9000000	1.2447105
11	1	1.3756457	1.0000000	0.	1.0000000	1.3756457
1	2	.3314688	-.0000000	0.	0.	.3314688
2	2	.4447264	.1000000	0.	.1000000	.4447264
3	2	.5579841	.2000000	0.	.2000000	.5579841
4	2	.6712418	.3000000	0.	.3000000	.6712418
5	2	.7844995	.4000000	0.	.4000000	.7844995
6	2	.8977572	.5000000	0.	.5000000	.8977572
7	2	1.0110149	.6000000	0.	.6000000	1.0110149
8	2	1.1242726	.7000000	0.	.7000000	1.1242726
9	2	1.2375303	.8000000	0.	.8000000	1.2375303
10	2	1.3507880	.9000000	0.	.9000000	1.3507880
11	2	1.4640457	1.0000000	0.	1.0000000	1.4640457
1	3	.5966437	-.0000000	0.	0.	.5966438
2	3	.6922239	.1000000	0.	.1000000	.6922239
3	3	.7878041	.2000000	0.	.2000000	.7878041
4	3	.8833843	.3000000	0.	.3000000	.8833843
5	3	.9789645	.4000000	0.	.4000000	.9789645
6	3	1.0745447	.5000000	0.	.5000000	1.0745447
7	3	1.1701249	.6000000	0.	.6000000	1.1701249
8	3	1.2657051	.7000000	0.	.7000000	1.2657051
9	3	1.3612853	.8000000	0.	.8000000	1.3612853
10	3	1.4568654	.9000000	0.	.9000000	1.4568655

FIGURE 7.1-3. Output for POTGEM Test Case 1 (Cont'd).

11	3	1.5524457	1.0000000	0.	1.0000000	1.5524457
1	4	.8618187	-.0000000	0.	0.	.8618188
2	4	.9397214	.1000000	0.	.1000000	.9397214
3	4	1.0176241	.2000000	0.	.2000000	1.0176241
4	4	1.0955268	.3000000	0.	.3000000	1.0955268
5	4	1.1734295	.4000000	0.	.4000000	1.1734295
6	4	1.2513322	.5000000	0.	.5000000	1.2513322
7	4	1.3292349	.6000000	0.	.6000000	1.3292349
8	4	1.4071376	.7000000	0.	.7000000	1.4071376
9	4	1.4850403	.8000000	0.	.8000000	1.4850403
10	4	1.5629430	.9000000	0.	.9000000	1.5629430
11	4	1.6408457	1.0000000	0.	1.0000000	1.6408457
1	5	1.0607000	-.0000000	0.	0.	1.0607000
2	5	1.1253445	.1000000	0.	.1000000	1.1253446
3	5	1.1899891	.2000000	0.	.2000000	1.1899891
4	5	1.2546337	.3000000	0.	.3000000	1.2546337
5	5	1.3192783	.4000000	0.	.4000000	1.3192783
6	5	1.3839228	.5000000	0.	.5000000	1.3839228
7	5	1.4485674	.6000000	0.	.6000000	1.4485674
8	5	1.5132120	.7000000	0.	.7000000	1.5132120
9	5	1.5778565	.8000000	0.	.8000000	1.5778565
10	5	1.6425011	.9000000	0.	.9000000	1.6425011
11	5	1.7071457	1.0000000	0.	1.0000000	1.7071457

UNIT VECTORS ALONG WAKE ELEMENTS

I	J	UVWX(I,J)	UVWY(I,J)	UVWZ(I,J)

UNAVAILABLE

BOUNDARY CONDITION FLAGS

I	J	BCFLAG(I,J)

UNAVAILABLE

DOUBLET SINGULARITY FLAGS

I	J	DSFLAG(I,J)
1	1	3_0
2	1	3_0

FIGURE 7.1-3. Output for POTGEM Test Case 1 (Cont'd).

3	1	30
4	1	30
5	1	30
6	1	30
7	1	30
8	1	30
9	1	30
10	1	30
1	2	30
2	2	30
3	2	30
4	2	30
5	2	30
6	2	30
7	2	30
8	2	30
9	2	30
10	2	30
1	3	30
2	3	30
3	3	30
4	3	30
5	3	30
6	3	30
7	3	30
8	3	30
9	3	30
10	3	30
1	4	30
2	4	30
3	4	30
4	4	30
5	4	30
6	4	30
7	4	30
8	4	30
9	4	30
10	4	30

SOURCE SINGULARITY FLAGS

FIGURE 7.1-3. Output for POTGEM Test Case 1 (Cont'd).

I J SSFLAG(I,J)

UNAVAILABLE

BOUNDARY CONDITION POINTS

I	J	XBC(I,J)	YBC(I,J)	ZBC(I,J)	SBC(I,J)	VBC(I,J)
1	1	.2599295	.0500000	0.	.0500000	.2599295
2	1	.3820259	.1500000	0.	.1500000	.3820259
3	1	.5041223	.2500000	0.	.2500000	.5041224
4	1	.6262188	.3500000	0.	.3500000	.6262188
5	1	.7483152	.4500000	0.	.4500000	.7483152
6	1	.8704117	.5500000	0.	.5500000	.8704117
7	1	.9925081	.6500000	0.	.6500000	.9925081
8	1	1.1146045	.7500000	0.	.7500000	1.1146046
9	1	1.2367010	.8500000	0.	.8500000	1.2367010
10	1	1.3587974	.9500000	0.	.9500000	1.3587974
1	2	.5162657	.0500000	0.	.0500000	.5162657
2	2	.6206846	.1500000	0.	.1500000	.6206847
3	2	.7251036	.2500000	0.	.2500000	.7251036
4	2	.8295225	.3500000	0.	.3500000	.8295225
5	2	.9339415	.4500000	0.	.4500000	.9339415
6	2	1.0383604	.5500000	0.	.5500000	1.0383604
7	2	1.1427794	.6500000	0.	.6500000	1.1427794
8	2	1.2471983	.7500000	0.	.7500000	1.2471983
9	2	1.3516172	.8500000	0.	.8500000	1.3516172
10	2	1.4560362	.9500000	0.	.9500000	1.4560362
1	3	.7726020	.0500000	0.	.0500000	.7726020
2	3	.8593434	.1500000	0.	.1500000	.8593434
3	3	.9460848	.2500000	0.	.2500000	.9460848
4	3	1.0328263	.3500000	0.	.3500000	1.0328263
5	3	1.1195677	.4500000	0.	.4500000	1.1195677
6	3	1.2063092	.5500000	0.	.5500000	1.2063092
7	3	1.2930506	.6500000	0.	.6500000	1.2930506
8	3	1.3797920	.7500000	0.	.7500000	1.3797920
9	3	1.4665335	.8500000	0.	.8500000	1.4665335
10	3	1.5532749	.9500000	0.	.9500000	1.5532749
1	4	1.0289382	.0500000	0.	.0500000	1.0289382
2	4	1.0980021	.1500000	0.	.1500000	1.0980022
3	4	1.1670661	.2500000	0.	.2500000	1.1670661
4	4	1.2361300	.3500000	0.	.3500000	1.2361300

FIGURE 7.1-3. Output for POTGEM Test Case 1 (Cont'd).

5	4	1.3051940	.4500000	0.	.4500000	1.3051940
6	4	1.3742579	.5500000	0.	.5500000	1.3742579
7	4	1.4433218	.6500000	0.	.6500000	1.4433219
8	4	1.5123858	.7500000	0.	.7500000	1.5123858
9	4	1.5814497	.8500000	0.	.8500000	1.5814497
10	4	1.6505137	.9500000	0.	.9500000	1.6505137

UNIT NORMALS AND AREAS

I	J	UNX(I,J)	UNY(I,J)	UNZ(I,J)	DA(I,J)
1	1	0.	0.	-1.0000000	.0256336
2	1	0.	0.	-1.0000000	.0238659
3	1	0.	0.	-1.0000000	.0220981
4	1	0.	0.	-1.0000000	.0203304
5	1	0.	0.	-1.0000000	.0185626
6	1	0.	0.	-1.0000000	.0167949
7	1	0.	0.	-1.0000000	.0150271
8	1	0.	0.	-1.0000000	.0132594
9	1	0.	0.	-1.0000000	.0114916
10	1	0.	0.	-1.0000000	.0097239
1	2	0.	0.	-1.0000000	.0256336
2	2	0.	0.	-1.0000000	.0238659
3	2	0.	0.	-1.0000000	.0220981
4	2	0.	0.	-1.0000000	.0203304
5	2	0.	0.	-1.0000000	.0185626
6	2	0.	0.	-1.0000000	.0167949
7	2	0.	0.	-1.0000000	.0150271
8	2	0.	0.	-1.0000000	.0132594
9	2	0.	0.	-1.0000000	.0114916
10	2	0.	0.	-1.0000000	.0097239
1	3	0.	0.	-1.0000000	.0256336
2	3	0.	0.	-1.0000000	.0238659
3	3	0.	0.	-1.0000000	.0220981
4	3	0.	0.	-1.0000000	.0203304
5	3	0.	0.	-1.0000000	.0185626
6	3	0.	0.	-1.0000000	.0167949
7	3	0.	0.	-1.0000000	.0150271
8	3	0.	0.	-1.0000000	.0132594
9	3	0.	0.	-1.0000000	.0114916
10	3	0.	0.	-1.0000000	.0097239
1	4	0.	0.	-1.0000000	.0192252

FIGURE 7.1-3. Output for POTGEM Test Case 1 (Cont'd).

2	4	0.	0.	-1.0000000	.0178994
3	4	0.	0.	-1.0000000	.0165736
4	4	0.	0.	-1.0000000	.0152478
5	4	0.	0.	-1.0000000	.0139220
6	4	0.	0.	-1.0000000	.0125962
7	4	0.	0.	-1.0000000	.0112703
8	4	0.	0.	-1.0000000	.0099445
9	4	0.	0.	-1.0000000	.0086187
10	4	0.	0.	-1.0000000	.0072929

NTOP VECTORS

I	J	NTOPX(I,J)	NTOPY(I,J)	NTOPZ(I,J)

UNAVAILABLE

NBOT VECTORS

I	J	NBOTX(I,J)	NBOTY(I,J)	NBOTZ(I,J)

UNAVAILABLE

VELOCITY ALONG NTOP VECTORS

I	J	QTOP(I,J)

UNAVAILABLE

VELOCITY ALONG NBOT VECTORS

I	J	QBOT(I,J)

UNAVAILABLE

CORNER POINTS ALONG VL AND VU EDGES

I	XVLC(I)	YVLC(I)	ZVLC(I)	SVLC(I)	VVLC(I)	XVUC(I)	YVUC(I)	ZVUC(I)	SVUC(I)	VVUC(I)
1	0.	0.	0.	0.	0.	1.06070	-.00000	0.	0.	1.06070
2	.13535	.10000	0.	.10000	.13535	1.12534	.10000	0.	.10000	1.12534
3	.27071	.20000	0.	.20000	.27071	1.18999	.20000	0.	.20000	1.18999
4	.40606	.30000	0.	.30000	.40606	1.25463	.30000	0.	.30000	1.25463

FIGURE 7.1-3. Output for POTGEM Test Case 1 (Cont'd).

5	.54142	.40000	0.	.40000	.54142	1.31928	.40000	0.	.40000	1.31928
6	.67677	.50000	0.	.50000	.67677	1.38392	.50000	0.	.50000	1.38392
7	.81213	.60000	0.	.60000	.81213	1.44857	.60000	0.	.60000	1.44857
8	.94748	.70000	0.	.70000	.94748	1.51321	.70000	0.	.70000	1.51321
9	1.08284	.80000	0.	.80000	1.08284	1.57786	.80000	0.	.80000	1.57786
10	1.21819	.90000	0.	.90000	1.21819	1.64250	.90000	0.	.90000	1.64250
11	1.35355	1.00000	0.	1.00000	1.35355	1.70715	1.00000	0.	1.00000	1.70715

BOUNDARY POINTS ALONG VL AND VU EDGES

I	XVLB(I)	YVLB(I)	ZVLB(I)	SVLB(I)	VVLB(I)	XVUB(I)	YVUB(I)	ZVUB(I)	SVUB(I)	VVUB(I)	CORD2(I)	SPAN1(I)
1	.068	.050	0.	.050	.068	1.093	.050	0.	.050	1.093	1.025	.100
2	.203	.150	0.	.150	.203	1.158	.150	0.	.150	1.158	.955	.100
3	.338	.250	0.	.250	.338	1.222	.250	0.	.250	1.222	.884	.100
4	.474	.350	0.	.350	.474	1.287	.350	0.	.350	1.287	.813	.100
5	.609	.450	0.	.450	.609	1.352	.450	0.	.450	1.352	.743	.100
6	.744	.550	0.	.550	.744	1.416	.550	0.	.550	1.416	.672	.100
7	.880	.650	0.	.650	.880	1.481	.650	0.	.650	1.481	.601	.100
8	1.015	.750	0.	.750	1.015	1.546	.750	0.	.750	1.546	.530	.100
9	1.151	.850	0.	.850	1.151	1.610	.850	0.	.850	1.610	.460	.100
10	1.286	.950	0.	.950	1.286	1.675	.950	0.	.950	1.675	.389	.100

CORNER POINTS ALONG SL AND SU EDGES

I	XSLC(I)	YSLC(I)	ZSLC(I)	SSLC(I)	VSLC(I)	XSUC(I)	YSUC(I)	ZSUC(I)	SSUC(I)	VSUC(I)
1	.06629	-.00000	0.	0.	.06629	1.37565	1.00000	0.	1.00000	1.37565
2	.33147	-.00000	0.	0.	.33147	1.46405	1.00000	0.	1.00000	1.46405
3	.59664	-.00000	0.	0.	.59664	1.55245	1.00000	0.	1.00000	1.55245
4	.86182	-.00000	0.	0.	.86182	1.64085	1.00000	0.	1.00000	1.64085
5	1.06070	-.00000	0.	0.	1.06070	1.70715	1.00000	0.	1.00000	1.70715

BOUNDARY POINTS ALONG SL AND SU EDGES

I	XSLB(I)	YSLB(I)	ZSLB(I)	SSLB(I)	VSLB(I)	XSUB(I)	YSUB(I)	ZSUB(I)	SSUB(I)	VSUB(I)	CORD1(I)	SPAN2(I)
1	.199	-.000	0.	0.	.199	1.420	1.000	0.	1.000	1.420	1.000	.265
2	.464	-.000	0.	0.	.464	1.508	1.000	0.	1.000	1.508	1.000	.265
3	.729	-.000	0.	0.	.729	1.597	1.000	0.	1.000	1.597	1.000	.265
4	.994	-.000	0.	0.	.994	1.685	1.000	0.	1.000	1.685	1.000	.199

FORCE SENSING LOCATIONS IN N1-DIRECTION

FIGURE 7.1-3. Output for POTGEM Test Case 1 (Cont'd).

I	J	XS1(I,J)	YS1(I,J)	ZS1(I,J)
1	1	.1317613	.0500000	0.
2	1	.2626965	.1500000	0.
3	1	.3936317	.2500000	0.
4	1	.5245669	.3500000	0.
5	1	.6555021	.4500000	0.
6	1	.7864373	.5500000	0.
7	1	.9173725	.6500000	0.
8	1	1.0483077	.7500000	0.
9	1	1.1792428	.8500000	0.
10	1	1.3101780	.9500000	0.
1	2	.3880976	.0500000	0.
2	2	.5013553	.1500000	0.
3	2	.6146130	.2500000	0.
4	2	.7278707	.3500000	0.
5	2	.8411284	.4500000	0.
6	2	.9543860	.5500000	0.
7	2	1.0676437	.6500000	0.
8	2	1.1809014	.7500000	0.
9	2	1.2941591	.8500000	0.
10	2	1.4074168	.9500000	0.
1	3	.6444338	.0500000	0.
2	3	.7400140	.1500000	0.
3	3	.8355942	.2500000	0.
4	3	.9311744	.3500000	0.
5	3	1.0267546	.4500000	0.
6	3	1.1223348	.5500000	0.
7	3	1.2179150	.6500000	0.
8	3	1.3134952	.7500000	0.
9	3	1.4090753	.8500000	0.
10	3	1.5046555	.9500000	0.
1	4	.9007701	.0500000	0.
2	4	.9786728	.1500000	0.
3	4	1.0565754	.2500000	0.
4	4	1.1344781	.3500000	0.
5	4	1.2123808	.4500000	0.
6	4	1.2902835	.5500000	0.
7	4	1.3681862	.6500000	0.
8	4	1.4460889	.7500000	0.
9	4	1.5239916	.8500000	0.
10	4	1.6018943	.9500000	0.

FIGURE 7.1-3. Output for POTGEM Test Case 1 (Cont'd).

```
  1  5      1.0930223       .0500000      0.
  2  5      1.1576668       .1500000      0.
  3  5      1.2223114       .2500000      0.
  4  5      1.2869560       .3500000      0.
  5  5      1.3516005       .4500000      0.
  6  5      1.4162451       .5500000      0.
  7  5      1.4808897       .6500000      0.
  8  5      1.5455342       .7500000      0.
  9  5      1.6101788       .8500000      0.
 10  5      1.6748234       .9500000      0.

FORCE SENSING LOCATIONS IN N2-DIRECTION
  I  J      XS2(I,J)        YS2(I,J)        ZS2(I,J)

UNAVAILABLE
+STOP
 STOP 777
```

FIGURE 7.1-3. Output for POTGEM Test Case 1 (Concluded).

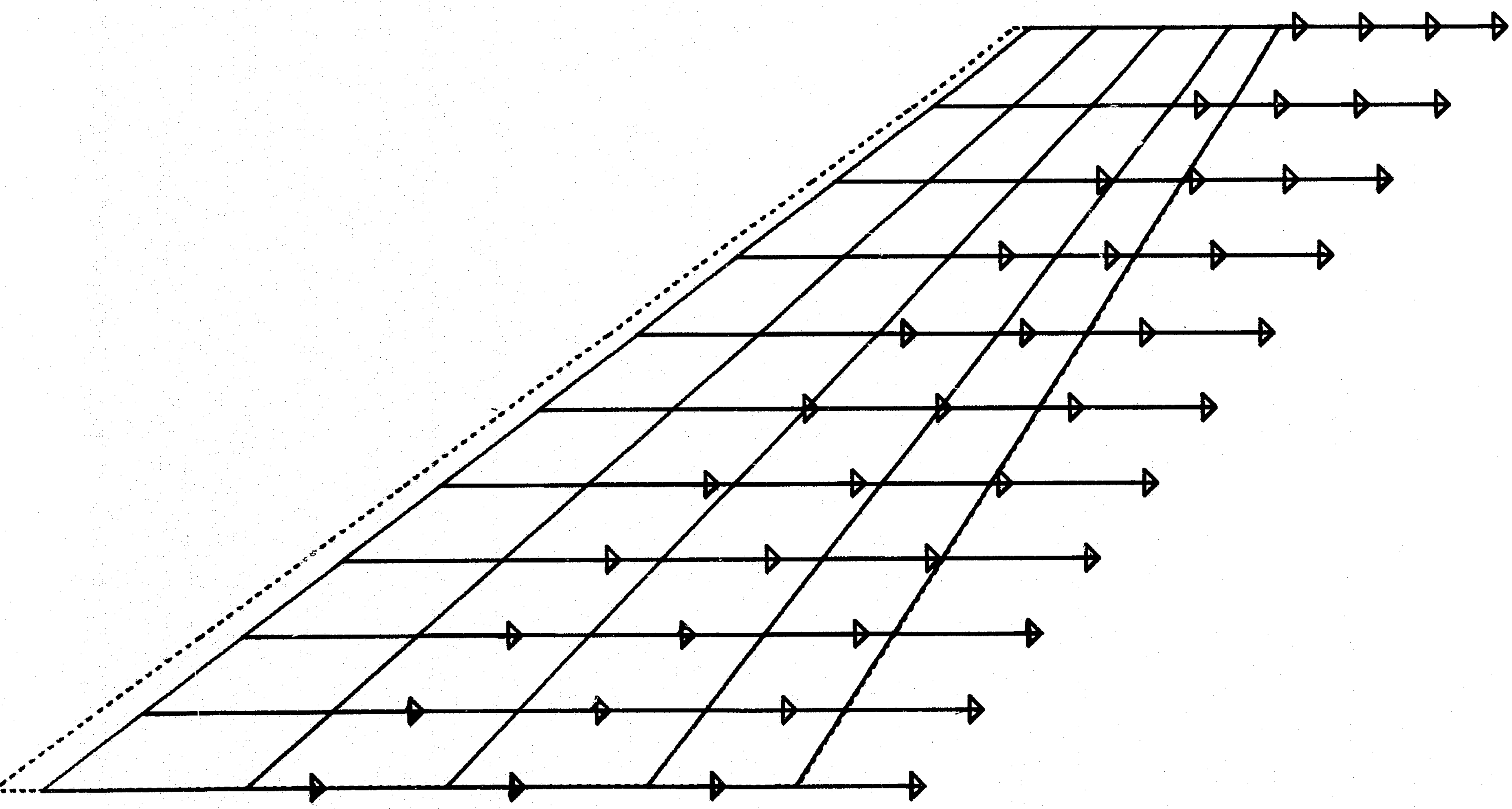


FIGURE 7.1-4. Planview of POTGEM Test Case 1.

```
TRUE
    THIS IS THE PLOTGM RUN TO PLOT THE PLANFORM VIEW OF
    GEOMETRY TEST CASE 1 (WARREN 12 WING).
    THIS VIEW INCLUDES THE PANELS, OUTLINE, AND
    UNIT WAKE VECTORS.
    THE SCALE IS SET TO PLOT THE SEMISPAN (1.0 UNITS)
    IN A DISTANCE OF 20.0 CM.
READ
    1
IPLOT
    0     0     0
PLOT
 $DATA YOFF=2,XSCALE=.05,YSCALE=.05 $END
OUTLINE
 $DATA IPEN=4,4 $END
WAKES
 $DATA WAKECM=7,ARRWCM=0.7 $END
STOP
```

FIGURE 7.1-5. PLOTGM Input That Generated Figure 7.1-4.

```
T
TITLE
TEST CASE 2 - WARREN 12 WING
CARY
SRT1
 $INCRV1 IC=1,COPT=0 $END
SRT1
 $INCRV1 IC=2,COPT=2 $END
SRT1
 $INCRV1 IC=4,COPT=1,NTAB=1,VAR2=-90. $END
SRT1
 $INCRV1 IC=5,COPT=0 $END
SRT1
 $INCRV1 IC=7,COPT=1,VAR2=1. $END
SRT1
 $INCRV1 IC=11,COPT=0 $END
DSEGMENTS
 $DATA NBPS=10,NBPV=4 $END
VLBC
 $DATA $END
SLBC
 $DATA IOPT=2 $END
SL
 $DATA IOPTSV=0 $END
SU
 $DATA IOPTSV=1,NTABSV=1,VAR2SV=1.0 $END
VL
 $DATA NTABSV=2,VAR1SV=0.,1.,VAR2SV=0.,1.3535457 $END
VU
 $DATA VAR2SV=1.0607,1.7071457 $END
PANL
 $DATA RS1=T $END
DSFL
     1    -1
     1    -1
    30
```

FIGURE 7.2-1. Input for POTGEM Test Case 2.

```
0
FINISH
 $DATA LOG(12)=T,T,INT(1)=1,INT(10)=1,FLT(1)=.70715,FLT(5)=1.,0.,0. $END
STORE
 $DATA ID=2 $END
PRINT
 $DATA PRINT=18*T $END
STOP
```

FIGURE 7.2-1. Input for POTGEM Test Case 2 (Concluded).

```
POTFAN GEOMETRY PROGRAM.  VERSION 1.3
=====================================

TIME = 08/09/76     02:24:23

ENTER BATCH
+TITLE

TEST CASE 2 - WARREN 12 WING


+CARY
+SRI1
+SRI1
+SRI1
+SRI1
+SRI1
+SRI1
+DSEGMENT:
+VLBC
+SLBC
+SL
+SU
+VL
+VU
+PANL
+DSFL
+FINISH
+STORE
FILE 2.GM-PNC/LIB$          HAS BEEN OPENED FOR WRITING ON UNIT  1
CREATION TIME = 08/09/76     02:24:34

CREATION OF GEOMETRY FILE
=========================

TITLE =  TEST CASE 2 - WARREN 12 WING

(LOG) =  F F F F T F F F F F F T T F F F T F T F
(INT) =     0   11    5   10    4    0    0    0    0    1    0    0    0
```

FIGURE 7.2-2. Output for POTGEM Test Case 2

```
(FLT) =   .70715000      1.0000000      .70714998      1.0000000      1.0000000          0.          0.      13.296146
          .13296146E-02          0.            0.            0.
+PRINT

PRINTOUT OF GEOMETRY FILE DATA
-------------------------------
TITLE = TEST CASE 2 - WARREN 12 WING

CREATION TIME = 08/09/76    02:24:34
(IFORM) = 1101111111
(ID)  =       2
(LOG) =  F F F F T F F F F F F T T F F F T F T F
(INT) =      0    11    5   10    4    0    0    0    0    1    0    0    0
(FLT) =          .7071500      1.0000000      .7071500      1.0000000      1.0000000       0.        0.
           13.2961460      .0013296      0.          0.          0.


PANEL CORNER POINTS
  I  J       X(I,J)        Y(I,J)        Z(I,J)        S(I,J)        V(I,J)
  1  1       .0662937     -.0000000      0.           0.            .0662938
  2  1       .1972289      .1000000      0.            .1000000     .1972289
  3  1       .3281641      .2000000      0.            .2000000     .3281641
  4  1       .4590993      .3000000      0.            .3000000     .4590993
  5  1       .5900345      .4000000      0.            .4000000     .5900345
  6  1       .7209697      .5000000      0.            .5000000     .7209697
  7  1       .8519049      .6000000      0.            .6000000     .8519049
  8  1       .9828401      .7000000      0.            .7000000     .9828401
  9  1      1.1137753      .8000000      0.            .8000000    1.1137753
 10  1      1.2447104      .9000000      0.            .9000000    1.2447105
 11  1      1.3756457     1.0000000      0.           1.0000000    1.3756457
  1  2       .3314688     -.0000000      0.           0.            .3314688
  2  2       .4447264      .1000000      0.            .1000000     .4447264
  3  2       .5579841      .2000000      0.            .2000000     .5579841
  4  2       .6712418      .3000000      0.            .3000000     .6712418
  5  2       .7844995      .4000000      0.            .4000000     .7844995
  6  2       .8977572      .5000000      0.            .5000000     .8977572
  7  2      1.0110149      .6000000      0.            .6000000    1.0110149
  8  2      1.1242726      .7000000      0.            .7000000    1.1242726
  9  2      1.2375303      .8000000      0.            .8000000    1.2375303
 10  2      1.3507880      .9000000      0.            .9000000    1.3507880
 11  2      1.4640457     1.0000000      0.           1.0000000    1.4640457
```

FIGURE 7.2-2. Output for POTGEM Test Case 2 (Cont'd).

1	3	.5966437	-.0000000	0.	0.	.5966438
2	3	.6922239	.1000000	0.	.1000000	.6922239
3	3	.7878041	.2000000	0.	.2000000	.7878041
4	3	.8833843	.3000000	0.	.3000000	.8833843
5	3	.9789645	.4000000	0.	.4000000	.9789645
6	3	1.0745447	.5000000	0.	.5000000	1.0745447
7	3	1.1701249	.6000000	0.	.6000000	1.1701249
8	3	1.2657051	.7000000	0.	.7000000	1.2657051
9	3	1.3612853	.8000000	0.	.8000000	1.3612853
10	3	1.4568654	.9000000	0.	.9000000	1.4568655
11	3	1.5524457	1.0000000	0.	1.0000000	1.5524457
1	4	.8618187	-.0000000	0.	0.	.8618188
2	4	.9397214	.1000000	0.	.1000000	.9397214
3	4	1.0176241	.2000000	0.	.2000000	1.0176241
4	4	1.0955268	.3000000	0.	.3000000	1.0955268
5	4	1.1734295	.4000000	0.	.4000000	1.1734295
6	4	1.2513322	.5000000	0.	.5000000	1.2513322
7	4	1.3292349	.6000000	0.	.6000000	1.3292349
8	4	1.4071376	.7000000	0.	.7000000	1.4071376
9	4	1.4850403	.8000000	0.	.8000000	1.4850403
10	4	1.5629430	.9000000	0.	.9000000	1.5629430
11	4	1.6408457	1.0000000	0.	1.0000000	1.6408457
1	5	1.0607000	-.0000000	0.	0.	1.0607000
2	5	1.1253445	.1000000	0.	.1000000	1.1253446
3	5	1.1899891	.2000000	0.	.2000000	1.1899891
4	5	1.2546337	.3000000	0.	.3000000	1.2546337
5	5	1.3192783	.4000000	0.	.4000000	1.3192783
6	5	1.3839228	.5000000	0.	.5000000	1.3839228
7	5	1.4485674	.6000000	0.	.6000000	1.4485674
8	5	1.5132120	.7000000	0.	.7000000	1.5132120
9	5	1.5778565	.8000000	0.	.8000000	1.5778565
10	5	1.6425011	.9000000	0.	.9000000	1.6425011
11	5	1.7071457	1.0000000	0.	1.0000000	1.7071457

UNIT VECTORS ALONG WAKE ELEMENTS

I	J	UVWX(I,J)	UVWY(I,J)	UVWZ(I,J)

UNAVAILABLE

FIGURE 7.2-2. Output for POTGEM Test Case 2 (Cont'd).

```
BOUNDARY CONDITION FLAGS
  I   J   BCFLAG(I,J)

UNAVAILABLE


DOUBLET SINGULARITY FLAGS
  I   J   DSFLAG(I,J)
  1   1        30
  2   1        30
  3   1        30
  4   1        30
  5   1        30
  6   1        30
  7   1        30
  8   1        30
  9   1        30
 10   1        30
  1   2        30
  2   2        30
  3   2        30
  4   2        30
  5   2        30
  6   2        30
  7   2        30
  8   2        30
  9   2        30
 10   2        30
  1   3        30
  2   3        30
  3   3        30
  4   3        30
  5   3        30
  6   3        30
  7   3        30
  8   3        30
  9   3        30
 10   3        30
  1   4        30
  2   4        30
  3   4        30
```

FIGURE 7.2-2. Output for POTGEM Test Case 2 (Cont'd).

