TECHNICAL MEMORANDUM

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Users' Manual for EVITS: A Steady State Fluids Code for Complex Two-Dimensional Geometries

by

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Components Technology Division

ARGONNE NATIONAL LABORATORY

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BASE TECHNOLOGY

July 1976

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ANL-CT-76-37
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ABSTRACT

A 2-D computer code, EVITS, has been developed for estimating steady state, incompressible, isothermal flow fields in complex geometries. A vorticity-stream function formulation is used along with a model to resolve viscous effects at solid boundaries. Sufficient geometry and boundary type options are included within the code so that a large number of flow situations can be specified without modifying the program. All instructions to the code are via an input dataset. Detailed instructions for preparing the user oriented input, along with examples, are included in this users' manual.

ACKNOWLEDGMENT

The author is indebted to R. R. Rohde of the Components Technology Division of ANL for his encouragement while EVITS was being conceived and developed, and to Verna Stainback for typing the final manuscript.

LIST OF TABLES AND FIGURES

1.0 INTRODUCTION

The purpose of the code EVITS (an acronym for explicit vorticity iterative time step) is to estimate two-dimensional, steady state, incompressible, isothermal flow fields in complex geometries. A secondary objective is to form a basis for future development of new solution procedures and boundary condition models.

Basically, EVITS is a synthesis of well-known two-dimensional fluid mechanics, proven iterative solution techniques and fundamental concepts of plane geometry.[1] In addition, promising boundary condition options resulting from numerical experimentation are included in the code.

The code utilizes the solution procedure put forth by Roache and Mueller.[2,3] The formulation is in terms of vorticity and stream function. Viscous effects are convected into the solution domain through the inlet and are generated at solid, no-slip surfaces. The vorticity is diffused and convected throughout the flow region using the vorticity transport equation. Conservation of mass is assured by using the Poisson equation for stream function.

This report is a users' manual for operating EVITS. It includes instructions to aid input preparation and output interpretation. Certain limitations and restrictions are identified and discussed. Because of the number of geometric configuration possibilities and boundary condition combinations readily available, EVITS is a useful tool in analyzing two-dimensional, steady state, incompressible, and isothermal flow distributions.

2.0 DOMAIN DEFINITION

2.1 Defining Domain Boundaries

The function of EVITS is to obtain flow fields in a closed, finite, two-dimensional region. To specify the shape of a closed finite region, the code uses the concept of ordered connected line segments. There are two types of line segments available to shape the geometric figure. One is a straight line and the other a circular arc. By connecting up to fifty of these line segments, end to end, a large number of geometrical configurations can be approximated.

A straight line segment is uniquely defined by two points. The convention of having the region of interest on the right as the line segment is drawn from the first point to the second serves to define a domain boundary. A circular arc is uniquely defined by three points in a plane. Similarly, by drawing the arc from the first point through the second and to the third point, the region of interest is placed on the right (see Fig. 2.1).

2.2 Constructing the Geometric Figure

Using the concept and convention described in Sect. 2.1 to define domain boundaries, many geometric configurations can be constructed. The procedure for defining a geometry can be best described with an example. For the rest of this report, line segments will be called sides and points where line segments meet will be called vertices.

Consider Fig. 2.2, where 2.2a is the geometry to be modeled. Identification of the vertices required by the code to specify the geometry of interest may be summarized by the following rules:

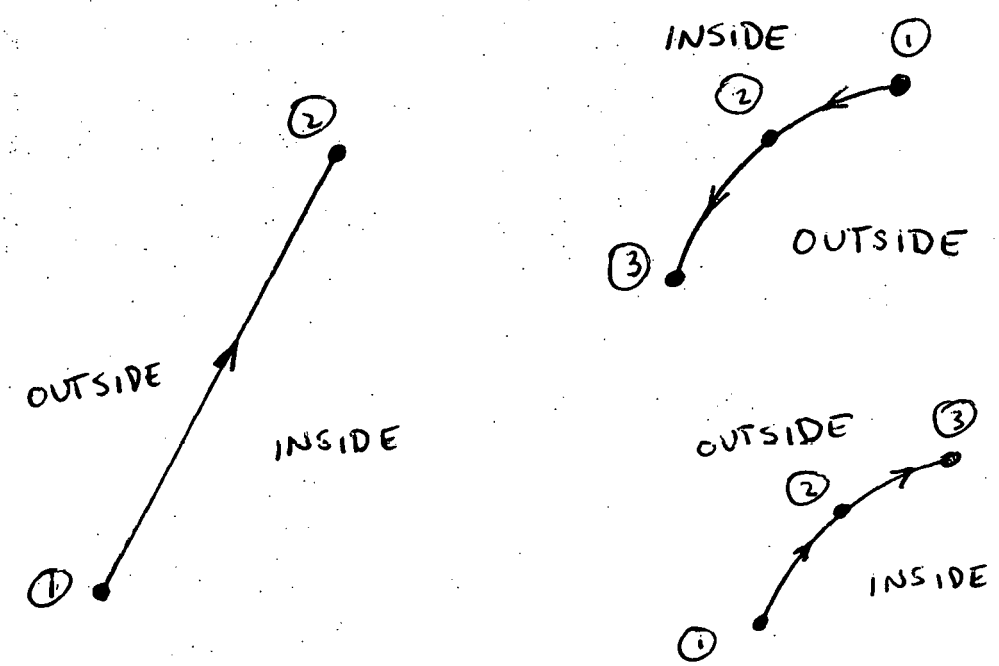


FIGURE 2.1 : INSIDE - OUTSIDE CONVENTION

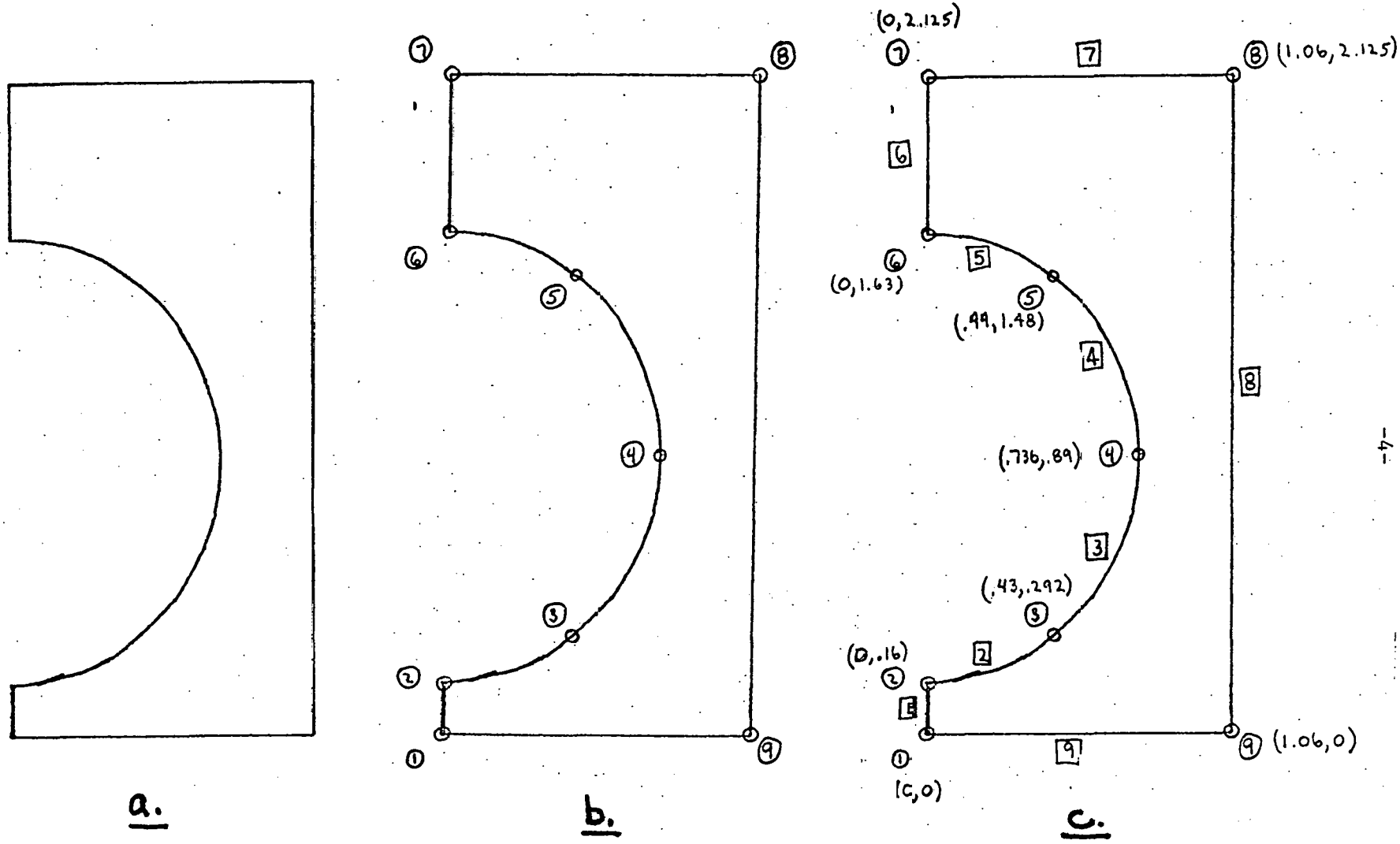


FIGURE 2.2 : DEFINITION OF GEOMETRY

1) Identify and locate points of discontinuity. These are labeled with circled numbers 1, 2, 6, 7, 8 and 9 in Fig. 2.2b.

   Rule one is sufficient if the figure has as its boundaries only straight lines. However, if there are one or more circular arcs, rules two and three must also be met and the additional defined vertices included in the specification.

2) Identify and locate tangent points on the arc where the tangent is horizontal or vertical (i.e., maximum arc is a quadrant). These are labeled with circled numbers 2, 4, and 6 in Fig. 2.2b.

3) On each arc insert a vertex between the vertices defined in rules one and two. These are labeled with circled numbers 3 and 5 in Fig. 2.2b.

Once all necessary vertices are identified, label the vertices sequentially, beginning with the leftmost, lowermost vertex labeled as one and proceeding around the figure such that the region of interest is always on the right. Note, 9 vertices are required to specify the configuration shown in Fig. 2.2. Having identified and labeled all necessary vertices, determine the location of each vertex relative to a coordinate system (x,y), where the origin is positioned at the intersection of a vertical line passing through the extreme leftmost vertex and a horizontal line passing through the extreme lowermost vertex. Note, it is not necessary to have a vertex at the origin (0,0), however vertex one is located at the origin in the particular

example geometry shown in Fig. 2.2.

Having identified and labeled the vertices, the sides are then identified and numbered. Numbering of the sides follows the convention that a side immediately following a vertex has the same number. For example, side one is between vertices one and two and side nine is between vertex nine and vertex one. These sides are indicated by the boxed numbers in Fig. 2.2c.

Once the vertices and sides have been identified and labeled, specification of side type is now considered. Each side is either a straight line segment or a circular arc. To differentiate between the two cases, coded values are assigned to each side by the following convention:

KSIDE(N) = 0 — 9 straight line segment

10 —19 circular arc

For geometric definition the only consideration necessary is whether the assigned coded values are less than or greater than ten. Further definition of these coded values will be discussed in Sect. 3.0, where specification of particular boundary types (i.e., inlet, outlet, solid wall, etc.) is described.

2.3 Geometric Input Variables

Input of the geometric configuration is part of the NAMELIST type input which EVITS utilizes. The NAMELIST name is FLOWØ1. The first card of the input data set must be

b&FLOWØ1[†]

[†] In this report "b" represents a blank.

Following this card are the input variables and their assigned values. After the last input variable card is the last card:

bb&END

This card ends the NAMELIST input dataset.

Specification of the geometric configuration is made by one scalar and three arrays:

NVERTX = number of vertices used to specify configuration

XVERTX(I) = x-coordinate of the i-th vertex

YVERTX(I) = y-coordinate of the i-th vertex

KSIDE(I) = coded value assigned to the i-th side.

Using the values indicated in Fig. 2.2c, the input dataset can be partially constructed as in Fig. 2.3. Note, that 1) all assigned values are followed by a comma, 2) repetitive values can be indicated by the number of repetitions followed by a *, followed by the value to be repeated, and 3) array values are assigned by specifying the initial subscript to the first value. Subsequent values are assigned subscripts, each automatically incremented by one. In this example, the KSIDE array assigns values 3 to side 1 indicating a straight line, 12 to sides 2 through 5, indicating circular arcs, 3 to side 6, 8 to side 7, 3 to side 8 and 4 to side 9. Since KSIDE values are less than 10 from side 6 through side 9, these are straight lines.

2.4 Grid Definition

The code utilizes an equal-spaced grid. Specification of the grid spacing is accomplished by two scalars:

```
&FLOW01
 NVERTX=9,
 XVERTX(1)=0.,.0.,.425,.7356,.4414,0.,0.,1.0625,1.0625,
 YVERTX(1)=0.,.1594,.2921875,.8950,1.4835,1.6306,2*2.125,0.,
 KSIDE(1)=3,4*12,3,8,3,4,
  CIN(1)=348.,
 VISCUS=.02,
 FLOUT=1,
 YTUBES=1.0625,NGRID=20,
 ITSMAX=500,
 DTIME=.1,
 FLIN=1.,
 FL2=9,
 &END
```

FIGURE 2.3 : SAMPLE INPUT DATASET

YTUBES = dimensional length to be partitioned into NGRID number of grid spaces

NGRID = number of grid spaces in distance YTUBES.

Using these values, the code automatically transforms the vertex coordinates into a grid coordinate system $(\hat{x},\hat{y})$, using the transformation:

$$\hat{x} = \frac{\text{NGRID}}{\text{YTUBES}} \; x + 1$$

$$\hat{y} = \frac{\text{NGRID}}{\text{YTUBES}} \; y + 1$$

The origin (0,0) in (x,y) coordinates is transformed to (1,1) in the dimensionless $(\hat{x},\hat{y})$ system. The maximum grid size is 41 x 41 spaces.

3.0 BOUNDARY CONDITION ASSIGNMENT

3.1 Types of Boundaries

There are ten types of boundary conditions (B.C.) available to simulate the flow problem. These are the no-slip, symmetry, fixed inlet, fixed outlet, free inlet, free outlet, internal object, line of resistance, matched, and dummy boundary conditions.

The no-slip boundary condition is used to specify a solid wall. At the wall the fluid sticks to the surface and both tangential and normal velocity components are zero. The no-slip B.C. is available for both a straight line and a circular arc.

The symmetry condition is specified when the geometry and expected flow field are symmetric about a line. It is available only as a straight line.

The fixed inlet B.C. is used to specify a known distribution of fluid entering the domain of interest. It may also be used to specify a moving boundary. All inlet and outlet boundary types are available for both straight lines and circular arcs.

The fixed outlet B.C. is used to specify a known distribution of fluid leaving the domain of interest.

The free inlet B.C. is used to specify a certain amount of fluid entering the region, with its particular normal velocity component distribution unknown and to be determined. This B.C. is not often used, because flow information does not readily propagate upstream for most finite difference techniques.

The free outlet B.C. is used when the normal velocity component distribution leaving the domain of interest is unknown, and an assumption of zero tangential velocity component is acceptable.

The internal object B.C. is used when the fluid field completely surrounds a solid object. While the boundary condition imposed at the surface of the solid object is of the no-slip type, the amount of fluid flowing on either side is determined as part of the solution. This boundary condition can be used with the free outlet B.C. to determine relative amounts of fluid leaving multiple outlets. It is available for both straight lines and circular arcs.

The resistance and matched boundary conditions are used together to grossly simulate a screen or tube bank placed completely across the flow path. The screen must be oriented in either a horizontal or vertical attitude. This boundary condition is available only as a horizontal or vertical straight line.

The dummy B.C. is used to specify no side. This is used to indicate a gap between the outside boundary and an internal object. It is also used to go from one internal object to another.

3.2 Boundary Type Code

In Sect. 2.3 the KSIDE(I) array was introduced to differentiate between a straight or curved side. The differentiation was accomplished by specifying KSIDE(I) less than or greater than ten. In this section particular values of KSIDE are associated with particular boundary types (i.e., straight

or curved inlet, straight or curved internal object, etc.). The assignment of boundary type to a particular side is made via the KSIDE(I) array using the appropriate coded value from Table 3.1. From the sample input in Fig. 2.3 it can be seen that the nine sides indicated in Fig. 2.2c are, respectively, 1) a line of symmetry; 2), 3), 4), and 5) curved, no-slip surfaces; 6) a line of symmetry; 7) a straight free outlet; 8) a line of symmetry; and 9) a straight fixed inlet. This example input specifies a problem to determine the flow field within an infinite row of equally spaced circular cylinders.

3.3 Velocity Profile Specification Across Inlet

The first step in specifying the inlet velocity distribution is to locate two vertices, one at the beginning and the other at the end of the inlet. If there is more than one inlet, locate the beginning vertex of the first inlet and end vertex of the last inlet. The internal structure of the code requires that the last vertex be labeled with a higher number than the beginning vertex, and that there is no outlet between the first and last inlet vertices. Internal to the code, the first vertex is doubly defined as vertex one and vertex NVERTX + 1. This restriction precludes vertex number one from being in the middle of an inlet, but does allow it to either start or end an inlet. In the example shown in Fig. 2.2, the inlet consists of only one side, side 9. It begins with vertex 9 and ends at vertex 1 (10).

Having determined the beginning and end vertices of the inlet, the characteristic length used throughout the solution may be calculated. Nominally, the characteristic length, CHARL, is automatically calculated in the

KSIDE VALUES		BOUNDARY TYPE
STRAIGHT	CURVED	
0	-	DUMMY
1	-	MATCHED
2	12	NO SLIP
3	-	SYMMETRY
4	14	FIXED INLET
5	15	FIXED OUTLET
6	-	RESISTANCE
7	17	FREE INLET
8	18	FREE OUTLET
9	19	INTERNAL OBJECT

TABLE 3.1 : CODE FOR BOUNDARY TYPES

code by determining the overall length as measured along the inlet in grid units. If L_{in} is the actual length of the inlet in dimensional units then:

$$\text{CHARL} = \frac{L_{in}*\text{NGRID}}{\text{YTUBES}} \quad .$$

The nominal value of CHARL can be overridden by assigning it a value in the NAMELIST input dataset. This is necessary to maintain values of the dimensionless stream function, S, between zero and one in geometries having multiple inlets. In such cases, L_{in}, and hence CHARL, would be the total length summed only along lengths where there is a normal velocity component.

Once the beginning and ending vertices of the inlet have been determined, a normalized position parameter, s, is defined. This parameter measures the normalized distance from the beginning vertex along the inlet. The values of s range from zero, at the beginning vertex, to one at the end vertex.

For example, consider Fig. 3.1. Sides 25 and 26 represent an inlet. The inlet begins with vertex 25 and ends with vertex 27. The normalized position parameter, s, starts with a value of zero at vertex 25 and is measured along curved sides 25 and 26 up to a value of one at vertex 27.