4	4	30
5	4	30
6	4	30
7	4	30
8	4	30
9	4	30
10	4	30

SOURCE SINGULARITY FLAGS

I J SSFLAG(I,J)

UNAVAILABLE

BOUNDARY CONDITION POINTS

I	J	XBC(I,J)	YBC(I,J)	ZBC(I,J)	SBC(I,J)	VBC(I,J)
1	1	.2599295	.0500000	0.	.0500000	.2599295
2	1	.3820259	.1500000	0.	.1500000	.3820259
3	1	.5041223	.2500000	0.	.2500000	.5041224
4	1	.6262188	.3500000	0.	.3500000	.6262188
5	1	.7483152	.4500000	0.	.4500000	.7483152
6	1	.8704117	.5500000	0.	.5500000	.8704117
7	1	.9925081	.6500000	0.	.6500000	.9925081
8	1	1.1146045	.7500000	0.	.7500000	1.1146046
9	1	1.2367010	.8500000	0.	.8500000	1.2367010
10	1	1.3587974	.9500000	0.	.9500000	1.3587974
1	2	.5162657	.0500000	0.	.0500000	.5162657
2	2	.6206846	.1500000	0.	.1500000	.6206847
3	2	.7251036	.2500000	0.	.2500000	.7251036
4	2	.8295225	.3500000	0.	.3500000	.8295225
5	2	.9339415	.4500000	0.	.4500000	.9339415
6	2	1.0383604	.5500000	0.	.5500000	1.0383604
7	2	1.1427794	.6500000	0.	.6500000	1.1427794
8	2	1.2471983	.7500000	0.	.7500000	1.2471983
9	2	1.3516172	.8500000	0.	.8500000	1.3516172
10	2	1.4560362	.9500000	0.	.9500000	1.4560362
1	3	.7726020	.0500000	0.	.0500000	.7726020
2	3	.8593434	.1500000	0.	.1500000	.8593434
3	3	.9460848	.2500000	0.	.2500000	.9460848
4	3	1.0328263	.3500000	0.	.3500000	1.0328263

FIGURE 7.2-2. Output for POTGEM Test Case 2 (Cont'd).

5	3	1.1195677	.4500000	0.	.4500000	1.1195677
6	3	1.2063092	.5500000	0.	.5500000	1.2063092
7	3	1.2930506	.6500000	0.	.6500000	1.2930506
8	3	1.3797920	.7500000	0.	.7500000	1.3797920
9	3	1.4665335	.8500000	0.	.8500000	1.4665335
10	3	1.5532749	.9500000	0.	.9500000	1.5532749
1	4	1.0289382	.0500000	0.	.0500000	1.0289382
2	4	1.0980021	.1500000	0.	.1500000	1.0980022
3	4	1.1670661	.2500000	0.	.2500000	1.1670661
4	4	1.2361300	.3500000	0.	.3500000	1.2361300
5	4	1.3051940	.4500000	0.	.4500000	1.3051940
6	4	1.3742579	.5500000	0.	.5500000	1.3742579
7	4	1.4433218	.6500000	0.	.6500000	1.4433219
8	4	1.5123858	.7500000	0.	.7500000	1.5123858
9	4	1.5814497	.8500000	0.	.8500000	1.5814497
10	4	1.6505137	.9500000	0.	.9500000	1.6505137

UNIT NORMALS AND AREAS

I	J	UNX(I,J)	UNY(I,J)	UNZ(I,J)	DA(I,J)
1	1	0.	0.	-1.0000000	.0256336
2	1	0.	0.	-1.0000000	.0238659
3	1	0.	0.	-1.0000000	.0220981
4	1	0.	0.	-1.0000000	.0203304
5	1	0.	0.	-1.0000000	.0185626
6	1	0.	0.	-1.0000000	.0167949
7	1	0.	0.	-1.0000000	.0150271
8	1	0.	0.	-1.0000000	.0132594
9	1	0.	0.	-1.0000000	.0114916
10	1	0.	0.	-1.0000000	.0097239
1	2	0.	0.	-1.0000000	.0256336
2	2	0.	0.	-1.0000000	.0238659
3	2	0.	0.	-1.0000000	.0220981
4	2	0.	0.	-1.0000000	.0203304
5	2	0.	0.	-1.0000000	.0185626
6	2	0.	0.	-1.0000000	.0167949
7	2	0.	0.	-1.0000000	.0150271
8	2	0.	0.	-1.0000000	.0132594
9	2	0.	0.	-1.0000000	.0114916
10	2	0.	0.	-1.0000000	.0097239
1	3	0.	0.	-1.0000000	.0256336

FIGURE 7.2-2. Output for POTGEM Test Case 2 (Cont'd).

2	3	0.	0.	-1.0000000	.0238659
3	3	0.	0.	-1.0000000	.0220981
4	3	0.	0.	-1.0000000	.0203304
5	3	0.	0.	-1.0000000	.0185626
6	3	0.	0.	-1.0000000	.0167949
7	3	0.	0.	-1.0000000	.0150271
8	3	0.	0.	-1.0000000	.0132594
9	3	0.	0.	-1.0000000	.0114916
10	3	0.	0.	-1.0000000	.0097239
1	4	0.	0.	-1.0000000	.0192252
2	4	0.	0.	-1.0000000	.0178994
3	4	0.	0.	-1.0000000	.0165736
4	4	0.	0.	-1.0000000	.0152478
5	4	0.	0.	-1.0000000	.0139220
6	4	0.	0.	-1.0000000	.0125962
7	4	0.	0.	-1.0000000	.0112703
8	4	0.	0.	-1.0000000	.0099445
9	4	0.	0.	-1.0000000	.0086187
10	4	0.	0.	-1.0000000	.0072929

NTOP VECTORS

I	J	NTOPX(I,J)	NTOPY(I,J)	NTOPZ(I,J)

UNAVAILABLE

NBOT VECTORS

I	J	NBOTX(I,J)	NBOTY(I,J)	NBOTZ(I,J)

UNAVAILABLE

VELOCITY ALONG NTOP VECTORS

I	J	UTOP(I,J)

UNAVAILABLE

VELOCITY ALONG NBOT VECTORS

I	J	UBOT(I,J)

FIGURE 7.2-2. Output for POTGEM Test Case 2 (Cont'd).

UNAVAILABLE

CORNER POINTS ALONG VL AND VU EDGES

I	XVLC(I)	YVLC(I)	ZVLC(I)	SVLC(I)	VVLC(I)	XVUC(I)	YVUC(I)	ZVUC(I)	SVUC(I)	VVUC(I)
1	0.	0.	0.	0.	0.	1.06070	-.00000	0.	0.	1.06070
2	.13535	.10000	0.	.10000	.13535	1.12534	.10000	0.	.10000	1.12534
3	.27071	.20000	0.	.20000	.27071	1.18999	.20000	0.	.20000	1.18999
4	.40606	.30000	0.	.30000	.40606	1.25463	.30000	0.	.30000	1.25463
5	.54142	.40000	0.	.40000	.54142	1.31928	.40000	0.	.40000	1.31928
6	.67677	.50000	0.	.50000	.67677	1.38392	.50000	0.	.50000	1.38392
7	.81213	.60000	0.	.60000	.81213	1.44857	.60000	0.	.60000	1.44857
8	.94748	.70000	0.	.70000	.94748	1.51321	.70000	0.	.70000	1.51321
9	1.08284	.80000	0.	.80000	1.08284	1.57786	.80000	0.	.80000	1.57786
10	1.21819	.90000	0.	.90000	1.21819	1.64250	.90000	0.	.90000	1.64250
11	1.35355	1.00000	0.	1.00000	1.35355	1.70715	1.00000	0.	1.00000	1.70715

BOUNDARY POINTS ALONG VL AND VU EDGES

I	XVLB(I)	YVLB(I)	ZVLB(I)	SVLB(I)	VVLB(I)	XVUB(I)	YVUB(I)	ZVUB(I)	SVUB(I)	VVUB(I)	CORD2(I)	SPAN1(I)
1	.068	.050	0.	.050	.068	1.093	.050	0.	.050	1.093	1.025	.100
2	.203	.150	0.	.150	.203	1.158	.150	0.	.150	1.158	.955	.100
3	.338	.250	0.	.250	.338	1.222	.250	0.	.250	1.222	.884	.100
4	.474	.350	0.	.350	.474	1.287	.350	0.	.350	1.287	.813	.100
5	.609	.450	0.	.450	.609	1.352	.450	0.	.450	1.352	.743	.100
6	.744	.550	0.	.550	.744	1.416	.550	0.	.550	1.416	.672	.100
7	.880	.650	0.	.650	.880	1.481	.650	0.	.650	1.481	.601	.100
8	1.015	.750	0.	.750	1.015	1.546	.750	0.	.750	1.546	.530	.100
9	1.151	.850	0.	.850	1.151	1.610	.850	0.	.850	1.610	.460	.100
10	1.286	.950	0.	.950	1.286	1.675	.950	0.	.950	1.675	.389	.100

CORNER POINTS ALONG SL AND SU EDGES

I	XSLC(I)	YSLC(I)	ZSLC(I)	SSLC(I)	VSLC(I)	XSUC(I)	YSUC(I)	ZSUC(I)	SSUC(I)	VSUC(I)
1	.06629	-.00000	0.	0.	.06629	1.37565	1.00000	0.	1.00000	1.37565
2	.33147	-.00000	0.	0.	.33147	1.46405	1.00000	0.	1.00000	1.46405
3	.59664	-.00000	0.	0.	.59664	1.55245	1.00000	0.	1.00000	1.55245
4	.86182	-.00000	0.	0.	.86182	1.64085	1.00000	0.	1.00000	1.64085
5	1.06070	-.00000	0.	0.	1.06070	1.70715	1.00000	0.	1.00000	1.70715

FIGURE 7.2-2. Output for POTGEM Test Case 2 (Cont'd).

BOUNDARY POINTS ALONG SL AND SU EDGES

I	XSLB(I)	YSLB(I)	ZSLB(I)	SSLB(I)	VSLB(I)	XSUB(I)	YSUB(I)	ZSUB(I)	SSUB(I)	VSUB(I)	CORD1(I)	SPAN2(I)
1	.199	-.000	0.	0.	.199	1.420	1.000	0.	1.000	1.420	1.000	.265
2	.464	-.000	0.	0.	.464	1.508	1.000	0.	1.000	1.508	1.000	.265
3	.729	-.000	0.	0.	.729	1.597	1.000	0.	1.000	1.597	1.000	.265
4	.994	-.000	0.	0.	.994	1.685	1.000	0.	1.000	1.685	1.000	.199

FORCE SENSING LOCATIONS IN N1-DIRECTION

I	J	XS1(I,J)	YS1(I,J)	ZS1(I,J)
1	1	.1317613	.0500000	0.
2	1	.2626965	.1500000	0.
3	1	.3936317	.2500000	0.
4	1	.5245669	.3500000	0.
5	1	.6555021	.4500000	0.
6	1	.7864373	.5500000	0.
7	1	.9173725	.6500000	0.
8	1	1.0483077	.7500000	0.
9	1	1.1792428	.8500000	0.
10	1	1.3101780	.9500000	0.
1	2	.3880976	.0500000	0.
2	2	.5013553	.1500000	0.
3	2	.6146130	.2500000	0.
4	2	.7278707	.3500000	0.
5	2	.8411284	.4500000	0.
6	2	.9543860	.5500000	0.
7	2	1.0676437	.6500000	0.
8	2	1.1809014	.7500000	0.
9	2	1.2941591	.8500000	0.
10	2	1.4074168	.9500000	0.
1	3	.6444338	.0500000	0.
2	3	.7400140	.1500000	0.
3	3	.8355942	.2500000	0.
4	3	.9311744	.3500000	0.
5	3	1.0267546	.4500000	0.
6	3	1.1223348	.5500000	0.
7	3	1.2179150	.6500000	0.
8	3	1.3134952	.7500000	0.
9	3	1.4090753	.8500000	0.
10	3	1.5046555	.9500000	0.
1	4	.9007701	.0500000	0.

FIGURE 7.2-2. Output for POTGEM Test Case 2 (Cont'd).

2	4	.9786728	.1500000	0.
3	4	1.0565754	.2500000	0.
4	4	1.1344781	.3500000	0.
5	4	1.2123808	.4500000	0.
6	4	1.2902835	.5500000	0.
7	4	1.3681862	.6500000	0.
8	4	1.4460889	.7500000	0.
9	4	1.5239916	.8500000	0.
10	4	1.6018943	.9500000	0.
1	5	1.0930223	.0500000	0.
2	5	1.1576668	.1500000	0.
3	5	1.2223114	.2500000	0.
4	5	1.2869560	.3500000	0.
5	5	1.3516005	.4500000	0.
6	5	1.4162451	.5500000	0.
7	5	1.4808897	.6500000	0.
8	5	1.5455342	.7500000	0.
9	5	1.6101788	.8500000	0.
10	5	1.6748234	.9500000	0.

FORCE SENSING LOCATIONS IN N2-DIRECTION

I	J	XS2(I,J)	YS2(I,J)	ZS2(I,J)

UNAVAILABLE
+STOP
 STOP 777

FIGURE 7.2-2. Output for POTGEM Test Case 2 (Concluded).

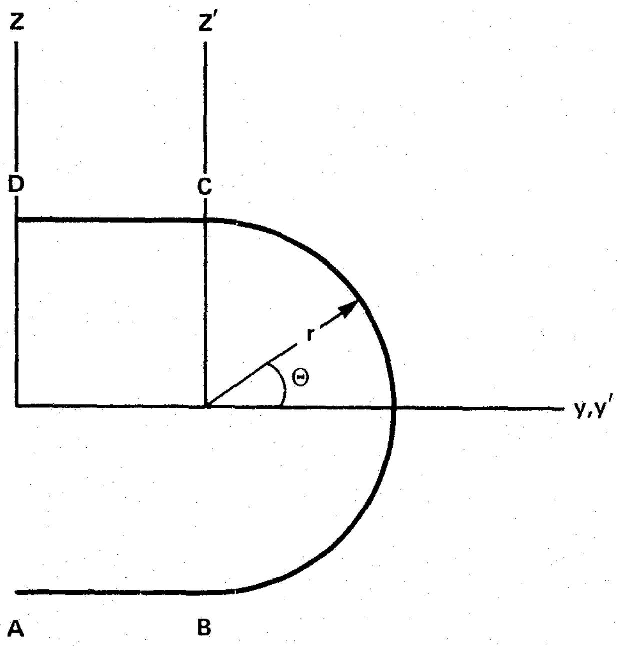


FIGURE 7.3-1. Cross Section of the NASA Ames 12.192 by 24.384 Meter Wind Tunnel Test Section.

```
T
TITLF
TFST CASE 3 - 40 X 80 WIND TUNNEL
SHTI
 $INCRV1 IC=2,VAR2=6.096 $END
CARY
SHT1
 $INCRV1 IC=11,VAR2=-6.096 $END
DSEGMENTS
 $DATA NBPS=3,NSEGVT=3,NBPV=3,10,3 $END
VLBC
 $DATA $END
SLBC
 $DATA $END
SL
 $DATA VAR2SV=-10. $END
SU
 $DATA VAR2SV=20. $END
VL
 $DATA VAR2SV=-6.096 $END
VU
 $DATA VAR2SV=0. $END
PANI
 $DATA $END
POLR
SHTI
 $INCRV1 IC=11,VAR2=6.096 $END
SEGMENT
 $DATA NSEGV=2 $END
SLBC
 $DATA $END
VL
 $DATA VAR2SV=-90. $END
VU
 $DATA VAR2SV=90. $END
PANI
```

FIGURE 7.3-2. Input for POTGEM Test Case 3.

```
 *DATA $END
CARY
SEGMENT
 *DATA NSEGV=3 $END
SIBC
 *DATA $END
VL
 *DATA VAR2SV=0. $END
VU
 *DATA VAR2SV=-6.096 $END
PANL
 *DATA $END
NKT1
 *DATA I2=15 $END
NKT1
 *DATA I2=4 $END
DSFI
      1    -1
      1    -1
      2
      3
      1    -1
      4
0
FINISH
 *DATA $END
STORE
 *DATA ID=3 $END
PRINT
 *DATA PRINT=18*T $END
STOP
```

FIGURE 7.3-2. Input for POTGEM Test Case 3 (Concluded).

```
POTFAN GEOMETRY PROGRAM,  VERSION 1.3
*************************************

TIME = 08/09/76     02:24:58

ENTER BATCH
+TITLE

TEST CASE 3 - 40 X 80 WIND TUNNEL


+SRI1
+CARY
+SRI1
+DSEGMENTS
+VLBC
+SLBC
+SL
+SU
+VL
+VU
+PANL
+POLR
+SRI1
+SEGMENT
+SLBC
+VL
+VU
+PANL
+CARY
+SEGMENT
+SLBC
+VL
+VU
+PANL
+NRI1
+NRI1
+DSFL
+FINISH
```

FIGURE 7.3-3. Output for POTGEM Test Case 3.

```
+STORE
FILE 3,GM-PNC/LIBS          HAS BEEN OPENED FOR WRITING ON UNIT  1
CREATION TIME = 08/09/76     02:25:10

CREATION OF GEOMETRY FILE
-------------------------

TITLE =  TEST CASE 3 - 40 X 80 WIND TUNNEL

(LOG) =  F F F F T F F F F F F F F F F T F F F
(INT) =     0   4   17    3   16    0    0    0    0    0    0    0    0
(FLT) =   937.93457          0.            0.          0.       1.0000000         0.          0.        442.04416
          .44204415E-01      0.            0.          0.
+PRINT

PRINTOUT OF GEOMETRY FILE DATA
------------------------------
TITLE = TEST CASE 3 - 40 X 80 WIND TUNNEL

CREATION TIME = 08/09/76     02:25:10
(IFORM) = 110111111
(ID)  =       3
(LOG) =  F F F F T F F F F F F F F F F T F F F
(INT) =     0   4   17    3   16    0    0    0    0    0    0    0    0
(FLT) =     937.9345700       0.          0.          0.          1.0000000      0.          0.
            442.0441690       .0442044    0.          0.          0.


PANEL CORNER POINTS
  I  J       X(I,J)            Y(I,J)            Z(I,J)          S(I,J)           V(I,J)
  1  1    -10.0000000        0.               -6.0960000    -10.0000000      -6.0960000
  2  1      -.0000001        0.               -6.0960000      -.0000001      -6.0960000
  3  1     10.0000000        0.               -6.0960000     10.0000000      -6.0960000
  4  1     20.0000000        0.               -6.0960000     20.0000000      -6.0960000
  1  2    -10.0000000        2.0320000        -6.0960000    -10.0000000      -4.0640000
  2  2      -.0000001        2.0320000        -6.0960000      -.0000001      -4.0640000
  3  2     10.0000000        2.0320000        -6.0960000     10.0000000      -4.0640000
  4  2     20.0000000        2.0320000        -6.0960000     20.0000000      -4.0640000
  1  3    -10.0000000        4.0640000        -6.0960000    -10.0000000      -2.0320000
  2  3      -.0000001        4.0640000        -6.0960000      -.0000001      -2.0320000
  3  3     10.0000000        4.0640000        -6.0960000     10.0000000      -2.0320000
```

FIGURE 7.3-3. Output for POTGEM Test Case 3 (Cont'd).

4	3	20.0000000	4.0640000	-6.0960000	20.0000000	-2.0320000
1	4	-10.0000000	6.0960000	-6.0960000	-10.0000000	-90.0000000
2	4	-.0000001	6.0960000	-6.0960000	-.0000001	-90.0000000
3	4	10.0000000	6.0960000	-6.0960000	10.0000000	-90.0000000
4	4	20.0000000	6.0960000	-6.0960000	20.0000000	-90.0000000
1	5	-10.0000000	7.9797674	-5.7976404	-10.0000000	-72.0000010
2	5	-.0000001	7.9797674	-5.7976404	-.0000001	-72.0000010
3	5	10.0000000	7.9797674	-5.7976404	10.0000000	-72.0000010
4	5	20.0000000	7.9797674	-5.7976404	20.0000000	-72.0000010
1	6	-10.0000000	9.6791390	-4.9317675	-10.0000000	-54.0000010
2	6	-.0000001	9.6791390	-4.9317675	-.0000001	-54.0000010
3	6	10.0000000	9.6791390	-4.9317675	10.0000000	-54.0000010
4	6	20.0000000	9.6791390	-4.9317675	20.0000000	-54.0000010
1	7	-10.0000000	11.0277670	-3.5831389	-10.0000000	-36.0000010
2	7	-.0000001	11.0277670	-3.5831389	-.0000001	-36.0000010
3	7	10.0000000	11.0277670	-3.5831389	10.0000000	-36.0000010
4	7	20.0000000	11.0277670	-3.5831389	20.0000000	-36.0000010
1	8	-10.0000000	11.8936400	-1.8837677	-10.0000000	-18.0000010
2	8	-.0000001	11.8936400	-1.8837677	-.0000001	-18.0000010
3	8	10.0000000	11.8936400	-1.8837677	10.0000000	-18.0000010
4	8	20.0000000	11.8936400	-1.8837677	20.0000000	-18.0000010
1	9	-10.0000000	12.1920000	-.0000002	-10.0000000	-.0000014
2	9	-.0000001	12.1920000	-.0000002	-.0000001	-.0000014
3	9	10.0000000	12.1920000	-.0000002	10.0000000	-.0000014
4	9	20.0000000	12.1920000	-.0000002	20.0000000	-.0000014
1	10	-10.0000000	11.8936410	1.8837673	-10.0000000	17.9999980
2	10	-.0000001	11.8936410	1.8837673	-.0000001	17.9999980
3	10	10.0000000	11.8936410	1.8837673	10.0000000	17.9999980
4	10	20.0000000	11.8936410	1.8837673	20.0000000	17.9999980
1	11	-10.0000000	11.0277680	3.5831386	-10.0000000	35.9999980
2	11	-.0000001	11.0277680	3.5831386	-.0000001	35.9999980
3	11	10.0000000	11.0277680	3.5831386	10.0000000	35.9999980
4	11	20.0000000	11.0277680	3.5831386	20.0000000	35.9999980
1	12	-10.0000000	9.6791390	4.9317673	-10.0000000	53.9999970
2	12	-.0000001	9.6791390	4.9317673	-.0000001	53.9999970
3	12	10.0000000	9.6791390	4.9317673	10.0000000	53.9999970
4	12	20.0000000	9.6791390	4.9317673	20.0000000	53.9999970
1	13	-10.0000000	7.9797679	5.7976403	-10.0000000	71.9999970
2	13	-.0000001	7.9797679	5.7976403	-.0000001	71.9999970
3	13	10.0000000	7.9797679	5.7976403	10.0000000	71.9999970
4	13	20.0000000	7.9797679	5.7976403	20.0000000	71.9999970

FIGURE 7.3-3. Output for POTGEM Test Case 3 (Cont'd).

1	14	-10.0000000	6.0960000	6.0960000	-10.0000000	0.
2	14	-.0000001	6.0960000	6.0960000	-.0000001	0.
3	14	10.0000000	6.0960000	6.0960000	10.0000000	0.
4	14	20.0000000	6.0960000	6.0960000	20.0000000	0.
1	15	-10.0000000	4.0640000	6.0960000	-10.0000000	-2.0319999
2	15	-.0000001	4.0640000	6.0960000	-.0000001	-2.0319999
3	15	10.0000000	4.0640000	6.0960000	10.0000000	-2.0319999
4	15	20.0000000	4.0640000	6.0960000	20.0000000	-2.0319999
1	16	-10.0000000	2.0320001	6.0960000	-10.0000000	-4.0639999
2	16	-.0000001	2.0320001	6.0960000	-.0000001	-4.0639999
3	16	10.0000000	2.0320001	6.0960000	10.0000000	-4.0639999
4	16	20.0000000	2.0320001	6.0960000	20.0000000	-4.0639999
1	17	-10.0000000	0.	6.0960000	-10.0000000	-6.0960000
2	17	-.0000001	0.	6.0960000	-.0000001	-6.0960000
3	17	10.0000000	0.	6.0960000	10.0000000	-6.0960000
4	17	20.0000000	0.	6.0960000	20.0000000	-6.0960000

UNIT VECTORS ALONG WAKE ELEMENTS

I	J	UVWX(I,J)	UVWY(I,J)	UVWZ(I,J)

UNAVAILABLE

BOUNDARY CONDITION FLAGS

I	J	BCFLAG(I,J)

UNAVAILABLE

DOUBLET SINGULARITY FLAGS

I	J	DSFLAG(I,J)
1	1	2
2	1	2
3	1	4
1	2	2
2	2	2
3	2	4
1	3	2
2	3	2
3	3	4

FIGURE 7.3-3. Output for POTGEM Test Case 3 (Cont'd).

1	4	2
2	4	2
3	4	4
1	5	2
2	5	2
3	5	4
1	6	2
2	6	2
3	6	4
1	7	2
2	7	2
3	7	4
1	8	2
2	8	2
3	8	4
1	9	2
2	9	2
3	9	4
1	10	2
2	10	2
3	10	4
1	11	2
2	11	2
3	11	4
1	12	2
2	12	2
3	12	4
1	13	2
2	13	2
3	13	4
1	14	2
2	14	2
3	14	4
1	15	2
2	15	2
3	15	4
1	16	2
2	16	2
3	16	4

FIGURE 7.3-3. Output for POTGEM Test Case 3 (Cont'd).

SOURCE SINGULARITY FLAGS

I J SSFLAG(I,J)

UNAVAILABLE

BOUNDARY CONDITION POINTS

I	J	XBC(I,J)	YBC(I,J)	ZBC(I,J)	SBC(I,J)	VBC(I,J)
1	1	-5.0000000	1.0160000	-6.0960000	-5.0000000	-5.0799999
2	1	5.0000000	1.0160000	-6.0960000	5.0000000	-5.0799999
3	1	15.0000000	1.0160000	-6.0960000	15.0000000	-5.0799999
1	2	-5.0000000	3.0480000	-6.0960000	-5.0000000	-3.0480000
2	2	5.0000000	3.0480000	-6.0960000	5.0000000	-3.0480000
3	2	15.0000000	3.0480000	-6.0960000	15.0000000	-3.0480000
1	3	-5.0000000	5.0799999	-6.0960000	-5.0000000	-1.0160001
2	3	5.0000000	5.0799999	-6.0960000	5.0000000	-1.0160001
3	3	15.0000000	5.0799999	-6.0960000	15.0000000	-1.0160001
1	4	-5.0000000	7.0496244	-6.0209481	-5.0000000	-81.0000010
2	4	5.0000000	7.0496244	-6.0209481	5.0000000	-81.0000010
3	4	15.0000000	7.0496244	-6.0209481	15.0000000	-81.0000010
1	5	-5.0000000	8.8635260	-5.4315757	-5.0000000	-63.0000010
2	5	5.0000000	8.8635260	-5.4315757	5.0000000	-63.0000010
3	5	15.0000000	8.8635260	-5.4315757	15.0000000	-63.0000010
1	6	-5.0000000	10.4065230	-4.3105229	-5.0000000	-45.0000010
2	6	5.0000000	10.4065230	-4.3105229	5.0000000	-45.0000010
3	6	15.0000000	10.4065230	-4.3105229	15.0000000	-45.0000010
1	7	-5.0000000	11.5275760	-2.7675262	-5.0000000	-27.0000010
2	7	5.0000000	11.5275760	-2.7675262	5.0000000	-27.0000010
3	7	15.0000000	11.5275760	-2.7675262	15.0000000	-27.0000010
1	8	-5.0000000	12.1169480	-.9536245	-5.0000000	-9.0000000
2	8	5.0000000	12.1169480	-.9536245	5.0000000	-9.0000000
3	8	15.0000000	12.1169480	-.9536245	15.0000000	-9.0000000
1	9	-5.0000000	12.1169480	.9536241	-5.0000000	8.9999970
2	9	5.0000000	12.1169480	.9536241	5.0000000	8.9999970
3	9	15.0000000	12.1169480	.9536241	15.0000000	8.9999970
1	10	-5.0000000	11.5275760	2.7675257	-5.0000000	26.9999970
2	10	5.0000000	11.5275760	2.7675257	5.0000000	26.9999970
3	10	15.0000000	11.5275760	2.7675257	15.0000000	26.9999970
1	11	-5.0000000	10.4065230	4.3105226	-5.0000000	44.9999970
2	11	5.0000000	10.4065230	4.3105226	5.0000000	44.9999970
3	11	15.0000000	10.4065230	4.3105226	15.0000000	44.9999970

FIGURE 7.3-3. Output for POTGEM Test Case 3 (Cont'd).

1	12	-5.0000000	8.8635260	5.4315755	-5.0000000	62.9999970
2	12	5.0000000	8.8635260	5.4315755	5.0000000	62.9999970
3	12	15.0000000	8.8635260	5.4315755	15.0000000	62.9999970
1	13	-5.0000000	7.0496248	6.0209480	-5.0000000	80.9999970
2	13	5.0000000	7.0496248	6.0209480	5.0000000	80.9999970
3	13	15.0000000	7.0496248	6.0209480	15.0000000	80.9999970
1	14	-5.0000000	5.0800000	6.0960000	-5.0000000	-1.0160000
2	14	5.0000000	5.0800000	6.0960000	5.0000000	-1.0160000
3	14	15.0000000	5.0800000	6.0960000	15.0000000	-1.0160000
1	15	-5.0000000	3.0480000	6.0960000	-5.0000000	-3.0480000
2	15	5.0000000	3.0480000	6.0960000	5.0000000	-3.0480000
3	15	15.0000000	3.0480000	6.0960000	15.0000000	-3.0480000
1	16	-5.0000000	1.0160001	6.0960000	-5.0000000	-5.0799999
2	16	5.0000000	1.0160001	6.0960000	5.0000000	-5.0799999
3	16	15.0000000	1.0160001	6.0960000	15.0000000	-5.0799999

UNIT NORMALS AND AREAS

I	J	UNX(I,J)	UNY(I,J)	UNZ(I,J)	DA(I,J)
1	1	0.	0.	1.0000000	20.3200000
2	1	0.	0.	1.0000000	20.3200000
3	1	0.	0.	1.0000000	20.3200000
1	2	0.	0.	1.0000000	20.3199990
2	2	0.	0.	1.0000000	20.3199990
3	2	0.	0.	1.0000000	20.3200000
1	3	0.	0.	1.0000000	20.3200000
2	3	0.	0.	1.0000000	20.3200000
3	3	0.	0.	1.0000000	20.3200010
1	4	0.	-.1563943	.9876947	19.0724880
2	4	0.	-.1563943	.9876947	19.0724880
3	4	0.	-.1563943	.9876947	19.0724880
1	5	0.	-.4539258	.8910395	19.0724900
2	5	0.	-.4539258	.8910395	19.0724900
3	5	0.	-.4539258	.8910395	19.0724900
1	6	0.	-.7071068	.7071068	19.0724880
2	6	0.	-.7071068	.7071068	19.0724880
3	6	0.	-.7071068	.7071068	19.0724890
1	7	0.	-.8910684	.4538691	19.0724890
2	7	0.	-.8910684	.4538691	19.0724890
3	7	0.	-.8910684	.4538691	19.0724900
1	8	0.	-.9877067	.1563186	19.0724890

FIGURE 7.3-3. Output for POTGEM Test Case 3 (Cont'd).

2	8	0.	-.9877067	.1563186	19.0724890
3	8	0.	-.9877067	.1563186	19.0724900
1	9	0.	-.9877075	-.1563132	19.0724880
2	9	0.	-.9877075	-.1563132	19.0724880
3	9	0.	-.9877076	-.1563132	19.0724880
1	10	0.	-.8910684	-.4538691	19.0724890
2	10	0.	-.8910684	-.4538691	19.0724890
3	10	0.	-.8910684	-.4538691	19.0724900
1	11	0.	-.7073870	-.7068265	19.0724880
2	11	0.	-.7073870	-.7068265	19.0724880
3	11	0.	-.7073870	-.7068265	19.0724890
1	12	0.	-.4539216	-.8910416	19.0724890
2	12	0.	-.4539216	-.8910416	19.0724890
3	12	0.	-.4539216	-.8910416	19.0724900
1	13	0.	-.1563943	-.9876947	19.0724940
2	13	0.	-.1563943	-.9876947	19.0724940
3	13	0.	-.1563943	-.9876947	19.0724940
1	14	0.	0.	-1.0000000	20.3199990
2	14	0.	0.	-1.0000000	20.3199990
3	14	0.	0.	-1.0000000	20.3200000
1	15	0.	0.	-1.0000000	20.3199990
2	15	0.	0.	-1.0000000	20.3199990
3	15	0.	0.	-1.0000000	20.3200000
1	16	0.	0.	-1.0000000	20.3200000
2	16	0.	0.	-1.0000000	20.3200000
3	16	0.	0.	-1.0000000	20.3200010

NTOP VECTORS

I	J	NTOPX(I,J)	NTOPY(I,J)	NTOPZ(I,J)

UNAVAILABLE

NBOT VECTORS

I	J	NBOTX(I,J)	NBOTY(I,J)	NBOTZ(I,J)

UNAVAILABLE

VELOCITY ALONG NTOP VECTORS

FIGURE 7.3-3. Output for POTGEM Test Case 3 (Cont'd).

I	J	OTOP(I,J)

UNAVAILABLE

VELOCITY ALONG NBOT VECTORS

I	J	NBOT(I,J)

UNAVAILABLE

CORNER POINTS ALONG VL AND VU EDGES

I	XVLC(I)	YVLC(I)	ZVLC(I)	SVLC(I)	VVLC(I)	XVUC(I)	YVUC(I)	ZVUC(I)	SVUC(I)	VVUC(I)
1	-10.00000	0.	-6.09600	-10.00000	-6.09600	-10.00000	0.	6.09600	-10.00000	-6.09600
2	-.00000	0.	-6.09600	-.00000	-6.09600	-.00000	0.	6.09600	-.00000	-6.09600
3	10.00000	0.	-6.09600	10.00000	-6.09600	10.00000	0.	6.09600	10.00000	-6.09600
4	20.00000	0.	-6.09600	20.00000	-6.09600	20.00000	0.	6.09600	20.00000	-6.09600

BOUNDARY POINTS ALONG VL AND VU EDGES

I	XVLB(I)	YVLB(I)	ZVLB(I)	SVLB(I)	VVLB(I)	XVUB(I)	YVUB(I)	ZVUB(I)	SVUB(I)	VVUB(I)	CORD2(I)	SPAN1(I)
1	-5.000	0.	-6.096	-5.000	-6.096	-5.000	0.	6.096	-5.000	-6.096	0.	0.
2	5.000	0.	-6.096	5.000	-6.096	5.000	0.	6.096	5.000	-6.096	0.	0.
3	15.000	0.	-6.096	15.000	-6.096	15.000	0.	6.096	15.000	-6.096	0.	0.

CORNER POINTS ALONG SL AND SU EDGES

I	XSLC(I)	YSLC(I)	ZSLC(I)	SSLC(I)	VSLC(I)	XSUC(I)	YSUC(I)	ZSUC(I)	SSUC(I)	VSUC(I)
1	-10.00000	0.	-6.09600	-10.00000	-6.09600	20.00000	0.	-6.09600	20.00000	-6.09600
2	-10.00000	2.03200	-6.09600	-10.00000	-4.06400	20.00000	2.03200	-6.09600	20.00000	-4.06400
3	-10.00000	4.06400	-6.09600	-10.00000	-2.03200	20.00000	4.06400	-6.09600	20.00000	-2.03200
4	-10.00000	6.09600	-6.09600	-10.00000	-90.00000	20.00000	6.09600	-6.09600	20.00000	-90.00000
5	-10.00000	7.97977	-5.79764	-10.00000	-72.00000	20.00000	7.97977	-5.79764	20.00000	-72.00000
6	-10.00000	9.67914	-4.93177	-10.00000	-54.00000	20.00000	9.67914	-4.93177	20.00000	-54.00000
7	-10.00000	11.02777	-3.58314	-10.00000	-36.00000	20.00000	11.02777	-3.58314	20.00000	-36.00000
8	-10.00000	11.89364	-1.88377	-10.00000	-18.00000	20.00000	11.89364	-1.88377	20.00000	-18.00000
9	-10.00000	12.19200	-.00000	-10.00000	-.00000	20.00000	12.19200	-.00000	20.00000	-.00000
10	-10.00000	11.89364	1.88377	-10.00000	18.00000	20.00000	11.89364	1.88377	20.00000	18.00000
11	-10.00000	11.02777	3.58314	-10.00000	36.00000	20.00000	11.02777	3.58314	20.00000	36.00000
12	-10.00000	9.67914	4.93177	-10.00000	54.00000	20.00000	9.67914	4.93177	20.00000	54.00000
13	-10.00000	7.97977	5.79764	-10.00000	72.00000	20.00000	7.97977	5.79764	20.00000	72.00000

FIGURE 7.3-3. Output for POTGEM Test Case 3 (Cont'd).

14	-10.00000	6.09600	6.09600	-10.00000	0.	20.00000	6.09600	6.09600	20.00000	0.
15	-10.00000	4.06400	6.09600	-10.00000	-2.03200	20.00000	4.06400	6.09600	20.00000	-2.03200
16	-10.00000	2.03200	6.09600	-10.00000	-4.06400	20.00000	2.03200	6.09600	20.00000	-4.06400
17	-10.00000	0.	6.09600	-10.00000	-6.09600	20.00000	0.	6.09600	20.00000	-6.09600

BOUNDARY POINTS ALONG SL AND SU EDGES

I	XSLB(I)	YSLB(I)	ZSLB(I)	SSLB(I)	VSLB(I)	XSUB(I)	YSUB(I)	ZSUB(I)	SSUB(I)	VSUB(I)	CORD1(I)	SPAN2(I)
1	-10.000	1.016	-6.096	-10.000	-5.080	20.000	1.016	-6.096	20.000	-5.080	0.	0.
2	-10.000	3.048	-6.096	-10.000	-3.048	20.000	3.048	-6.096	20.000	-3.048	0.	0.
3	-10.000	5.080	-6.096	-10.000	-1.016	20.000	5.080	-6.096	20.000	-1.016	0.	0.
4	-10.000	7.050	-6.021	-10.000	-81.000	20.000	7.050	-6.021	20.000	-81.000	0.	0.
5	-10.000	8.864	-5.432	-10.000	-63.000	20.000	8.864	-5.432	20.000	-63.000	0.	0.
6	-10.000	10.407	-4.311	-10.000	-45.000	20.000	10.407	-4.311	20.000	-45.000	0.	0.
7	-10.000	11.528	-2.768	-10.000	-27.000	20.000	11.528	-2.768	20.000	-27.000	0.	0.
8	-10.000	12.117	-.954	-10.000	-9.000	20.000	12.117	-.954	20.000	-9.000	0.	0.
9	-10.000	12.117	.954	-10.000	9.000	20.000	12.117	.954	20.000	9.000	0.	0.
10	-10.000	11.528	2.768	-10.000	27.000	20.000	11.528	2.768	20.000	27.000	0.	0.
11	-10.000	10.407	4.311	-10.000	45.000	20.000	10.407	4.311	20.000	45.000	0.	0.
12	-10.000	8.864	5.432	-10.000	63.000	20.000	8.864	5.432	20.000	63.000	0.	0.
13	-10.000	7.050	6.021	-10.000	81.000	20.000	7.050	6.021	20.000	81.000	0.	0.
14	-10.000	5.080	6.096	-10.000	-1.016	20.000	5.080	6.096	20.000	-1.016	0.	0.
15	-10.000	3.048	6.096	-10.000	-3.048	20.000	3.048	6.096	20.000	-3.048	0.	0.
16	-10.000	1.016	6.096	-10.000	-5.080	20.000	1.016	6.096	20.000	-5.080	0.	0.

FORCE SENSING LOCATIONS IN N1-DIRECTION

I	J	XS1(I,J)	YS1(I,J)	ZS1(I,J)

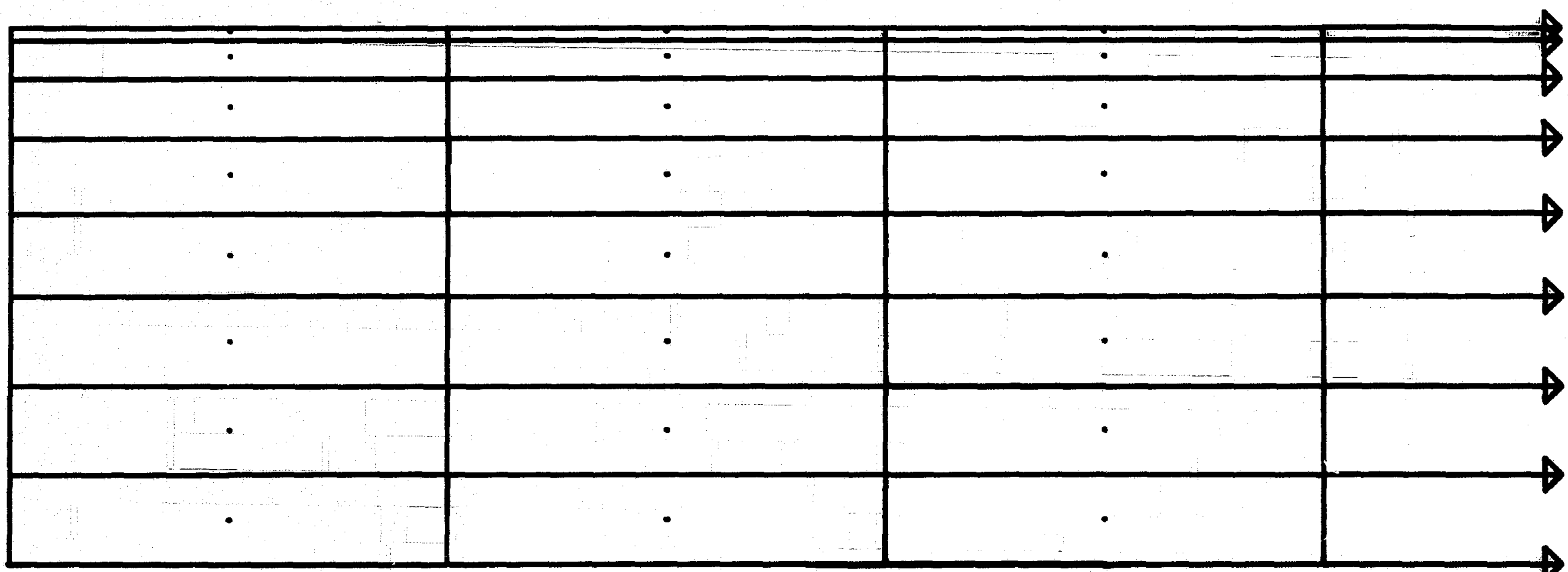
UNAVAILABLE

FORCE SENSING LOCATIONS IN N2-DIRECTION

I	J	XS2(I,J)	YS2(I,J)	ZS2(I,J)

UNAVAILABLE
+STOP
STOP 777

FIGURE 7.3-3. Output for POTEGM Test Case 3 (Concluded).



NASA AMES 40X80 TUNNEL

FIGURE 7.3-4(a). Top View of POTGEM Test Case 3.

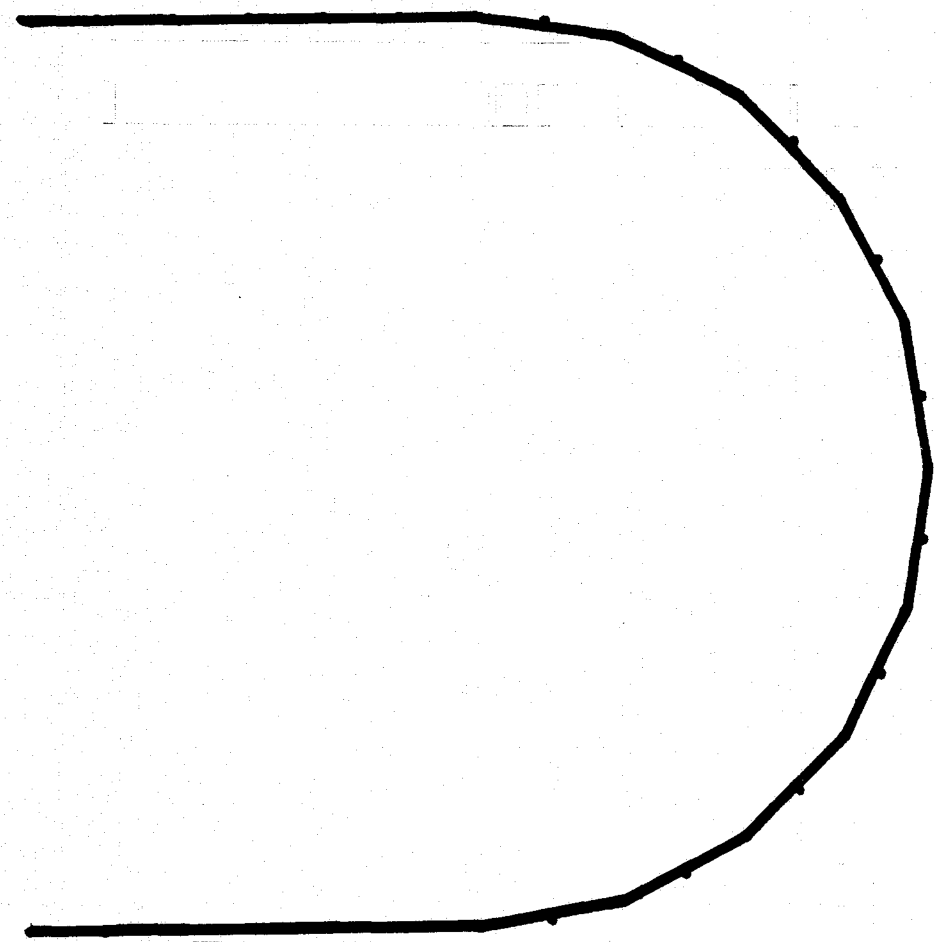


FIGURE 7.3-4(b). Front View of POTGEM Test Case 3.

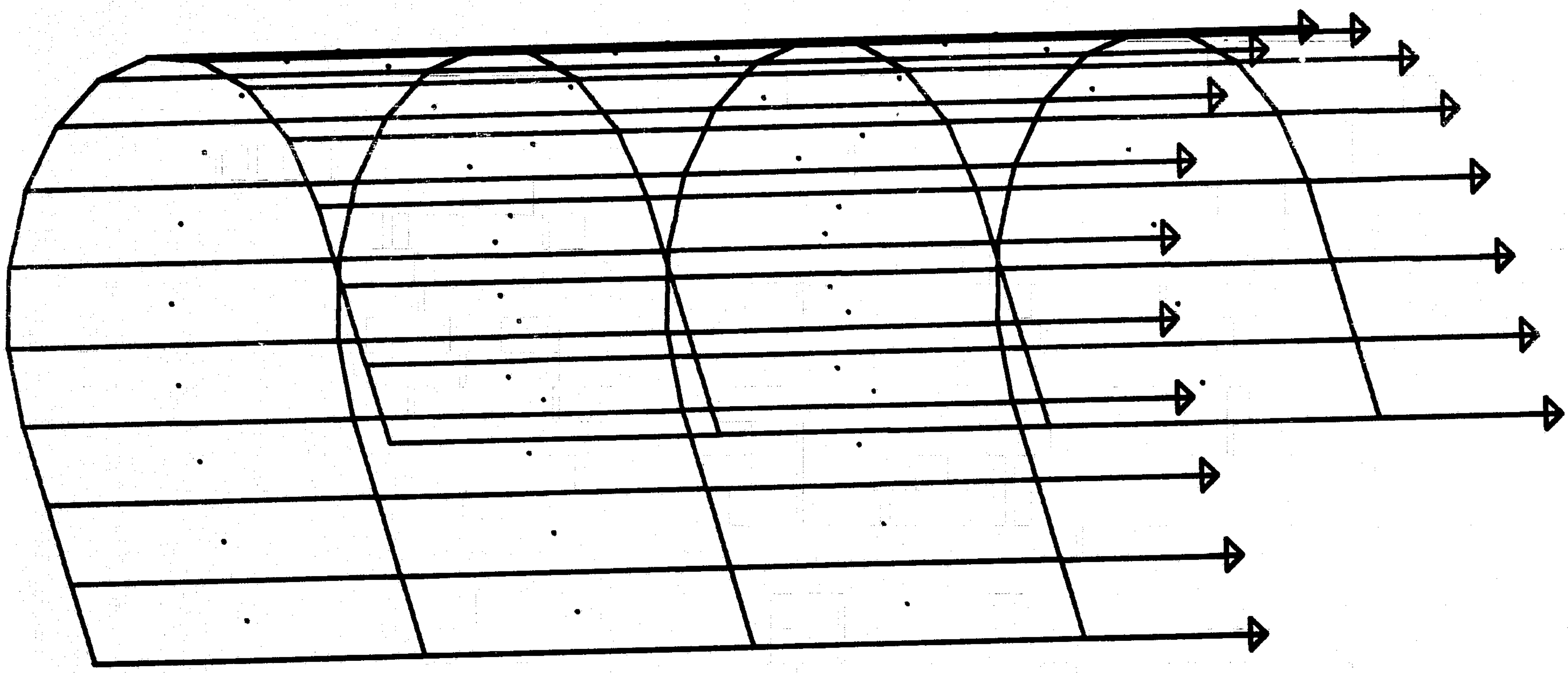


FIGURE 7.3-4(c). Oblique View of POTGEM Test Case 3.

```
TRUE
    THIS IS A PLOTGM RUN TO PLOT AN X-Y VIEW, Y-Z VIEW, AND
    OBLIQUE VIEW OF A SAMPLE PANELLING ARRANGEMENT ON THE
    NASA AMES 12.2 M. BY 24.2 M. (40X80) WIND TUNNEL.
    THE PANEL ARRANGEMENT TO BE PLOTTED IS THAT PRODUCED BY
    POTGEM TEST CASE 3 AS DESCRIBED IN NASA TM-X 73,127,
    "NASA AMES POTENTIAL FLOW ANALYSIS (POTGEM) GEOMETRY
    PROGRAM (POTGEM). VERSION 1."

    READ IN THE GEOMETRY FILE
READ
    3
    INITIALIZE THE PLOTTER FOR AN OFFLINE PLOT AT 15
    CHARACTERS PER SECOND.
    THE PLOTTER DIRECTIVES WILL BE STORED ON FILE 3.PT FOR LATER
    PLOTTING.  THE FILE WILL BE CREATED BY WRITES TO UNIT 8.
IPLOT
   15     3     8
    PLOT THE PLAN VIEW (X-Y VIEW) 10 CM. TO THE
    RIGHT AND 10 CM. ABOVE THE CURRENT PEN LOCATION.
PLOT
 $DATA YOFF=10,XOFF=10,XSCALE=1.0,YSCALE=1.0 $END
    NOW PLOT THE CONTROL POINTS.  THESE WILL
    SHOW UP AS DOTS.
PBCP
```

FIGURE 7.3-5. PLOTGM Input That Generated Figure 7.3-4.

```
WAKES
 $DATA WAKECM=5.0,ARRWCM=.75 $END
    ENTER TITLE AND PLOT IT.
RTITLE
NASA AMES 40X80 TUNNEL
PTITLE
 $DATA XTITLE=10,YTITLE=5,HEIGHT=.762 $END
    NOW PLOT THE FRONT VIEW (Y-Z VIEW).
PAGE
YZVIEW
PLOT
 $DATA $END
PBCP
    FINALLY, PLOT AN OBLIQUE VIEW OF THE TUNNEL.
PAGE
OBVIEW
PLOT
 $DATA $END
PBCP
WAKES
 $DATA $END
STOP
```

FIGURE 7.3-5. PLOTGM Input That Generated Figure 7.3-4 (Concluded).

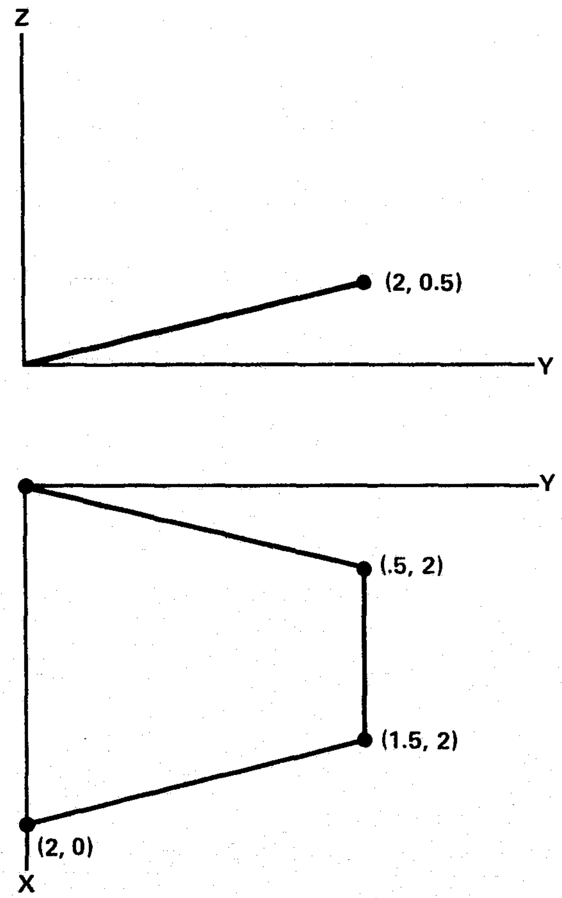


FIGURE 7.4-1. The Thin, Swept, Uncambered, Untwisted Wing with Dihedral Used for Test Case 4.

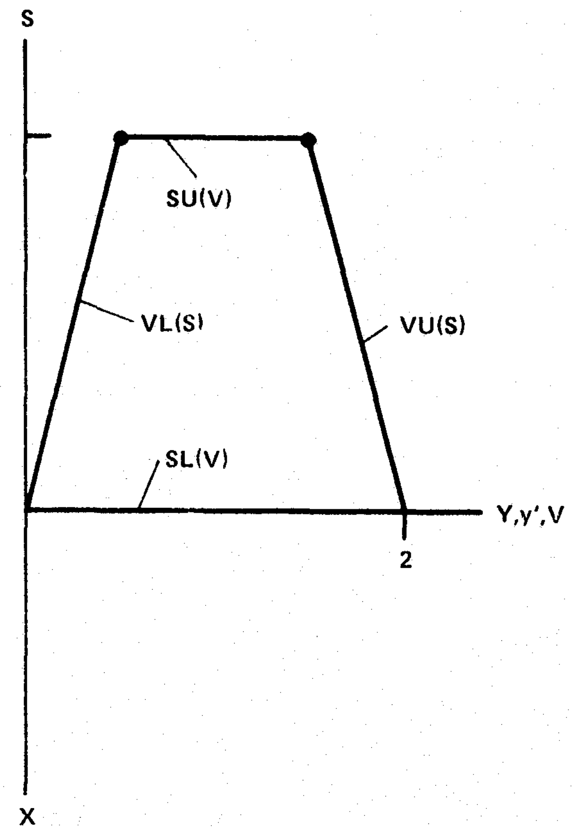


FIGURE 7.4-2. Rotation and Selection of S and V for Test Case No. 4.