Once the position parameter has been defined, specification of the normal and tangential velocity components along the inlet can be considered. These components, N and T, respectively, are specified as piecewise functions over the inlet. The inlet can be partitioned into a maximum of ten different subregions. In each subregion, $s_i < s < s_{i+1}$, the normal and tangential velocity components can assume the following forms:

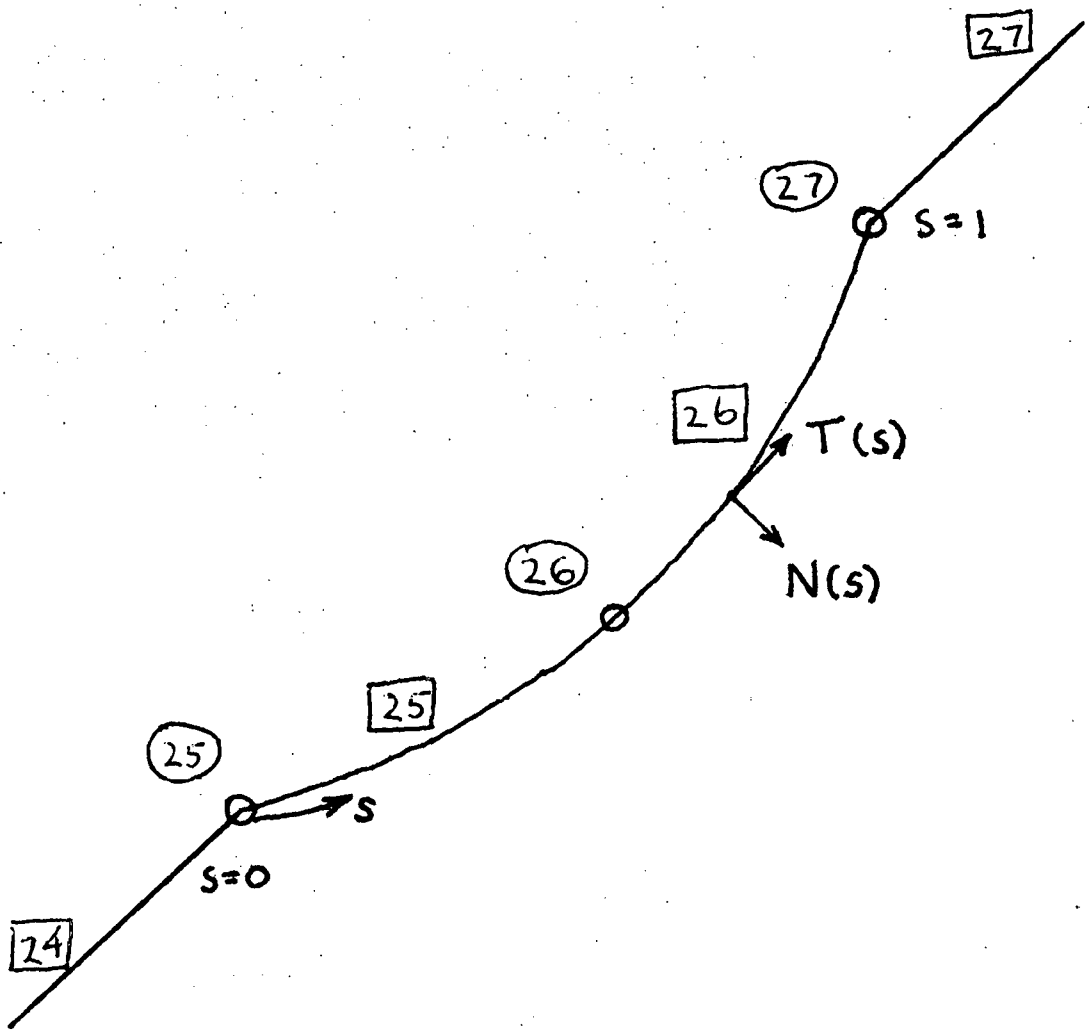


FIGURE 3.1: VELOCITY SPECIFICATION ALONG AN INLET

$$N_i(s) = AIN(I)*s^2 + BIN(I)*s + CIN(I) + \frac{DIN(I)}{s + EIN(I)} \qquad (3.1)$$

and

$$T_i(s) = AIT(I)*s^2 + BIT(I)*s + CIT(I) \qquad (3.2)$$

Unit vectors for the velocity components are indicated in Fig. 3.1. The normal component unit vector is directed into the domain of interest, while the tangential component unit vector is directed along the inlet in the direction of increasing vertex labels.

The number of subregions is defined by the number of points of discontinuity between zero and one. This information is input by the variables: NPIN = number of points of discontinuity along inlet; PIN(I) = s value of i-th discontinuity along inlet. For NPIN number of points of discontinuity there are NPIN + 1 number of subregions. Functional relationships are input by the arrays AIN(I), BIN(I), CIN(I), DIN(I) and EIN(I), for the inlet normal velocity component given in Eq. (3.1), and AIT(I), BIT(I) and CIT(I), for the inlet tangential velocity component given in Eq. (3.2).

As an example consider specifying N and T along the inlet shown in Fig. 3.1. Suppose specification of the N and T distributions along the inlet can be accomplished by using three subregions. Fig. 3.2 indicates a velocity distribution specification using three sugregions, each indicated by a circled number. Between each subregion is a point of discontinuity, indicated by a boxed number. In the first subregion, $0 < s < .25$, the normal velocity component is an increasing parabolic ramp, $N = -16s^2 + 8s$, while the tangential component is a positive constant, $T = 1$. Subregion two, $.25 < s < .75$, indicates flow radially into the domain of interest with $N = 1$ and $T = 0$. Subregion three, $.75 < s < 1.$, shows a decreasing parabolic ramp in the normal

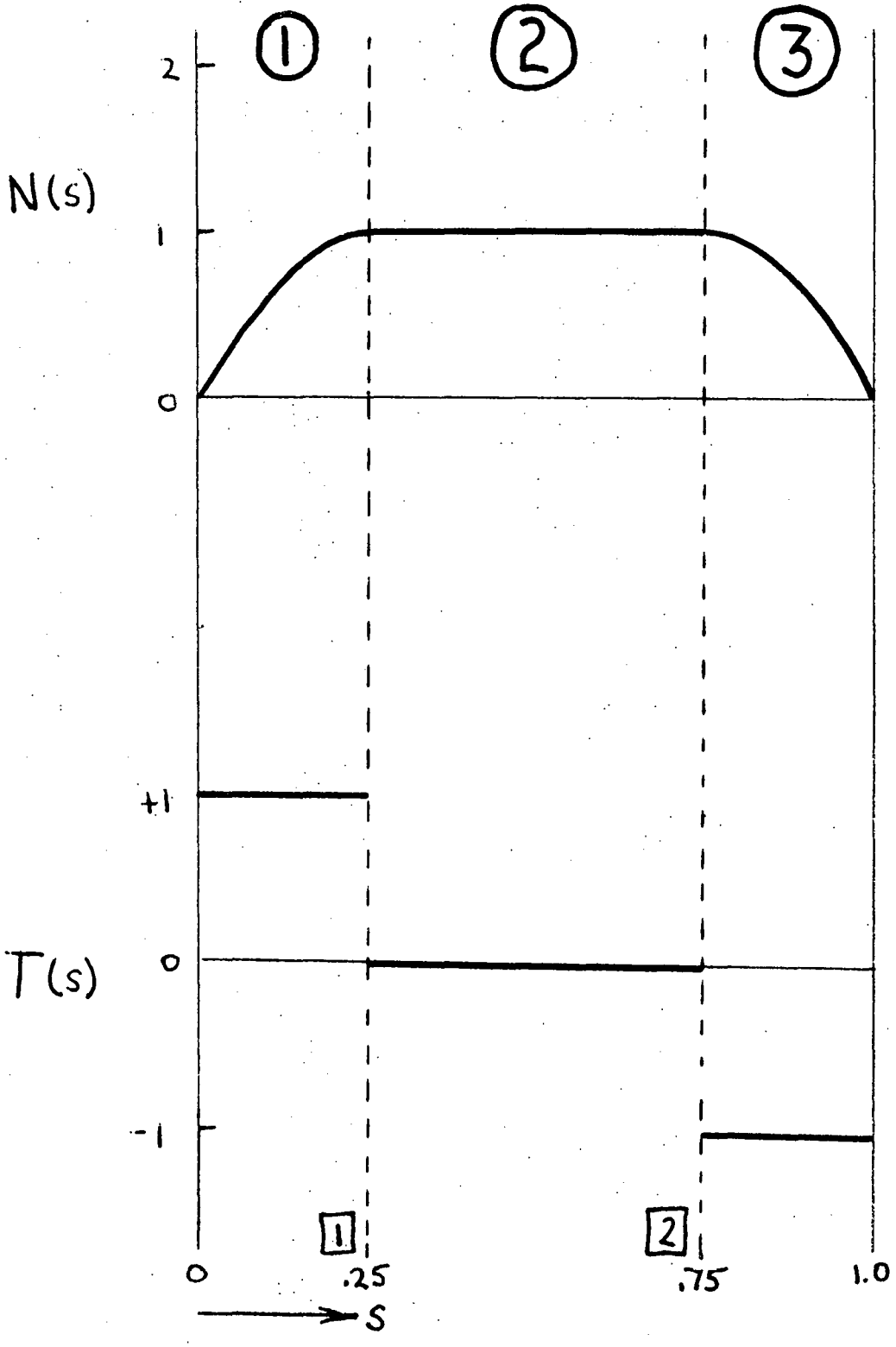


FIGURE 3.2 : NORMAL AND TANGENTIAL VELOCITY COMPONENT SPECIFICATION

component, $N = -16s^2 + 24s - 8$, and a negative constant for the tangential component, $T = -1$. Input to the code to describe this distribution is accomplished by:

NPIN = 2, PIN(1) = .25,.75,

AIN(1) = -16.,0.,-16.,BIN(1) = 8.,0.,24.,CIN(1) = 0.,1.,-8.,

CIT(1) = 1.,0.,-1.,

Nominally, all values of AIN, BIN, CIN, DIN, AIT, BIT and CIT are zero except for CIN(1) = 1. Array values of EIN are nominally 1.

Once the velocity distribution has been specified across the inlet, the characteristic velocity, CHARU, is calculated. It is the average velocity across the inlet and is given by

$$\text{CHARU} = \int_0^1 ds\ N(s) \quad .$$

3.4 Velocity Profile Specification Across Outlet

Specification of the outlet velocity profile proceeds in much the same way as the specification across the inlet. The beginning and end outlet vertices are identified. These have the same restrictions on vertex one as with the inlet. A normalized position parameter is introduced and up to ten subregions are available for specifying the normal and tangential velocity components along the outlet as functions of s. In each subregion, $s_i < s \leq s_{i+1}$, the normal and tangential velocity components have the forms:

$$N_i(s) = \text{AON(I)}*s^2 + \text{BON(I)}*s + \text{CON(I)} + \frac{\text{DON(I)}}{s + \text{EON(I)}} \qquad (3.3)$$

and

$$T_i(s) = \text{AOT(I)}*s^2 + \text{BOT(I)}*s + \text{COT(I)} \quad . \qquad (3.4)$$

The only significant difference in specifying the outlet velocity distribution is in the normal component unit vector. While the tangential component unit vector is directed along the outlet in the direction of increasing vertex labels, the normal component unit vector is directed outward from the domain of interest. Points of discontinuity between subregions are specified by:

NPOUT = number of points of discontinuity along outlet

POUT(I) = s value of i-th discontinuity along outlet.

Thus, if the three subregion velocity distribution shown in Fig. 3.2 is for an outlet, it would be specified by the following input:

NPOUT = 2,POUT(1) = .25,.75,

AON(1) = -16.,0.,-16.,

BON(1) = 8.,0.,24.,

CON(1) = 0.,1.,-8.,

COT(1) = 1.,0.,-1.,

Nominal values of the AON, BON, CON, DON, AOT, BOT and COT arrays are all zero except for CON(1) = 1. Array values of EON are nominally 1.

4.0 SOLUTION PROCEDURE

4.1 Non-dimensionalization of Equations

In this section, relevant equations are stated in dimensional form. The variables are non-dimensionalized, substituted into the dimensional equations, rearranged and resulting dimensionless equations stated.

The velocity - stream function relationships are

$$u = -\frac{\partial \psi}{\partial y} \tag{4.1a}$$

$$v = \frac{\partial \psi}{\partial x} \quad . \tag{4.1b}$$

The following relationships are defined in terms of dimensionless velocities U, V and stream function S:

$$u = \text{CHARU*U}$$

$$v = \text{CHARU*V}$$

$$\psi = \left(\frac{\text{CHARU*CHARL*YTUBES}}{\text{NGRID}}\right) S$$

$$x = \frac{\text{YTUBES}}{\text{NGRID}} (\hat{x} - 1)$$

$$y = \frac{\text{YTUBES}}{\text{NGRID}} (\hat{y} - 1)$$

Using these definitions in Eq. (4.1a,b) we obtain

$$U = -\text{CHARL*} \frac{\partial S}{\partial \hat{y}} \tag{4.2a}$$

$$V = \text{CHARL*} \frac{\partial S}{\partial \hat{x}} \quad . \tag{4.2b}$$

The Poisson equation for stream function,

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \omega = 0 \text{ (zero)}$$

is non-dimensionalized by defining

$$\omega = \left(\frac{\text{CHARU*NGRID}}{\text{CHARL*YTUBES}}\right) O \tag{4.3}$$

and using the relationships above to yield

$$\frac{\partial^2 S}{\partial \hat{x}^2} + \frac{\partial^2 S}{\partial \hat{y}^2} + \frac{1}{\text{CHARL}^2}\,\Omega = 0 \text{ (zero)}. \tag{4.4}$$

The vorticity transport equation,

$$\frac{\partial \omega}{\partial t} + u\frac{\partial \omega}{\partial x} + v\frac{\partial \omega}{\partial y} = \text{VISCOS}*\left(\frac{\partial^2 \omega}{\partial x^2} + \frac{\partial^2 \omega}{\partial y^2}\right),$$

is non-dimensionalized by defining a dimensionless time and cell Reynolds number as

$$t = \frac{\text{YTUBES}}{\text{CHARU*NGRID}}\,\hat{t}$$

$$\text{REYNLD} = \frac{\text{CHARU*YTUBES}}{\text{VISCOS*NGRID}} \tag{4.5}$$

and using the relationships above to yield:

$$\frac{\partial \Omega}{\partial \hat{t}} = -U\frac{\partial \Omega}{\partial \hat{x}} - V\frac{\partial \Omega}{\partial \hat{y}} + \frac{1}{\text{REYNLD}}\left[\frac{\partial^2 \Omega}{\partial x^2} + \frac{\partial^2 \Omega}{\partial y^2}\right]. \tag{4.6}$$

These equations, 4.2a,b, 4.4, and 4.6 are the equations dealt with in the solution sequence.

4.2 Iterative Solution

After initial assignment of stream function and vorticity values throughout the domain, the solution enters the iterative sequence. Each pass through this sequence improves the S,Ω distributions until, finally, the vorticity distribution converges to within a predetermined limit. Nominally, S is set initially to .5 and Ω to 0. .

Upon entering the iterative sequence, the old values of stream function boundary conditions and vorticity are used to solve for a new stream function distribution (old refers to values determined in the previous iterative

sequence sweep). From this new stream function distribution, new velocity component (U,V) distributions are determined.

The next step in the sequence is to improve the boundary values of stream function, vorticity and velocity components from the new stream function distribution. Finally, a new vorticity distribution is determined by an explicit time stepping of the vorticity transport equation using the old vorticity distribution, new velocity component distributions and new boundary conditions. This iterative sequence is repeated ITSMAX number of times or until the change in vorticity summed over all internal nodes is less than EPSMAX,

$$\sum_{i,j} \left| \Delta O_{ij} \right| < \text{EPSMAX} \quad . \tag{4.7}$$

Once this convergence criterion is met, it may be argued that the solution is invariant with time or $\frac{\partial O}{\partial t} = 0$. Thus a steady state has been reached.

4.3 S.O.R. Solution of Stream Function

Given the vorticity distribution, O_{ij}, and stream function boundary conditions, Eq. (4.4) is solved for the stream function distribution, S_{ij}, using the successive overrelaxation technique (S.O.R.). The finite difference form of Eq. (4.4) is

$$S_{ij}^{new} = (1 - \text{RELAX}) S_{ij}^{old} + \frac{\text{RELAX}}{4} \left(S_{i-1,j}^{old} + S_{i+1,j}^{old} + S_{i,j+1}^{old} + S_{i,j-1}^{old} \right) + \frac{1}{\text{CHARL}^2} O_{ij} \quad . \tag{4.8}$$

Here RELAX is the successive overrelaxation factor which has a value somewhere between $1 < \text{RELAX} < 2$.

One sweep consists of applying Eq. (4.8) once at each internal grid point. The sweeps continue until the number of sweeps reaches ITMAXS (nominally 250) or the stream function distribution converges,

$$\sum_{i,j} \left| \Delta S_{ij} \right| < \text{EPSMAX}. \tag{4.9}$$

Note, EPSMAX is used as a convergence criterion on both stream function and vorticity.

The rapidity of S.O.R. convergence (number of sweeps needed to obtain convergence criterion) is strongly dependent on the S.O.R. factor, RELAX. This factor is geometry dependent and is very difficult to calculate, analytically, except for the simplest of geometries. To circumvent this situation, a trial and error routine is nominally called upon to obtain an approximation of RELAX. If RELAX is known it may be input. If not, it will be estimated.

4.4 Explicit Time Step of Vorticity

Given the old vorticity distribution, new velocity component distributions and new vorticity boundary values, Eq. (4.6) is used to explicitly increment the vorticity one time step. The finite difference form of Eq. (4.6) is

$$O_{ij}^{new} = O_{ij}^{old} + \text{DTIME}\left(\frac{\text{DEL2O}}{\text{REYNLD}} - \text{DUODX} - \text{DVODY}\right). \tag{4.10}$$

In this equation the viscous terms, DEL2O, are

$$\text{DEL2O} = O_{i-1,j}^{old} + O_{i+1,j}^{old} + O_{i,j+1}^{old} + O_{i,j-1}^{old} - 4\, O_{ij}^{old} .$$

The convective terms, DUODX and DVODY, are finite differenced using upwind differencing and are given by

$$\text{DUODX} = \begin{cases} U_{i+1,j} O_{i+1,j} - U_{ij} O_{ij} & U_{ij} \leq 0 \\ U_{ij} O_{ij} - U_{i-1,j} O_{i-1,j} & U_{ij} > 0 \end{cases} .$$

and

$$\text{DVODY} = \begin{cases} V_{i,j+1} O_{i,j+1} - V_{ij} O_{ij} & V_{ij} \leq 0 \\ V_{ij} O_{ij} - V_{i,j-1} O_{i,j-1} & V_{ij} > 0 \end{cases} .$$

Control of the time step sweep is through the cell Reynolds number, REYNLD, and dimensionless time increment, DTIME. Nominally,

```
REYNLD = CHARU*YTUBES/VISCOS/NGRID

DTIME  = .2/(2.*NGRID/REYNLD + 1.)  .
```

These values can be overridden by inputing either one or both via the NAMELIST input.

5.0 OUTPUT

5.1 Internally Generated Arrays: KPOINT, L Arrays, LN Arrays

To fully understand the output, it is necessary to have some knowledge of the internal workings of EVITS. Once the geometry has been transformed and put onto a grid basis, a coded array called KPOINT(I,J) is generated characterizing every point on the grid. The boundaries of the grid form the smallest rectangle which can circumscribe the figure. Grid points are located by coordinates (I,J), where (1,1) corresponds to (0,0) in the dimensional (x,y) coordinate system and is located at the lower left-hand corner of the minimum rectangle. The limits of the rectangle are indicated by IMAXI and JMAX and are included in the output.

The values of KPOINT(I,J) indicate the node at (I,J) is:

-1 on [or internal but within .1 grid spacing of] the surface

0 outside the figure

1 inside the figure and totally surrounded by internal nodes

2 inside but adjacent to the surface in the x^- direction

3 inside but adjacent to the surface in the y^+ direction

4 inside but adjacent to the surface in the x^+ direction

5 inside but adjacent to the surface in the y^- direction

6 inside but adjacent to the surface in the x^- and y^+ directions

7 inside but adjacent to the surface in the x^- and y^- directions

8 inside but adjacent to the surface in the x^+ and y^+ directions

9 inside but adjacent to the surface in the x^+ and y^- directions.

From the above KPOINT values and their corresponding meanings, it can be seen that there is no provision for a node that is internal but adjacent to surfaces

in both the x^- and x^+ directions or a node that is internal but adjacent to surfaces in both the y^- and y^+ directions. These two situations are probibited by the internal workings of the code and, thus, impose a restriction on the geometry/grid spacing specification. If such a conflict is encountered, adjustment of the geometry and/or grid spacing must be made.

Points along the perimeter are positioned by the counter, L. Starting with vertex one, each intersection of a side with a grid line is identified and sequentially numbered with the counter, L. Beginning and ending vertex points of each side are also included and appropriately numbered by the counter, L. This counter starts with a value of 2 at the first vertex and proceeds around the figure being incremented at each grid line intersection, side terminator, and side initiator. With this methodology there may be more than one L value corresponding to the same perimeter point. With respect to the L counter, sides are described by two arrays, LBEG(N) and LEND(N). These arrays indicate the values of L beginning and ending the N-th side.

A number of arrays are generated internally as a function of L, and may be referred to as "L" arrays. These are:

PERP(L) = length measured in grid spaces from vertex one to the L-th perimeter point along perimeter

XB(L) = $\hat{x}$ coordinate of L-th perimeter point

YB(L) = $\hat{y}$ coordinate of L-th perimeter point

SB(L) = dimensionless stream function boundary value at the L-th perimeter point

UB(L) = dimensionless $\hat{x}$-direction velocity component boundary value at the L-th perimeter point

VB(L) = dimensionless $\hat{y}$-direction velocity component boundary value at the L-th perimeter point

OB(L) = dimensionless vorticity boundary value at the L-th perimeter point .

In addition to L, another perimeter counter is used. This in the LN counter. From every internal point adjacent to a surface, a line is projected to the adjacent surface such that the projected line and the local surface tangent are perpendicular. The point where the projected line intersects the adjacent side may be referred to as a normal perimeter point. Beginning with vertex one and proceeding around the figure, each normal perimeter point is identified and sequentially numbered with the counter, LN. The LN counter starts with a value of two. The distance as measured along the projected line in grid units must be greater than .1 grid unit. This cutoff imposes another restriction on the geometry/grid spacing specification. A normal perimeter point closer than .1 grid space to the corresponding adjacent internal node is not counted by the LN counter. On a curved or diagonal side there are usually some normal perimeter points not counted. However, if there is a large number of uncounted normal perimeter points, adjustment of the geometry and/or grid spacing must be made.

Along each side, N, the first and last normal perimeter points can be identified and their corresponding LN values noted. This information is included in two arrays, LNBEG(N) and LNEND(N). These arrays indicate the first and last LN values, respectively, encountered along the N-th side. Internally generated LN arrays are:

PERPN(LN) = length measured along the perimeter in grid spaces from vertex one to the LN-th normal perimeter point

XBN(LN) = $\hat{x}$ coordinate of the LN-th normal perimeter point

YBN(LN) = $\hat{y}$ coordinate of the LN-th normal perimeter point

IBN(LN) = $\hat{x}$ coordinate of the adjacent internal node from which the LN-th normal perimeter point was projected

JBN(LN) = $\hat{y}$ coordinate of the adjacent internal node from which the LN-th normal perimeter point was projected

DISTN(LN) = related to the distance, d, between an adjacent internal node and its corresponding normal perimeter point by the equation:

$$\text{DISTN} = \frac{1}{2}\left(\frac{d}{\text{CHARL}}\right)^2$$

SBN(LN) = dimensionless stream function boundary value at the LN-th normal perimeter point

OBN(LN) = dimensionless vorticity boundary value at the LN-th normal perimeter point.

5.2 Printer Output: SAMPLE 1

There are two types of output possible from EVITS, printer output and disc output. Printer output is available in two forms, nominal printer output and extended printer output. The essential difference between nominal and extended printer output is L and LN array information. Extended printer output is recommended and is obtained by including FL2 = 5., into the NAMELIST input.

Discussion of printer output is best illustrated with an example.

Consider the working diagram of Fig. 5.1. Coded side types are indicated by the underlined numbers. From such a diagram NAMELIST input is easily constructed and appears in Fig. 5.2. In this example consider the basic dimensional quantities to be centimeters and seconds. That is, the coordinates indicated in Fig. 5.1 are in centimeters. From the specification of YTUBES and NGRID in Fig. 5.2 it is seen that the grid coarseness is one centimeter per grid unit. Since there is no inlet velocity distribution specified, the nominal, CIN(1) = 1, is assumed. This indicates uniform one centimeter per second flow across the inlet. Since the kinematic viscosity is not specified, it is nominally set to VISCOS = 1 $\frac{cm^2}{sec}$. The assignments FL2 = 5., and FLOUT = 1., indicate extended printer output and disc output, respectively.

Figures 5.3 to 5.15 show the extended printer output obtained from EVITS using SAMPLE1.DATA as input. Fig. 5.3 gives a summary of the geometry input and the transformed grid geometry. Following this is a summary of the beginning and ending L and LN values for each side. The CHARL and CHARU values are indicated as well as a summary of the inlet and outlet velocity distributions used. Note, the outlet summary indicates the initial outlet velocity distribution since side 7 is specified as a free outlet.

The KPOINT distribution is given in Fig. 5.4 along with the nominally determined values of EPSMAX, ITSMAX, RELAX, DTIME, REYNLD and VISCOS. All printed output up to this point has been determined prior to the solution sequence.

The L and LN arrays are shown in Figs. 5.4 to 5.7. The array values are those after the iterative solution has been completed. This is indicated

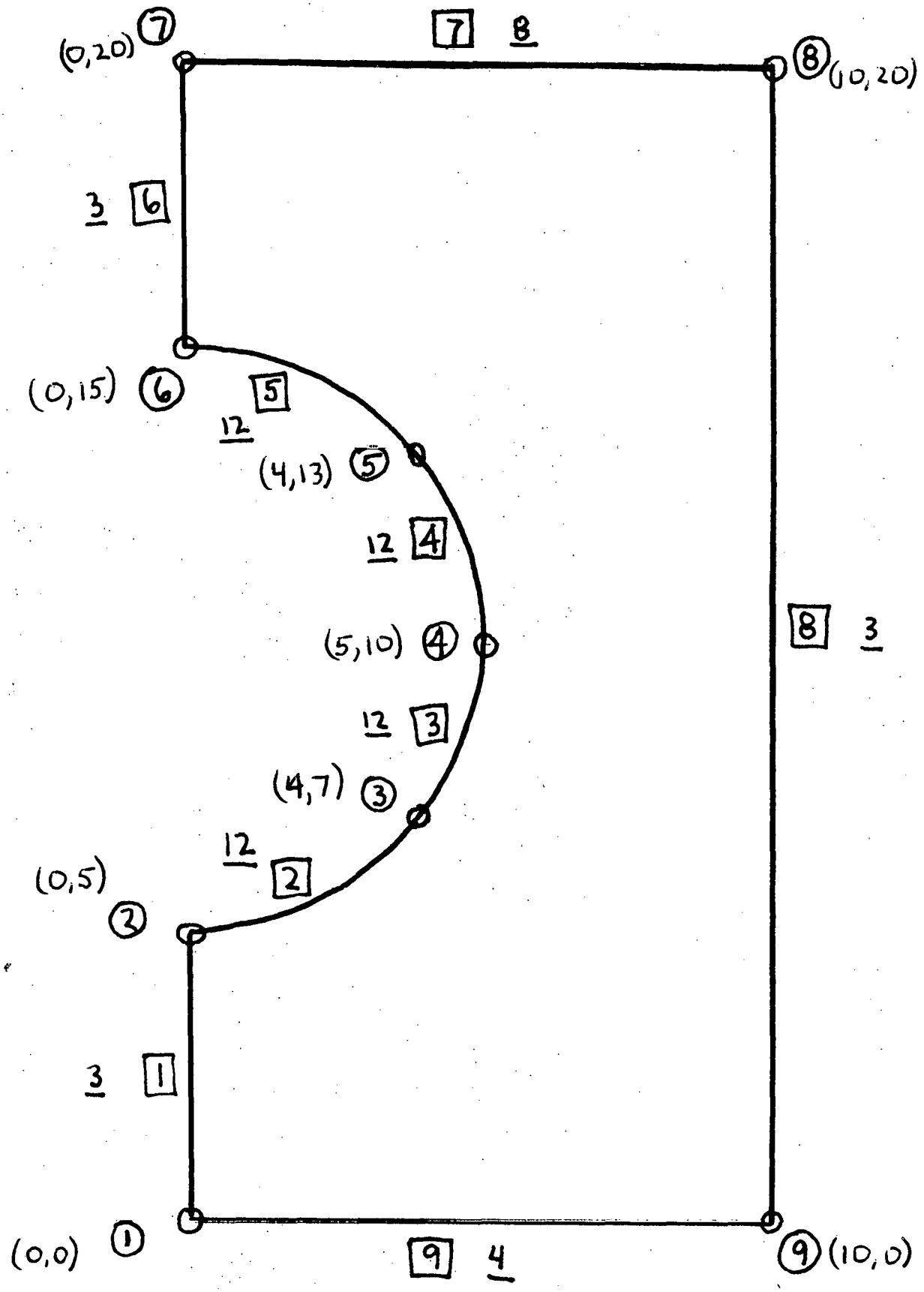
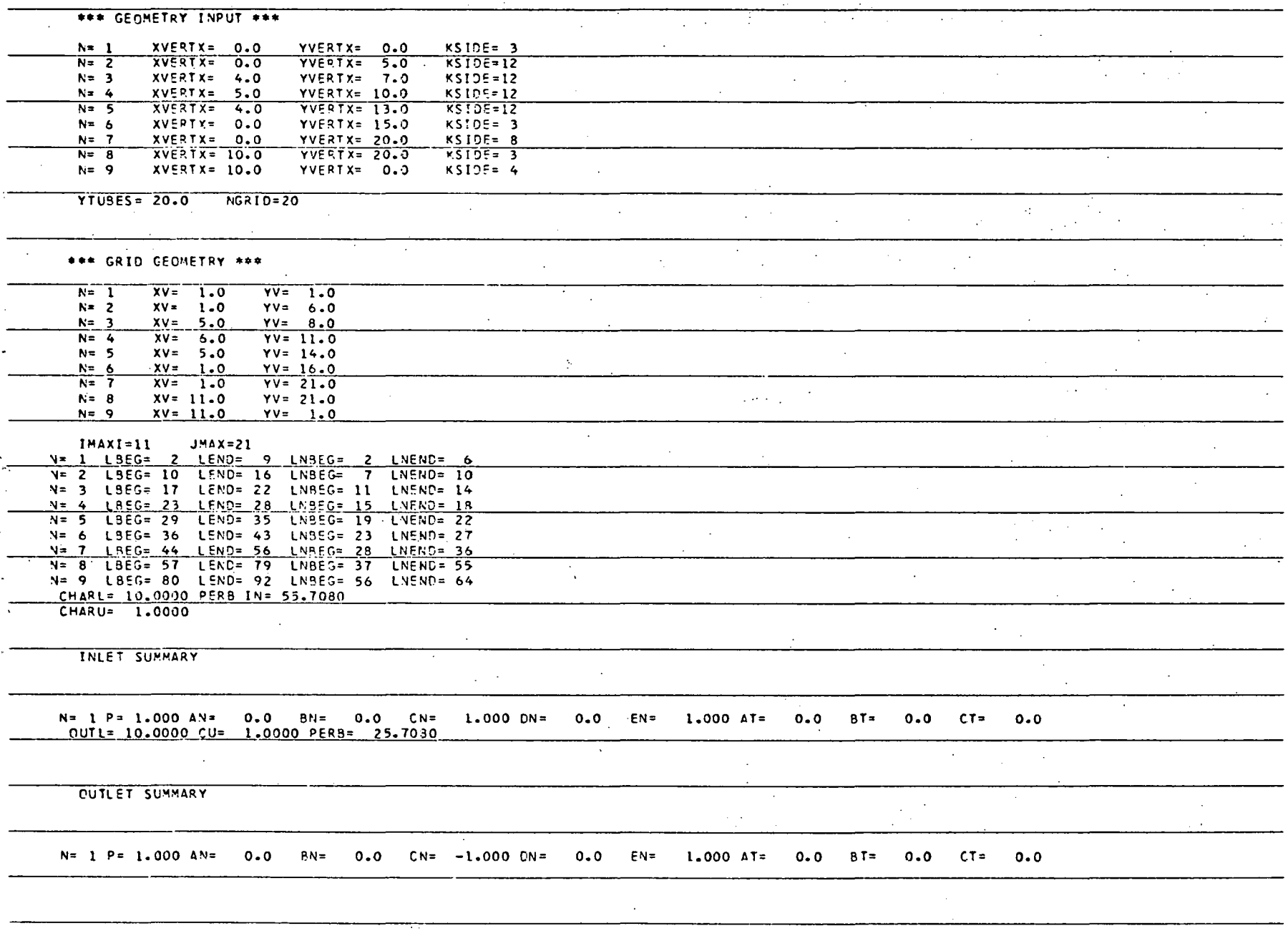


FIGURE 5.1 : SAMPLE1 GEOMETRY

```
SAMPLE1.DATA
           &FLOW01
            NVERTX=9,
            XVERTX(1)=2*0.,4.,5.,4.,2*0.,2*10.,
            YVERTX(1)=0.,5.,7.,10.,13.,15.,2*20.,0.,
            KSIDE(1)=3,4*12,3,8,3,4,
            YTUBES=20,
            NGRID=20,
            FL2=5.
            FLOUT=1.,
            &END
```

FIGURE 5.2: SAMPLE1 INPUT



```
*** GEOMETRY INPUT ***

N= 1    XVERTX=  0.0    YVERTX=  0.0    KSIDE= 3
N= 2    XVERTX=  0.0    YVERTX=  5.0    KSIDE=12
N= 3    XVERTX=  4.0    YVERTX=  7.0    KSIDE=12
N= 4    XVERTX=  5.0    YVERTX= 10.0    KSIDE=12
N= 5    XVERTX=  4.0    YVERTX= 13.0    KSIDE=12
N= 6    XVERTX=  0.0    YVERTX= 15.0    KSIDE= 3
N= 7    XVERTX=  0.0    YVERTX= 20.0    KSIDE= 8
N= 8    XVERTX= 10.0    YVERTX= 20.0    KSIDE= 3
N= 9    XVERTX= 10.0    YVERTX=  0.0    KSIDE= 4

YTUSES= 20.0    NGRID=20


*** GRID GEOMETRY ***

N= 1    XV=  1.0    YV=  1.0
N= 2    XV=  1.0    YV=  6.0
N= 3    XV=  5.0    YV=  8.0
N= 4    XV=  6.0    YV= 11.0
N= 5    XV=  5.0    YV= 14.0
N= 6    XV=  1.0    YV= 16.0
N= 7    XV=  1.0    YV= 21.0
N= 8    XV= 11.0    YV= 21.0
N= 9    XV= 11.0    YV=  1.0

IMAXI=11    JMAX=21
N= 1  LBEG=  2  LEND=  9  LNBEG=  2  LNEND=  6
N= 2  LBEG= 10  LEND= 16  LNBEG=  7  LNEND= 10
N= 3  LBEG= 17  LEND= 22  LNBEG= 11  LNEND= 14
N= 4  LBEG= 23  LEND= 28  LNBEG= 15  LNEND= 18
N= 5  LBEG= 29  LEND= 35  LNBEG= 19  LNEND= 22
N= 6  LBEG= 36  LEND= 43  LNBEG= 23  LNEND= 27
N= 7  LBEG= 44  LEND= 56  LNBEG= 28  LNEND= 36
N= 8  LBEG= 57  LEND= 79  LNBEG= 37  LNEND= 55
N= 9  LBEG= 80  LEND= 92  LNBEG= 56  LNEND= 64
CHARL= 10.0000 PERB IN= 55.7080
CHARU=  1.0000


INLET SUMMARY


N= 1 P= 1.000 AN=  0.0  BN=  0.0  CN=  1.000 DN=  0.0  EN=  1.000 AT=  0.0  BT=  0.0  CT=  0.0
OUTL= 10.0000 CU=  1.0000 PERB=  25.7030


OUTLET SUMMARY


N= 1 P= 1.000 AN=  0.0  BN=  0.0  CN= -1.000 DN=  0.0  EN=  1.000 AT=  0.0  BT=  0.0  CT=  0.0
```

FIGURE 5.3 : SAMPLE1 OUTPUT

FIGURE 5.4

KPCINT DISTRIBUTION

```
    1 2 3 4 5 6 7 8 91011
21 -1-1-1-1-1-1-1-1-1-1-1
20 -1 6 3 3 3 3 3 3 3 8-1
19 -1 2 1 1 1 1 1 1 1 4-1
18 -1 2 1 1 1 1 1 1 1 4-1
17 -1 2 1 1 1 1 1 1 1 4-1
16 -1 7 5 5 1 1 1 1 1 4-1
15  0 0 0-1 7 1 1 1 1 4-1
14  0 0 0 0-1 2 1 1 1 4-1
13  0 0 0 0 0 0 2 1 1 1 4-1
12  0 0 0 0 0 0 7 1 1 1 4-1
11  0 0 0 0 0 0-1 2 1 1 4-1
10  0 0 0 0 0 0 6 1 1 1 4-1
 9  0 0 0 0 0 0 2 1 1 1 4-1
 8  0 0 0 0-1 2 1 1 1 4-1
 7  0 0 0-1 6 1 1 1 1 4-1
 6 -1 6 3 3 1 1 1 1 1 4-1
 5 -1 2 1 1 1 1 1 1 1 4-1
 4 -1 2 1 1 1 1 1 1 1 4-1
 3 -1 2 1 1 1 1 1 1 1 4-1
 2 -1 7 5 5 5 5 5 5 5 9-1
 1 -1-1-1-1-1-1-1-1-1-1-1
```