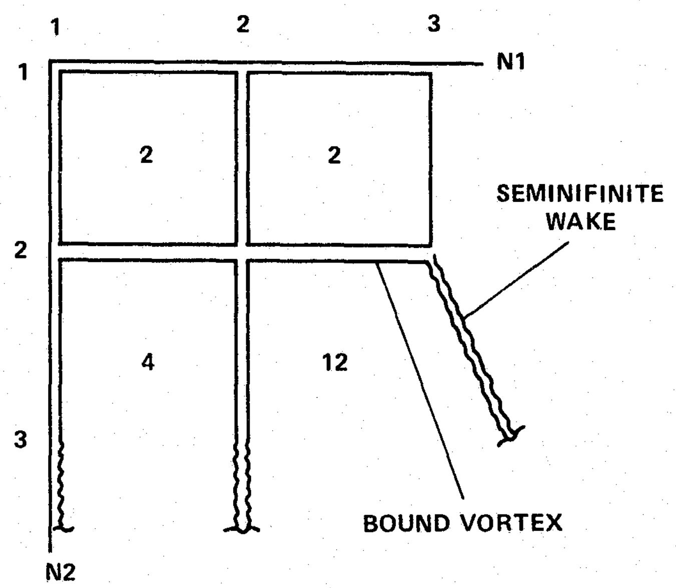


FIGURE 7.4-3. Vortex Singularity Model and Doublet Singularity Flags for Test Case 4.

```
T
TITLE
TEST CASE 4 -- THIN, SWEPT, UNCAMBERED, UNTWISTED WING WITH DIHEDRAL
CARY
SPT1
 $INCRV1 IC=1,COPT=3 $END
SPT1
 $INCRV1 IC=11,COPT=0,SCS=0, $END
SPT1
 $INCRV1 IC=12,NTAB=1,VAR2(1)=0,5,COPT=1,SCS=2 $END
DSEGMENTS
 $DATA NBPS(1)=2,NBPV(1)=2 $END
VLBC
 $DATA $END
SLBC
 $DATA IOPT=2 $END
SL
 $DATA IOPTSV=0 $END
SU
 $DATA IOPTSV=1,NTABSV=1,VAR2SV(1)=2 $END
VL
 $DATA NTABSV=2,VAR1SV(1)=0,2,VAR2SV(1)=0,0.5 $END
VU
 $DATA VAR2SV(1)=2,1.5 $END
GRID
PANL
 $DATA RS1=T,RS2=T $END
ROSS
 $DATA EAXIS(1)=0,0,-1,PHI=90 $END
ROSS
 $DATA EAXIS(1)=0,1,0,PHI=45 $END
DEFL
     1     2
     1
     2
     1
```

FIGURE 7.4-4. Input for POTGEM Test Case 4.

```
              2
              6
              2
              2
             12
        0
        FINISH
         $DATA LOG(13)=T,INT(10)=1,FLT(5)=1,0,0,FLT(1)=3 $END
        STORE
         $DATA ID=4 $END
        PRINT
         $DATA PRINT(1)=18*T $END
        STOP
```

FIGURE 7.4-4. Input for POTGEM Test Case 4 (Concluded).

```
POTFAN GEOMETRY PROGRAM,  VERSION 1.3
****************************************

TIME = 08/09/76    07:34:24

ENTER BATCH
+TITLE

TEST CASE 4 -- THIN, SWEPT, UNCAMBERED, UNTWISTED WING WITH DIHEDRAL


+CARY
+SRI1
+SRI1
+SRI1
+DSEGMENTS
+VLRC
+SLRC
+SL
+SU
+VL
+VU
+GRID

NSEGS =  1     NSEGV =  1     NBPS(NSEGS) =  2     NBPV(NSEGV) =  2

XGPVLC =
-1.0000  0.       1.0000

XGPVUC =
-1.0000  0.       1.0000

XGPVLR =
 -.5000   .5000

XGPVUR =
 -.5000   .5000
```

FIGURE 7.4-5. Output for POTGEM Test Case 4.

```
XGPSLC =
 -.7500    .2500  1.0000

XGPSUC =
 -.7500    .2500  1.0000

XGPSLR =
 -.2500    .7500

XGPSUR =
 -.2500    .7500
+PANL
+ROSS
+ROSS
+DSEL
+FINISH
+STORE
FILE 4.GM-POC/LIB$          HAS BEEN OPENED FOR WRITING ON UNIT  1
CREATION TIME = 08/09/76    07:34:24
UNIT  1 ENDFILED AND RELEASED

CREATION OF GEOMETRY FILE
-------------------------

TITLE =  TEST CASE 4 -- THIN, SWEPT, UNCAMBERED, UNTWISTED WING WITH DIHEDRAL

(LOG) =  F F F F T F F F F F F F T F F F T F T T
(INT) =     0    5    3    2    2    0    0    0    0    1    0    0    0
(FLT) =   3.0000000      2.0000000      1.0606601      2.0000000      1.0000000           0.            0.      86.602540
          .86602540E-02       0.             0.             0.
+PRINT

PRINTOUT OF GEOMETRY FILE DATA
------------------------------
TITLE = TEST CASE 4 -- THIN, SWEPT, UNCAMBERED, UNTWISTED WING WITH DIHEDRAL

CREATION TIME = 08/09/76    07:34:24
(IFORM) = 11011111111
(IP)  =       4
```

FIGURE 7.4-5. Output for POTGEM Test Case 4 (Cont'd).

```
(LOG) =  F F F F T F F F F F F F T F F F T F T T
(INT) =      0    3    3    2    2    0    0    0    0    1    0    0    0
(FLT) =      3.0000000      2.0000000      1.0606601      2.0000000      1.0000000      0.          0.
            86.6025400       .0086603      0.             0.             0.

PANEL CORNER POINTS
  I  J      X(I,J)         Y(I,J)         Z(I,J)         S(I,J)         V(I,J)
  1  1      .1767767      -.0000000      -.1767767      0.              .2500000
  2  1      .4861359      1.0000000      -.1325825      1.0000000       .4375000
  3  1      .7954951      2.0000000      -.0883883      2.0000000       .6250000
  1  2      .8838835      -.0000000      -.8838835      0.             1.2500000
  2  2     1.0164660      1.0000000      -.6629126      1.0000000      1.1875000
  3  2     1.1490485      2.0000000      -.4419417      2.0000000      1.1250000
  1  3     1.4142135      -.0000000     -1.4142135      0.             2.0000000
  2  3     1.4142135      1.0000000     -1.0606602      1.0000000      1.7500000
  3  3     1.4142135      2.0000000      -.7071068      2.0000000      1.5000000

UNIT VECTORS ALONG WAKE ELEMENTS
  I  J      VWX(I,J)      UVWY(I,J)      UVWZ(I,J)

UNAVAILABLE

BOUNDARY CONDITION FLAGS
  I  J  BCFLAG(I,J)

UNAVAILABLE

DOUBLET SINGULARITY FLAGS
  I  J  DSFLAG(I,J)
  1  1      2
  2  1      2
  1  2      6
  2  2     12
```


FIGURE 7.4-5. Output for POTGEM Test Case 4 (Cont'd).

```
SOURCE SINGULARITY FLAGS
  I   J   SSFLAG(I,J)

UNAVAILABLE


BOUNDARY CONDITION POINTS
  I   J      XBC(I,J)       YBC(I,J)       ZBC(I,J)       SBC(I,J)       VBC(I,J)
  1   1       .6408155       .5000000      -.4640388       .5000000       .7812500
  2   1       .8617864      1.5000000      -.3314563      1.5000000       .8437500
  1   2      1.2595339       .5000000     -1.0827572       .5000000      1.6562500
  2   2      1.3037281      1.5000000      -.7733980      1.5000000      1.4687500


UNIT NORMALS AND AREAS
  I   J      UNX(I,J)       UNY(I,J)       UNZ(I,J)       DA(I,J)
  1   1      -.6859943       .2425356      -.6859943       .9019293
  2   1      -.6859943       .2425356      -.6859943       .6442352
  1   2      -.6859943       .2425356      -.6859943       .6764470
  2   2      -.6859943       .2425356      -.6859943       .4831764


NTOP VECTORS
  I   J     NTOPX(I,J)     NTOPY(I,J)     NTOPZ(I,J)

UNAVAILABLE


NBOT VECTORS
  I   J     NBOTX(I,J)     NBOTY(I,J)     NBOTZ(I,J)

UNAVAILABLE


VELOCITY ALONG NTOP VECTORS
  I   J      UTOP(I,J)

UNAVAILABLE
```

FIGURE 7.4-5. Output for POTGEM Test Case 4 (Cont'd).

VELOCITY ALONG NBOT VECTORS

I	J	UBOT(I,J)

UNAVAILABLE

CORNER POINTS ALONG VL AND VU EDGES

I	XVLC(I)	YVLC(I)	ZVLC(I)	SVLC(I)	VVLC(I)	XVUC(I)	YVUC(I)	ZVUC(I)	SVUC(I)	VVUC(I)
1	0.	0.	0.	0.	0.	1.41421	-.00000	-1.41421	0.	2.00000
2	.35355	1.00000	.00000	1.00000	.25000	1.41421	1.00000	-1.00000	1.00000	1.75000
3	.70711	2.00000	.00000	2.00000	.50000	1.41421	2.00000	-.70711	2.00000	1.50000

BOUNDARY POINTS ALONG VL AND VU EDGES

I	XVLB(I)	YVLB(I)	ZVLB(I)	SVLB(I)	VVLB(I)	XVUB(I)	YVUB(I)	ZVUB(I)	SVUB(I)	VVUB(I)	CORD2(I)	SPAN1(I)
1	.177	.500	.000	.500	.125	1.414	.500	-1.237	.500	1.875	1.237	1.000
2	.530	1.500	0.	1.500	.375	1.414	1.500	-.884	1.500	1.625	.884	1.000

CORNER POINTS ALONG SL AND SU EDGES

I	XSLC(I)	YSLC(I)	ZSLC(I)	SSLC(I)	VSLC(I)	XSUC(I)	YSUC(I)	ZSUC(I)	SSUC(I)	VSUC(I)
1	.17678	-.00000	-.17678	0.	.25000	.79550	2.00000	-.08839	2.00000	.62500
2	.88388	-.00000	-.88388	0.	1.25000	1.14905	2.00000	-.44194	2.00000	1.12500
3	1.41421	-.00000	-1.41421	0.	2.00000	1.41421	2.00000	-.70711	2.00000	1.50000

BOUNDARY POINTS ALONG SL AND SU EDGES

I	XSLB(I)	YSLB(I)	ZSLB(I)	SSLB(I)	VSLB(I)	XSUB(I)	YSUB(I)	ZSUB(I)	SSUB(I)	VSUB(I)	CORD1(I)	SPAN2(I)
1	.530	-.000	-.530	0.	.750	.972	2.000	-.265	2.000	.875	2.000	.707
2	1.237	-.000	-1.237	0.	1.750	1.326	2.000	-.619	2.000	1.375	2.000	.530

FORCE SENSING LOCATIONS IN N_1-DIRECTION

I	J	XS1(I,J)	YS1(I,J)	ZS1(I,J)
1	1	.3314563	.5000000	-.1546796
2	1	.6008155	1.5000000	-.1104854
1	2	.9501747	.5000000	-.7733980
2	2	1.0827572	1.5000000	-.5524272

FIGURE 7.4-5. Output for POTGEM Test Case 4 (Cont'd).

```
  1  3      1.4142135       .5000000     -1.2374368
  2  3      1.4142135      1.5000000      -.8838835

FORCE SENSING LOCATIONS IN N2-DIRECTION
  I  J      XS2(I,J)        YS2(I,J)       ZS2(I,J)
  1  1       .5303301       -.0000000      -.5303301
  2  1       .7513009       1.0000000      -.3977476
  3  1       .9722718       2.0000000      -.2651650
  1  2      1.2374368       -.0000000     -1.2374368
  2  2      1.2816310       1.0000000      -.9280776
  3  2      1.3258252       2.0000000      -.6187184
+STOP
 STOP 777
```

FIGURE 7.4-5. Output for POTGEM Test Case 4 (Concluded).

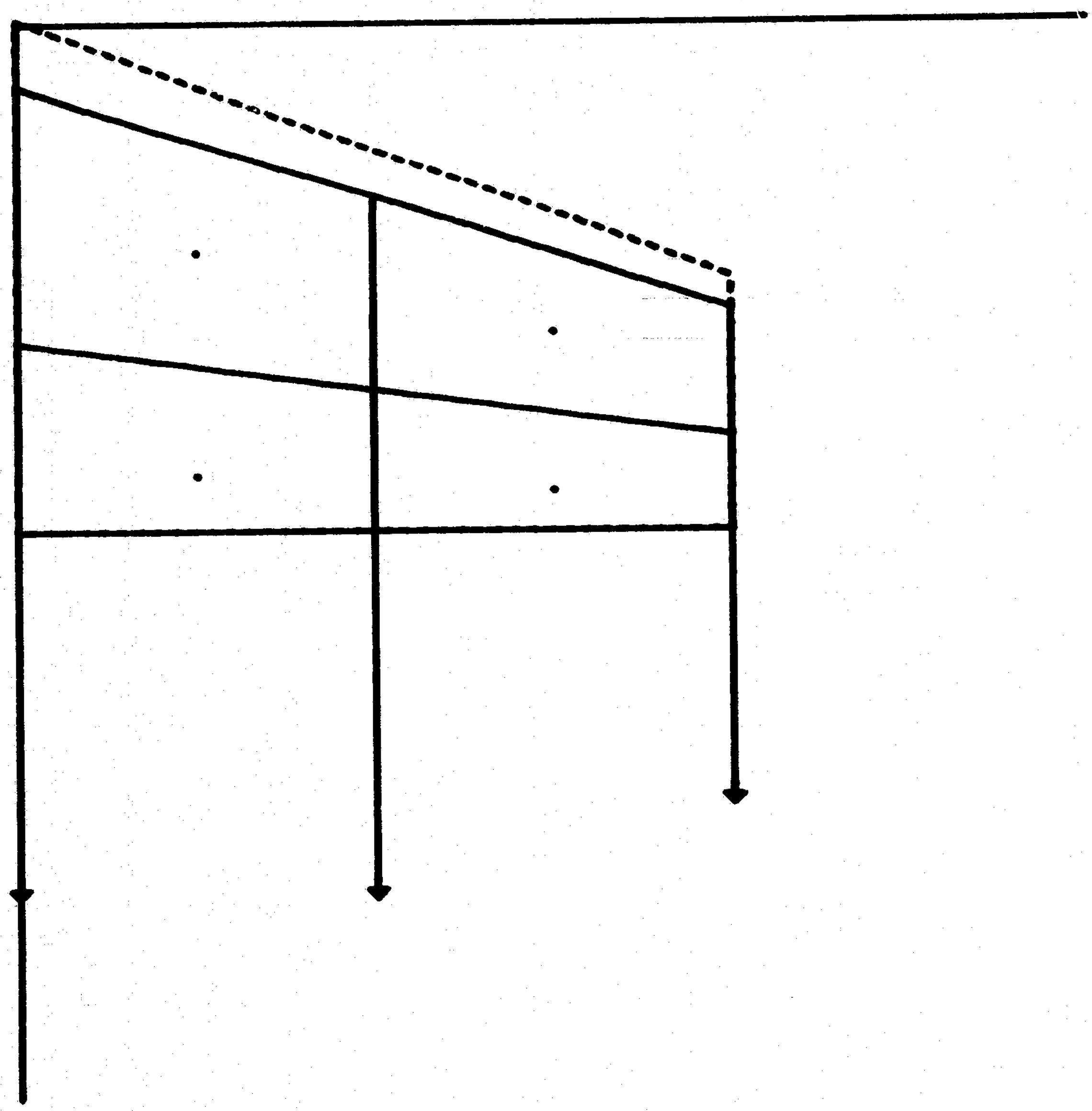


FIGURE 7.4-6(a). Top View of POTGEM Test Case 4.

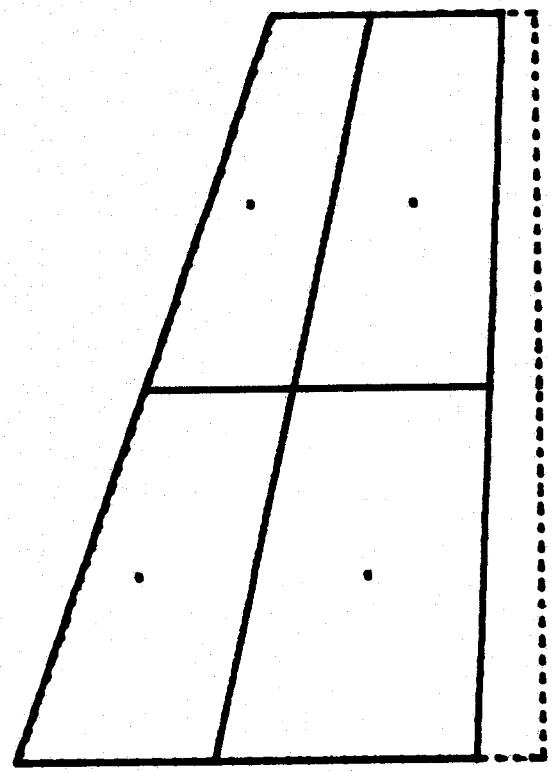


FIGURE 7.4-6(b). Front View of POTCEM Test Case 4.

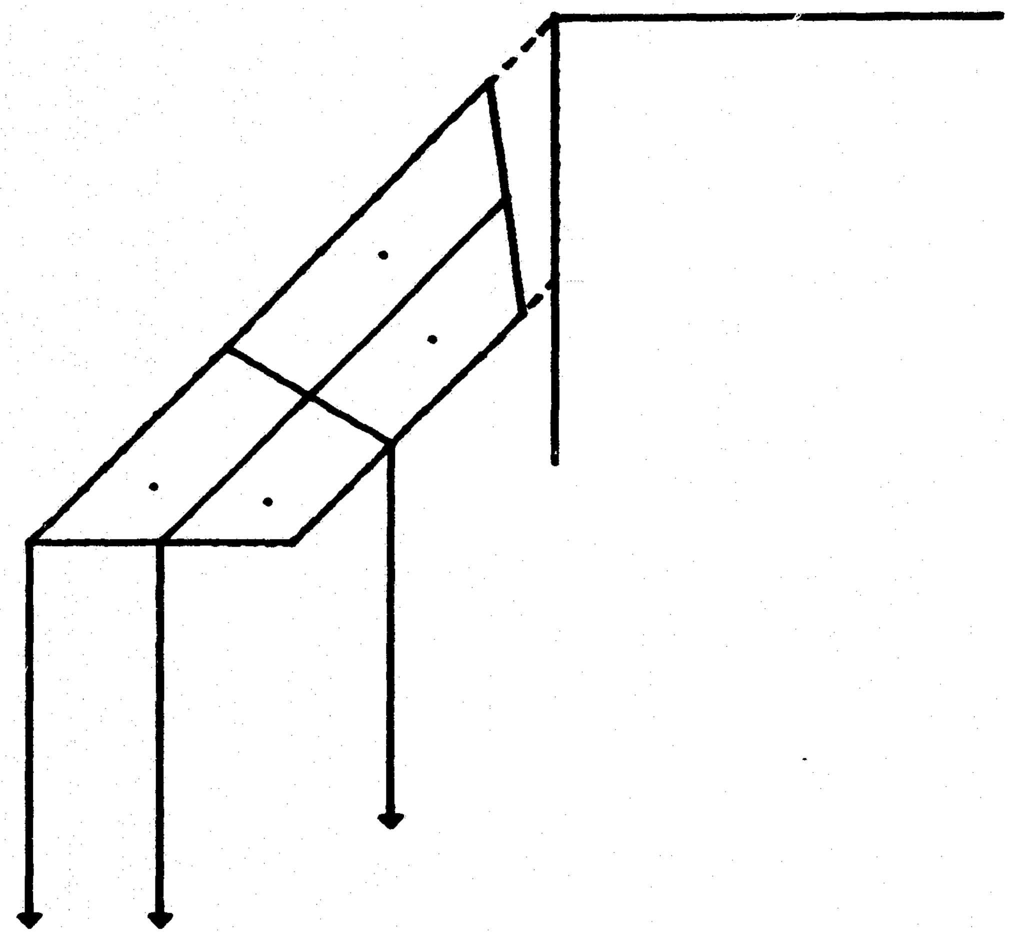


FIGURE 7.4-6(c). Side View of POTGEM Test Case 4.

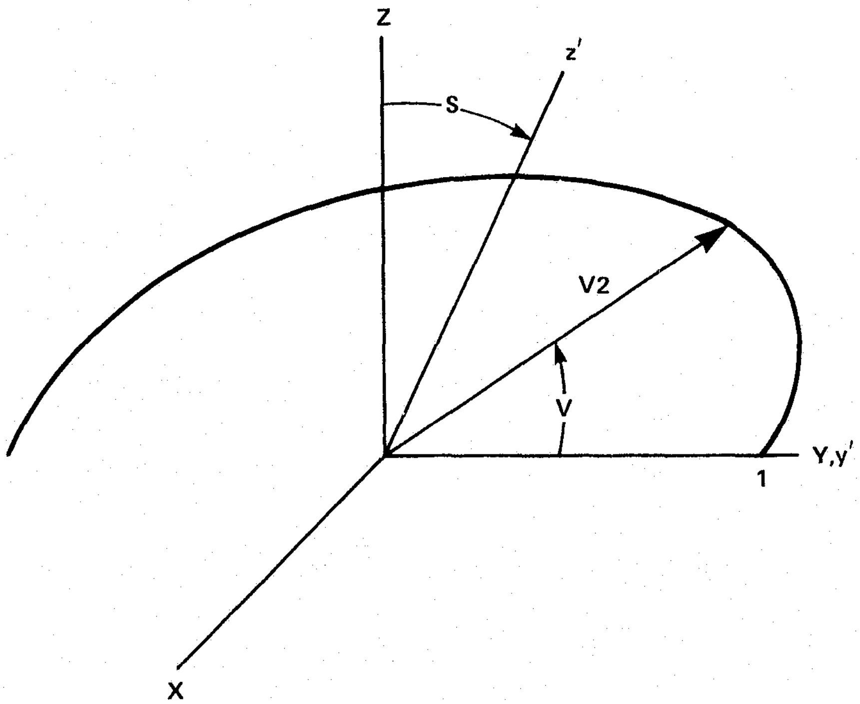


FIGURE 7.5-1. S and V Variables for Test Case 4.

```
T
TITLE
TEST CASE 5 -- SPHERE WITH S THE CIRCUMFERENTIAL VARIABLE
SRT1
 $INCRV1 IC=1,COPT=0 $END
SRT1
 $INCRV1 IC=4,COPT=3 $END
SRT1
 $INCRV1 IC=5,COPT=0 $END
SRT1
 $INCRV1 IC=6,COPT=4,VAR2(1)=1 $END
SRT1
 $INCRV1 IC=11 $END
DSEGMENTS
 $DATA NBPS(1)=5,NBPV(1)=10 $END
VLBC
 $DATA $END
SLBC
 $DATA IOPT=2 $END
SL
 $DATA IOPTSV=0 $END
VL
 $DATA $END
SU
 $DATA IOPTSV=1,NTABSV=1,VAR2SV(1)=90 $END
VU
 $DATA VAR2SV(1)=180 $END
PANL
 $DATA $END
ROSS
 $DATA EAXIS(1)=0,0,1,PHI=90 $END
DSFL
     1     5
     1     9
    19
     1     5
```

FIGURE 7.5-2. Input for POTGEM Test Case 5.

```
      10
      27
    0
    FINISH
     $DATA FLT(1)=3,1415927,3*1,LOG(12)=T,INT(10)=1,1 $END
    STORE
     $DATA ID=5 $END
    PRINT
     $DATA PRINT(1)=18*T $END
    STOP
```

FIGURE 7.5-2. Input for POTGEM Test Case 5 (Concluded).

```
POTFAN GEUMFTRY PROGRAM,  VERSION 1.3
************************************

TIME = 08/09/76     07:34:57

FNTER BATCH
+TITLE

TEST CASE 5 -- SPHERE WITH S THE CIRCUMFERENTIAL VARIABLE


+SRI1
+SRI1
+SRI1
+SRI1
+SRI1
+DSEGMENTS
+VLBC
+SLBC
+SL
+VL
+SU
+VU
+PANL
+ROSS
+DSFI
+FINISH
+STORE
FILE 5,GM=PEC/LIB$          HAS BEEN OPENED FOR WRITING ON UNIT  1
CREATION TIME = 08/09/76     07:34:59

CREATION OF GEOMETRY FILE
-------------------------

TITLE =  TEST CASE 5 -- SPHERE WITH S THE CIRCUMFERENTIAL VARIABLE

(LOG) =  F F F F T F F F F F F T F F F F T F F F
```

FIGURE 7.5-3. Output for POTGEM Test Case 5.

```
(INT) =      0     6    11     5    10     0     0     0     0     1     1     0     0
(FLT) =   3.1415927     1.0000000     1.0000000     1.0000000     1.0000000          0.          0.     25.066283
          .25066283E-02          0.          0.          0.
+PRINT

PRINTOUT OF GEOMETRY FILE DATA
==============================
TITLE = TEST CASE 5 -- SPHERE WITH S THE CIRCUMFERENTIAL VARIABLE

CREATION TIME = 08/09/76    07:34:59
(IFORM) = 110111111
(ID)  =      5
(LOG) =  F F F F T F F F F F F T F F F T F F F
(INT) =      0     6    11     5    10     0     0     0     0     1     1     0     0
(FLT) =        3.1415927     1.0000000     1.0000000     1.0000000     1.0000000     0.          0.
              25.0662830      .0025066     0.            0.            0.


PANEL CORNER POINTS
  I  J       X(I,J)        Y(I,J)        Z(I,J)        S(I,J)        V(I,J)
  1  1      -.9969173     -.0000000      .0784591     0.             4.4999997
  2  1      -.9969173     -.0242452      .0746190    18.0000000      4.4999997
  3  1      -.9969173     -.0461171      .0634747    36.0000000      4.4999997
  4  1      -.9969173     -.0634747      .0461171    53.9999990      4.4999997
  5  1      -.9969173     -.0746190      .0242452    71.9999990      4.4999997
  6  1      -.9969173     -.0784591     -.0000000    90.0000000      4.4999997
  1  2      -.9238795     -.0000000      .3826834     0.            22.5000000
  2  2      -.9238795     -.1182557      .3639536    18.0000000     22.5000000
  3  2      -.9238795     -.2249357      .3095974    36.0000000     22.5000000
  4  2      -.9238795     -.3095974      .2249357    53.9999990     22.5000000
  5  2      -.9238795     -.3639536      .1182557    71.9999990     22.5000000
  6  2      -.9238795     -.3826834     -.0000000    90.0000000     22.5000000
  1  3      -.7604060     -.0000000      .6494480     0.            40.4999990
  2  3      -.7604060     -.2006905      .6176618    18.0000000     40.4999990
  3  3      -.7604060     -.3817360      .5254145    36.0000000     40.4999990
  4  3      -.7604060     -.5254145      .3817360    53.9999990     40.4999990
  5  3      -.7604060     -.6176618      .2006905    71.9999990     40.4999990
  6  3      -.7604060     -.6494480     -.0000000    90.0000000     40.4999990
  1  4      -.5224986     -.0000000      .8526401     0.            58.4999990
```

FIGURE 7.5-3. Output for POTGEM Test Case 5 (Cont'd).