EPSMAX= 0.5130D-03 ITSMAX= 7017

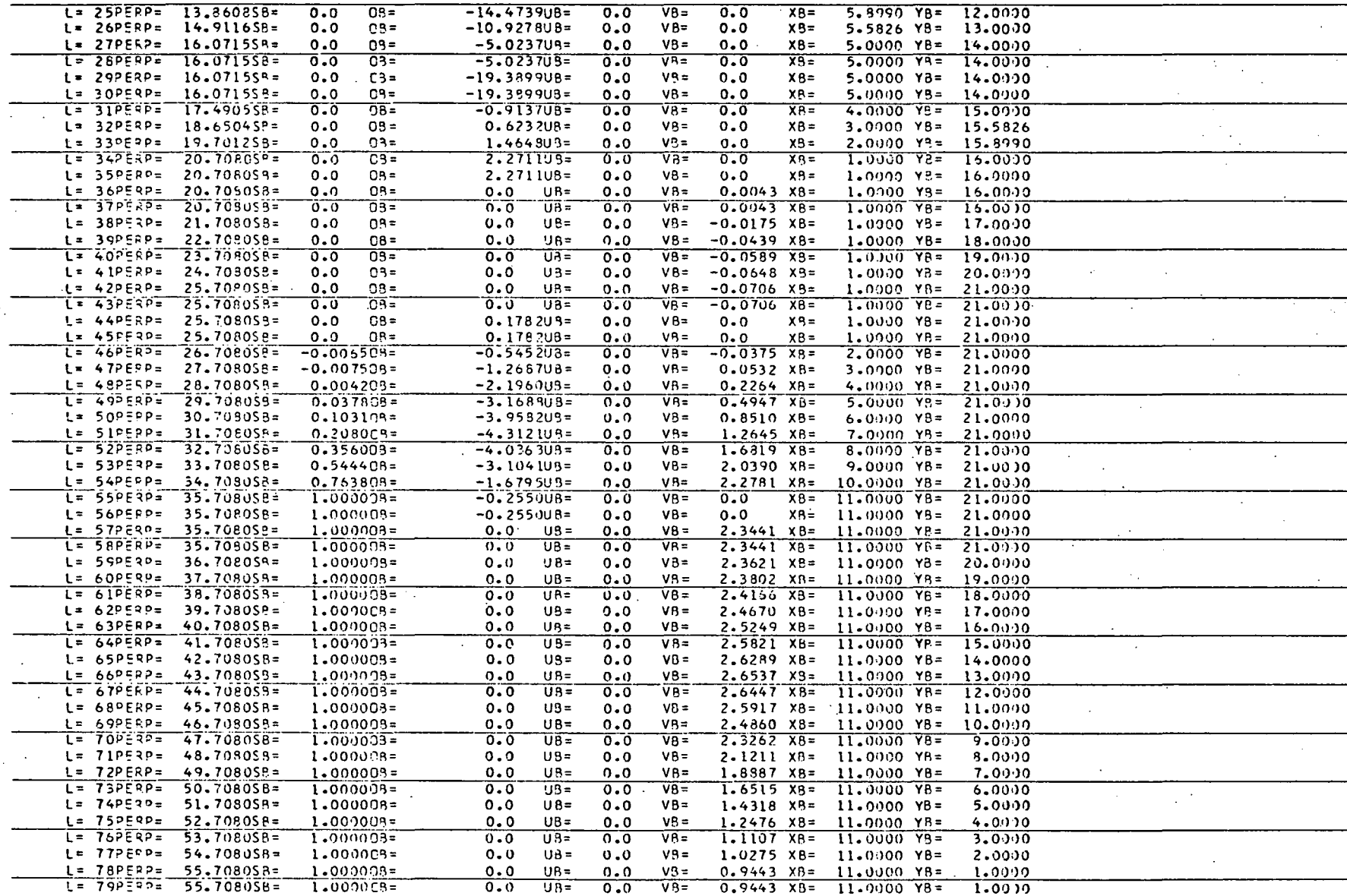
OPTIMUM OVERRELAXATION FACTOR IS APPROXIMATELY=1.5156

MAXIMUM SOR ITERATIONS= 22

SOR RELAXATION FACTOR USED=1.5156

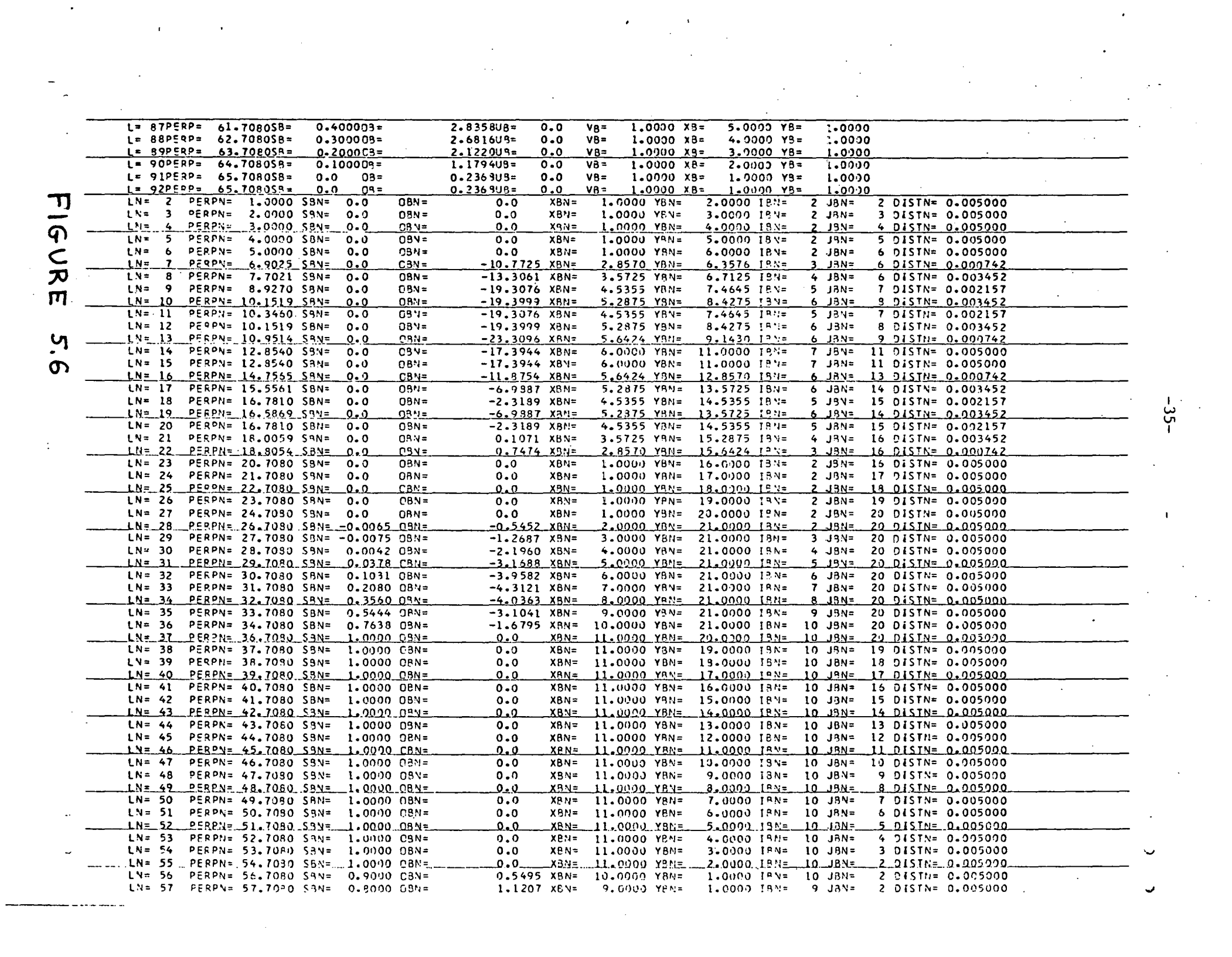
DTIME= 0.0049 REYNLD=0.1000000000D 01 VISCOS= 1.0000000 TIME= 0.0

```
L= 2PERP=   0.0    SB=   0.0  OB=      0.0  UB=   0.0  VB=   1.0989 XB=  1.0000 YB=  1.0000
L= 3PERP=   0.0    SB=   0.0  OB=      0.0  UB=   0.0  VB=   1.0989 XB=  1.0000 YB=  1.0000
L= 4PERP=  1.0000SB=   0.0  OB=      0.0  UB=   0.0  VB=   0.9410 XB=  1.0000 YB=  2.0000
L= 5PERP=  2.0000SB=   0.0  OB=      0.0  UB=   0.0  VB=   0.7832 XB=  1.0000 YB=  3.0000
L= 6PERP=  3.0000SB=   0.0  OB=      0.0  UB=   0.0  VB=   0.5367 XB=  1.0000 YB=  4.0000
L= 7PERP=  4.0000SB=   0.0  OB=      0.0  UB=   0.0  VB=   0.2290 XB=  1.0000 YB=  5.0000
L= 8PERP=  5.0000SB=   0.0  OB=      0.0  UB=   0.0  VB=  -0.0093 XB=  1.0000 YB=  6.0000
L= 9PERP=  5.0000SB=   0.0  OB=      0.0  UB=   0.0  VB=  -0.0093 XB=  1.0000 YB=  6.0000
L=10PERP=  5.0000SB=   0.0  OB=     -4.7438UB=   0.0  VB=   0.0    XB=  1.0000 YB=  6.0000
L=11PERP=  5.0000SB=   0.0  OB=     -4.7438UB=   0.0  VB=   0.0    XB=  1.0000 YB=  6.0000
L=12PERP=  6.0068SB=   0.0  OB=     -7.9341UB=   0.0  VB=   0.0    XB=  2.0000 YB=  6.1010
L=13PERP=  7.0576SB=   0.0  OB=    -11.2638UB=   0.0  VB=   0.0    XB=  3.0000 YB=  6.4174
L=14PERP=  8.2175SB=   0.0  OB=    -15.8314UB=   0.0  VB=   0.0    XB=  4.0000 YB=  7.0000
L=15PERP=  9.6365SB=   0.0  OB=    -19.3611UB=   0.0  VB=   0.0    XB=  5.0000 YB=  8.0000
L=16PERP=  9.6365SB=   0.0  OB=    -19.3611UB=   0.0  VB=   0.0    XB=  5.0000 YB=  8.0000
L=17PERP=  9.6365SB=   0.0  OB=    -19.6448UB=   0.0  VB=   0.0    XB=  5.0000 YB=  8.0000
L=18PERP=  9.6365SB=   0.0  OB=    -19.6448UB=   0.0  VB=   0.0    XB=  5.0000 YB=  8.0000
L=19PERP= 10.7964SB=   0.0  OB=    -22.5515UB=   0.0  VB=   0.0    XB=  5.5826 YB=  9.0000
L=20PERP= 11.8472SB=   0.0  OB=    -20.5247UB=   0.0  VB=   0.0    XB=  5.8990 YB= 10.0000
L=21PERP= 12.8540SB=   0.0  OB=    -17.3944UB=   0.0  VB=   0.0    XB=  6.0000 YB= 11.0000
L=22PERP= 12.8540SB=   0.0  OB=    -17.3944UB=   0.0  VB=   0.0    XB=  6.0000 YB= 11.0000
L=23PERP= 12.8540SB=   0.0  OB=    -17.3944UB=   0.0  VB=   0.0    XB=  6.0000 YB= 11.0000
L=24PERP= 12.8540SB=   0.0  OB=    -17.3944UB=   0.0  VB=   0.0    XB=  6.0000 YB= 11.0000
```



L= 25PERP=	13.8608SB=	0.0	0B=	-14.4739UB=	0.0	VB=	0.0	XB=	5.8990	YB=	12.0000
L= 26PERP=	14.9116SB=	0.0	0B=	-10.9278UB=	0.0	VB=	0.0	XB=	5.5826	YB=	13.0000
L= 27PERP=	16.0715SB=	0.0	0B=	-5.0237UB=	0.0	VB=	0.0	XB=	5.0000	YB=	14.0000
L= 28PERP=	16.0715SB=	0.0	0B=	-5.0237UB=	0.0	VB=	0.0	XB=	5.0000	YB=	14.0000
L= 29PERP=	16.0715SB=	0.0	0B=	-19.3899UB=	0.0	VB=	0.0	XB=	5.0000	YB=	14.0000
L= 30PERP=	16.0715SB=	0.0	0B=	-19.3899UB=	0.0	VB=	0.0	XB=	5.0000	YB=	14.0000
L= 31PERP=	17.4905SB=	0.0	0B=	-0.9137UB=	0.0	VB=	0.0	XB=	4.0000	YB=	15.0000
L= 32PERP=	18.6504SB=	0.0	0B=	0.6232UB=	0.0	VB=	0.0	XB=	3.0000	YB=	15.5826
L= 33PERP=	19.7012SB=	0.0	0B=	1.4648UB=	0.0	VB=	0.0	XB=	2.0000	YB=	15.8990
L= 34PERP=	20.7080SB=	0.0	0B=	2.2711UB=	0.0	VB=	0.0	XB=	1.0000	YB=	16.0000
L= 35PERP=	20.7080SB=	0.0	0B=	2.2711UB=	0.0	VB=	0.0	XB=	1.0000	YB=	16.0000
L= 36PERP=	20.7080SB=	0.0	0B=	0.0 UB=	0.0	VB=	0.0043	XB=	1.0000	YB=	16.0000
L= 37PERP=	20.7080SB=	0.0	0B=	0.0 UB=	0.0	VB=	0.0043	XB=	1.0000	YB=	16.0000
L= 38PERP=	21.7080SB=	0.0	0B=	0.0 UB=	0.0	VB=	-0.0175	XB=	1.0000	YB=	17.0000
L= 39PERP=	22.7080SB=	0.0	0B=	0.0 UB=	0.0	VB=	-0.0439	XB=	1.0000	YB=	18.0000
L= 40PERP=	23.7080SB=	0.0	0B=	0.0 UB=	0.0	VB=	-0.0589	XB=	1.0000	YB=	19.0000
L= 41PERP=	24.7080SB=	0.0	0B=	0.0 UB=	0.0	VB=	-0.0648	XB=	1.0000	YB=	20.0000
L= 42PERP=	25.7080SB=	0.0	0B=	0.0 UB=	0.0	VB=	-0.0706	XB=	1.0000	YB=	21.0000
L= 43PERP=	25.7080SB=	0.0	0B=	0.0 UB=	0.0	VB=	-0.0706	XB=	1.0000	YB=	21.0000
L= 44PERP=	25.7080SB=	0.0	0B=	0.1782UB=	0.0	VB=	0.0	XB=	1.0000	YB=	21.0000
L= 45PERP=	25.7080SB=	0.0	0B=	0.1782UB=	0.0	VB=	0.0	XB=	1.0000	YB=	21.0000
L= 46PERP=	26.7080SB=	-0.0065SB=		-0.5452UB=	0.0	VB=	-0.0375	XB=	2.0000	YB=	21.0000
L= 47PERP=	27.7080SB=	-0.0075SB=		-1.2667UB=	0.0	VB=	0.0532	XB=	3.0000	YB=	21.0000
L= 48PERP=	28.7080SB=	0.0042SB=		-2.1960UB=	0.0	VB=	0.2264	XB=	4.0000	YB=	21.0000
L= 49PERP=	29.7080SB=	0.0378SB=		-3.1689UB=	0.0	VB=	0.4947	XB=	5.0000	YB=	21.0000
L= 50PERP=	30.7080SB=	0.1031SB=		-3.9582UB=	0.0	VB=	0.8510	XB=	6.0000	YB=	21.0000
L= 51PERP=	31.7080SB=	0.2080SB=		-4.3121UB=	0.0	VB=	1.2645	XB=	7.0000	YB=	21.0000
L= 52PERP=	32.7080SB=	0.3560SB=		-4.0363UB=	0.0	VB=	1.6819	XB=	8.0000	YB=	21.0000
L= 53PERP=	33.7080SB=	0.5444SB=		-3.1041UB=	0.0	VB=	2.0390	XB=	9.0000	YB=	21.0000
L= 54PERP=	34.7080SB=	0.7638SB=		-1.6795UB=	0.0	VB=	2.2781	XB=	10.0000	YB=	21.0000
L= 55PERP=	35.7080SB=	1.0000SB=		-0.2550UB=	0.0	VB=	0.0	XB=	11.0000	YB=	21.0000
L= 56PERP=	35.7080SB=	1.0000SB=		-0.2550UB=	0.0	VB=	0.0	XB=	11.0000	YB=	21.0000
L= 57PERP=	35.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.3441	XB=	11.0000	YB=	21.0000
L= 58PERP=	35.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.3441	XB=	11.0000	YB=	21.0000
L= 59PERP=	36.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.3621	XB=	11.0000	YB=	20.0000
L= 60PERP=	37.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.3802	XB=	11.0000	YB=	19.0000
L= 61PERP=	38.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.4156	XB=	11.0000	YB=	18.0000
L= 62PERP=	39.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.4670	XB=	11.0000	YB=	17.0000
L= 63PERP=	40.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.5249	XB=	11.0000	YB=	16.0000
L= 64PERP=	41.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.5821	XB=	11.0000	YB=	15.0000
L= 65PERP=	42.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.6289	XB=	11.0000	YB=	14.0000
L= 66PERP=	43.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.6537	XB=	11.0000	YB=	13.0000
L= 67PERP=	44.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.6447	XB=	11.0000	YB=	12.0000
L= 68PERP=	45.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.5917	XB=	11.0000	YB=	11.0000
L= 69PERP=	46.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.4860	XB=	11.0000	YB=	10.0000
L= 70PERP=	47.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.3262	XB=	11.0000	YB=	9.0000
L= 71PERP=	48.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	2.1211	XB=	11.0000	YB=	8.0000
L= 72PERP=	49.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	1.8887	XB=	11.0000	YB=	7.0000
L= 73PERP=	50.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	1.6515	XB=	11.0000	YB=	6.0000
L= 74PERP=	51.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	1.4318	XB=	11.0000	YB=	5.0000
L= 75PERP=	52.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	1.2476	XB=	11.0000	YB=	4.0000
L= 76PERP=	53.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	1.1107	XB=	11.0000	YB=	3.0000
L= 77PERP=	54.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	1.0275	XB=	11.0000	YB=	2.0000
L= 78PERP=	55.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	0.9443	XB=	11.0000	YB=	1.0000
L= 79PERP=	55.7080SB=	1.0000SB=		0.0 UB=	0.0	VB=	0.9443	XB=	11.0000	YB=	1.0000
L= 80PERP=	55.7080SB=	1.0000SB=		-0.0218UB=	0.0	VB=	1.0000	XB=	11.0000	YB=	1.0000
L= 81PERP=	55.7080SB=	1.0000SB=		-0.0218UB=	0.0	VB=	1.0000	XB=	11.0000	YB=	1.0000
L= 82PERP=	56.7080SB=	0.9000SB=		0.5495UB=	0.0	VB=	1.0000	XB=	10.0000	YB=	1.0000
L= 83PERP=	57.7080SB=	0.8000SB=		1.1207UB=	0.0	VB=	1.0000	XB=	9.0000	YB=	1.0000
L= 84PERP=	58.7080SB=	0.7000SB=		1.6994UB=	0.0	VB=	1.0000	XB=	8.0000	YB=	1.0000
L= 85PERP=	59.7080SB=	0.6000SB=		2.2373UB=	0.0	VB=	1.0000	XB=	7.0000	YB=	1.0000
L= 86PERP=	60.7080SB=	0.5000SB=		2.6518UB=	0.0	VB=	1.0000	XB=	6.0000	YB=	1.0000

FIGURE 5.5



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L= 88PERP=  62.7080SB=   0.300008=    2.6816U8=   0.0   V8=  1.0000 X8=   4.0000 Y8=   1.0000
L= 89PERP=  63.7080SB=   0.200008=    2.1220U8=   0.0   V8=  1.0000 X8=   3.0000 Y8=   1.0000
L= 90PERP=  64.7080SB=   0.100009=    1.1794U8=   0.0   V8=  1.0000 X8=   2.0000 Y8=   1.0000
L= 91PERP=  65.7080SB=   0.0    08=    0.2369U8=   0.0   V8=  1.0000 X8=   1.0000 Y8=   1.0000
L= 92PERP=  65.7080SB=   0.0    08=    0.2369U8=   0.0   V8=  1.0000 X8=   1.0000 Y8=   1.0000
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LN=  3  PERPN=  2.0000 SBN=  0.0  OBN=      0.0  XBN=  1.0000 YBN=   3.0000 IBN=  2 JBN=  4 DISTN= 0.005000
LN=  4  PERPN=  3.0000 SBN=  0.0  OBN=      0.0  XBN=  1.0000 YBN=   4.0000 IBN=  2 JBN=  5 DISTN= 0.005000
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LN= 56  PERPN= 56.7080 SBN=  0.9000 OBN=     0.5495 XBN= 10.0000 YBN=   1.0000 IBN= 10 JBN=  2 DISTN= 0.005000
LN= 57  PERPN= 57.7080 SBN=  0.8000 OBN=     1.1207 XBN=  9.0000 YBN=   1.0000 IBN=  9 JBN=  2 DISTN= 0.005000
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FIGURE 5.6

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LN= 60  PERPN= 60.7080 SBN=  0.5000 OBN=    2.6518 XBN=  6.0000 YBN=  1.0000 IBN=  6 JBN=  2 DISTN= 0.005000
LN= 61  PERPN= 61.7080 SBN=  0.4000 OBN=    2.9358 XBN=  5.0000 YBN=  1.0000 IBN=  5 JBN=  2 DISTN= 0.005000
LN= 62  PERPN= 62.7080 SBN=  0.3000 OBN=    2.6816 XBN=  4.0000 YBN=  1.0000 IBN=  4 JBN=  2 DISTN= 0.005000
LN= 63  PERPN= 63.7080 SBN=  0.2000 OBN=    2.1220 XBN=  3.0000 YBN=  1.0000 IBN=  3 JBN=  2 DISTN= 0.005000
LN= 64  PERPN= 64.7080 SBN=  0.1000 OBN=    1.1794 XBN=  2.0000 YBN=  1.0000 IBN=  2 JBN=  2 DISTN= 0.005000

CALCULATION HAS BEEN COMPLETED WITH NUMBER OF VORTICITY STEPS= 2016  EPO=       0.511E-03
DTIME= 0.0049 REYNLD=0.1000000000 01 VISCOS=  1.0000000 TIME=    9.83
```

FIGURE 5.7

U-FIELD
***** FLOWOUT HAS BEEN WRITTEN *****

	1	2	3	4	5	6	7	8	9	10	11
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.003	0.002	-0.004	-0.012	-0.020	-0.024	-0.023	-0.017	-0.009	0.0
19	0.0	0.010	0.008	-0.010	-0.037	-0.062	-0.075	-0.070	-0.052	-0.027	0.0
18	0.0	0.021	0.017	-0.014	-0.063	-0.106	-0.126	-0.116	-0.085	-0.043	0.0
17	0.0	0.024	0.027	-0.012	-0.082	-0.145	-0.170	-0.153	-0.108	-0.054	0.0
16	0.0	-0.037	0.018	-0.003	-0.089	-0.174	-0.203	-0.175	-0.119	-0.058	0.0
15	0.0	0.0	0.0	0.0	-0.070	-0.188	-0.219	-0.178	-0.113	-0.052	0.0
14	0.0	0.0	0.0	0.0	0.0	-0.172	-0.206	-0.152	-0.085	-0.036	0.0
13	0.0	0.0	0.0	0.0	0.0	-0.115	-0.150	-0.088	-0.034	-0.009	0.0
12	0.0	0.0	0.0	0.0	0.0	-0.044	-0.046	0.013	0.041	0.031	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.096	0.148	0.136	0.079	0.0
10	0.0	0.0	0.0	0.0	0.0	0.086	0.279	0.306	0.243	0.133	0.0
9	0.0	0.0	0.0	0.0	0.0	0.331	0.495	0.465	0.346	0.182	0.0
8	0.0	0.0	0.0	0.0	0.0	0.612	0.680	0.589	0.422	0.219	0.0
7	0.0	0.0	0.0	0.0	0.597	0.800	0.784	0.651	0.457	0.235	0.0
6	0.0	-0.051	0.291	0.608	0.827	0.874	0.799	0.646	0.448	0.228	0.0
5	0.0	0.273	0.544	0.740	0.833	0.821	0.728	0.579	0.398	0.202	0.0
4	0.0	0.277	0.501	0.644	0.699	0.676	0.591	0.466	0.318	0.161	0.0

FIGURE 5.8

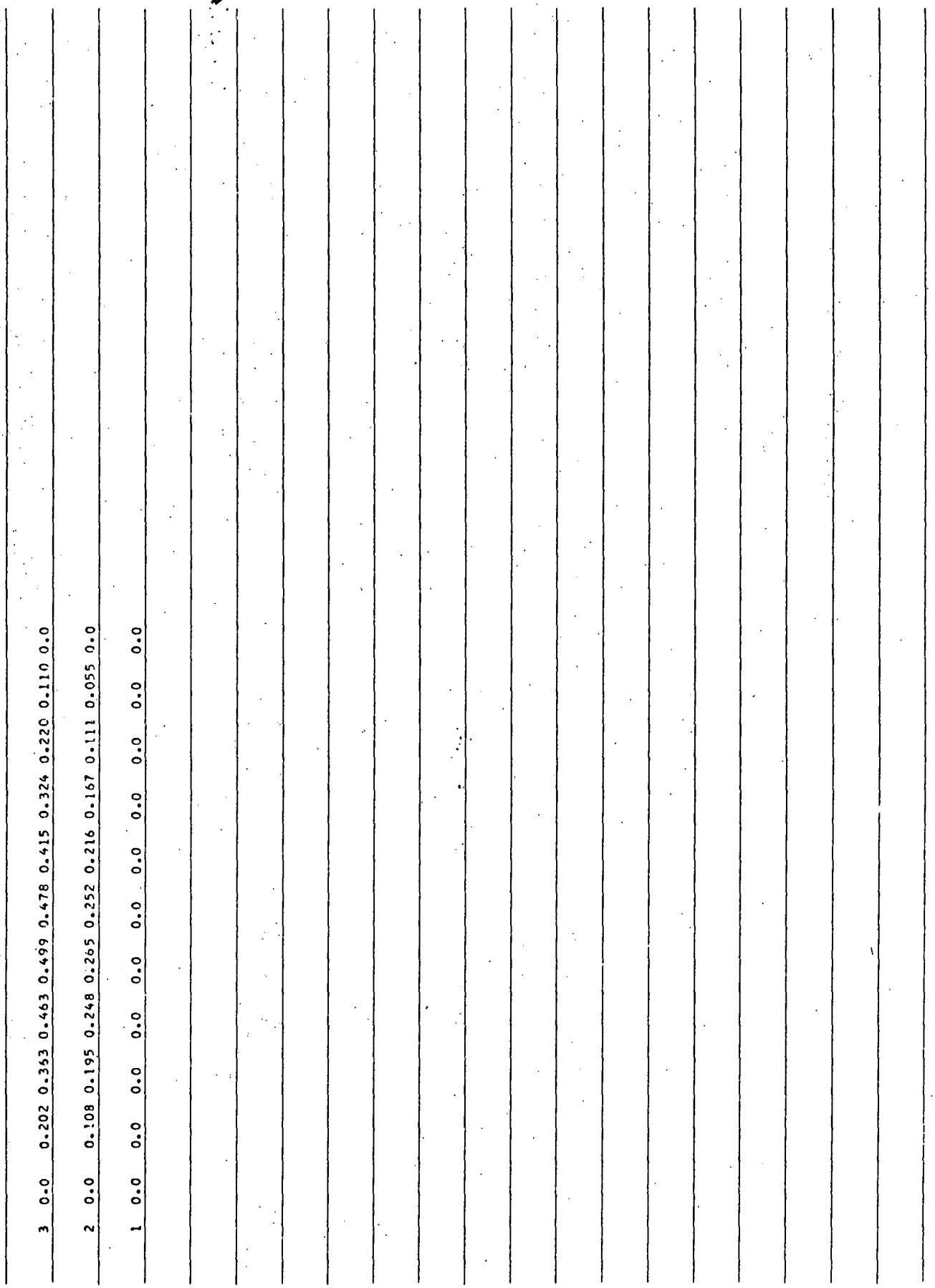
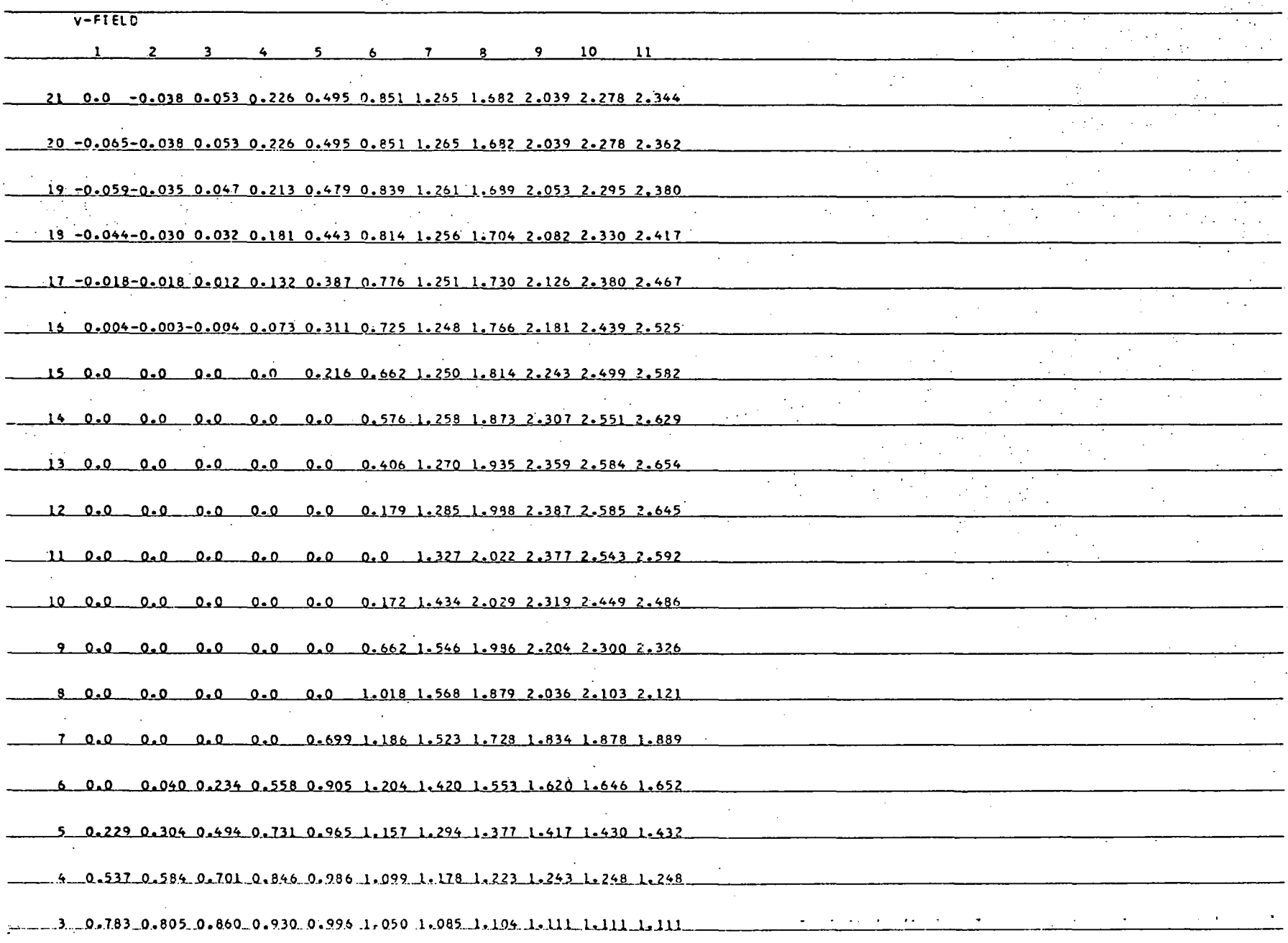

3 0.0 0.202 0.363 0.463 0.499 0.478 0.415 0.324 0.220 0.110 0.0
2 0.0 0.108 0.195 0.248 0.265 0.252 0.216 0.167 0.111 0.055 0.0
1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

FIGURE 5.9



V-FIELD	1	2	3	4	5	6	7	8	9	10	11
21	0.0	-0.038	0.053	0.226	0.495	0.851	1.265	1.682	2.039	2.278	2.344
20	-0.065	-0.038	0.053	0.226	0.495	0.851	1.265	1.682	2.039	2.278	2.362
19	-0.059	-0.035	0.047	0.213	0.479	0.839	1.261	1.689	2.053	2.295	2.380
18	-0.044	-0.030	0.032	0.181	0.443	0.814	1.256	1.704	2.082	2.330	2.417
17	-0.018	-0.018	0.012	0.132	0.387	0.776	1.251	1.730	2.126	2.380	2.467
16	0.004	-0.003	-0.004	0.073	0.311	0.725	1.248	1.766	2.181	2.439	2.525
15	0.0	0.0	0.0	0.0	0.216	0.662	1.250	1.814	2.243	2.499	2.582
14	0.0	0.0	0.0	0.0	0.0	0.576	1.258	1.873	2.307	2.551	2.629
13	0.0	0.0	0.0	0.0	0.0	0.406	1.270	1.935	2.359	2.584	2.654
12	0.0	0.0	0.0	0.0	0.0	0.179	1.285	1.998	2.387	2.585	2.645
11	0.0	0.0	0.0	0.0	0.0	0.0	1.327	2.022	2.377	2.543	2.592
10	0.0	0.0	0.0	0.0	0.0	0.172	1.434	2.029	2.319	2.449	2.486
9	0.0	0.0	0.0	0.0	0.0	0.662	1.546	1.986	2.204	2.300	2.326
8	0.0	0.0	0.0	0.0	0.0	1.018	1.568	1.879	2.036	2.103	2.121
7	0.0	0.0	0.0	0.0	0.699	1.186	1.523	1.728	1.834	1.878	1.889
6	0.0	0.040	0.234	0.558	0.905	1.204	1.420	1.553	1.620	1.646	1.652
5	0.229	0.304	0.494	0.731	0.965	1.157	1.294	1.377	1.417	1.430	1.432
4	0.537	0.584	0.701	0.846	0.986	1.099	1.178	1.223	1.243	1.248	1.248
3	0.783	0.805	0.860	0.930	0.996	1.050	1.085	1.104	1.111	1.111	1.111

FIGURE 5.10

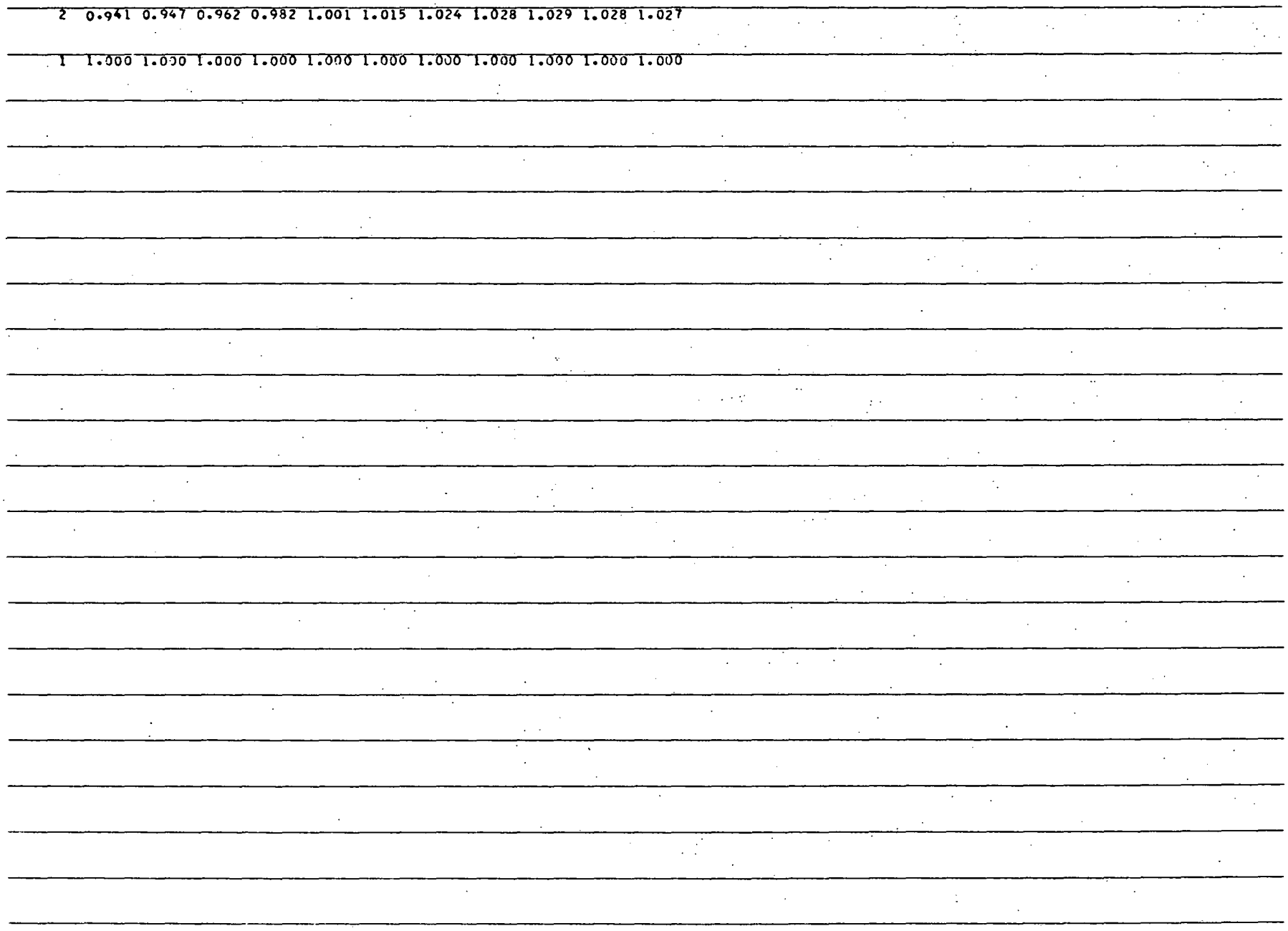
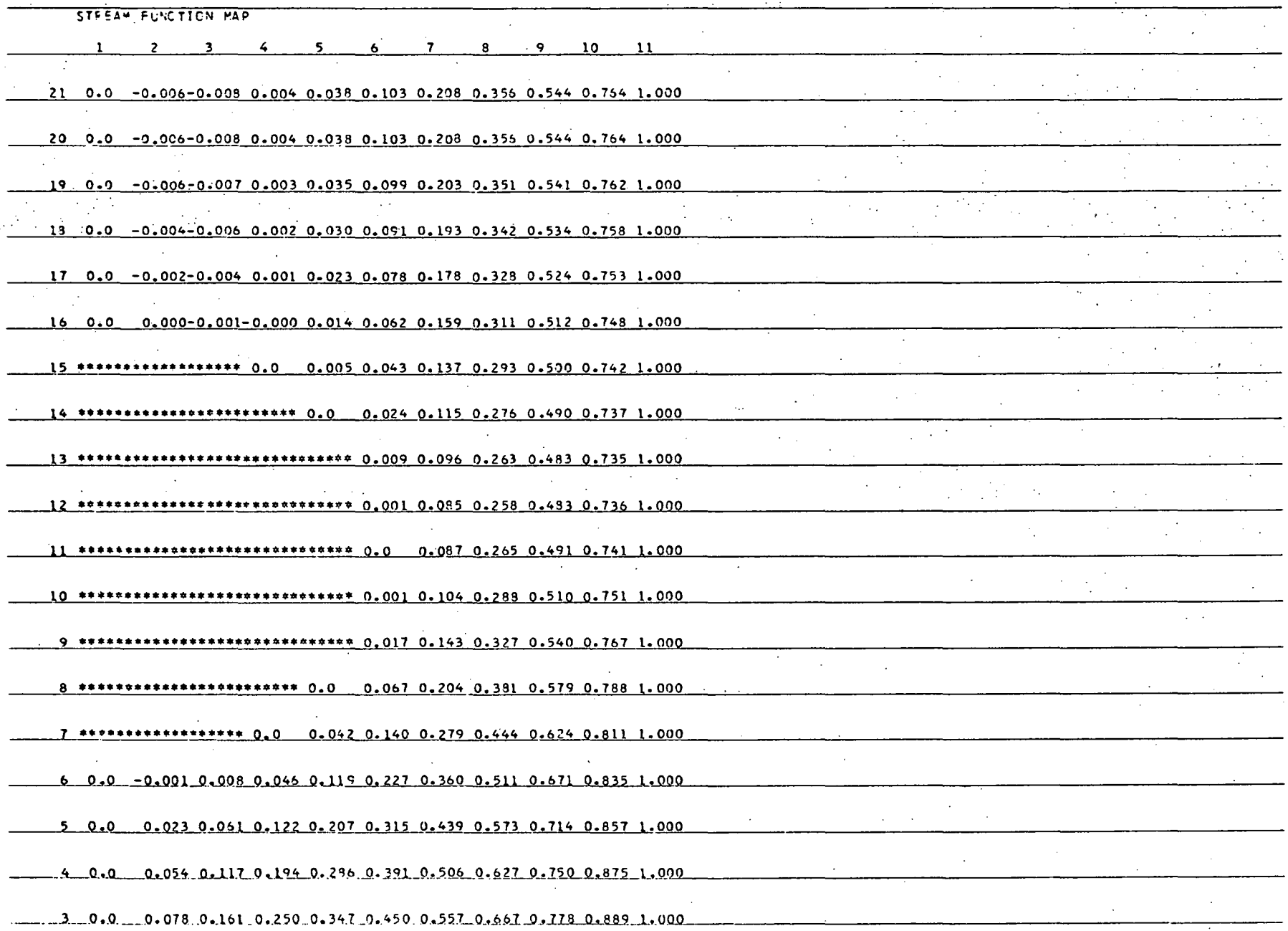

2 0.941 0.947 0.962 0.982 1.001 1.015 1.024 1.028 1.029 1.028 1.027
1 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000

FIGURE 5.11



STREAM FUNCTION MAP

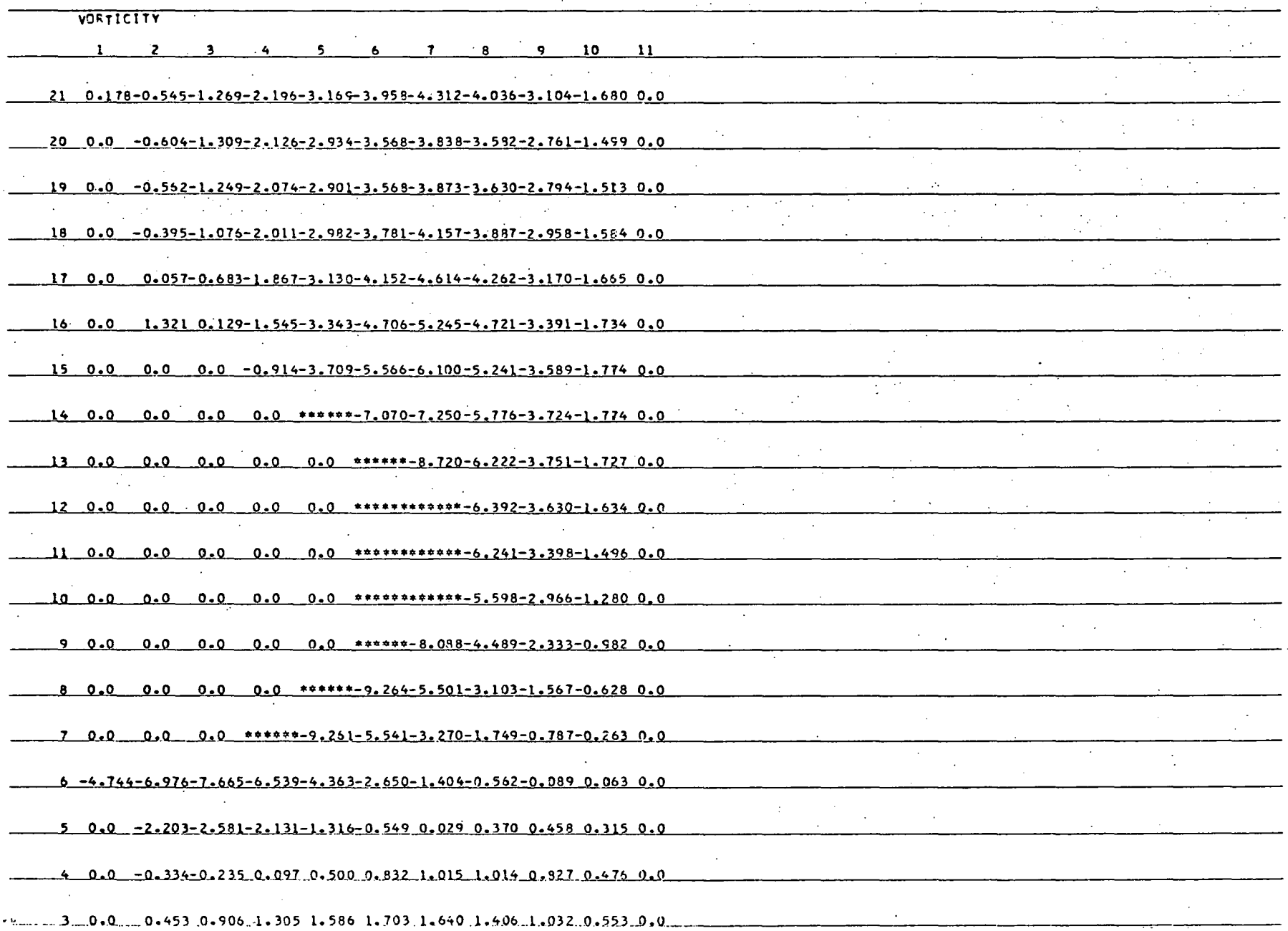
	1	2	3	4	5	6	7	8	9	10	11
21	0.0	-0.006	-0.008	0.004	0.038	0.103	0.208	0.356	0.544	0.764	1.000
20	0.0	-0.006	-0.008	0.004	0.038	0.103	0.208	0.355	0.544	0.764	1.000
19	0.0	-0.006	-0.007	0.003	0.035	0.099	0.203	0.351	0.541	0.762	1.000
18	0.0	-0.004	-0.006	0.002	0.030	0.091	0.193	0.342	0.534	0.758	1.000
17	0.0	-0.002	-0.004	0.001	0.023	0.078	0.178	0.328	0.524	0.753	1.000
16	0.0	0.000	-0.001	-0.000	0.014	0.062	0.159	0.311	0.512	0.748	1.000
15	**********	**********	0.0	0.005	0.043	0.137	0.293	0.500	0.742	1.000	
14	**********	**********	**********	0.0	0.024	0.115	0.276	0.490	0.737	1.000	
13	**********	**********	**********	**********	0.009	0.096	0.263	0.483	0.735	1.000	
12	**********	**********	**********	**********	0.001	0.085	0.258	0.483	0.736	1.000	
11	**********	**********	**********	**********	0.0	0.087	0.265	0.491	0.741	1.000	
10	**********	**********	**********	**********	0.001	0.104	0.288	0.510	0.751	1.000	
9	**********	**********	**********	**********	0.017	0.143	0.327	0.540	0.767	1.000	
8	**********	**********	**********	0.0	0.067	0.204	0.381	0.579	0.788	1.000	
7	**********	**********	0.0	0.042	0.140	0.279	0.444	0.624	0.811	1.000	
6	0.0	-0.001	0.008	0.046	0.119	0.227	0.360	0.511	0.671	0.835	1.000
5	0.0	0.023	0.061	0.122	0.207	0.315	0.439	0.573	0.714	0.857	1.000
4	0.0	0.054	0.117	0.194	0.296	0.391	0.506	0.627	0.750	0.875	1.000
3	0.0	0.078	0.161	0.250	0.347	0.450	0.557	0.667	0.778	0.889	1.000

FIGURE 5.12