2	4	-.5224986	-.2634803	.8109090	18.0000000	58.4999990
3	4	-.5224986	-.5011693	.6898004	36.0000000	58.4999990
4	4	-.5224986	-.6898003	.5011693	53.9999990	58.4999990
5	4	-.5224986	-.8109090	.2634803	71.9999990	58.4999990
6	4	-.5224986	-.8526401	-.0000000	90.0000000	58.4999990
1	5	-.2334454	-.0000000	.9723699	0.	76.4999990
2	5	-.2334454	-.3004788	.9247787	18.0000000	76.4999990
3	5	-.2334454	-.5715447	.7866638	36.0000000	76.4999990
4	5	-.2334454	-.7866638	.5715447	53.9999990	76.4999990
5	5	-.2334454	-.9247787	.3004788	71.9999990	76.4999990
6	5	-.2334454	-.9723699	-.0000000	90.0000000	76.4999990
1	6	.0784590	.0000000	.9969173	0.	94.4999980
2	6	.0784590	-.3080644	.9481247	18.0000000	94.4999980
3	6	.0784590	-.5859733	.8065231	36.0000000	94.4999980
4	6	.0784590	-.8065230	.5859733	53.9999990	94.4999980
5	6	.0784590	-.9481247	.3080644	71.9999990	94.4999980
6	6	.0784590	-.9969173	-.0000000	90.0000000	94.4999980
1	7	.3826834	.0000000	.9238796	0.	112.4999970
2	7	.3826834	-.2854945	.8786617	18.0000000	112.4999970
3	7	.3826834	-.5430428	.7474343	36.0000000	112.4999970
4	7	.3826834	-.7474342	.5430428	53.9999990	112.4999970
5	7	.3826834	-.8786617	.2854945	71.9999990	112.4999970
6	7	.3826834	-.9238796	-.0000000	90.0000000	112.4999970
1	8	.6494480	.0000000	.7604060	0.	130.5000000
2	8	.6494480	-.2349784	.7231891	18.0000000	130.5000000
3	8	.6494480	-.4469554	.6151814	36.0000000	130.5000000
4	8	.6494480	-.6151814	.4469555	53.9999990	130.5000000
5	8	.6494480	-.7231891	.2349784	71.9999990	130.5000000
6	8	.6494480	-.7604060	-.0000000	90.0000000	130.5000000
1	9	.8526401	.0000000	.5224987	0.	148.5000000
2	9	.8526401	-.1614610	.4969258	18.0000000	148.5000000
3	9	.8526401	-.3071170	.4227103	36.0000000	148.5000000
4	9	.8526401	-.4227103	.3071170	53.9999990	148.5000000
5	9	.8526401	-.4969257	.1614610	71.9999990	148.5000000
6	9	.8526401	-.5224986	-.0000000	90.0000000	148.5000000
1	10	.9723699	.0000000	.2334455	0.	166.5000000
2	10	.9723699	-.0721386	.2220198	18.0000000	166.5000000
3	10	.9723699	-.1372158	.1888613	36.0000000	166.5000000
4	10	.9723699	-.1888613	.1372158	53.9999990	166.5000000

FIGURE 7.5-3. Output for POTGEM Test Case 5 (Cont'd).

```
 5 10       .9723699      -.2220198       .0721386     71.9999990     166.5000000
 6 10       .9723699      -.2334455      -.0000000     90.0000000     166.5000000
 1 11      1.0000000       .0000000       .0000000      0.            180.0000000
 2 11      1.0000000      -.0000000       .0000000     18.0000000     180.0000000
 3 11      1.0000000      -.0000000       .0000000     36.0000000     180.0000000
 4 11      1.0000000      -.0000000       .0000000     53.9999990     180.0000000
 5 11      1.0000000      -.0000000       .0000000     71.9999990     180.0000000
 6 11      1.0000000      -.0000000      -.0000000     90.0000000     180.0000000


UNIT VECTORS ALONG WAKE ELEMENTS
  I  J     UVWX(I,J)      UVWY(I,J)      UVWZ(I,J)

UNAVAILABLE


BOUNDARY CONDITION FLAGS
  I  J  BCFLAG(I,J)

UNAVAILABLE


DOUBLET SINGULARITY FLAGS
  I  J  DSFLAG(I,J)
  1  1       19
  2  1       19
  3  1       19
  4  1       19
  5  1       19
  1  2       19
  2  2       19
  3  2       19
  4  2       19
  5  2       19
  1  3       19
  2  3       19
  3  3       19
  4  3       19
  5  3       19
```

FIGURE 7.5-3. Output for POTGEM Test Case 5 (Cont'd).

1	4	19
2	4	19
3	4	19
4	4	19
5	4	19
1	5	19
2	5	19
3	5	19
4	5	19
5	5	19
1	6	19
2	6	19
3	6	19
4	6	19
5	6	19
1	7	19
2	7	19
3	7	19
4	7	19
5	7	19
1	8	19
2	8	19
3	8	19
4	8	19
5	8	19
1	9	19
2	9	19
3	9	19
4	9	19
5	9	19
1	10	27
2	10	27
3	10	27
4	10	27
5	10	27

SOURCE SINGULARITY FLAGS
I J SSFLAG(I,J)

FIGURE 7.5-3. Output for POTGEM Test Case 5 (Cont'd).

UNAVAILABLE

BOUNDARY CONDITION POINTS

I	J	XBC(I,J)	YBC(I,J)	ZBC(I,J)	SBC(I,J)	VBC(I,J)
1	1	-.9723699	-.0365189	.2305713	8.9999990	13.4999990
2	1	-.9723699	-.1059820	.2080013	27.0000000	13.4999990
3	1	-.9723699	-.1650708	.1650708	45.0000000	13.4999990
4	1	-.9723699	-.2080013	.1059820	62.9999990	13.4999990
5	1	-.9723699	-.2305712	.0365189	80.9999990	13.4999990
1	2	-.8526402	-.0817368	.5160657	8.9999990	31.4999990
2	2	-.8526402	-.2372094	.4655496	27.0000000	31.4999990
3	2	-.8526402	-.3694623	.3694623	45.0000000	31.4999990
4	2	-.8526402	-.4655496	.2372094	62.9999990	31.4999990
5	2	-.8526402	-.5160657	.0817368	80.9999990	31.4999990
1	3	-.6494481	-.1189537	.7510441	8.9999990	49.4999980
2	3	-.6494481	-.3452171	.6775267	27.0000000	49.4999980
3	3	-.6494481	-.5376882	.5376882	45.0000000	49.4999980
4	3	-.6494481	-.6775266	.3452171	62.9999990	49.4999980
5	3	-.6494481	-.7510441	.1189537	80.9999990	49.4999980
1	4	-.3826835	-.1445266	.9125050	8.9999990	67.4999980
2	4	-.3826835	-.4194325	.8231827	27.0000000	67.4999980
3	4	-.3826835	-.6532815	.6532815	45.0000000	67.4999980
4	4	-.3826835	-.8231826	.4194325	62.9999990	67.4999980
5	4	-.3826835	-.9125050	.1445266	80.9999990	67.4999980
1	5	-.0784591	-.1559522	.9846436	8.9999990	85.4999980
2	5	-.0784591	-.4525910	.8882598	27.0000000	85.4999980
3	5	-.0784591	-.7049270	.7049270	45.0000000	85.4999980
4	5	-.0784591	-.8882598	.4525910	62.9999990	85.4999980
5	5	-.0784591	-.9846436	.1559522	80.9999990	85.4999980
1	6	.2334453	-.1521122	.9603985	8.9999990	103.4999970
2	6	.2334453	-.4414467	.8663880	27.0000000	103.4999970
3	6	.2334453	-.6875694	.6875694	45.0000000	103.4999970
4	6	.2334453	-.8663879	.4414467	62.9999990	103.4999970
5	6	.2334453	-.9603984	.1521122	80.9999990	103.4999970
1	7	.5224985	-.1333823	.8421428	8.9999990	121.4999980
2	7	.5224985	-.3870905	.7597080	27.0000000	121.4999980
3	7	.5224985	-.6029077	.6029077	45.0000000	121.4999980
4	7	.5224985	-.7597080	.3870906	62.9999990	121.4999980

FIGURE 7.5-3. Output for POTGEM Test Case 5 (Cont'd).

5	7	.5224985	-.8421428	.1333823	80.9999990	121.4999980
1	8	.7604059	-.1015961	.6414523	8.9999990	139.5000000
2	8	.7604059	-.2948433	.5786625	27.0000000	139.5000000
3	8	.7604059	-.4592292	.4592292	45.0000000	139.5000000
4	8	.7604059	-.5786625	.2948433	62.9999990	139.5000000
5	8	.7604059	-.6414523	.1015961	80.9999990	139.5000000
1	9	.9238795	-.0598649	.3779721	8.9999990	157.5000000
2	9	.9238795	-.1737347	.3409735	27.0000000	157.5000000
3	9	.9238795	-.2705981	.2705981	45.0000000	157.5000000
4	9	.9238795	-.3409735	.1737347	62.9999990	157.5000000
5	9	.9238795	-.3779721	.0598649	80.9999990	157.5000000
1	10	.9969173	-.0122737	.0774932	8.9999990	175.5000000
2	10	.9969173	-.0356197	.0699076	27.0000000	175.5000000
3	10	.9969173	-.0554790	.0554790	45.0000000	175.5000000
4	10	.9969173	-.0699076	.0356197	62.9999990	175.5000000
5	10	.9969173	-.0774932	.0122737	80.9999990	175.5000000

UNIT NORMALS AND AREAS

I	J	UNX(I,J)	UNY(I,J)	UNZ(I,J)	DA(I,J)
1	1	-.9723523	-.0365668	.2306378	.0223073
2	1	-.9723518	-.1060107	.2080715	.0223073
3	1	-.9723548	-.1651154	.1651154	.0223073
4	1	-.9723512	-.2080683	.1060227	.0223073
5	1	-.9723523	-.2306438	.0365292	.0223073
1	2	-.8526058	-.0817634	.5161184	.0500647
2	2	-.8525861	-.2372028	.4656520	.0500647
3	2	-.8525799	-.3695318	.3695318	.0500647
4	2	-.8525861	-.4655978	.2373092	.0500647
5	2	-.8526046	-.5161475	.0815925	.0500647
1	3	-.6493522	-.1189132	.7511334	.0731370
2	3	-.6493682	-.3453779	.6775213	.0731370
3	3	-.6494157	-.5377077	.5377078	.0731370
4	3	-.6494782	-.6775239	.3451658	.0731370
5	3	-.6494717	-.7510254	.1189426	.0731370
1	4	-.3827577	-.1445023	.9124777	.0891621
2	4	-.3828302	-.4194507	.8231052	.0891621
3	4	-.3827067	-.6532747	.6532747	.0891621
4	4	-.3827888	-.8231425	.4194153	.0891621

FIGURE 7.5-3. Output for POTGEM Test Case 5 (Cont'd).

5	4	-.3827577	-.9125003	.1443600	.0891621
1	5	-.0784985	-.1558293	.9846600	.0963765
2	5	-.0786133	-.4525625	.8882607	.0963765
3	5	-.0785345	-.7049228	.7049228	.0963765
4	5	-.0784241	-.8882740	.4525693	.0963765
5	5	-.0784985	-.9846825	.1556869	.0963765
1	6	.2335332	-.1519898	.9603964	.0939478
2	6	.2334914	-.4414139	.8663922	.0939478
3	6	.2334794	-.6875636	.6875636	.0939478
4	6	.2334456	-.8663800	.4414621	.0939478
5	6	.2335332	-.9603873	.1520475	.0939478
1	7	.5225673	-.1334036	.8420968	.0821590
2	7	.5226325	-.3869853	.7596694	.0821590
3	7	.5226386	-.6028470	.6028470	.0821590
4	7	.5224942	-.7597450	.3870238	.0821590
5	7	.5225673	-.8421193	.1332613	.0821590
1	8	.7605071	-.1015889	.6413334	.0623440
2	8	.7604449	-.2949371	.5785634	.0623440
3	8	.7604672	-.4591785	.4591785	.0623440
4	8	.7603647	-.5787334	.2948103	.0623440
5	8	.7604165	-.6414318	.1016468	.0623440
1	9	.9238914	-.0598710	.3779421	.0366101
2	9	.9238809	-.1737604	.3409567	.0366101
3	9	.9238827	-.2705926	.2705926	.0366101
4	9	.9238948	-.3409267	.1737451	.0366101
5	9	.9238759	-.3779915	.0597974	.0366101
1	10	.9969258	-.0122832	.0773828	.0084805
2	10	.9969258	-.0355719	.0698115	.0084805
3	10	.9969258	-.0554026	.0554026	.0084805
4	10	.9969259	-.0698098	.0355710	.0084805
5	10	.9969258	-.0773861	.0122624	.0084805

NTOP VECTORS

I	J	NTOPX(I,J)	NTOPY(I,J)	NTOPZ(I,J)

UNAVAILABLE

FIGURE 7.5-3. Output for POTGEM Test Case 5 (Cont'd).

NBOT VECTORS

I	J	NBOTX(I,J)	NBOTY(I,J)	NBOTZ(I,J)

UNAVAILABLE

VELOCITY ALONG NTOP VECTORS

I	J	VTOP(I,J)

UNAVAILABLE

VELOCITY ALONG NBOT VECTORS

I	J	VBOT(I,J)

UNAVAILABLE

CORNER POINTS ALONG VL AND VU EDGES

I	XVLC(I)	YVLC(I)	ZVLC(I)	SVLC(I)	VVLC(I)	XVUC(I)	YVUC(I)	ZVUC(I)	SVUC(I)	VVUC(I)
1	-1.00000	-.00000	0.	0.	0.	1.00000	.00000	.00000	0.	180.00000
2	-1.00000	-.00000	0.	18.00000	0.	1.00000	-.00000	.00000	18.00000	180.00000
3	-1.00000	-.00000	0.	36.00000	0.	1.00000	-.00000	.00000	36.00000	180.00000
4	-1.00000	-.00000	0.	54.00000	0.	1.00000	-.00000	.00000	54.00000	180.00000
5	-1.00000	-.00000	0.	72.00000	0.	1.00000	-.00000	.00000	72.00000	180.00000
6	-1.00000	-.00000	0.	90.00000	0.	1.00000	-.00000	-.00000	90.00000	180.00000

BOUNDARY POINTS ALONG VL AND VU EDGES

I	XVLB(I)	YVLB(I)	ZVLB(I)	SVLB(I)	VVLB(I)	XVUB(I)	YVUB(I)	ZVUB(I)	SVUB(I)	VVUB(I)	CORD2(I)	SPAN1(I)
1	-1.000	-.000	0.	9.000	0.	1.000	-.000	.000	9.000	180.000	2.000	0.
2	-1.000	-.000	0.	27.000	0.	1.000	-.000	.000	27.000	180.000	2.000	0.
3	-1.000	-.000	0.	45.000	0.	1.000	-.000	.000	45.000	180.000	2.000	0.
4	-1.000	-.000	0.	63.000	0.	1.000	-.000	.000	63.000	180.000	2.000	0.
5	-1.000	-.000	0.	81.000	0.	1.000	-.000	.000	81.000	180.000	2.000	0.

CORNER POINTS ALONG SL AND SU EDGES

I	XSLC(I)	YSLC(I)	ZSLC(I)	SSLC(I)	VSLC(I)	XSUC(I)	YSUC(I)	ZSUC(I)	SSUC(I)	VSUC(I)

FIGURE 7.5-3. Output for POTGEM Test Case 5 (Cont'd).

```
  1    -.99692    -.00000    .07846    0.       4.50000   -.99692   -.07846   -.00000   90.00000     4.50000
  2    -.92388    -.00000    .38268    0.      22.50000   -.92388   -.38268   -.00000   90.00000    22.50000
  3    -.76041    -.00000    .64945    0.      40.50000   -.76041   -.64945   -.00000   90.00000    40.50000
  4    -.52250    -.00000    .85264    0.      58.50000   -.52250   -.85264   -.00000   90.00000    58.50000
  5    -.23345    -.00000    .97237    0.      76.50000   -.23345   -.97237   -.00000   90.00000    76.50000
  6     .07846     .00000    .99692    0.      94.50000    .07846   -.99692   -.00000   90.00000    94.50000
  7     .38268     .00000    .92388    0.     112.50000    .38268   -.92388   -.00000   90.00000   112.50000
  8     .64945     .00000    .76041    0.     130.50000    .64945   -.76041   -.00000   90.00000   130.50000
  9     .85264     .00000    .52250    0.     148.50000    .85264   -.52250   -.00000   90.00000   148.50000
 10     .97237     .00000    .23345    0.     166.50000    .97237   -.23345   -.00000   90.00000   166.50000
 11    1.00000     .00000    .00000    0.     180.00000   1.00000   -.00000   -.00000   90.00000   180.00000


BOUNDARY POINTS ALONG SL AND SU EDGES
  I    XSLB(I)   YSLB(I)   ZSLB(I)   SSLB(I)   VSLB(I)   XSUB(I)   YSUB(I)   ZSUB(I)   SSUB(I)   VSUB(I)   CORD1(I)   SPAN2(I)
  1     -.972     -.000      .233      0.       13.500     -.972     -.233     -.000     90.000     13.500      .233       .073
  2     -.853     -.000      .522      0.       31.500     -.853     -.522     -.000     90.000     31.500      .522       .163
  3     -.649     -.000      .760      0.       49.500     -.649     -.760     -.000     90.000     49.500      .760       .238
  4     -.383     -.000      .924      0.       67.500     -.383     -.924     -.000     90.000     67.500      .924       .289
  5     -.078     -.000      .997      0.       85.500     -.078     -.997     -.000     90.000     85.500      .997       .312
  6      .233      .000      .972      0.      103.500      .233     -.972     -.000     90.000    103.500      .972       .304
  7      .522      .000      .853      0.      121.500      .522     -.853     -.000     90.000    121.500      .853       .267
  8      .760      .000      .649      0.      139.500      .760     -.649     -.000     90.000    139.500      .649       .203
  9      .924      .000      .383      0.      157.500      .924     -.383     -.000     90.000    157.500      .383       .120
 10      .997      .000      .078      0.      175.500      .997     -.078     -.000     90.000    175.500      .078       .028


FORCE SENSING LOCATIONS IN N1-DIRECTION
  I   J      XS1(I,J)        YS1(I,J)        ZS1(I,J)

UNAVAILABLE


FORCE SENSING LOCATIONS IN N2-DIRECTION
  I   J      XS2(I,J)        YS2(I,J)        ZS2(I,J)

UNAVAILABLE
+STOP
 STOP 777
```

FIGURE 7.5-3. Output for POTGEM Test Case 5 (Concluded).

```
T
TITLF
TFST CASE 6 -- TWO DIMENSIONAL AIRFOIL
CARY
SHT1
 $I,CRV1 IC=11,COPT=6,IOPT1=1,PARAM=0.,NTAB=43,
 VAR1= 1.0, 0.9983622, 0.9935470, 0.9855340, 0.9743373, 0.9600039, 0.942615
 0.9222884, 0.8991708, 0.8734423, 0.845310, 0.8150037, 0.7827722, 0.748878
 0.7135940, 0.6771951, 0.6399556, 0.6021480, 0.5640343, 0.5258664, 0.487883
 0.4503093, 0.4133530, 0.3772072, 0.3420477, 0.3080369, 0.2753196, 0.244028
 0.2142782, 0.1861764, 0.1598156, 0.1352774, 0.1126334, 0.9194654E-01
 0.7326961E-01, 0.5664764F-01, 0.4211732F-01, 0.2970805E-01, 0.1944131F-01
 0.1133259F-01, 0.5389590E-02, 0.1613787E-02, 8*.0
 VAR2= -0.4356997E-05, -0.2324360E-03, -0.9588039E-04, 0.3166141F-03, 0.9069827E-3
 0.1571516F-02, 0.2204748F-02, 0.2704052F-02, 0.2973656E-02, 0.2929086F-02
 0.2500009F-02, 0.1633710F-02, 0.2954737F-03, -0.1526688F-02, -0.3826301F-02
 -0.6576072E-02, -0.9730574F-02, -0.1322808E-01, -0.1699367E-01, -0.2094175E-01
 -0.2497944E-01, -0.2900910E-01, -0.3293188E-01, -0.3665068F-01, -0.4007220E-01
 -0.4310983E-01, -0.4568411F-01, -0.4772490E-01, -0.4917301E-01, -0.4997965E-01
 -0.5010815E-01, -0.4953281F-01, -0.4823973E-01, -0.4622664F-01, -0.4350132E-01
 -0.4008242F-01, -0.3599801E-01, -0.3128479E-01, -0.2598772E-01, -0.2015871E-01
 -0.1385612F-01, -0.7143803E-02, -0.8996113E-04, 7*.0
 $END
DSEGMENTS
 $DATA NSEGVT=2,NBPS=1,NBPV=30,30 $END
VLBC
 $DATA $END
SLBC
 $DATA IOPT=6 $END
SL
 $DATA VAR2SV=-.5 $END
SU
 $DATA VAR2SV=.5 $END
VL
 $DATA VAR2SV=1. $END
VU
```

FIGURE 7.6-1. Input for POTGEM Test Case 6.

```
 $DATA VAR2SV=0.0 $END
PANL
 $DATA UNEPSV=.0001 $END
SRT1
 $INCRV1 IC=11,COPT=6,IOPT1=1,PARAM=0.,NTAB=47,
 VAR1= 0.0, 0.5360453E-03, 0.3204324E-02, 0.7980466E-02, 0.1483292E-01, 0.237257E-1
 0.3461587E-01, 0.4745365E-01, 0.6218497E-01, 0.7874876E-01, 0.9707928E-01
 0.1171044E0, 0.1387470E0, 0.1619247E0, 0.1865507E0, 0.2125319E0, 0.2397717E0
 0.2681689E0, 0.2976173E0, 0.3280070E0, 0.3592237E0, 0.3911495E0, 0.4236625E0
 0.4566361E0, 0.4899412E0, 0.5234444E0, 0.5570085E0, 0.5904924E0, 0.6237516E0
 0.6566373E0, 0.6889974E0, 0.7206745E0, 0.7515085E0, 0.7813352E0, 0.8099871E0
 0.8372933E0, 0.8630801E0, 0.8871725E0, 0.9093951E0, 0.9295721E0, 0.9475313E0
 0.9631051E0, 0.9761329E0, 0.9864645E0, 0.9939623E0, 0.9985082E0, 0.10E01
 3*.0
 VAR2= -0.8996113E-04, 0.7233523E-02, 0.147520E-01, 0.2238896E-01, 0.3006683E-01
 0.3770793E-01, 0.4523517E-01, 0.5257268E-01, 0.596470E-01, 0.6638741E-01, 0.72727E-1
 0.7860291E-01, 0.8395720E-01, 0.8873755E-01, 0.9289736E-01, 0.9639704E-01
 0.9920382E-01, 0.1012926E0, 0.1026458E0, 0.1032543E0, 0.1031172E0, 0.1022425E0
 0.1006469E0, 0.9835541E-01, 0.9540266E-01, 0.9183091E-01, 0.8769143E-01, 0.83043E-1
 0.7795185E-01, 0.7249117E-01, 0.6673938E-01, 0.6078041E-01, 0.5470140E-01
 0.4859197E-01, 0.4254199E-01, 0.3664087E-01, 0.3097472E-01, 0.2562474E-01
 0.2066502E-01, 0.1616049E-01, 0.1216468E-01, 0.8717481E-02, 0.5844172E-02
 0.3553224E-02, 0.1835613E-02, 0.6646207E-03, -0.4343466E-05, 3*.0
 $END
SEGMENT
 $DATA NSEGV=2 $END
SLBC
 $DATA IOPT=4 $END
VU
 $DATA VAR2SV=1. $END
PANL
 $DATA $END
NRT1
 $DATA I2=31 $END
ROSS
 $DATA EAXIS=0.,0.,-1.,PHI=90. $END
```

FIGURE 7.6-1. Input for POTGEM Test Case 6 (Cont'd).

```
DSFLAG
     1
     1
     1
     1
     2    -1
    32
     0
BCFLAG
     1
     1
     1
     1
     2    -1
     0
     0
UVW
     1
     1    -1
0.0          1.0        0.0
     2
     1    -1
0.0          -1.0        0.0
0
FINISH
 .DATA FLT=4*1, LOG(12)=T $END
STORE
 .DATA ID=6 $END
PRINT
 .DATA PRINT=18*T $END
STOP
```


FIGURE 7.6-1. Input for POTGEM Test Case 6 (Concluded).

```
POTFAN GEOMETRY PROGRAM,  VERSION 1.3
*************************************

TIME = 08/09/76     07:37:19

ENTER BATCH
+TITLE

TEST CASE 6 -- TWO DIMENSIONAL AIRFOIL


+CARY
+SRI1
+DSEGMENTS
+VLBC
+SLBC
+SL
+SU
+VL
+VU
+PANL
+SRI1
+SEGMENT
+SLB
+VU
+PANL
+NRI1
+ROSS
+DSFLAG
+BCFLAG
+UVW
+FINISH
+STORE
FILE 6.GM-PNC/LIB$          HAS BEEN OPENED FOR WRITING ON UNIT  1
CREATION TIME = 08/09/76     07:37:24

CREATION OF GEOMETRY FILE
```

FIGURE 7.6-2. Output for POTGEM Test Case 6.

```
-------------------------

TITLE =  TEST CASE 6 -- TWO DIMENSIONAL AIRFOIL

(LOG) =  T F T F T F F F F F F T F F F F T F F F
(INT) =     1   2   61    1   60    1    0    0    0    0    0    0    0
(FLT) =  1.0000000      1.0000000      1.0000000      1.0000000      1.0000000          0.          0.       12.909945
         .12909944E-02       0.             0.             0.
+PRINT

PRINTOUT OF GEOMETRY FILE DATA
-------------------------------
TITLE = TEST CASE 6 -- TWO DIMENSIONAL AIRFOIL

CREATION TIME = 08/09/76     07:37:24
(IFORM) = 1110011111
(ID)   =      6
(LOG) =  T F T F T F F F F F F T F F F F T F F F
(INT) =     1   2   61    1   60    1    0    0    0    0    0    0    0
(FLT) =        1.0000000      1.0000000      1.0000000      1.0000000      1.0000000       0.          0.
              12.9099450      .0012910       0.             0.             0.
```

PANEL CORNER POINTS

I	J	X(I,J)	Y(I,J)	Z(I,J)	S(I,J)	V(I,J)
1	1	1.0000000	.5000000	-.0000044	-.5000000	1.0000000
2	1	1.0000000	-.5000000	-.0000044	.5000000	1.0000000
1	2	.9476640	.5000000	.0020404	-.5000000	.9476640
2	2	.9476640	-.5000000	.0020404	.5000000	.9476640
1	3	.8954715	.5000000	.0029895	-.5000000	.8954715
2	3	.8954715	-.5000000	.0029895	.5000000	.8954715
1	4	.8435655	.5000000	.0024616	-.5000000	.8435655
2	4	.8435655	-.5000000	.0024616	.5000000	.8435655
1	5	.7920883	.5000000	.0007224	-.5000000	.7920883
2	5	.7920883	-.5000000	.0007224	.5000000	.7920883
1	6	.7411809	.5000000	-.0019940	-.5000000	.7411809
2	6	.7411809	-.5000000	-.0019940	.5000000	.7411809
1	7	.6909830	.5000000	-.0054941	-.5000000	.6909830
2	7	.6909830	-.5000000	-.0054941	.5000000	.6909830

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

1	8	.6416320	.5000000	-.0095825	-.5000000	.6416320
2	8	.6416320	-.5000000	-.0095825	.5000000	.6416320
1	9	.5932633	.5000000	-.0140870	-.5000000	.5932633
2	9	.5932633	-.5000000	-.0140870	.5000000	.5932633
1	10	.5460095	.5000000	-.0188406	-.5000000	.5460095
2	10	.5460095	-.5000000	-.0188406	.5000000	.5460095
1	11	.5000000	.5000000	-.0236824	-.5000000	.5000000
2	11	.5000000	-.5000000	-.0236824	.5000000	.5000000
1	12	.4553610	.5000000	-.0284687	-.5000000	.4553610
2	12	.4553610	-.5000000	-.0284687	.5000000	.4553610
1	13	.4122147	.5000000	-.0330509	-.5000000	.4122147
2	13	.4122147	-.5000000	-.0330509	.5000000	.4122147
1	14	.3706796	.5000000	-.0373020	-.5000000	.3706796
2	14	.3706796	-.5000000	-.0373020	.5000000	.3706796
1	15	.3308694	.5000000	-.0411038	-.5000000	.3308694
2	15	.3308694	-.5000000	-.0411038	.5000000	.3308694
1	16	.2928932	.5000000	-.0443496	-.5000000	.2928932
2	16	.2928932	-.5000000	-.0443496	.5000000	.2928932
1	17	.2568552	.5000000	-.0469453	-.5000000	.2568552
2	17	.2568552	-.5000000	-.0469453	.5000000	.2568552
1	18	.2228540	.5000000	-.0488122	-.5000000	.2228540
2	18	.2228540	-.5000000	-.0488122	.5000000	.2228540
1	19	.1909830	.5000000	-.0498864	-.5000000	.1909830
2	19	.1909830	-.5000000	-.0498864	.5000000	.1909830
1	20	.1613294	.5000000	-.0501200	-.5000000	.1613294
2	20	.1613294	-.5000000	-.0501200	.5000000	.1613294
1	21	.1339746	.5000000	-.0494801	-.5000000	.1339746
2	21	.1339746	-.5000000	-.0494801	.5000000	.1339746
1	22	.1089935	.5000000	-.0479498	-.5000000	.1089935
2	22	.1089935	-.5000000	-.0479498	.5000000	.1089935
1	23	.0864545	.5000000	-.0455272	-.5000000	.0864545
2	23	.0864545	-.5000000	-.0455272	.5000000	.0864545
1	24	.0664196	.5000000	-.0422252	-.5000000	.0664196
2	24	.0664196	-.5000000	-.0422252	.5000000	.0664196
1	25	.0489435	.5000000	-.0380716	-.5000000	.0489435
2	25	.0489435	-.5000000	-.0380716	.5000000	.0489435
1	26	.0340742	.5000000	-.0331078	-.5000000	.0340742
2	26	.0340742	-.5000000	-.0331078	.5000000	.0340742
1	27	.0218524	.5000000	-.0273888	-.5000000	.0218524

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

2	27	.0218524	-.5000000	-.0273888	.5000000	.0218524
1	28	.0123117	.5000000	-.0209823	-.5000000	.0123117
2	28	.0123117	-.5000000	-.0209823	.5000000	.0123117
1	29	.0054781	.5000000	-.0139739	-.5000000	.0054781
2	29	.0054781	-.5000000	-.0139739	.5000000	.0054781
1	30	.0013705	.5000000	-.0065903	-.5000000	.0013705
2	30	.0013705	-.5000000	-.0065903	.5000000	.0013705
1	31	.0000000	.5000000	-.0000900	-.5000000	0.
2	31	-.0000000	-.5000000	-.0000900	.5000000	0.
1	32	.0013705	.5000000	.0103631	-.5000000	.0013705
2	32	.0013705	-.5000000	.0103631	.5000000	.0013705
1	33	.0054781	.5000000	.0187957	-.5000000	.0054781
2	33	.0054781	-.5000000	.0187957	.5000000	.0054781
1	34	.0123117	.5000000	.0275021	-.5000000	.0123117
2	34	.0123117	-.5000000	.0275021	.5000000	.0123117
1	35	.0218524	.5000000	.0362389	-.5000000	.0218524
2	35	.0218524	-.5000000	.0362389	.5000000	.0218524
1	36	.0340742	.5000000	.0448944	-.5000000	.0340742
2	36	.0340742	-.5000000	.0448944	.5000000	.0340742
1	37	.0489435	.5000000	.0533440	-.5000000	.0489435
2	37	.0489435	-.5000000	.0533440	.5000000	.0489435
1	38	.0664196	.5000000	.0614761	-.5000000	.0664196
2	38	.0664196	-.5000000	.0614761	.5000000	.0664196
1	39	.0864545	.5000000	.0691782	-.5000000	.0864545
2	39	.0864545	-.5000000	.0691782	.5000000	.0864545
1	40	.1089935	.5000000	.0763404	-.5000000	.1089935
2	40	.1089935	-.5000000	.0763404	.5000000	.1089935
1	41	.1339746	.5000000	.0828568	-.5000000	.1339746
2	41	.1339746	-.5000000	.0828568	.5000000	.1339746
1	42	.1613294	.5000000	.0886261	-.5000000	.1613294
2	42	.1613294	-.5000000	.0886261	.5000000	.1613294
1	43	.1909830	.5000000	.0935547	-.5000000	.1909830
2	43	.1909830	-.5000000	.0935547	.5000000	.1909830
1	44	.2228540	.5000000	.0975582	-.5000000	.2228540
2	44	.2228540	-.5000000	.0975582	.5000000	.2228540
1	45	.2568552	.5000000	.1005574	-.5000000	.2568552
2	45	.2568552	-.5000000	.1005574	.5000000	.2568552
1	46	.2928932	.5000000	.1024818	-.5000000	.2928932
2	46	.2928932	-.5000000	.1024818	.5000000	.2928932

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

1	47	.3308694	.5000000	.1032724	-.5000000	.3308694
2	47	.3308694	-.5000000	.1032724	.5000000	.3308694
1	48	.3706796	.5000000	.1028852	-.5000000	.3706796
2	48	.3706796	-.5000000	.1028852	.5000000	.3706796
1	49	.4122147	.5000000	.1012867	-.5000000	.4122147
2	49	.4122147	-.5000000	.1012867	.5000000	.4122147
1	50	.4553610	.5000000	.0984561	-.5000000	.4553610
2	50	.4553610	-.5000000	.0984561	.5000000	.4553610
1	51	.5000000	.5000000	.0943913	-.5000000	.5000000
2	51	.5000000	-.5000000	.0943913	.5000000	.5000000
1	52	.5460095	.5000000	.0891073	-.5000000	.5460095
2	52	.5460095	-.5000000	.0891073	.5000000	.5460095
1	53	.5932633	.5000000	.0826363	-.5000000	.5932633
2	53	.5932633	-.5000000	.0826363	.5000000	.5932633
1	54	.6416320	.5000000	.0750329	-.5000000	.6416320
2	54	.6416320	-.5000000	.0750329	.5000000	.6416320
1	55	.6909830	.5000000	.0663751	-.5000000	.6909830
2	55	.6909830	-.5000000	.0663751	.5000000	.6909830
1	56	.7411809	.5000000	.0567657	-.5000000	.7411809
2	56	.7411809	-.5000000	.0567657	.5000000	.7411809
1	57	.7920883	.5000000	.0463406	-.5000000	.7920883
2	57	.7920883	-.5000000	.0463406	.5000000	.7920883
1	58	.8435655	.5000000	.0352702	-.5000000	.8435655
2	58	.8435655	-.5000000	.0352702	.5000000	.8435655
1	59	.8954715	.5000000	.0237741	-.5000000	.8954715
2	59	.8954715	-.5000000	.0237741	.5000000	.8954715
1	60	.9476640	.5000000	.0121352	-.5000000	.9476640
2	60	.9476640	-.5000000	.0121352	.5000000	.9476640
1	61	1.0000000	.5000000	-.0000043	-.5000000	1.0000000
2	61	1.0000000	-.5000000	-.0000043	.5000000	1.0000000

UNIT VECTORS ALONG WAKE ELEMENTS

I	J	UVWX(I,J)	UVWY(I,J)	UVWZ(I,J)
1	1	0.	1.0000000	0.
2	1	0.	-1.0000000	0.
1	2	0.	1.0000000	0.
2	2	0.	-1.0000000	0.
1	3	0.	1.0000000	0.

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

2	3	0.	-1.0000000	0.
1	4	0.	1.0000000	0.
2	4	0.	-1.0000000	0.
1	5	0.	1.0000000	0.
2	5	0.	-1.0000000	0.
1	6	0.	1.0000000	0.
2	6	0.	-1.0000000	0.
1	7	0.	1.0000000	0.
2	7	0.	-1.0000000	0.
1	8	0.	1.0000000	0.
2	8	0.	-1.0000000	0.
1	9	0.	1.0000000	0.
2	9	0.	-1.0000000	0.
1	10	0.	1.0000000	0.
2	10	0.	-1.0000000	0.
1	11	0.	1.0000000	0.
2	11	0.	-1.0000000	0.
1	12	0.	1.0000000	0.
2	12	0.	-1.0000000	0.
1	13	0.	1.0000000	0.
2	13	0.	-1.0000000	0.
1	14	0.	1.0000000	0.
2	14	0.	-1.0000000	0.
1	15	0.	1.0000000	0.
2	15	0.	-1.0000000	0.
1	16	0.	1.0000000	0.
2	16	0.	-1.0000000	0.
1	17	0.	1.0000000	0.
2	17	0.	-1.0000000	0.
1	18	0.	1.0000000	0.
2	18	0.	-1.0000000	0.
1	19	0.	1.0000000	0.
2	19	0.	-1.0000000	0.
1	20	0.	1.0000000	0.
2	20	0.	-1.0000000	0.
1	21	0.	1.0000000	0.
2	21	0.	-1.0000000	0.
1	22	0.	1.0000000	0.
2	22	0.	-1.0000000	0.

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

1 23	0.	1.0000000	0.
2 23	0.	-1.0000000	0.
1 24	0.	1.0000000	0.
2 24	0.	-1.0000000	0.
1 25	0.	1.0000000	0.
2 25	0.	-1.0000000	0.
1 26	0.	1.0000000	0.
2 26	0.	-1.0000000	0.
1 27	0.	1.0000000	0.
2 27	0.	-1.0000000	0.
1 28	0.	1.0000000	0.
2 28	0.	-1.0000000	0.
1 29	0.	1.0000000	0.
2 29	0.	-1.0000000	0.
1 30	0.	1.0000000	0.
2 30	0.	-1.0000000	0.
1 31	0.	1.0000000	0.
2 31	0.	-1.0000000	0.
1 32	0.	1.0000000	0.
2 32	0.	-1.0000000	0.
1 33	0.	1.0000000	0.
2 33	0.	-1.0000000	0.
1 34	0.	1.0000000	0.
2 34	0.	-1.0000000	0.
1 35	0.	1.0000000	0.
2 35	0.	-1.0000000	0.
1 36	0.	1.0000000	0.
2 36	0.	-1.0000000	0.
1 37	0.	1.0000000	0.
2 37	0.	-1.0000000	0.
1 38	0.	1.0000000	0.
2 38	0.	-1.0000000	0.
1 39	0.	1.0000000	0.
2 39	0.	-1.0000000	0.
1 40	0.	1.0000000	0.
2 40	0.	-1.0000000	0.
1 41	0.	1.0000000	0.
2 41	0.	-1.0000000	0.
1 42	0.	1.0000000	0.

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

2	42	0.	-1.0000000	0.
1	43	0.	1.0000000	0.
2	43	0.	-1.0000000	0.
1	44	0.	1.0000000	0.
2	44	0.	-1.0000000	0.
1	45	0.	1.0000000	0.
2	45	0.	-1.0000000	0.
1	46	0.	1.0000000	0.
2	46	0.	-1.0000000	0.
1	47	0.	1.0000000	0.
2	47	0.	-1.0000000	0.
1	48	0.	1.0000000	0.
2	48	0.	-1.0000000	0.
1	49	0.	1.0000000	0.
2	49	0.	-1.0000000	0.
1	50	0.	1.0000000	0.
2	50	0.	-1.0000000	0.
1	51	0.	1.0000000	0.
2	51	0.	-1.0000000	0.
1	52	0.	1.0000000	0.
2	52	0.	-1.0000000	0.
1	53	0.	1.0000000	0.
2	53	0.	-1.0000000	0.
1	54	0.	1.0000000	0.
2	54	0.	-1.0000000	0.
1	55	0.	1.0000000	0.
2	55	0.	-1.0000000	0.
1	56	0.	1.0000000	0.
2	56	0.	-1.0000000	0.
1	57	0.	1.0000000	0.
2	57	0.	-1.0000000	0.
1	58	0.	1.0000000	0.
2	58	0.	-1.0000000	0.
1	59	0.	1.0000000	0.
2	59	0.	-1.0000000	0.
1	60	0.	1.0000000	0.
2	60	0.	-1.0000000	0.
1	61	0.	1.0000000	0.
2	61	0.	-1.0000000	0.

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

BOUNDARY CONDITION FLAGS

I	J	BCFLAG(I,J)
1	1	1
1	2	0
1	3	0
1	4	0
1	5	0
1	6	0
1	7	0
1	8	0
1	9	0
1	10	0
1	11	0
1	12	0
1	13	0
1	14	0
1	15	0
1	16	0
1	17	0
1	18	0
1	19	0
1	20	0
1	21	0
1	22	0
1	23	0
1	24	0
1	25	0
1	26	0
1	27	0
1	28	0
1	29	0
1	30	0
1	31	0
1	32	0
1	33	0
1	34	0
1	35	0

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

```
 1 36       0
 1 37       0
 1 38       0
 1 39       0
 1 40       0
 1 41       0
 1 42       0
 1 43       0
 1 44       0
 1 45       0
 1 46       0
 1 47       0
 1 48       0
 1 49       0
 1 50       0
 1 51       0
 1 52       0
 1 53       0
 1 54       0
 1 55       0
 1 56       0
 1 57       0
 1 58       0
 1 59       0
 1 60       0

DOUBLET SINGULARITY FLAGS
 I  J  DSFLAG(I,J)
 1  1       1
 1  2      32
 1  3      32
 1  4      32
 1  5      32
 1  6      32
 1  7      32
 1  8      32
 1  9      32
 1 10      32
```


FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

1	11	32
1	12	32
1	13	32
1	14	32
1	15	32
1	16	32
1	17	32
1	18	32
1	19	32
1	20	32
1	21	32
1	22	32
1	23	32
1	24	32
1	25	32
1	26	32
1	27	32
1	28	32
1	29	32
1	30	32
1	31	32
1	32	32
1	33	32
1	34	32
1	35	32
1	36	32
1	37	32
1	38	32
1	39	32
1	40	32
1	41	32
1	42	32
1	43	32
1	44	32
1	45	32
1	46	32
1	47	32
1	48	32
1	49	32

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

```
 1 50        32
 1 51        32
 1 52        32
 1 53        32
 1 54        32
 1 55        32
 1 56        32
 1 57        32
 1 58        32
 1 59        32
 1 60        32

SOURCE SINGULARITY FLAGS
  I  J  SSFLAG(I,J)

UNAVAILABLE

BOUNDARY CONDITION POINTS
```

I	J	XBC(I,J)	YBC(I,J)	ZBC(I,J)	SBC(I,J)	VBC(I,J)
1	1	.9738230	-.0000000	.0009326	0.	.9738230
1	2	.9215409	-.0000000	.0027178	0.	.9215409
1	3	.8694738	-.0000000	.0028925	0.	.8694738
1	4	.8177644	-.0000000	.0017278	0.	.8177644
1	5	.7665546	-.0000000	-.0005264	0.	.7665546
1	6	.7159846	-.0000000	-.0036593	0.	.7159846
1	7	.6661931	-.0000000	-.0074741	0.	.6661931
1	8	.6173165	-.0000000	-.0117948	0.	.6173165
1	9	.5694889	-.0000000	-.0164441	0.	.5694889
1	10	.5228412	-.0000000	-.0212593	0.	.5228412
1	11	.4775014	-.0000000	-.0260905	0.	.4775014
1	12	.4335938	-.0000000	-.0307920	0.	.4335938
1	13	.3912386	-.0000000	-.0352263	0.	.3912386
1	14	.3505519	-.0000000	-.0392678	0.	.3505519
1	15	.3116454	-.0000000	-.0428037	0.	.3116454
1	16	.2746256	-.0000000	-.0457341	0.	.2746256
1	17	.2395940	-.0000000	-.0479736	0.	.2395940
1	18	.2066467	-.0000000	-.0494512	0.	.2066467

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

1	19	.1758738	-.0000000	-.0501103	0.	.1758738
1	20	.1473598	-.0000000	-.0499105	0.	.1473598
1	21	.1211829	-.0000000	-.0488263	0.	.1211829
1	22	.0974147	-.0000000	-.0468489	0.	.0974147
1	23	.0761205	-.0000000	-.0439840	0.	.0761205
1	24	.0573585	-.0000000	-.0402524	0.	.0573585
1	25	.0411803	-.0000000	-.0356888	0.	.0411803
1	26	.0276301	-.0000000	-.0303403	0.	.0276301
1	27	.0167451	-.0000000	-.0242682	0.	.0167451
1	28	.0085551	-.0000000	-.0175466	0.	.0085551
1	29	.0030827	-.0000000	-.0102383	0.	.0030827
1	30	.0003427	-.0000000	-.0033404	0.	.0003427
1	31	.0003427	-.0000000	.0057655	0.	.0003427
1	32	.0030827	-.0000000	.0145037	0.	.0030827
1	33	.0085551	-.0000000	.0231338	0.	.0085551
1	34	.0167451	-.0000000	.0318701	0.	.0167451
1	35	.0276301	-.0000000	.0405829	0.	.0276301
1	36	.0411803	-.0000000	.0491514	0.	.0411803
1	37	.0573585	-.0000000	.0574586	0.	.0573585
1	38	.0761205	-.0000000	.0653899	0.	.0761205
1	39	.0974147	-.0000000	.0728336	0.	.0974147
1	40	.1211829	-.0000000	.0796840	0.	.1211829
1	41	.1473598	-.0000000	.0858393	0.	.1473598
1	42	.1758738	-.0000000	.0912015	0.	.1758738
1	43	.2066467	-.0000000	.0956791	0.	.2066467
1	44	.2395940	-.0000000	.0991882	0.	.2395940
1	45	.2746256	-.0000000	.1016565	0.	.2746256
1	46	.3116454	-.0000000	.1030215	0.	.3116454
1	47	.3505519	-.0000000	.1032295	0.	.3505519
1	48	.3912386	-.0000000	.1022391	0.	.3912386
1	49	.4335938	-.0000000	.1000253	0.	.4335938
1	50	.4775014	-.0000000	.0965777	0.	.4775014
1	51	.5228412	-.0000000	.0919003	0.	.5228412
1	52	.5694889	-.0000000	.0860171	0.	.5694889
1	53	.6173165	-.0000000	.0789718	0.	.6173165
1	54	.6661931	-.0000000	.0708302	0.	.6661931
1	55	.7159846	-.0000000	.0616815	0.	.7159846
1	56	.7665546	-.0000000	.0516454	0.	.7665546
1	57	.8177644	-.0000000	.0408736	0.	.8177644

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

1 58	.8694738	-.0000000	.0295594	0.	.8694738
1 59	.9215409	-.0000000	.0179521	0.	.9215409
1 60	.9738230	-.0000000	.0063540	0.	.9738230

UNIT NORMALS AND AREAS

I	J	UNX(I,J)	UNY(I,J)	UNZ(I,J)	DA(I,J)
1	1	-.0496880	.0000000	-.9987648	.0523759
1	2	-.0181037	.0000000	-.9998361	.0522011
1	3	.0103192	-.0000000	-.9999468	.0519087
1	4	.0337174	-.0000000	-.9994314	.0515066
1	5	.0536652	-.0000000	-.9985590	.0509798
1	6	.0694030	-.0000000	-.9975887	.0503198
1	7	.0828655	-.0000000	-.9965607	.0495200
1	8	.0929636	-.0000000	-.9956695	.0485780
1	9	.0999792	-.0000000	-.9949895	.0474924
1	10	.1045243	-.0000000	-.9945223	.0462636
1	11	.1066508	-.0000000	-.9942965	.0448949
1	12	.1058760	-.0000000	-.9943794	.0433888
1	13	.1020906	-.0000000	-.9947751	.0417521
1	14	.0952280	-.0000000	-.9954555	.0399913
1	15	.0851610	-.0000000	-.9963672	.0381146
1	16	.0717375	-.0000000	-.9974235	.0361314
1	17	.0548097	-.0000000	-.9984968	.0340523
1	18	.0337436	-.0000000	-.9994305	.0318891
1	19	.0079370	-.0000000	-.9999685	.0296545
1	20	-.0233629	.0000000	-.9997271	.0273023
1	21	-.0611664	.0000000	-.9981276	.0250280
1	22	-.1068892	.0000000	-.9942709	.0226688
1	23	-.1625777	.0000000	-.9866957	.0203053
1	24	-.2310075	.0000000	-.9729520	.0179629
1	25	-.3164676	.0000000	-.9486033	.0156759
1	26	-.4239519	.0000000	-.9056847	.0134937
1	27	-.5579031	.0000000	-.8299061	.0114921
1	28	-.7167414	.0000000	-.6973391	.0097885
1	29	-.8801617	.0000000	-.4746740	.0084493
1	30	-.9789399	.0000000	-.2041485	.0066452
1	31	-.9933659	.0000000	.1149966	.0105425
1	32	-.8994453	.0000000	.4370333	.0093798

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

1	33	-.7871473	.0000000	.6167651	.0110679
1	34	-.6753516	.0000000	.7374959	.0129367
1	35	-.5781320	.0000000	.8159432	.0149763
1	36	-.4946046	.0000000	.8691181	.0171024
1	37	-.4223109	.0000000	.9064510	.0192755
1	38	-.3588981	.0000000	.9333767	.0214644
1	39	-.3024825	.0000000	.9531549	.0236496
1	40	-.2524421	.0000000	.9676120	.0258170
1	41	-.2066644	.0000000	.9784119	.0279566
1	42	-.1642858	.0000000	.9864128	.0300604
1	43	-.1247512	.0000000	.9921881	.0321215
1	44	-.0876758	.0000000	.9961491	.0341331
1	45	-.0533689	.0000000	.9985749	.0360894
1	46	-.0210111	.0000000	.9997793	.0379844
1	47	.0096436	-.0000000	.9999535	.0398121
1	48	.0386079	-.0000000	.9992544	.0415659
1	49	.0654306	-.0000000	.9978571	.0432390
1	50	.0906315	-.0000000	.9958845	.0448237
1	51	.1141710	-.0000000	.9934611	.0463119
1	52	.1356967	-.0000000	.9907504	.0476949
1	53	.1553221	-.0000000	.9878639	.0489627
1	54	.1728841	-.0000000	.9849422	.0501046
1	55	.1880672	-.0000000	.9821562	.0511095
1	56	.2007935	-.0000000	.9796336	.0519638
1	57	.2104350	-.0000000	.9776079	.0526541
1	58	.2164664	-.0000000	.9762901	.0531638
1	59	.2179228	-.0000000	.9759660	.0534745
1	60	.2152831	-.0000000	.9765517	.0537255

NTOP VECTORS

I	J	NTOPX(I,J)	NTOPY(I,J)	NTOPZ(I,J)

UNAVAILABLE

NBOT VECTORS

I	J	NBOTX(I,J)	NBOTY(I,J)	NBOTZ(I,J)

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

UNAVAILABLE

VELOCITY ALONG NTOP VECTORS

I J UTOP(I,J)

UNAVAILABLE

VELOCITY ALONG NBOT VECTORS

I J UBOT(I,J)

UNAVAILABLE

CORNER POINTS ALONG VL AND VU EDGES

I	XVLC(I)	YVLC(I)	ZVLC(I)	SVLC(I)	VVLC(I)	XVUC(I)	YVUC(I)	ZVUC(I)	SVUC(I)	VVUC(I)
1	1.00000	.50000	-.00000	-.50000	1.00000	1.00000	.50000	-.00000	-.50000	1.00000
2	1.00000	-.50000	-.00000	.50000	1.00000	1.00000	-.50000	-.00000	.50000	1.00000

BOUNDARY POINTS ALONG VL AND VU EDGES

I	XVLB(I)	YVLB(I)	ZVLB(I)	SVLB(I)	VVLB(I)	XVUB(I)	YVUB(I)	ZVUB(I)	SVUB(I)	VVUB(I)	CORD2(I)	SPAN1(I)
1	1.000	-.000	-.000	0.	1.000	1.000	-.000	-.000	0.	1.000	0.	1.000

CORNER POINTS ALONG SL AND SU EDGES

I	XSLC(I)	YSLC(I)	ZSLC(I)	SSLC(I)	VSLC(I)	XSUC(I)	YSUC(I)	ZSUC(I)	SSUC(I)	VSUC(I)
1	1.00000	.50000	-.00000	-.50000	1.00000	1.00000	-.50000	-.00000	.50000	1.00000
2	.94766	.50000	.00204	-.50000	.94766	.94766	-.50000	.00204	.50000	.94766
3	.89547	.50000	.00299	-.50000	.89547	.89547	-.50000	.00299	.50000	.89547
4	.84357	.50000	.00246	-.50000	.84357	.84357	-.50000	.00246	.50000	.84357
5	.79209	.50000	.00072	-.50000	.79209	.79209	-.50000	.00072	.50000	.79209
6	.74118	.50000	-.00199	-.50000	.74118	.74118	-.50000	-.00199	.50000	.74118
7	.69098	.50000	-.00549	-.50000	.69098	.69098	-.50000	-.00549	.50000	.69098
8	.64163	.50000	-.00958	-.50000	.64163	.64163	-.50000	-.00958	.50000	.64163
9	.59326	.50000	-.01409	-.50000	.59326	.59326	-.50000	-.01409	.50000	.59326
10	.54601	.50000	-.01884	-.50000	.54601	.54601	-.50000	-.01884	.50000	.54601
11	.50000	.50000	-.02368	-.50000	.50000	.50000	-.50000	-.02368	.50000	.50000

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

12	.45536	.50000	-.02847	-.50000	.45536	.45536	-.50000	-.02847	.50000	.45536
13	.41221	.50000	-.03305	-.50000	.41221	.41221	-.50000	-.03305	.50000	.41221
14	.37068	.50000	-.03730	-.50000	.37068	.37068	-.50000	-.03730	.50000	.37068
15	.33087	.50000	-.04110	-.50000	.33087	.33087	-.50000	-.04110	.50000	.33087
16	.29289	.50000	-.04435	-.50000	.29289	.29289	-.50000	-.04435	.50000	.29289
17	.25686	.50000	-.04695	-.50000	.25686	.25686	-.50000	-.04695	.50000	.25686
18	.22285	.50000	-.04881	-.50000	.22285	.22285	-.50000	-.04881	.50000	.22285
19	.19098	.50000	-.04989	-.50000	.19098	.19098	-.50000	-.04989	.50000	.19098
20	.16133	.50000	-.05012	-.50000	.16133	.16133	-.50000	-.05012	.50000	.16133
21	.13397	.50000	-.04948	-.50000	.13397	.13397	-.50000	-.04948	.50000	.13397
22	.10899	.50000	-.04795	-.50000	.10899	.10899	-.50000	-.04795	.50000	.10899
23	.08645	.50000	-.04553	-.50000	.08645	.08645	-.50000	-.04553	.50000	.08645
24	.06642	.50000	-.04223	-.50000	.06642	.06642	-.50000	-.04223	.50000	.06642
25	.04894	.50000	-.03807	-.50000	.04894	.04894	-.50000	-.03807	.50000	.04894
26	.03407	.50000	-.03311	-.50000	.03407	.03407	-.50000	-.03311	.50000	.03407
27	.02185	.50000	-.02739	-.50000	.02185	.02185	-.50000	-.02739	.50000	.02185
28	.01231	.50000	-.02098	-.50000	.01231	.01231	-.50000	-.02098	.50000	.01231
29	.00548	.50000	-.01397	-.50000	.00548	.00548	-.50000	-.01397	.50000	.00548
30	.00137	.50000	-.00659	-.50000	.00137	.00137	-.50000	-.00659	.50000	.00137
31	.00000	.50000	-.00009	-.50000	0.	-.00000	-.50000	-.00009	.50000	0.
32	.00137	.50000	.01036	-.50000	.00137	.00137	-.50000	.01036	.50000	.00137
33	.00548	.50000	.01880	-.50000	.00548	.00548	-.50000	.01880	.50000	.00548
34	.01231	.50000	.02750	-.50000	.01231	.01231	-.50000	.02750	.50000	.01231
35	.02185	.50000	.03624	-.50000	.02185	.02185	-.50000	.03624	.50000	.02185
36	.03407	.50000	.04489	-.50000	.03407	.03407	-.50000	.04489	.50000	.03407
37	.04894	.50000	.05334	-.50000	.04894	.04894	-.50000	.05334	.50000	.04894
38	.06642	.50000	.06148	-.50000	.06642	.06642	-.50000	.06148	.50000	.06642
39	.08645	.50000	.06918	-.50000	.08645	.08645	-.50000	.06918	.50000	.08645
40	.10899	.50000	.07634	-.50000	.10899	.10899	-.50000	.07634	.50000	.10899
41	.13397	.50000	.08286	-.50000	.13397	.13397	-.50000	.08286	.50000	.13397
42	.16133	.50000	.08863	-.50000	.16133	.16133	-.50000	.08863	.50000	.16133
43	.19098	.50000	.09355	-.50000	.19098	.19098	-.50000	.09355	.50000	.19098
44	.22285	.50000	.09756	-.50000	.22285	.22285	-.50000	.09756	.50000	.22285
45	.25686	.50000	.10056	-.50000	.25686	.25686	-.50000	.10056	.50000	.25686
46	.29289	.50000	.10248	-.50000	.29289	.29289	-.50000	.10248	.50000	.29289
47	.33087	.50000	.10327	-.50000	.33087	.33087	-.50000	.10327	.50000	.33087
48	.37068	.50000	.10289	-.50000	.37068	.37068	-.50000	.10289	.50000	.37068
49	.41221	.50000	.10129	-.50000	.41221	.41221	-.50000	.10129	.50000	.41221
50	.45536	.50000	.09846	-.50000	.45536	.45536	-.50000	.09846	.50000	.4553

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

51	.50000	.50000	.09439	-.50000	.50000	.50000	-.50000	.09439	.50000	.50000
52	.54601	.50000	.08911	-.50000	.54601	.54601	-.50000	.08911	.50000	.54601
53	.59326	.50000	.08264	-.50000	.59326	.59326	-.50000	.08264	.50000	.59326
54	.64163	.50000	.07503	-.50000	.64163	.64163	-.50000	.07503	.50000	.64163
55	.69098	.50000	.06638	-.50000	.69098	.69098	-.50000	.06638	.50000	.69098
56	.74118	.50000	.05677	-.50000	.74118	.74118	-.50000	.05677	.50000	.74118
57	.79209	.50000	.04634	-.50000	.79209	.79209	-.50000	.04634	.50000	.79209
58	.84357	.50000	.03527	-.50000	.84357	.84357	-.50000	.03527	.50000	.84357
59	.89547	.50000	.02377	-.50000	.89547	.89547	-.50000	.02377	.50000	.89547
60	.94766	.50000	.01214	-.50000	.94766	.94766	-.50000	.01214	.50000	.94766
61	1.00000	.50000	-.00000	-.50000	1.00000	1.00000	-.50000	-.00000	.50000	1.00000

BOUNDARY POINTS ALONG SL AND SU EDGES

I	XSLB(I)	YSLB(I)	ZSLB(I)	SSLB(I)	VSLB(I)	XSUB(I)	YSUB(I)	ZSUB(I)	SSUB(I)	VSUB(I)	CORD1(I)	SPAN2(I)
1	.974	.500	.001	-.500	.974	.974	-.500	.001	.500	.974	1.000	.052
2	.922	.500	.003	-.500	.922	.922	-.500	.003	.500	.922	1.000	.052
3	.869	.500	.003	-.500	.869	.869	-.500	.003	.500	.869	1.000	.052
4	.818	.500	.002	-.500	.818	.818	-.500	.002	.500	.818	1.000	.051
5	.767	.500	-.001	-.500	.767	.767	-.500	-.001	.500	.767	1.000	.051
6	.716	.500	-.004	-.500	.716	.716	-.500	-.004	.500	.716	1.000	.050
7	.666	.500	-.007	-.500	.666	.666	-.500	-.007	.500	.666	1.000	.049
8	.617	.500	-.012	-.500	.617	.617	-.500	-.012	.500	.617	1.000	.048
9	.569	.500	-.016	-.500	.569	.569	-.500	-.016	.500	.569	1.000	.047
10	.523	.500	-.021	-.500	.523	.523	-.500	-.021	.500	.523	1.000	.046
11	.478	.500	-.026	-.500	.478	.478	-.500	-.026	.500	.478	1.000	.045
12	.434	.500	-.031	-.500	.434	.434	-.500	-.031	.500	.434	1.000	.043
13	.391	.500	-.035	-.500	.391	.391	-.500	-.035	.500	.391	1.000	.042
14	.351	.500	-.039	-.500	.351	.351	-.500	-.039	.500	.351	1.000	.040
15	.312	.500	-.043	-.500	.312	.312	-.500	-.043	.500	.312	1.000	.038
16	.275	.500	-.046	-.500	.275	.275	-.500	-.046	.500	.275	1.000	.036
17	.240	.500	-.048	-.500	.240	.240	-.500	-.048	.500	.240	1.000	.034
18	.207	.500	-.049	-.500	.207	.207	-.500	-.049	.500	.207	1.000	.032
19	.176	.500	-.050	-.500	.176	.176	-.500	-.050	.500	.176	1.000	.030
20	.147	.500	-.050	-.500	.147	.147	-.500	-.050	.500	.147	1.000	.027
21	.121	.500	-.049	-.500	.121	.121	-.500	-.049	.500	.121	1.000	.025
22	.097	.500	-.047	-.500	.097	.097	-.500	-.047	.500	.097	1.000	.023
23	.076	.500	-.044	-.500	.076	.076	-.500	-.044	.500	.076	1.000	.020
24	.057	.500	-.040	-.500	.057	.057	-.500	-.040	.500	.057	1.000	.017

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Cont'd).