```
2  0.0   0.094 0.189 0.287 0.386 0.487 0.589 0.692 0.794 0.897 1.000

1  0.0   0.100 0.200 0.300 0.400 0.500 0.600 0.700 0.800 0.900 1.000
```

FIGURE 5.13



VORTICITY

	1	2	3	4	5	6	7	8	9	10	11
21	0.178	-0.545	-1.269	-2.196	-3.169	-3.958	-4.312	-4.036	-3.104	-1.680	0.0
20	0.0	-0.604	-1.309	-2.126	-2.934	-3.568	-3.838	-3.592	-2.761	-1.499	0.0
19	0.0	-0.562	-1.249	-2.074	-2.901	-3.568	-3.873	-3.630	-2.794	-1.513	0.0
18	0.0	-0.395	-1.076	-2.011	-2.982	-3.781	-4.157	-3.887	-2.958	-1.584	0.0
17	0.0	0.057	-0.683	-1.867	-3.130	-4.152	-4.614	-4.262	-3.170	-1.665	0.0
16	0.0	1.321	0.129	-1.545	-3.343	-4.706	-5.245	-4.721	-3.391	-1.734	0.0
15	0.0	0.0	0.0	-0.914	-3.709	-5.566	-6.100	-5.241	-3.589	-1.774	0.0
14	0.0	0.0	0.0	0.0	******	-7.070	-7.250	-5.776	-3.724	-1.774	0.0
13	0.0	0.0	0.0	0.0	0.0	******	-8.720	-6.222	-3.751	-1.727	0.0
12	0.0	0.0	0.0	0.0	0.0	**********	-6.392	-3.630	-1.634	0.0	
11	0.0	0.0	0.0	0.0	0.0	**********	-6.241	-3.398	-1.496	0.0	
10	0.0	0.0	0.0	0.0	0.0	**********	-5.598	-2.966	-1.280	0.0	
9	0.0	0.0	0.0	0.0	0.0	******	-8.088	-4.489	-2.333	-0.982	0.0
8	0.0	0.0	0.0	0.0	******	-9.264	-5.501	-3.103	-1.567	-0.628	0.0
7	0.0	0.0	0.0	******	-9.261	-5.541	-3.270	-1.749	-0.787	-0.263	0.0
6	-4.744	-6.976	-7.665	-6.539	-4.363	-2.650	-1.404	-0.562	-0.089	0.063	0.0
5	0.0	-2.203	-2.581	-2.131	-1.316	-0.549	0.029	0.370	0.458	0.315	0.0
4	0.0	-0.334	-0.235	0.097	0.500	0.832	1.015	1.014	0.827	0.476	0.0
3	0.0	0.453	0.906	1.305	1.586	1.703	1.640	1.406	1.032	0.553	0.0

FIGURE 5.14

```
2  0.0    0.870 1.588 2.078 2.301 2.266 2.016 1.611 1.113 0.568 0.0

1  0.237 1.179 2.122 2.682 2.836 2.652 2.237 1.699 1.121 0.549-0.022
```

FIGURE 5.15

in Fig. 5.7 where the number of passes through the iterative sequence is given with the last value of EPO = $\Sigma\ |\Delta O|$. It is seen that the value of EPO is less than EPSMAX, indicating how the solution sequence was terminated.

The x and y direction dimensionless velocity component distributions, U and V, respectively, are shown in Figs. 5.8 to 5.11. Dimensional velocities are obtained by multiplying the values indicated by CHARU.

Figures 5.12 and 5.13 show the dimensionless stream function distribution, S. The map indicates equal flow channels. Since the values of S bounding the main flow are zero and one, any intermediate value indicates the fractional flow through a particular region. The constant .5 value indicates half the flow is to the right and half to the left of the .5 streamline. Dimensional values of stream function are obtained by multiplying the numbers shown by $\left(\frac{\text{CHARU*CHARL*YTUBES}}{\text{NGRID}}\right)$.

Figures 5.14 and 5.15 show the dimensionless vorticity distribution, O. The stars indicate that the vorticity is a larger negative number than allowed for in the FORMAT specification. Dimensional vorticity values are obtained by multiplying the numbers shown by $\left(\frac{\text{CHARU*NGRID}}{\text{CHARL*YTUBES}}\right)$.

Note that the U component of velocity and the stream function, S, at coordinates (2,6) is negative. This does not seem reasonable. It appears that it is caused by the multiple valued boundary point at the intersection of sides one and two. Upon inspecting the L arrays there are four L values assigned to that point, L = 8, 9, 10 and 11. This in itself is not bad, however; the first two have vorticity zero and the last two, OB = -4.7438.

The internal workings of the code are picking up the latter vorticity boundary condition where it seems more reasonable to expect the former value. This can be corrected by adjusting the grid size or geometry. For example, NGRID may be changed to a value of 21.

5.3 Disc Output

In addition to printed output, EVITS has the capability of writing and reading data to and from a disc or other compatible peripheral. By specifying FLOUT = 1., data are written on logical record unit 10. These data include detailed geometry and boundary value information as well as the final distributions of S, O, U and V. This information can then be used to initialize another solution of EVITS or, with the use of a plotting code, obtain a streamline plot of the S distribution. Note in Fig. 5.2 FLOUT = 1., is included in the input. Acknowledgement that the data have been written on unit 10 appears in Fig. 5.8, just below U-Field. At this point the data have been written on the disc.

5.4 Disc Input

If it is desired to use data from a previous run to initialize the arrays and the appropriate data are available on disc, specification FLIN = 1., is included in the NAMELIST input. This causes formatted data to be read from logical record unit nine and an alternative route taken through the code. If this option is specified, acknowledgement that the data have been read is given before the geometry summary.

6.0 DISCUSSION OF OPERATION

6.1 Specification of the Resistance Boundary Condition

As mentioned in Sect. 3.0, one of the possible boundary conditions is a line of resistance across the flow path. This is one of the experimental boundary conditions. The boundary condition models a screen or a bank of tubes, where the viscous effects can be lumped into, and characterized by, a pressure drop coefficient, PRESSK(M), and a coefficient of flow deflection, BDFL(M).[4] If N and T are the normal and tangential velocity components at the line of resistance, then the pressure drop, ΔP, and deflection are given by

$$\frac{\Delta P}{\rho} = \frac{1}{2}*\text{PRESSK(M)}*\text{CHARU}^2*\text{N}^2 \quad \text{and} \tag{6.1}$$

$$T_{downstream} = \text{BDFL(M)} + T_{upstream} \quad , \tag{6.2}$$

where ρ is the fluid density. Using these equations, flow variables into and out of the resistance are related.

To specify the line of resistance, two sides are necessary. These may be referred to as the resistance side and the matched side. Flow goes into the resistance through one side and leavesthe resistance from the other. Up to ten different resistance lines may be specified in a particular problem. Each may be characterized by different values of PRESSK(M) and BDFL(M).

The number of resistances in the problem is specified by NMATCH. This indicates the number of side pairs to be matched. By sequentially considering each side, the order of each pair to be matched can be determined. The first side of each match (e.g., side 15) is assigned the coded value 6 [KSIDE(15) = 6]. The second side of the pair to be matched (e.g., side 17)

is assigned the coded value 1 [KSIDE(17) = 1]. To specify that first side is to be matched to second side, MATCH(M) is used. This array specifies the side number of the M-th match. For example, if side 15 is to be matched to side 17 and is the third pair to be matched, MATCH(3) = 17, indicating the matched side of the third match is side numbered 17.

6.2 SAMPLE 2: Resistance

To clarify the use of the resistance boundary condition, an example may be considered. Consider the working diagram of Fig. 6.1. Flow enters a channel uniformly from the bottom and exits at the top. A screen is placed midway between the inlet and outlet. Note the sequence of numbered vertices and sides used to specify the problem. From this diagram, NAMELIST input was constructed and appears in Fig. 6.2.

There is one resistance, hence NMATCH = 1. The first side of the match is side two, hence KSIDE(2) = 6. The side to be matched is side 4, hence KSIDE(4) = 1 and MATCH(1) = 4. In addition, the extended printer output option has been specified, along with writing the final output on a disc. Note PRESSK(1) = 10 and BDFL(1) =1. These values correspond to a moderate pressure drop across the screen with no flow deflection. The solution sequence will stop at the 1000-th iteration if the solution has not yet converged (ITSMAX = 1000).

Figures 6.3 to 6.10 contain the output from EVITS. From Fig. 6.6 it is seen that the number of passes through the iterative sequence was 1000, indicating the ITSMAX cutoff terminated the solution. However, EPO was close to terminating the solution itself, as can be seen from the nominally calculated EPSMAX appearing in Fig. 6.4. Figures 6.8 and 6.9 indicate a flow

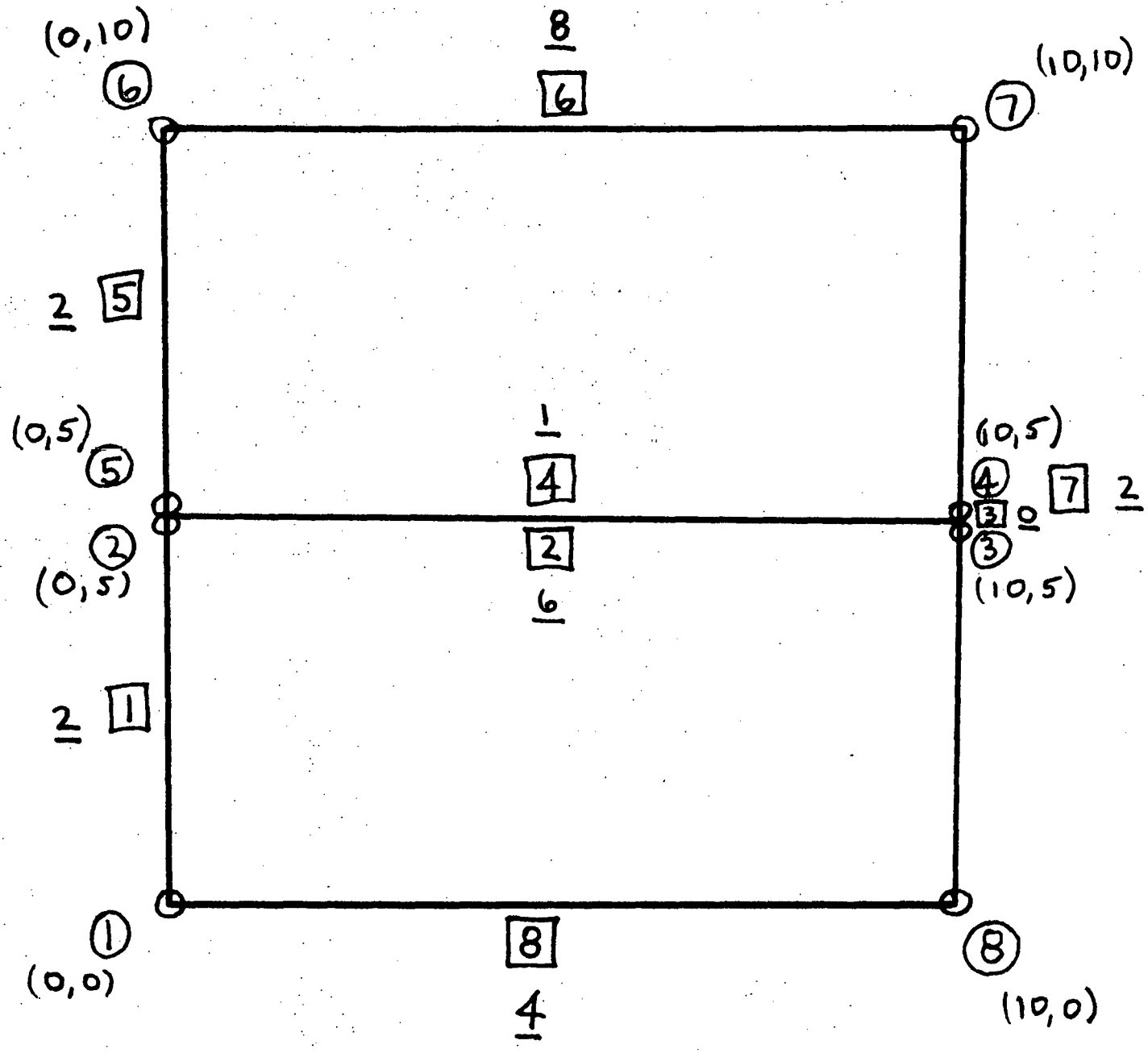
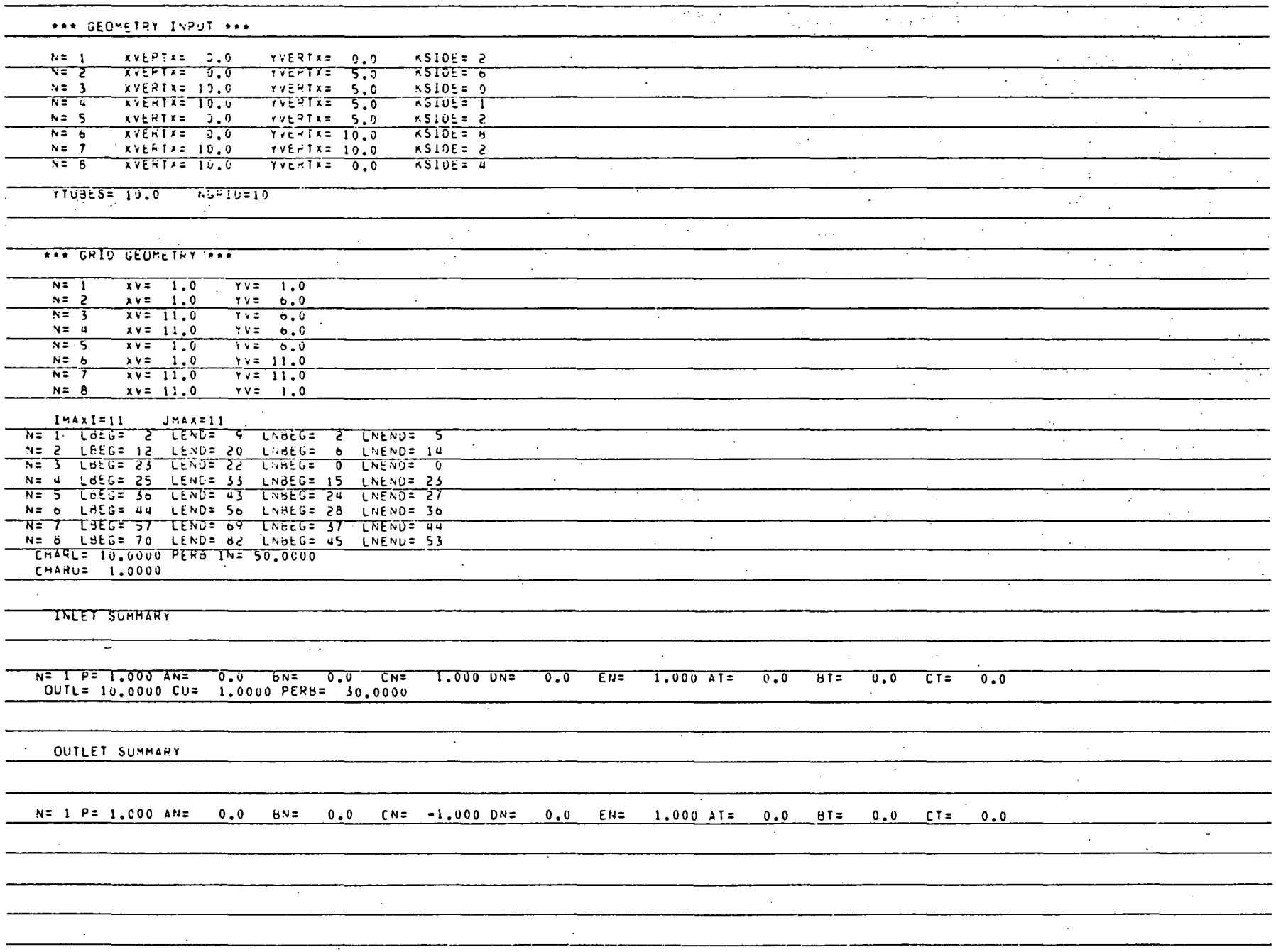


FIGURE 6.1 : SAMPLE2 GEOMETRY

SAMPLE2.DATA