25	.041	.500	-.036	-.500	.041	.041	-.500	-.036	.500	.041	1.000	.015
26	.028	.500	-.030	-.500	.028	.028	-.500	-.030	.500	.028	1.000	.012
27	.017	.500	-.024	-.500	.017	.017	-.500	-.024	.500	.017	1.000	.010
28	.009	.500	-.018	-.500	.009	.009	-.500	-.018	.500	.009	1.000	.007
29	.003	.500	-.010	-.500	.003	.003	-.500	-.010	.500	.003	1.000	.004
30	.000	.500	-.003	-.500	.000	.000	-.500	-.003	.500	.000	1.000	.001
31	.000	.500	.006	-.500	.000	.000	-.500	.006	.500	.000	1.000	.001
32	.003	.500	.015	-.500	.003	.003	-.500	.015	.500	.003	1.000	.004
33	.009	.500	.023	-.500	.009	.009	-.500	.023	.500	.009	1.000	.007
34	.017	.500	.032	-.500	.017	.017	-.500	.032	.500	.017	1.000	.010
35	.028	.500	.041	-.500	.028	.028	-.500	.041	.500	.028	1.000	.012
36	.041	.500	.049	-.500	.041	.041	-.500	.049	.500	.041	1.000	.015
37	.057	.500	.057	-.500	.057	.057	-.500	.057	.500	.057	1.000	.017
38	.076	.500	.065	-.500	.076	.076	-.500	.065	.500	.076	1.000	.020
39	.097	.500	.073	-.500	.097	.097	-.500	.073	.500	.097	1.000	.023
40	.121	.500	.080	-.500	.121	.121	-.500	.080	.500	.121	1.000	.025
41	.147	.500	.086	-.500	.147	.147	-.500	.086	.500	.147	1.000	.027
42	.176	.500	.091	-.500	.176	.176	-.500	.091	.500	.176	1.000	.030
43	.207	.500	.096	-.500	.207	.207	-.500	.096	.500	.207	1.000	.032
44	.240	.500	.099	-.500	.240	.240	-.500	.099	.500	.240	1.000	.034
45	.275	.500	.102	-.500	.275	.275	-.500	.102	.500	.275	1.000	.036
46	.312	.500	.103	-.500	.312	.312	-.500	.103	.500	.312	1.000	.038
47	.351	.500	.103	-.500	.351	.351	-.500	.103	.500	.351	1.000	.040
48	.391	.500	.102	-.500	.391	.391	-.500	.102	.500	.391	1.000	.042
49	.434	.500	.100	-.500	.434	.434	-.500	.100	.500	.434	1.000	.043
50	.478	.500	.097	-.500	.478	.478	-.500	.097	.500	.478	1.000	.045
51	.523	.500	.092	-.500	.523	.523	-.500	.092	.500	.523	1.000	.046
52	.569	.500	.086	-.500	.569	.569	-.500	.086	.500	.569	1.000	.047
53	.617	.500	.079	-.500	.617	.617	-.500	.079	.500	.617	1.000	.048
54	.666	.500	.071	-.500	.666	.666	-.500	.071	.500	.666	1.000	.049
55	.716	.500	.062	-.500	.716	.716	-.500	.062	.500	.716	1.000	.050
56	.767	.500	.052	-.500	.767	.767	-.500	.052	.500	.767	1.000	.051
57	.818	.500	.041	-.500	.818	.818	-.500	.041	.500	.818	1.000	.051
58	.869	.500	.030	-.500	.869	.869	-.500	.030	.500	.869	1.000	.052
59	.922	.500	.018	-.500	.922	.922	-.500	.018	.500	.922	1.000	.052
60	.974	.500	.006	-.500	.974	.974	-.500	.006	.500	.974	1.000	.052

FORCE SENSING LOCATIONS IN N1-DIRECTION

FIGURE 7.6-2. Output for POTGEM Test Case 6 (Concluded).

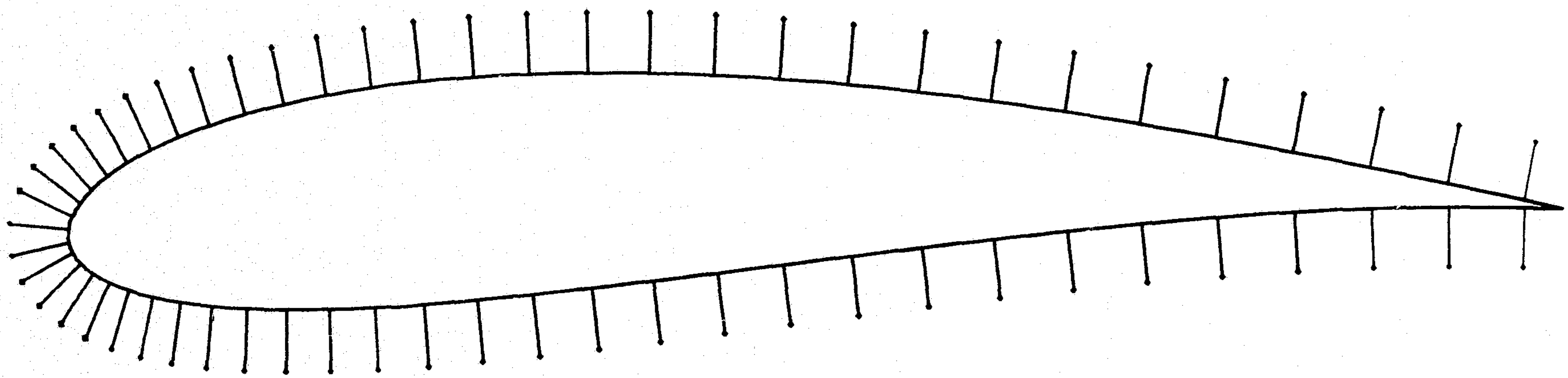


FIGURE 7.6-3(a). Side View of POTGEM Test Case 6.

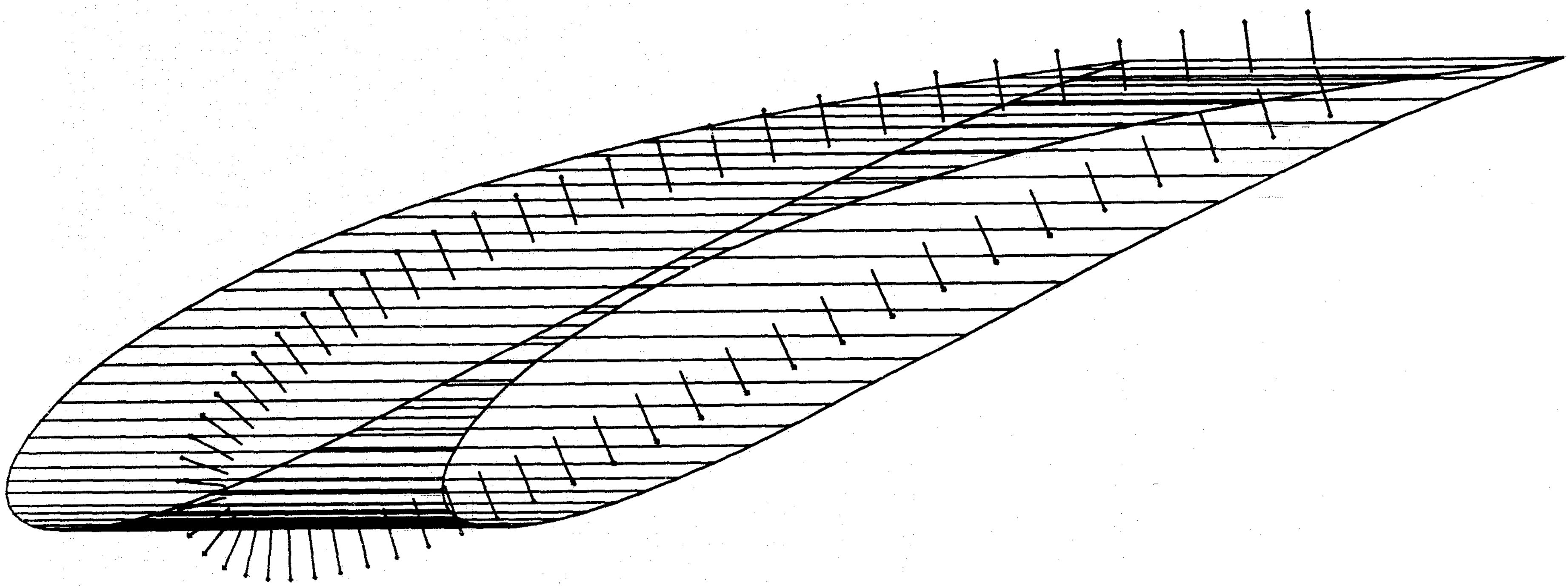


FIGURE 7.6-3(b). Oblique View of POTGEM Test Case 6.

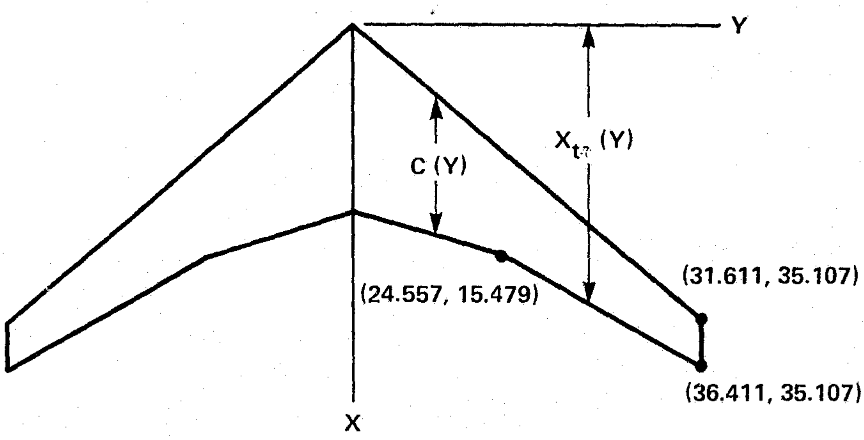


FIGURE 7.7-1. Planform of Test Case 7.

```
T
TITLE
TEST CASE 7 - THIN WING WITH TWIST, CAMBER AND DIHEDRAL
CARY
    THE NEXT 2 COMMANDS CAUSE THE AXIS TO COINCIDE WITH THE TRAILING EDGE
SHT1
 *INCRV1 IC=2,NTAB=3,VAR1(1)=0.,15.479,35.107,
          VAR2(1)=-19.6025,-24.557,-36.411,COPT=1 $END
SHT1
 *INCRV1 IC=3,VAR2(1)=0.,3.86975,8.77675 $END
    THE NEXT COMMAND DEFINES THE TWIST ABOUT THE TRAILING EDGE
    AS PHI = -.0097363*S**2  (DEG.)
SHT1
 *INCRV1 IC=4,COPT=-2,PARAM(2)=0.,NTAB=3,VAR1(1)=0.,0.,-.0097363 $END
    THE NEXT 2 COMMANDS CAUSE THE TWIST AXIS TO BE THE X-AXIS
SHT1
 *INCRV1 IC=5,COPT=1,NTAB=1,VAR2(1)=1. $END
SHT1
 *INCRV1 IC=6,COPT=0 $END
    THE NEXT COMMAND CAUSES YPSCAL TO EQUAL THE LOCAL CHORD.
SHT1
 *INCRV1 IC=8,COPT=1,NTAB=3,VAR1(1)=0.,15.479,35.107,
           VAR2(1)=19.6025,10.619419,4.8 $END
    THE NEXT 4 COMMANDS DEFINE THE 4 CROSS SECTIONS
SHT1
 *INCRV1 IC=11,COPT=0,SCS=0. $END
SHT1
 *INCRV1 IC=12,SCS=15.479,COPT=-2,PARAM(2)=0.,NTAB=3,
          VAR1(1)=0.,10.619419,-10.619419 $END
    THE AFFINE TRANSFORMATION CAPABILITY WILL BE USED IN THE NEXT
    COMMAND TO AVOID HAND MULTIPLYING THE Z/C VALUES BY 12*C
    AND TO AVOID TRANSFORMING THE INDEPENDENT VARIABLE TO V BY HAND.
        AFTRAN(4)=93.55896=12*C
SHT1
 *INCRV1 IC=13,SCS=25.0,COPT=6,PARAM=0.,NTAB=15,
          VAR1(1)=-.02,0.,.02,.04,.06,.08,.10,.12,.14,.15,.16,.18,.20,.2025,1.,
```

FIGURE 7.7-2. Input for POTGEM Test Case 7.

```
                VAR2(1)=-.0067692,0.,.0054767,.0097886,.0130632,.0154283,.0170115,
                         .0179405,.0183428,.0183864,.0183463,.0180785,.0176670,
                         .0176119,0.,
                AFFINE=T,AFTRAN=-1.,0.,0.,93.55896,1.,0. $END
       SPT1
        $INCRV1 IC=14,SCS=35.107,AFTRAN(4)=72.,PCFINL=T $END
           2 SPANWISE SEGMENTS WILL BE USED.  THERE WILL BE 7 PANELS IN THE
           INBOARD SEGMENT AND 9 PANELS IN THE OUTBOARD SEGMENT.  THERE WILL
           BE 5 CHORDWISE PANELS SET BACK 1/4 PANEL FROM LEADING EDGE.
       DSEGMENTS
        $DATA NSEGST=2,NBPS=7,9,NBPV=5 $END
       VLBC
        $DATA $END
       SLBC
        $DATA IOPT=2 $END
       SL
        $DATA IOPTSV=0 $END
       SU
        $DATA IOPTSV=1,NTABSV=1,VAR2SV(1)=15.479 $END
           THE VL(S) CURVE DEFINED BY THE FOLLOWING COMMAND WILL BE
           SATISFACTORY FOR THE 2ND SEGMENT ALSO.
       VL
        $DATA VAR2SV(1)=1. $END
       VU
        $DATA IOPTSV=0 $END
       PANL
        $DATA $END
       SEGMENT
        $DATA NSEGS=2 $END
       VLBC
        $DATA IOPT=1 $END
       SU
        $DATA IOPTSV=1,VAR2SV=35.107 $END
       PANL
        $DATA $END
           THE FOLLOWING COMMAND ELIMINATES THE NULL ROW OF PANELS
```

FIGURE 7.7-2. Input for POTGEM Test Case 7 (Cont'd).

```
          BETWEEN THE 1ST AND 2ND SEGMENTS
      NPI2
       $DATA I1=8 $END
      ROSS
       $DATA EAXIS(1)=0.,0.,1.,PHI=90. $END
      DEFL
          1    -1
          1    -1
          2
          1    16
          5     5
          6
         16    16
          4     4
          4
         16    16
          5     5
         12
          0
      FINISH
       $DATA FLT(5)=1.,0.,.176326981 $END
      STORE
       $DATA ID=7 $END
      PRINT
       $DATA $END
      STOP
```

FIGURE 7.7-2. Input for POTGEM Test Case 7 (Concluded).

```
POTFAN GEOMETRY PROGRAM, VERSION 1.3
************************************

TIME = 08/09/76     07:38:12

ENTER BATCH
+TITLE

TEST CASE 7 - THIN WING WITH TWIST, CAMBER AND DIHEDRAL


+CARY
+     THE NEXT 2 COMMANDS CAUSE THE AXIS TO COINCIDE WITH THE TRAILING EDGE
+SRI1
+SRI1
+     THE NEXT COMMAND DEFINES THE TWIST ABOUT THE TRAILING EDGE
+     AS P-I = -.0097363*S**2  (DEG.)
+SRI1
+     THE NEXT 2 COMMANDS CAUSE THE TWIST AXIS TO BE THE X-AXIS
+SRI1
+SRI1
+     THE NEXT COMMAND CAUSES YPSCAL TO EQUAL THE LOCAL CHORD.
+SRI1
+     THE NEXT 4 COMMANDS DEFINE THE 4 CROSS SECTIONS
+SRI1
+SRI1
+     THE DEFINE TRANSFORMATION CAPABILITY WILL BE USED IN THE NEXT
+     COMMAND TO AVOID HAND MULTIPLYING THE Z/C VALUES BY 12.C
+     AND TO AVOID TRANSFORMING THE INDEPENDENT VARIABLE TO V BY HAND.
+          *FTRAN(4)=95.55896=12*C
+SRI1
+SRI1

(VAR1(*,14),VAR2(*,14)) =
     1.0200000     -.4873824      1.0000000     0.             .9800000      .3943224      .9600000      .7047792

      .9400000      .9405504       .9200000     1.1108376      .9000000     1.2248280      .8800000     1.2917160
```

FIGURE 7.7-3. Output for POTGEM Test Case 7.

```
     .8600000       1.3206816          .8500000        1.3238208           .8400000        1.3209336          .8200000        1.3016520

     .8000000       1.2720240          .7975000        1.2680568       0.                 0.
+     2 SPANWISE SEGMENTS WILL BE USED.  THERE WILL BE 7 PANELS IN THE
+     INBOARD SEGMENT AND 9 PANELS IN THE OUTBOARD SEGMENT.  THERE WILL
+     BE 5 CHORDWISE PANELS SET BACK 1/4 PANEL FROM LEADING EDGE.
+DSEGMENTS
+VLBC
+SLBC
+SL
+SU
+     THE VL-S1 CURVE DEFINED BY THE FOLLOWING COMMAND WILL BE
+     SATISFACTORY FOR THE 2ND SEGMENT ALSO.
+VL
+VU
+PANI
+SEGMENT
+VLBC
+SU
+PANI
+     THE FOLLOWING COMMAND ELIMINATES THE NULL ROW OF PANELS
+     BETWEEN THE 1ST AND 2ND SEGMENTS
+NRI2
+ROSS
+DSEI
+FINISH
+STORE
FILE 7.GM=PAC/LIBS          HAS BEEN OPENED FOR WRITING ON UNIT  1
CREATION TIME = 08/09/76     07:38:26

CREATION OF GEOMETRY FILE
-------------------------

TITLE =  TEST CASE 7 - THIN WING WITH TWIST, CAMBER AND DIHEDRAL

(LOG) =  F F F F T F F F F F F F F F F T F F F
(INT) =      0   17    6   16    5    0    0    0    0    0    0    0
(FLT) =  401.49040      35.106999      10.918957      35.106999      .98480775            0.         .17364818       224.02299
```

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

```
          .22402299E-01          0.             0.             0.
+PRINT

PRINTOUT OF GEOMETRY FILE DATA
-------------------------------
TITLE = TEST CASE 7 - THIN WING WITH TWIST, CAMBER AND DIHEDRAL

CREATION TIME = 08/09/76     07:38:20
(IFORM) = 110111111
(ID)    =      7
(LOG)   =  T F F F T F F F F F F F F F F F T F F F
(INT)   =      0   17    6   16    5    0    0    0    0    0    0    0    0
(FLT)   =      401.4904000     35.1069990     10.9189570     35.1069990      .9848078      0.          .1736482
               224.0229900      .0224023      0.              0.             0.


PANEL CORNER POINTS
   I   J      X(I,J)          Y(I,J)          Z(I,J)          S(I,J)          V(I,J)
   1   1       .9801249        .0000000       0.              0.              .9500000
   2   1      2.9069893       2.2112857        .6104210       2.2112857       .9500000
   3   1      4.8335716       4.4225713       1.1959718       4.4225714       .9500000
   4   1      6.7596813       6.6338570       1.7627275       6.6338571       .9500000
   5   1      8.6851800       8.8451430       2.3167590       8.8451430       .9500000
   6   1     10.6099340      11.0564280       2.8641313      11.0564280       .9500000
   7   1     12.5337610      13.2677140       3.4109012      13.2677140       .9500000
   8   1     14.4563800      15.4790000       3.9631141      15.4790000       .9500000
   9   1     16.3795280      17.6598880       4.5485559      17.6598890       .9500000
  10   1     18.2997800      19.8407770       5.1344998      19.8407770       .9500000
  11   1     20.2165860      22.0216660       5.7237971      22.0216660       .9500000
  12   1     22.1292940      24.2025550       6.3192591      24.2025550       .9500000
  13   1     24.0510310      26.3834440       6.8067142      26.3834440       .9500000
  14   1     25.9811200      28.5643320       7.2391884      28.5643330       .9500000
  15   1     27.9125960      30.7452210       7.6872207      30.7452220       .9500000
  16   1     29.8450350      32.9261100       8.1537990      32.9261100       .9500000
  17   1     31.7777920      35.1069990       8.6418920      35.1070000       .9500000
   1   2      4.9006249        .0000000       0.              0.              .7500000
   2   2      6.5706519       2.2112857        .8258537       2.2112857       .7500000
   3   2      8.2393220       4.4225713       1.6320706       4.4225714       .7500000
   4   2      9.9053500       6.6338570       2.4234352       6.6338571       .7500000
```

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

5	2	11.5674920	8.8451430	3.2047096	8.8451430	.7500000
6	2	13.2245090	11.0564280	3.9806230	11.0564280	.7500000
7	2	14.8751250	13.2677140	4.7558605	13.2677140	.7500000
8	2	16.5179890	15.4790000	5.5350512	15.4790000	.7500000
9	2	18.3048830	17.6598880	5.9061142	17.6598890	.7500000
10	2	20.0926290	19.8407770	6.2775055	19.8407770	.7500000
11	2	21.8817890	22.0216660	6.6515689	22.0216660	.7500000
12	2	23.6728410	24.2025550	7.0306663	24.2025550	.7500000
13	2	25.4643570	26.3834440	7.4323506	26.3834440	.7500000
14	2	27.2565580	28.5643320	7.8524908	28.5643330	.7500000
15	2	29.0503230	30.7452210	8.2846900	30.7452220	.7500000
16	2	30.8454920	32.9261100	8.7313180	32.9261100	.7500000
17	2	32.6417270	35.1069990	9.1947380	35.1070000	.7500000
1	3	8.8211250	.0000000	0.	0.	.5500000
2	3	10.2344160	2.2112857	.9199216	2.2112857	.5500000
3	3	11.6458790	4.4225713	1.8254412	4.4225714	.5500000
4	3	13.0537410	6.6338570	2.7200587	6.6338571	.5500000
5	3	14.4562580	8.8451430	3.6072439	8.8451430	.5500000
6	3	15.8516900	11.0564280	4.4904217	11.0564280	.5500000
7	3	17.2382690	13.2677140	5.3729569	13.2677140	.5500000
8	3	18.6141770	15.4790000	6.2581389	15.4790000	.5500000
9	3	20.2756390	17.6598880	6.4077737	17.6598890	.5500000
10	3	21.9432760	19.8407770	6.5577943	19.8407770	.5500000
11	3	23.6187890	22.0216660	6.7101015	22.0216660	.5500000
12	3	25.3038120	24.2025550	6.8666802	24.2025550	.5500000
13	3	26.9785430	26.3834440	7.2092867	26.3834440	.5500000
14	3	28.6440540	28.5643320	7.6627821	28.5643330	.5500000
15	3	30.3107110	30.7452210	8.1251210	30.7452220	.5500000
16	3	31.9783980	32.9261100	8.5980400	32.9261100	.5500000
17	3	33.6468670	35.1069990	9.0832740	35.1070000	.5500000
1	4	12.7416250	.0000000	0.	0.	.3500000
2	4	13.8982800	2.2112857	.8926248	2.2112857	.3500000
3	4	15.0532430	4.4225713	1.7760835	4.4225714	.3500000
4	4	16.2048550	6.6338570	2.6525980	6.6338571	.3500000
5	4	17.3514780	8.8451430	3.5243619	8.8451430	.3500000
6	4	18.4914740	11.0564280	4.3935273	11.0564280	.3500000
7	4	19.6231920	13.2677140	5.2621903	13.2677140	.3500000
8	4	20.7449460	15.4790000	6.1323771	15.4790000	.3500000
9	4	22.2810900	17.6598880	6.2553988	17.6598890	.3500000

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

10	4	23.8246940	19.8407770	6.3787581	19.8407770	.3500000
11	4	25.3776630	22.0216660	6.5037808	22.0216660	.3500000
12	4	26.9418550	24.2025550	6.6318908	24.2025550	.3500000
13	4	28.4927290	26.3834440	6.9862228	26.3834440	.3500000
14	4	30.0315490	28.5643320	7.4730734	28.5643330	.3500000
15	4	31.5710990	30.7452210	7.9655516	30.7452220	.3500000
16	4	33.1113030	32.9261100	8.4647630	32.9261100	.3500000
17	4	34.6520060	35.1069990	8.9718110	35.1070000	.3500000
1	5	16.6621250	.0000000	0.	0.	.1500000
2	5	17.5622450	2.2112857	.7439632	2.2112857	.1500000
3	5	18.4614140	4.4225713	1.4839977	4.4225714	.1500000
4	5	19.3586920	6.6338570	2.2210532	6.6338571	.1500000
5	5	20.2531520	8.8451430	2.9560637	8.8451430	.1500000
6	5	21.1436640	11.0564280	3.6899399	11.0564280	.1500000
7	5	22.0298950	13.2677140	4.4235607	13.2677140	.1500000
8	5	22.9102950	15.4790000	5.1577659	15.4790000	.1500000
9	5	24.3212340	17.6598880	5.4489894	17.6598890	.1500000
10	5	25.7368850	19.8407770	5.7403972	19.8407770	.1500000
11	5	27.1584140	22.0216660	6.0326069	22.0216660	.1500000
12	5	28.5869680	24.2025550	6.3262981	24.2025550	.1500000
13	5	30.0069150	26.3834440	6.7631589	26.3834440	.1500000
14	5	31.4190440	28.5643320	7.2833647	28.5643330	.1500000
15	5	32.8314860	30.7452210	7.8059824	30.7452220	.1500000
16	5	34.2442090	32.9261100	8.3314860	32.9261100	.1500000
17	5	35.6571460	35.1069990	8.8603480	35.1070000	.1500000
1	6	19.6025000	.0000000	0.	0.	0.
2	6	20.3102850	2.2112857	.5528214	2.2112857	0.
3	6	21.0180710	4.4225713	1.1056428	4.4225714	0.
4	6	21.7258570	6.6338570	1.6584645	6.6338571	0.
5	6	22.4336420	8.8451430	2.2112857	8.8451430	0.
6	6	23.1414280	11.0564280	2.7641071	11.0564280	0.
7	6	23.8492140	13.2677140	3.3169285	13.2677140	0.
8	6	24.5569990	15.4790000	3.8697500	15.4790000	0.
9	6	25.8741100	17.6598880	4.4149721	17.6598890	0.
10	6	27.1912220	19.8407770	4.9601943	19.8407770	0.
11	6	28.5083330	22.0216660	5.5054166	22.0216660	0.
12	6	29.8254440	24.2025550	6.0506387	24.2025550	0.
13	6	31.1425550	26.3834440	6.5958610	26.3834440	0.
14	6	32.4596650	28.5643320	7.1410832	28.5643330	0.