```
&PLOT01
NVERTX=8,
XVERTX(1)=2*0.,2*10.,2*0.,2*10.,
YVERTX(1)=0.,4*5.,2*10.,0.,
KSIDE(1)=2,6,0,1,2,8,2,4,
YTUBES=10.,
NGRID=10,
PRESSR(1)=10.,60FL(1)=1.,
NMATCH=1,
MATCH(1)=4,
FL2=5.,
FLOUT=1.,
ITSMAX=1000,
&END
```

FIGURE 6.2: SAMPLE2 INPUT



```
*** GEOMETRY INPUT ***

N= 1    XVERTX=  0.0    YVERTX=  0.0    KSIDE= 2
N= 2    XVERTX=  0.0    YVERTX=  5.0    KSIDE= 6
N= 3    XVERTX= 10.0    YVERTX=  5.0    KSIDE= 0
N= 4    XVERTX= 10.0    YVERTX=  5.0    KSIDE= 1
N= 5    XVERTX=  0.0    YVERTX=  5.0    KSIDE= 2
N= 6    XVERTX=  0.0    YVERTX= 10.0    KSIDE= 8
N= 7    XVERTX= 10.0    YVERTX= 10.0    KSIDE= 2
N= 8    XVERTX= 10.0    YVERTX=  0.0    KSIDE= 4

YTUBES= 10.0    NGRID=10


*** GRID GEOMETRY ***

N= 1    XV=  1.0    YV=  1.0
N= 2    XV=  1.0    YV=  6.0
N= 3    XV= 11.0    YV=  6.0
N= 4    XV= 11.0    YV=  6.0
N= 5    XV=  1.0    YV=  6.0
N= 6    XV=  1.0    YV= 11.0
N= 7    XV= 11.0    YV= 11.0
N= 8    XV= 11.0    YV=  1.0

 IMAXI=11    JMAX=11
N= 1  LBEG=  2  LEND=  9  LNBEG=  2  LNEND=  5
N= 2  LBEG= 12  LEND= 20  LNBEG=  6  LNEND= 14
N= 3  LBEG= 23  LEND= 22  LNBEG=  0  LNEND=  0
N= 4  LBEG= 25  LEND= 33  LNBEG= 15  LNEND= 23
N= 5  LBEG= 36  LEND= 43  LNBEG= 24  LNEND= 27
N= 6  LBEG= 44  LEND= 56  LNBEG= 28  LNEND= 36
N= 7  LBEG= 57  LEND= 69  LNBEG= 37  LNEND= 44
N= 8  LBEG= 70  LEND= 82  LNBEG= 45  LNEND= 53
 CHARL= 10.0000 PERB IN= 50.0000
 CHARU=  1.0000


 INLET SUMMARY


N= 1 P= 1.000 AN=   0.0   BN=   0.0   CN=   1.000 DN=   0.0   EN=   1.000 AT=   0.0   BT=   0.0   CT=   0.0
  OUTL= 10.0000 CU=  1.0000 PERB=  30.0000


 OUTLET SUMMARY


N= 1 P= 1.000 AN=   0.0   BN=   0.0   CN=  -1.000 DN=   0.0   EN=   1.000 AT=   0.0   BT=   0.0   CT=   0.0
```

FIGURE 6.3 : SAMPLE2 OUTPUT

KPOINT DISTRIBUTION

```
    1 2 3 4 5 6 7 8 91011
11 -1-1-1-1-1-1-1-1-1-1-1
10 -1 6 3 3 3 3 3 3 3 8-1
 9 -1 2 1 1 1 1 1 1 1 4-1
 8 -1 2 1 1 1 1 1 1 1 4-1
 7 -1 7 5 5 5 5 5 5 5 9-1
 6 -1-1-1-1-1-1-1-1-1-1-1
 5 -1 6 3 3 3 3 3 3 3 8-1
 4 -1 2 1 1 1 1 1 1 1 4-1
 3 -1 2 1 1 1 1 1 1 1 4-1
 2 -1 7 5 5 5 5 5 5 5 9-1
 1 -1-1-1-1-1-1-1-1-1-1-1
```

EPSMAX= 0.24300-03 ITSMAX= 1000

OPTIMUM OVERRELAXATION FACTOR IS APPROXIMATELY=1.3906

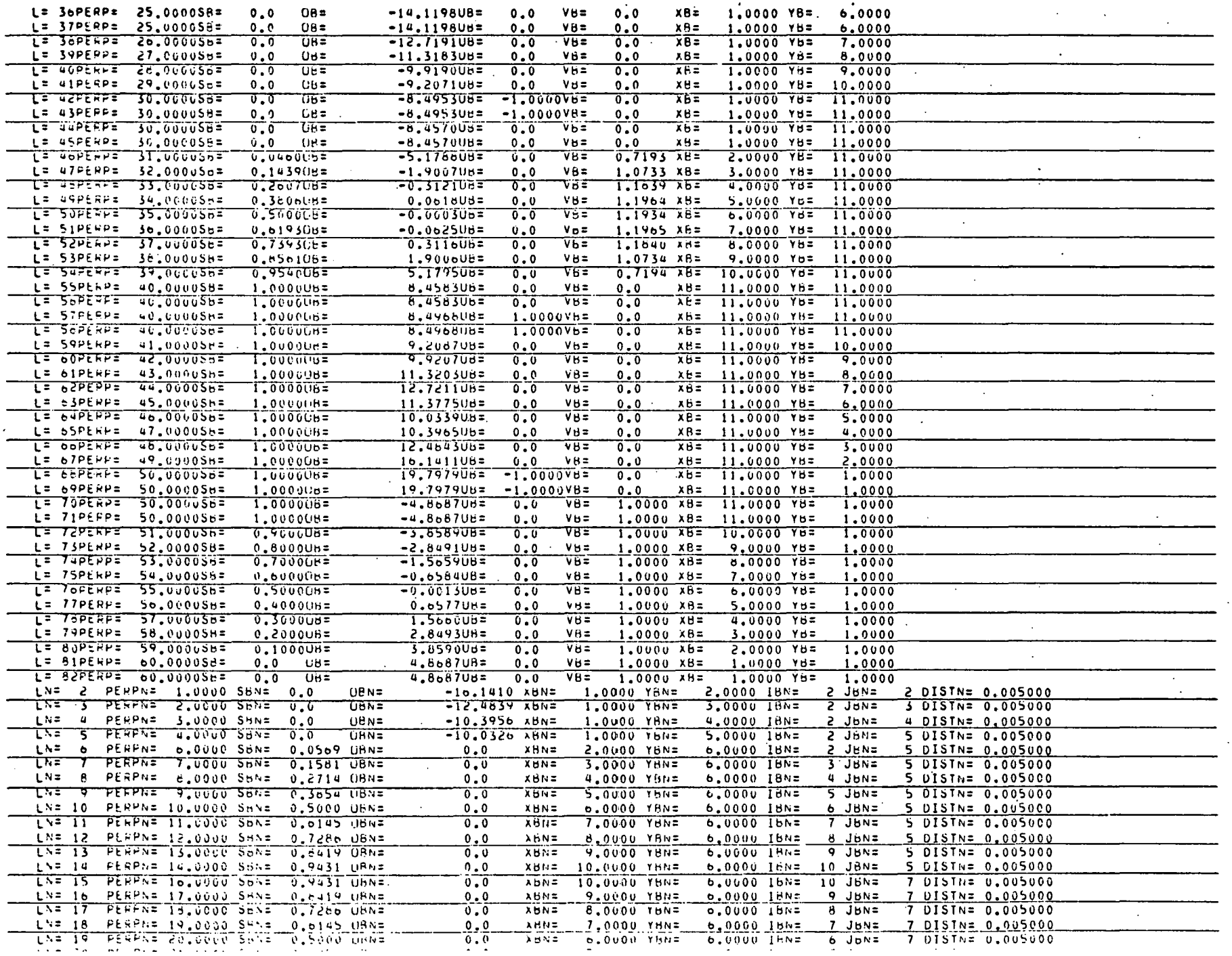
MAXIMUM SOR ITERATIONS= 15

SOR RELAXATION FACTOR USED=1.3906

DTIME= 0.0095 REYNLD=0.1000000000 01 VISCOS= 1.0000000 TIME= 0.0

L= 2	PERP=	0.0	SB=	0.0	UB=	-19.7981	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	1.0000
L= 3	PERP=	0.0	SB=	0.0	UB=	-19.7981	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	1.0000
L= 4	PERP=	1.0000	SB=	0.0	UB=	-16.1410	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	2.0000
L= 5	PERP=	2.0000	SB=	0.0	UB=	-12.4839	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	3.0000
L= 6	PERP=	3.0000	SB=	0.0	UB=	-10.3956	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	4.0000
L= 7	PERP=	4.0000	SB=	0.0	UB=	-10.0320	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	5.0000
L= 8	PERP=	5.0000	SB=	0.0	UB=	-9.6696	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	6.0000
L= 9	PERP=	5.0000	SB=	0.0	UB=	-9.6696	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	6.0000
L= 10	PERP=	5.0000	SB=	0.0	UB=	0.0	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	6.0000
L= 11	PERP=	5.0000	SB=	0.0	UB=	0.0	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	6.0000
L= 12	PERP=	6.0000	SB=	0.0569	UB=	-4.1860	UB=	-0.0672	VB=	1.0124	XB=	2.0000	YB=	6.0000
L= 13	PERP=	7.0000	SB=	0.1581	UB=	-2.7658	UB=	-0.0903	VB=	1.0725	XB=	3.0000	YB=	6.0000
L= 14	PERP=	8.0000	SB=	0.2714	UB=	-1.2067	UB=	-0.0668	VB=	1.1366	XB=	4.0000	YB=	6.0000
L= 15	PERP=	9.0000	SB=	0.3854	UB=	-0.4097	UB=	-0.0276	VB=	1.1429	XB=	5.0000	YB=	6.0000
L= 16	PERP=	10.0000	SB=	0.5000	UB=	-0.0129	UB=	-0.0000	VB=	1.1454	XB=	6.0000	YB=	6.0000
L= 17	PERP=	11.0000	SB=	0.6145	UB=	0.4078	UB=	0.0276	VB=	1.1431	XB=	7.0000	YB=	6.0000
L= 18	PERP=	12.0000	SB=	0.7286	UB=	1.2061	UB=	0.0668	VB=	1.1367	XB=	8.0000	YB=	6.0000
L= 19	PERP=	13.0000	SB=	0.8419	UB=	2.7657	UB=	0.0903	VB=	1.0727	XB=	9.0000	YB=	6.0000
L= 20	PERP=	14.0000	SB=	0.9431	UB=	4.1863	UB=	0.0672	VB=	1.0125	XB=	10.0000	YB=	6.0000
L= 21	PERP=	15.0000	SB=	0.0	UB=	0.0	UB=	0.0	VB=	0.0	XB=	11.0000	YB=	6.0000
L= 22	PERP=	15.0000	SB=	0.0	UB=	0.0	UB=	0.0	VB=	0.0	XB=	11.0000	YB=	6.0000
L= 23	PERP=	15.0000	SB=	0.0	UB=	0.0	UB=	0.0	VB=	0.0	XB=	11.0000	YB=	6.0000
L= 24	PERP=	15.0000	SB=	0.0	UB=	0.0	UB=	0.0	VB=	0.0	XB=	11.0000	YB=	6.0000
L= 25	PERP=	16.0000	SB=	0.9431	UB=	-1.8255	UB=	0.0672	VB=	1.0125	XB=	10.0000	YB=	6.0000
L= 26	PERP=	17.0000	SB=	0.8419	UB=	-3.4428	UB=	0.0903	VB=	1.0727	XB=	9.0000	YB=	6.0000
L= 27	PERP=	18.0000	SB=	0.7286	UB=	-2.3147	UB=	0.0668	VB=	1.1367	XB=	8.0000	YB=	6.0000
L= 28	PERP=	19.0000	SB=	0.6145	UB=	-0.9272	UB=	0.0276	VB=	1.1431	XB=	7.0000	YB=	6.0000
L= 29	PERP=	20.0000	SB=	0.5000	UB=	-0.0049	UB=	-0.0000	VB=	1.1454	XB=	6.0000	YB=	6.0000
L= 30	PERP=	21.0000	SB=	0.3854	UB=	0.0323	UB=	-0.0276	VB=	1.1429	XB=	5.0000	YB=	6.0000
L= 31	PERP=	22.0000	SB=	0.2714	UB=	2.3130	UB=	-0.0668	VB=	1.1366	XB=	4.0000	YB=	6.0000
L= 32	PERP=	23.0000	SB=	0.1581	UB=	5.4423	UB=	-0.0903	VB=	1.0725	XB=	3.0000	YB=	6.0000
L= 33	PERP=	24.0000	SB=	0.0569	UB=	1.8252	UB=	-0.0672	VB=	1.0124	XB=	2.0000	YB=	6.0000
L= 34	PERP=	25.0000	SB=	0.0	UB=	0.0	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	6.0000
L= 35	PERP=	25.0000	SB=	0.0	UB=	0.0	UB=	0.0	VB=	0.0	XB=	1.0000	YB=	6.0000

FIGURE 6.4