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

15	6	43.7767770	30.7452210	7.6863054	30.7452220	0.
16	6	45.0938880	32.9261100	8.2315280	32.9261100	0.
17	6	46.4109990	35.1069990	8.7767500	35.1070000	0.

UNIT VECTORS ALONG WAKE ELEMENTS

I J UVWX(I,J) UVWY(I,J) UVWZ(I,J)

UNAVAILABLE

BOUNDARY CONDITION FLAGS

I J BCFLAG(I,J)

UNAVAILABLE

DOUBLET SINGULARITY FLAGS

I	J	DBFLAG(I,J)
1	1	2
2	1	2
3	1	2
4	1	2
5	1	2
6	1	2
7	1	2
8	1	2
9	1	2
10	1	2
11	1	2
12	1	2
13	1	2
14	1	2
15	1	2
16	1	2
1	2	2
2	2	2
3	2	2
4	2	2

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

5	2	2
6	2	2
7	2	2
8	2	2
9	2	2
10	2	2
11	2	2
12	2	2
13	2	2
14	2	2
15	2	2
16	2	2
1	3	2
2	3	2
3	3	2
4	3	2
5	3	2
6	3	2
7	3	2
8	3	2
9	3	2
10	3	2
11	3	2
12	3	2
13	3	2
14	3	2
15	3	2
16	3	2
1	4	2
2	4	2
3	4	2
4	4	2
5	4	2
6	4	2
7	4	2
8	4	2
9	4	2
10	4	2
11	4	2

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

12	4	2
13	4	2
14	4	2
15	4	2
16	4	4
1	5	6
2	5	6
3	5	6
4	5	6
5	5	6
6	5	6
7	5	6
8	5	6
9	5	6
10	5	6
11	5	6
12	5	6
13	5	6
14	5	6
15	5	6
16	5	12

SOURCE SINGULARITY FLAGS

I J SNFLAG(I,J)

UNAVAILABLE

BOUNDARY CONDITION POINTS

I	J	XBC(I,J)	YBC(I,J)	ZBC(I,J)	SBC(I,J)	VBC(I,J)
1	1	3.8396496	1.1056428	.3697753	1.1056428	.8500000
2	1	5.6377413	3.3169286	1.0912772	3.3169286	.8500000
3	1	7.4345226	5.5282142	1.7932414	5.5282143	.8500000
4	1	9.2292090	7.7394999	2.4810903	7.7395000	.8500000
5	1	11.0210410	9.9507850	3.1602287	9.9507860	.8500000
6	1	12.8092420	12.1620710	3.8360364	12.1620710	.8500000
7	1	14.5929680	14.3733570	4.5138606	14.3733570	.8500000
8	1	16.4082760	16.5694440	5.1286113	16.5694440	.8500000

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

9	1	18.2568550	18.7503330	5.6750262	18.7503330	.8500000
10	1	20.1021900	20.9312220	6.2229809	20.9312220	.8500000
11	1	21.9439160	23.1121110	6.7749831	23.1121110	.8500000
12	1	23.7840410	25.2929990	7.3108783	25.2930000	.8500000
13	1	25.6391580	27.4738880	7.7103723	27.4738880	.8500000
14	1	27.4960480	29.6547770	8.1222030	29.6547770	.8500000
15	1	29.3546130	31.8356660	8.5490550	31.8356660	.8500000
16	1	31.2145680	34.0165540	8.9936100	34.0165550	.8500000
1	2	7.6318039	1.1056428	.4464160	1.1056428	.6500000
2	2	9.1728200	3.3169286	1.3254457	3.3169286	.6500000
3	2	10.7113600	5.5282142	2.1895291	5.5282143	.6500000
4	2	12.2458400	7.7394999	3.0427954	7.7395000	.6500000
5	2	13.7746960	9.9507850	3.8893400	9.9507860	.6500000
6	2	15.2963520	12.1620710	4.7332106	12.1620710	.6500000
7	2	16.8091830	14.3733570	5.5783929	14.3733570	.6500000
8	2	18.4234200	16.5694440	6.1207851	16.5694440	.6500000
9	2	20.1494330	18.7503330	6.3567032	18.7503330	.6500000
10	2	21.8800970	20.9312220	6.5940542	20.9312220	.6500000
11	2	23.6166240	23.1121110	6.8350049	23.1121110	.6500000
12	2	25.3575340	25.2929990	7.1056877	25.2930000	.6500000
13	2	27.0857060	27.4738880	7.5380494	27.4738880	.6500000
14	2	28.8152480	29.6547770	7.9798362	29.6547770	.6500000
15	2	30.5460930	31.8356660	8.4331010	31.8356660	.6500000
16	2	32.2780290	34.0165540	8.8998960	34.0165550	.6500000
1	3	11.4239710	1.1056428	.4623744	1.1056428	.4500000
2	3	12.7082400	3.3169286	1.3775673	3.3169286	.4500000
3	3	13.9897730	5.5282142	2.2824089	5.5282143	.4500000
4	3	15.2667940	7.7394999	3.1797460	7.7395000	.4500000
5	3	16.5375390	9.9507850	4.0723873	9.9507860	.4500000
6	3	17.8002380	12.1620710	4.9630895	12.1620710	.4500000
7	3	19.0530870	14.3733570	5.8545403	14.3733570	.4500000
8	3	20.4738400	16.5694440	6.3574039	16.5694440	.4500000
9	3	22.0760460	18.7503330	6.4693696	18.7503330	.4500000
10	3	23.6865420	20.9312220	6.5625137	20.9312220	.4500000
11	3	25.3072190	23.1121110	6.6985132	23.1121110	.4500000
12	3	26.9349080	25.2929990	6.8649376	25.2930000	.4500000
13	3	28.5365990	27.4738680	7.3320256	27.4738880	.4500000
14	3	30.1392400	29.6547770	7.8056387	29.6547770	.4500000
15	3	31.7427820	31.8356660	8.2871980	31.8356660	.4500000

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

16	3	33.3470800	34.0165540	8.7781240	34.0165550	.4500000
1	4	15.2161510	1.1056428	.4176504	1.1056428	.2500000
2	4	16.2440000	3.3169286	1.2476421	3.3169286	.2500000
3	4	17.2697620	5.5282142	2.0718809	5.5282143	.2500000
4	4	18.2920720	7.7394999	2.8919417	7.7395000	.2500000
5	4	19.3095720	9.9507850	3.7093704	9.9507860	.2500000
6	4	20.3209010	12.1620710	4.5256728	12.1620710	.2500000
7	4	21.3246790	14.3733570	5.3423027	14.3733570	.2500000
8	4	22.5593420	16.5694440	5.8425875	16.5694440	.2500000
9	4	24.0359560	18.7503330	6.0253767	18.7503330	.2500000
10	4	25.5199910	20.9312220	6.2089241	20.9312220	.2500000
11	4	27.0130840	23.1121110	6.3942596	23.1121110	.2500000
12	4	28.5122820	25.2929990	6.6241875	25.2930000	.2500000
13	4	29.9874930	27.4738880	7.1260018	27.4738880	.2500000
14	4	31.4632320	29.6547770	7.6314412	29.6547770	.2500000
15	4	32.9394710	31.8356660	8.1412950	31.8356660	.2500000
16	4	34.4161310	34.0165540	8.6563530	34.0165550	.2500000
1	5	19.0083430	1.1056428	.3122439	1.1056428	.0500000
2	5	19.7801000	3.3169286	.9356700	3.3169286	.0500000
3	5	20.5513270	5.5282142	1.5579451	5.5282143	.0500000
4	5	21.3216740	7.7394999	2.1793827	7.7395000	.0500000
5	5	22.0907940	9.9507850	2.8002893	9.9507860	.0500000
6	5	22.8583400	12.1620710	3.4209608	12.1620710	.0500000
7	5	23.6239600	14.3733570	4.0416802	14.3733570	.0500000
8	5	24.6799270	16.5694440	4.5763358	16.5694440	.0500000
9	5	26.0291620	18.7503330	5.0247244	18.7503330	.0500000
10	5	27.3804450	20.9312220	5.4732854	20.9312220	.0500000
11	5	28.7342190	23.1121110	5.9222444	23.1121110	.0500000
12	5	30.0896560	25.2929990	6.3834374	25.2930000	.0500000
13	5	31.4383870	27.4738880	6.9199780	27.4738880	.0500000
14	5	32.7872230	29.6547770	7.4572437	29.6547770	.0500000
15	5	34.1361600	31.8356660	7.9953922	31.8356660	.0500000
16	5	35.4851810	34.0165540	8.5345820	34.0165550	.0500000

UNIT NORMALS AND AREAS

I	J	UNX(I,J)	UNY(I,J)	UNZ(I,J)	DA(I,J)
1	1	.0269473	.2947488	-.9551947	8.7767790
2	1	.0889628	.2385487	-.9670471	8.0884320

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

3	1	.1624938	.1729049	-.9714421	7.4705653
4	1	.2475506	.0968012	-.9640271	6.9360656
5	1	.3424741	.0102235	-.9394717	6.5000352
6	1	.4431294	-.0851029	-.8924090	6.1784334
7	1	.5426756	-.1849325	-.8193309	5.9855506
8	1	.5552256	-.2743643	-.7851425	5.6784288
9	1	.4931270	-.2057153	-.8452851	5.0938376
10	1	.3999404	-.1087659	-.9100646	4.5319505
11	1	.2628148	.0236667	-.9645555	4.0040907
12	1	.1089801	.0863467	-.9902866	3.5866994
13	1	.1284765	.0744404	-.9889148	3.2807368
14	1	.1495455	.0621984	-.9867966	3.0048504
15	1	.1721693	.0495220	-.9838218	2.7297753
16	1	.1962905	.0366774	-.9798596	2.4557089
1	2	.0113625	.3657542	-.9306421	8.9919640
2	2	.0360012	.3431492	-.9385119	8.3143980
3	2	.0705566	.3178351	-.9455171	7.6535445
4	2	.1100451	.2889960	-.9509844	7.0110598
5	2	.1577224	.2554963	-.9538581	6.3895310
6	2	.2150799	.2158865	-.9524357	5.7928681
7	2	.2837714	.1681278	-.9440375	5.2268870
8	2	.2862131	-.1234611	-.9501786	4.6714138
9	2	.2002734	-.0527437	-.9783193	4.2697192
10	2	.0940522	.0341673	-.9949608	3.9490699
11	2	-.0309565	.1352611	-.9903263	3.7321280
12	2	-.1439675	.2993130	-.9432312	3.5778349
13	2	-.1342928	.2958700	-.9457412	3.3460451
14	2	-.1247014	.2932854	-.9478572	3.0466649
15	2	-.1157489	.2919994	-.9493885	2.7493594
16	2	-.1082310	.2925874	-.9500940	2.4543614
1	3	-.0034982	.3863291	-.9223544	9.0694540
2	3	-.0101520	.3854124	-.9226886	8.4528230
3	3	-.0165505	.3853457	-.9226239	7.8404948
4	3	-.0230055	.3862721	-.9220979	7.2323956
5	3	-.0299458	.3883465	-.9210267	6.6285459
6	3	-.0379682	.3918479	-.9192463	6.0290830
7	3	-.0479207	.3970126	-.9165613	5.4343507
8	3	-.0667749	.0999101	-.9927533	4.5489289
9	3	-.0843981	.1131187	-.9899905	4.2873366

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

10	3	-.1043389	.1289544	-.9861461	4.0318066
11	3	-.1272653	.1479867	-.9807668	3.7837845
12	3	-.1436443	.3058707	-.9411745	3.5927880
13	3	-.1340279	.3019332	-.9438606	3.3526942
14	3	-.1244945	.2986132	-.9462195	3.0519051
15	3	-.1155899	.2963279	-.9480658	2.7531244
16	3	-.1081100	.2954650	-.9492169	2.4566225
1	4	-.0184630	.3601170	-.9327244	8.9758280
2	4	-.0578611	.3731211	-.9259767	8.4304710
3	4	-.1011724	.3874288	-.9163313	7.9049879
4	4	-.1491810	.4030197	-.9029508	7.4034948
5	4	-.2026715	.4196957	-.8847494	6.9310804
6	4	-.2622909	.4371367	-.8602994	6.4939584
7	4	-.3284076	.4544116	-.8280450	6.0995701
8	4	-.3691086	.3224446	-.8716584	5.2808126
9	4	-.3276871	.2976468	-.8966758	4.8245777
10	4	-.2771520	.2671202	-.9229483	4.3797331
11	4	-.2150482	.2289588	-.9493851	3.9500083
12	4	-.1433312	.3123693	-.9390855	3.6392320
13	4	-.1337504	.3079661	-.9419489	3.3594788
14	4	-.1242763	.3039074	-.9445611	3.0572403
15	4	-.1154349	.3005507	-.9467545	2.7569446
16	4.	-.1080234	.2983582	-.9483213	2.4589064
1	5	-.0343160	.2825459	-.9586398	6.5891076
2	5	-.1078617	.3041940	-.9464840	6.2207965
3	5	-.1878885	.3260217	-.9265030	5.8914660
4	5	-.2736461	.3472363	-.8969642	5.6062224
5	5	-.3634144	.3666644	-.8564387	5.3785920
6	5	-.4543528	.3832253	-.8041778	5.2099108
7	5	-.5428159	.3956022	-.7408440	5.1084773
8	5	-.5360079	.4748926	-.6979775	4.8689519
9	5	-.4790513	.4514305	-.7528083	4.2677265
10	5	-.3996004	.4158935	-.8169162	3.6941341
11	5	-.2855537	.3603737	-.8880259	3.1641678
12	5	-.1430000	.3188583	-.9369527	2.7811529
13	5	-.1334749	.3139548	-.9400090	2.5241370
14	5	-.1240483	.3091837	-.9428772	2.2964840
15	5	-.1152703	.3048281	-.9454061	2.0702462
16	5	-.1079164	.3012309	-.9474249	1.8456896

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

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NTOP VECTORS
  I  J     NTOPX(I,J)      NTOPY(I,J)      NTOPZ(I,J)

UNAVAILABLE


NBOT VECTORS
  I  J     NBOTX(I,J)      NBOTY(I,J)      NBOTZ(I,J)

UNAVAILABLE


VELOCITY ALONG NTOP VECTORS
  I  J      UTOP(I,J)

UNAVAILABLE


VELOCITY ALONG NBOT VECTORS
  I  J      UBOT(I,J)

UNAVAILABLE
```


CORNER POINTS ALONG VL AND VU EDGES

I	XVLC(I)	YVLC(I)	ZVLC(I)	SVLC(I)	VVLC(I)	XVUC(I)	YVUC(I)	ZVUC(I)	SVUC(I)	VVUC(I)
1	0.	0.	0.	0.	1.00000	19.60250	.00000	0.	0.	0.
2	1.99109	2.21129	.53760	2.21129	1.00000	20.31029	2.21129	.55282	2.21129	0.
3	3.98226	4.42257	1.04902	4.42257	1.00000	21.01807	4.42257	1.10564	4.42257	0.
4	5.97369	6.63386	1.54066	6.63386	1.00000	21.72586	6.63386	1.65846	6.63386	0.
5	7.96561	8.84514	2.01893	8.84514	1.00000	22.43364	8.84514	2.21129	8.84514	0.
6	9.95826	11.05643	2.49021	11.05643	1.00000	23.14143	11.05643	2.76411	11.05643	0.
7	11.95182	13.26771	2.96093	13.26771	1.00000	23.84921	13.26771	3.31693	13.26771	0.
8	13.94638	15.47900	3.43750	15.47900	1.00000	24.55700	15.47900	3.86975	15.47900	0.
9	15.91530	17.65989	3.88670	17.65989	1.00000	25.87411	17.65989	4.41497	17.65989	0.
10	17.88587	19.84078	4.33679	19.84078	1.00000	27.19122	19.84078	4.96019	19.84078	0.
11	19.85818	22.02167	4.79095	22.02167	1.00000	28.50833	22.02167	5.50542	22.02167	0.

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Cont'd).

12	21.83220	24.20256	5.25236	24.20256	1.00000	29.82544	24.20256	6.05064	24.20256	0.
13	23.80776	26.38344	5.72419	26.38344	1.00000	31.14256	26.38344	6.59586	26.38344	0.
14	25.78454	28.56433	6.20960	28.56433	1.00000	32.45967	28.56433	7.14108	28.56433	0.
15	27.76201	30.74522	6.71176	30.74522	1.00000	33.77678	30.74522	7.68631	30.74522	0.
16	29.73945	32.92611	7.23379	32.92611	1.00000	35.09389	32.92611	8.23153	32.92611	0.
17	31.71589	35.10700	7.77877	35.10700	1.00000	36.41100	35.10700	8.77675	35.10700	0.

BOUNDARY POINTS ALONG VL AND VU EDGES

I	XVLB(I)	YVLB(I)	ZVLB(I)	SVLB(I)	VVLB(I)	XVUB(I)	YVUB(I)	ZVUB(I)	SVUB(I)	VVUB(I)	CORD2(I)	SPAN1(I)
1	.996	1.106	.272	1.106	1.000	19.956	1.106	.276	1.106	0.	18.961	2.211
2	2.987	3.317	.796	3.317	1.000	20.664	3.317	.829	3.317	0.	17.678	2.211
3	4.978	5.528	1.297	5.528	1.000	21.372	5.528	1.382	5.528	0.	16.394	2.211
4	6.970	7.739	1.781	7.740	1.000	22.080	7.739	1.935	7.740	0.	15.110	2.211
5	8.962	9.951	2.255	9.951	1.000	22.788	9.951	2.488	9.951	0.	13.826	2.211
6	10.955	12.162	2.725	12.162	1.000	23.495	12.162	3.041	12.162	0.	12.540	2.211
7	12.949	14.373	3.198	14.373	1.000	24.203	14.373	3.593	14.373	0.	11.254	2.211
8	14.931	16.569	3.662	16.569	1.000	25.216	16.569	4.142	16.569	0.	10.285	2.181
9	16.900	18.750	4.111	18.750	1.000	26.533	18.750	4.688	18.750	0.	9.632	2.181
10	18.872	20.931	4.563	20.931	1.000	27.850	20.931	5.233	20.931	0.	8.978	2.181
11	20.845	23.112	5.021	23.112	1.000	29.167	23.112	5.778	23.112	0.	8.322	2.181
12	22.820	25.293	5.487	25.293	1.000	30.484	25.293	6.323	25.293	0.	7.664	2.181
13	24.796	27.474	5.965	27.474	1.000	31.801	27.474	6.868	27.474	0.	7.005	2.181
14	26.773	29.655	6.458	29.655	1.000	33.118	29.655	7.414	29.655	0.	6.345	2.181
15	28.751	31.836	6.970	31.836	1.000	34.435	31.836	7.959	31.836	0.	5.685	2.181
16	30.728	34.017	7.503	34.017	1.000	35.752	34.017	8.504	34.017	0.	5.025	2.181

CORNER POINTS ALONG SL AND SU EDGES

I	XSLC(I)	YSLC(I)	ZSLC(I)	SSLC(I)	VSLC(I)	XSUC(I)	YSUC(I)	ZSUC(I)	SSUC(I)	VSUC(I)
1	.98012	.00000	0.	0.	.95000	31.77779	35.10700	8.64189	35.10700	.95000
2	4.90062	.00000	0.	0.	.75000	32.64173	35.10700	9.19474	35.10700	.75000
3	8.82113	.00000	0.	0.	.55000	33.64687	35.10700	9.08327	35.10700	.55000
4	12.74163	.00000	0.	0.	.35000	34.65201	35.10700	8.97181	35.10700	.35000
5	16.66213	.00000	0.	0.	.15000	35.65715	35.10700	8.86035	35.10700	.15000
6	19.60250	.00000	0.	0.	0.	36.41100	35.10700	8.77675	35.10700	0.

BOUNDARY POINTS ALONG SL AND SU EDGES

FIGURE 7.7-3. Output for POTGEM Test Case 7 (Concluded).

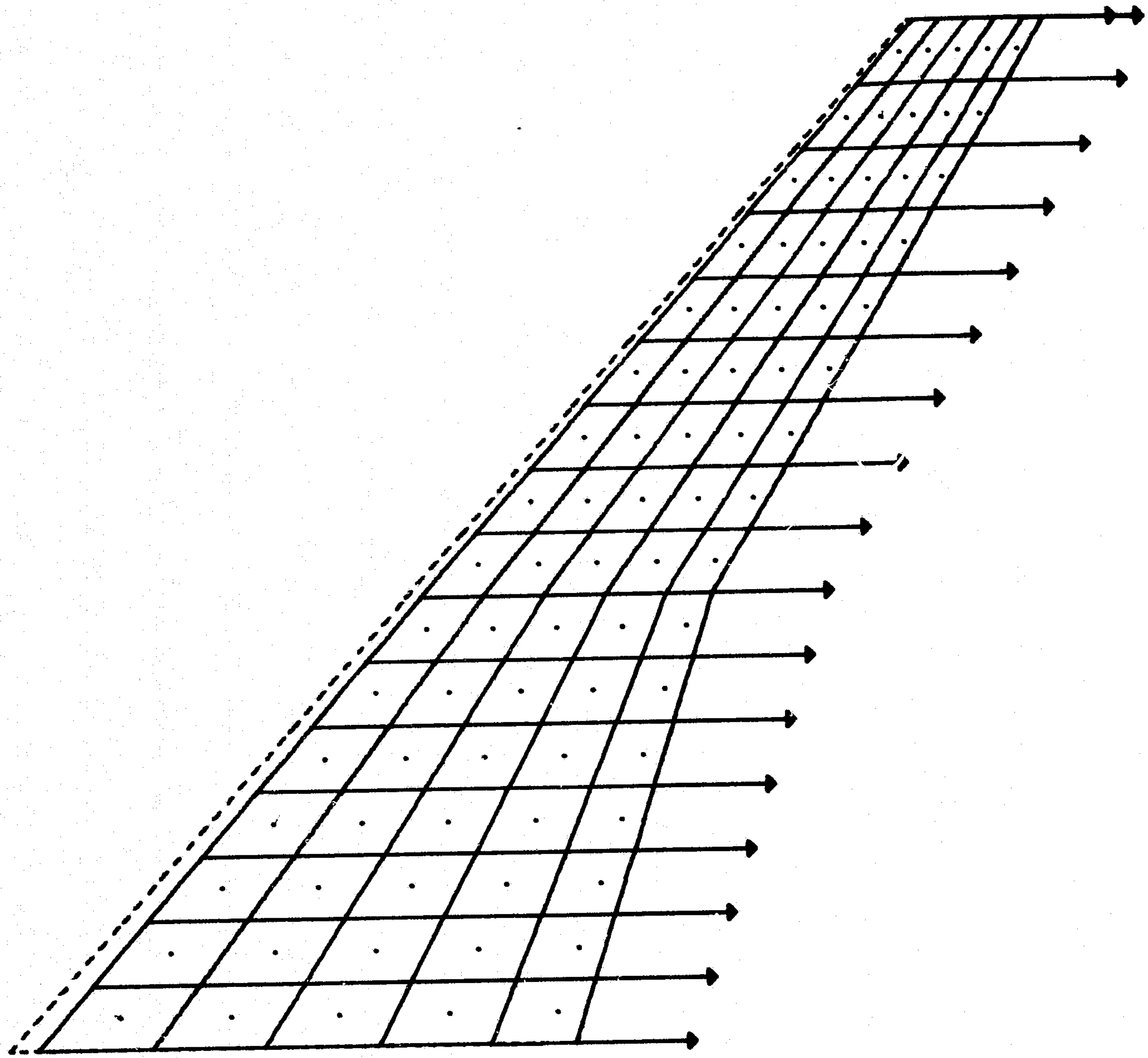

FIGURE 7.7-4(a). Top View of POTGEM Test Case 7.

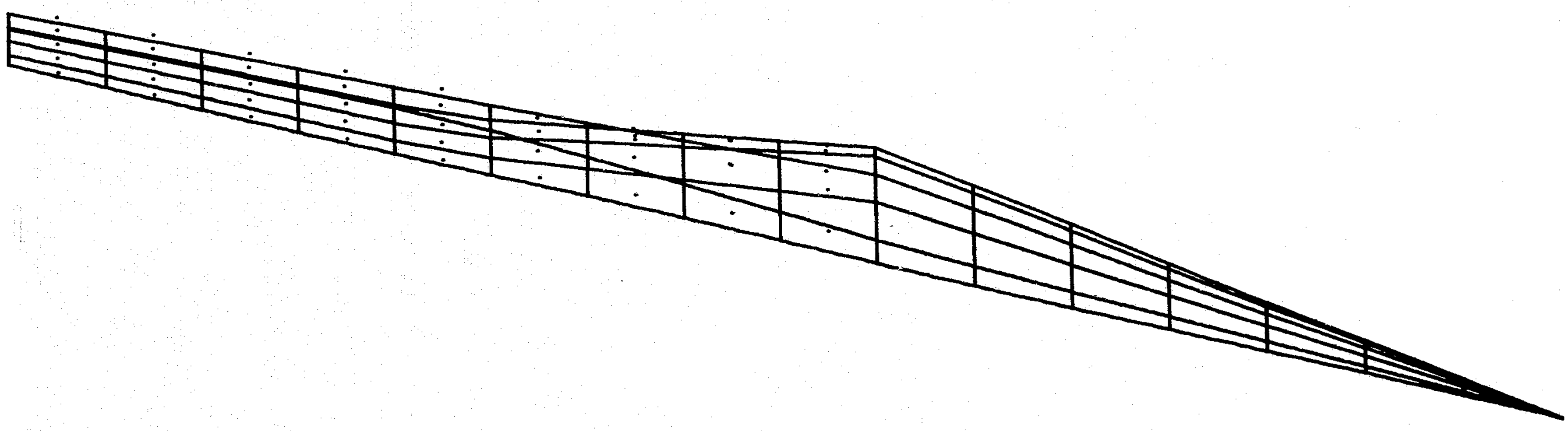

FIGURE 7.7-4(b). Front View of POTGEM Test Case 7.

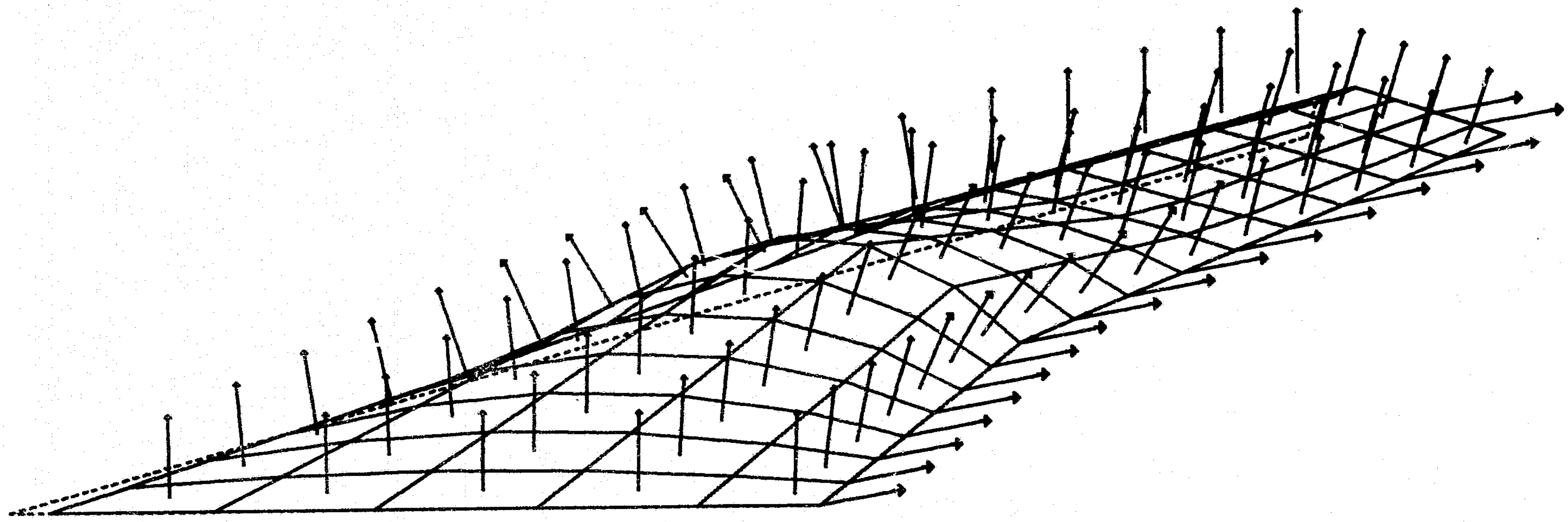

FIGURE 7.7-4(c). Side View of POTGEM Test Case 7.