```
L= 36PERP= 25.0000SB= 0.0  DB= -14.1198UB= 0.0  VB= 0.0  XB= 1.0000 YB= 6.0000
L= 37PERP= 25.0000SB= 0.0  DB= -14.1198UB= 0.0  VB= 0.0  XB= 1.0000 YB= 6.0000
L= 38PERP= 26.0000SB= 0.0  DB= -12.7191UB= 0.0  VB= 0.0  XB= 1.0000 YB= 7.0000
L= 39PERP= 27.0000SB= 0.0  DB= -11.3183UB= 0.0  VB= 0.0  XB= 1.0000 YB= 8.0000
L= 40PERP= 28.0000SB= 0.0  DB= -9.9190UB= 0.0  VB= 0.0  XB= 1.0000 YB= 9.0000
L= 41PERP= 29.0000SB= 0.0  DB= -9.2071UB= 0.0  VB= 0.0  XB= 1.0000 YB= 10.0000
L= 42PERP= 30.0000SB= 0.0  DB= -8.4953UB= -1.0000VB= 0.0  XB= 1.0000 YB= 11.0000
L= 43PERP= 30.0000SB= 0.0  DB= -8.4953UB= -1.0000VB= 0.0  XB= 1.0000 YB= 11.0000
L= 44PERP= 30.0000SB= 0.0  DB= -8.4570UB= 0.0  VB= 0.0  XB= 1.0000 YB= 11.0000
L= 45PERP= 30.0000SB= 0.0  DB= -8.4570UB= 0.0  VB= 0.0  XB= 1.0000 YB= 11.0000
L= 46PERP= 31.0000SB= 0.0460DB= -5.1786UB= 0.0  VB= 0.7193 XB= 2.0000 YB= 11.0000
L= 47PERP= 32.0000SB= 0.1439DB= -1.9007UB= 0.0  VB= 1.0733 XB= 3.0000 YB= 11.0000
L= 48PERP= 33.0000SB= 0.2607DB= -0.3121UB= 0.0  VB= 1.1639 XB= 4.0000 YB= 11.0000
L= 49PERP= 34.0000SB= 0.3206DB= 0.0618UB= 0.0  VB= 1.1964 XB= 5.0000 YB= 11.0000
L= 50PERP= 35.0000SB= 0.5000DB= -0.0003UB= 0.0  VB= 1.1934 XB= 6.0000 YB= 11.0000
L= 51PERP= 36.0000SB= 0.6193DB= -0.0625UB= 0.0  VB= 1.1965 XB= 7.0000 YB= 11.0000
L= 52PERP= 37.0000SB= 0.7393DB= 0.3116UB= 0.0  VB= 1.1840 XB= 8.0000 YB= 11.0000
L= 53PERP= 38.0000SB= 0.8561DB= 1.9006UB= 0.0  VB= 1.0734 XB= 9.0000 YB= 11.0000
L= 54PERP= 39.0000SB= 0.9540DB= 5.1795UB= 0.0  VB= 0.7194 XB= 10.0000 YB= 11.0000
L= 55PERP= 40.0000SB= 1.0000DB= 8.4583UB= 0.0  VB= 0.0  XB= 11.0000 YB= 11.0000
L= 56PERP= 40.0000SB= 1.0000DB= 8.4583UB= 0.0  VB= 0.0  XB= 11.0000 YB= 11.0000
L= 57PERP= 40.0000SB= 1.0000DB= 8.4966UB= 1.0000VB= 0.0  XB= 11.0000 YB= 11.0000
L= 58PERP= 40.0000SB= 1.0000DB= 8.4966UB= 1.0000VB= 0.0  XB= 11.0000 YB= 11.0000
L= 59PERP= 41.0000SB= 1.0000DB= 9.2087UB= 0.0  VB= 0.0  XB= 11.0000 YB= 10.0000
L= 60PERP= 42.0000SB= 1.0000DB= 9.9207UB= 0.0  VB= 0.0  XB= 11.0000 YB= 9.0000
L= 61PERP= 43.0000SB= 1.0000DB= 11.3203UB= 0.0  VB= 0.0  XB= 11.0000 YB= 8.0000
L= 62PERP= 44.0000SB= 1.0000DB= 12.7211UB= 0.0  VB= 0.0  XB= 11.0000 YB= 7.0000
L= 63PERP= 45.0000SB= 1.0000DB= 11.3775UB= 0.0  VB= 0.0  XB= 11.0000 YB= 6.0000
L= 64PERP= 46.0000SB= 1.0000DB= 10.0339UB= 0.0  VB= 0.0  XB= 11.0000 YB= 5.0000
L= 65PERP= 47.0000SB= 1.0000DB= 10.3965UB= 0.0  VB= 0.0  XB= 11.0000 YB= 4.0000
L= 66PERP= 48.0000SB= 1.0000DB= 12.4643UB= 0.0  VB= 0.0  XB= 11.0000 YB= 3.0000
L= 67PERP= 49.0000SB= 1.0000DB= 16.1411UB= 0.0  VB= 0.0  XB= 11.0000 YB= 2.0000
L= 68PERP= 50.0000SB= 1.0000DB= 19.7979UB= -1.0000VB= 0.0  XB= 11.0000 YB= 1.0000
L= 69PERP= 50.0000SB= 1.0000DB= 19.7979UB= -1.0000VB= 0.0  XB= 11.0000 YB= 1.0000
L= 70PERP= 50.0000SB= 1.0000DB= -4.8687UB= 0.0  VB= 1.0000 XB= 11.0000 YB= 1.0000
L= 71PERP= 50.0000SB= 1.0000DB= -4.8687UB= 0.0  VB= 1.0000 XB= 11.0000 YB= 1.0000
L= 72PERP= 51.0000SB= 0.9000DB= -3.8589UB= 0.0  VB= 1.0000 XB= 10.0000 YB= 1.0000
L= 73PERP= 52.0000SB= 0.8000DB= -2.8491UB= 0.0  VB= 1.0000 XB= 9.0000 YB= 1.0000
L= 74PERP= 53.0000SB= 0.7000DB= -1.5659UB= 0.0  VB= 1.0000 XB= 8.0000 YB= 1.0000
L= 75PERP= 54.0000SB= 0.6000DB= -0.6584UB= 0.0  VB= 1.0000 XB= 7.0000 YB= 1.0000
L= 76PERP= 55.0000SB= 0.5000DB= -0.0013UB= 0.0  VB= 1.0000 XB= 6.0000 YB= 1.0000
L= 77PERP= 56.0000SB= 0.4000DB= 0.6577UB= 0.0  VB= 1.0000 XB= 5.0000 YB= 1.0000
L= 78PERP= 57.0000SB= 0.3000DB= 1.5660UB= 0.0  VB= 1.0000 XB= 4.0000 YB= 1.0000
L= 79PERP= 58.0000SB= 0.2000DB= 2.8493UB= 0.0  VB= 1.0000 XB= 3.0000 YB= 1.0000
L= 80PERP= 59.0000SB= 0.1000DB= 3.8590UB= 0.0  VB= 1.0000 XB= 2.0000 YB= 1.0000
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LN= 7 PERPN= 7.0000 SBN= 0.1581 DBN= 0.0 XBN= 3.0000 YBN= 6.0000 IBN= 3 JBN= 5 DISTN= 0.005000
LN= 8 PERPN= 8.0000 SBN= 0.2714 DBN= 0.0 XBN= 4.0000 YBN= 6.0000 IBN= 4 JBN= 5 DISTN= 0.005000
LN= 9 PERPN= 9.0000 SBN= 0.3854 DBN= 0.0 XBN= 5.0000 YBN= 6.0000 IBN= 5 JBN= 5 DISTN= 0.005000
LN= 10 PERPN= 10.0000 SBN= 0.5000 DBN= 0.0 XBN= 6.0000 YBN= 6.0000 IBN= 6 JBN= 5 DISTN= 0.005000
LN= 11 PERPN= 11.0000 SBN= 0.6145 DBN= 0.0 XBN= 7.0000 YBN= 6.0000 IBN= 7 JBN= 5 DISTN= 0.005000
LN= 12 PERPN= 12.0000 SBN= 0.7286 DBN= 0.0 XBN= 8.0000 YBN= 6.0000 IBN= 8 JBN= 5 DISTN= 0.005000
LN= 13 PERPN= 13.0000 SBN= 0.8419 DBN= 0.0 XBN= 9.0000 YBN= 6.0000 IBN= 9 JBN= 5 DISTN= 0.005000
LN= 14 PERPN= 14.0000 SBN= 0.9431 DBN= 0.0 XBN= 10.0000 YBN= 6.0000 IBN= 10 JBN= 5 DISTN= 0.005000
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LN= 16 PERPN= 17.0000 SBN= 0.8419 DBN= 0.0 XBN= 9.0000 YBN= 6.0000 IBN= 9 JBN= 7 DISTN= 0.005000
LN= 17 PERPN= 18.0000 SBN= 0.7286 DBN= 0.0 XBN= 8.0000 YBN= 6.0000 IBN= 8 JBN= 7 DISTN= 0.005000
LN= 18 PERPN= 19.0000 SBN= 0.6145 DBN= 0.0 XBN= 7.0000 YBN= 6.0000 IBN= 7 JBN= 7 DISTN= 0.005000
LN= 19 PERPN= 20.0000 SBN= 0.5000 DBN= 0.0 XBN= 6.0000 YBN= 6.0000 IBN= 6 JBN= 7 DISTN= 0.005000
```

FIGURE 6.5

```
LN= 21  PERPN= 22.0000 SBN= 0.2714 UBN=        0.0     XBN=  4.0000 YBN=  6.0000 IBN=  4 JBN=  7 DISTN= 0.005000
LN= 22  PERPN= 23.0000 SBN= 0.1581 UBN=        0.0     XBN=  3.0000 YBN=  6.0000 IBN=  3 JBN=  7 DISTN= 0.005000
LN= 23  PERPN= 24.0000 SBN= 0.0569 UBN=        0.0     XBN=  2.0000 YBN=  6.0000 IBN=  2 JBN=  7 DISTN= 0.005000
LN= 24  PERPN= 26.0000 SBN= 0.0    UBN=  -12.7191 XBN=  1.0000 YBN=  7.0000 IBN=  2 JBN=  7 DISTN= 0.005000
LN= 25  PERPN= 27.0000 SBN= 0.0    UBN=  -11.3183 XBN=  1.0000 YBN=  8.0000 IBN=  2 JBN=  8 DISTN= 0.005000
LN= 26  PERPN= 28.0000 SBN= 0.0    UBN=   -9.9190 XBN=  1.0000 YBN=  9.0000 IBN=  2 JBN=  9 DISTN= 0.005000
LN= 27  PERPN= 29.0000 SBN= 0.0    UBN=   -9.2071 XBN=  1.0000 YBN= 10.0000 IBN=  2 JBN= 10 DISTN= 0.005000
LN= 28  PERPN= 31.0000 SBN= 0.0460 UBN=   -5.1788 XBN=  2.0000 YBN= 11.0000 IBN=  2 JBN= 10 DISTN= 0.005000
LN= 29  PERPN= 32.0000 SBN= 0.1439 UBN=   -1.9007 XBN=  3.0000 YBN= 11.0000 IBN=  3 JBN= 10 DISTN= 0.005000
LN= 30  PERPN= 33.0000 SBN= 0.2607 UBN=   -0.3121 XBN=  4.0000 YBN= 11.0000 IBN=  4 JBN= 10 DISTN= 0.005000
LN= 31  PERPN= 34.0000 SBN= 0.3806 UBN=    0.0616 XBN=  5.0000 YBN= 11.0000 IBN=  5 JBN= 10 DISTN= 0.005000
LN= 32  PERPN= 35.0000 SBN= 0.5000 UBN=   -0.0003 XBN=  6.0000 YBN= 11.0000 IBN=  6 JBN= 10 DISTN= 0.005000
LN= 33  PERPN= 36.0000 SBN= 0.6193 UBN=   -0.0625 XBN=  7.0000 YBN= 11.0000 IBN=  7 JBN= 10 DISTN= 0.005000
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LN= 35  PERPN= 38.0000 SBN= 0.8561 UBN=    1.9006 XBN=  9.0000 YBN= 11.0000 IBN=  9 JBN= 10 DISTN= 0.005000
LN= 36  PERPN= 39.0000 SBN= 0.9540 UBN=    5.1795 XBN= 10.0000 YBN= 11.0000 IBN= 10 JBN= 10 DISTN= 0.005000
LN= 37  PERPN= 41.0000 SBN= 1.0000 UBN=    9.2087 XBN= 11.0000 YBN= 10.0000 IBN= 10 JBN= 10 DISTN= 0.005000
LN= 38  PERPN= 42.0000 SBN= 1.0000 UBN=    9.9207 XBN= 11.0000 YBN=  9.0000 IBN= 10 JBN=  9 DISTN= 0.005000
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LN= 44  PERPN= 49.0000 SBN= 1.0000 UBN=   16.1411 XBN= 11.0000 YBN=  2.0000 IBN= 10 JBN=  2 DISTN= 0.005000
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LN= 46  PERPN= 52.0000 SBN= 0.8000 UBN=   -2.8491 XBN=  9.0000 YBN=  1.0000 IBN=  9 JBN=  2 DISTN= 0.005000
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LN= 48  PERPN= 54.0000 SBN= 0.6000 UBN=   -0.6584 XBN=  7.0000 YBN=  1.0000 IBN=  7 JBN=  2 DISTN= 0.005000
LN= 49  PERPN= 55.0000 SBN= 0.5000 UBN=   -0.0013 XBN=  6.0000 YBN=  1.0000 IBN=  6 JBN=  2 DISTN= 0.005000
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LN= 52  PERPN= 58.0000 SBN= 0.2000 UBN=    2.8493 XBN=  3.0000 YBN=  1.0000 IBN=  3 JBN=  2 DISTN= 0.005000
LN= 53  PERPN= 59.0000 SBN= 0.1000 UBN=    3.8590 XBN=  2.0000 YBN=  1.0000 IBN=  2 JBN=  2 DISTN= 0.005000

CALCULATION HAS BEEN COMPLETED WITH NUMBER OF VORTICITY STEPS= 1000  EPO=       0.280D-03
DTIME= 0.0095 REYNLD=0.1000000000 01 VISCUS=  1.0000000 TIME=    9.52
```

FIGURE 6.6

U-FIELD
***** FLOWOUT HAS BEEN WRITTEN *****

	1	2	3	4	5	6	7	8	9	10	11
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000
10	0.0	0.018	0.028	0.023	0.011	-0.000	-0.011	-0.023	-0.028	-0.018	0.0
9	0.0	0.053	0.077	0.061	0.029	-0.000	-0.029	-0.061	-0.077	-0.053	0.0
8	0.0	0.070	0.089	0.064	0.026	-0.000	-0.026	-0.064	-0.089	-0.070	0.0
7	0.0	0.001	-0.006	-0.008	-0.005	-0.000	0.005	0.008	0.006	-0.001	0.0
6	0.0	-0.067	-0.090	-0.067	-0.026	-0.000	0.026	0.067	0.090	0.067	0.0
5	0.0	-0.025	-0.027	-0.017	-0.004	0.000	0.004	0.017	0.027	0.025	0.0
4	0.0	0.061	0.066	0.070	0.038	0.000	-0.038	-0.070	-0.066	-0.061	0.0
3	0.0	0.144	0.166	0.121	0.060	0.000	-0.060	-0.121	-0.166	-0.144	0.0
2	0.0	0.168	0.166	0.105	0.049	0.000	-0.049	-0.106	-0.168	-0.188	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

FIGURE 6.7

V-FIELD

	1	2	3	4	5	6	7	8	9	10	11
11	0.0	0.719	1.073	1.184	1.196	1.193	1.196	1.184	1.073	0.719	0.0
10	0.0	0.719	1.073	1.184	1.196	1.193	1.196	1.184	1.073	0.719	0.0
9	0.0	0.747	1.079	1.168	1.173	1.171	1.173	1.168	1.079	0.747	0.0
8	0.0	0.796	1.082	1.136	1.155	1.136	1.155	1.136	1.082	0.796	0.0
7	0.0	0.836	1.072	1.105	1.110	1.118	1.110	1.105	1.072	0.836	0.0
6	0.0	1.012	1.073	1.137	1.143	1.145	1.143	1.137	1.073	1.013	0.0
5	0.0	0.745	1.073	1.168	1.176	1.173	1.176	1.168	1.073	0.746	0.0
4	0.0	0.763	1.080	1.160	1.160	1.153	1.160	1.160	1.080	0.763	0.0
3	0.0	0.832	1.082	1.120	1.105	1.097	1.106	1.120	1.082	0.832	0.0
2	0.0	0.929	1.057	1.055	1.039	1.033	1.039	1.055	1.057	0.929	0.0
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

FIGURE 6.8

STREAM FUNCTION MAP

	1	2	3	4	5	6	7	8	9	10	11
11	0.0	0.046	0.144	0.261	0.381	0.500	0.619	0.739	0.856	0.954	1.000
10	0.0	0.046	0.144	0.261	0.381	0.500	0.619	0.739	0.856	0.954	1.000
9	0.0	0.050	0.149	0.265	0.383	0.500	0.617	0.735	0.851	0.950	1.000
8	0.0	0.057	0.159	0.273	0.386	0.500	0.614	0.727	0.841	0.943	1.000
7	0.0	0.064	0.167	0.278	0.388	0.500	0.612	0.722	0.833	0.936	1.000
6	0.0	0.057	0.158	0.271	0.385	0.500	0.615	0.729	0.842	0.943	1.000
5	0.0	0.050	0.149	0.265	0.383	0.500	0.617	0.735	0.851	0.950	1.000
4	0.0	0.052	0.153	0.268	0.385	0.500	0.615	0.732	0.847	0.948	1.000
3	0.0	0.062	0.166	0.279	0.390	0.500	0.610	0.721	0.834	0.938	1.000
2	0.0	0.081	0.186	0.292	0.397	0.500	0.603	0.708	0.814	0.919	1.000
1	0.0	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000

FIGURE 6.9

VORTICITY

	1	2	3	4	5	6	7	8	9	10	11
11	-8.457	-5.179	-1.901	-0.312	0.062	-0.000	-0.062	0.312	1.901	5.179	8.497
10	-9.207	-5.535	-2.457	-0.773	-0.166	0.000	0.166	0.773	2.457	5.535	9.209
9	-9.919	-5.367	-2.032	-0.472	-0.063	-0.000	0.062	0.472	2.032	5.367	9.921
8	*******	-4.606	-0.911	0.260	0.160	-0.002	-0.161	-0.261	0.911	4.607	11.320
7	*******	-2.624	0.959	1.262	0.291	-0.002	-0.290	-1.263	-0.960	2.624	12.721
6	******	1.825	3.442	2.313	0.032	-0.005	-0.027	-2.315	-3.443	-1.825	11.378
5	*******	-5.729	-2.927	-1.237	-0.410	-0.003	0.408	1.236	2.927	5.730	10.034
4	*******	-5.730	-2.488	-0.865	-0.219	-0.002	0.219	0.865	2.488	5.731	10.396
3	*******	-4.932	-1.432	-0.174	0.094	0.002	-0.093	0.174	1.432	4.932	12.484
2	*******	-2.535	0.383	0.745	0.439	0.002	-0.438	-0.745	-0.382	2.535	16.141
1	4.869	3.859	2.849	1.566	0.658	-0.001	-0.658	-1.566	-2.849	-3.859	-4.869

FIGURE 6.10

trying to develop a velocity profile due to viscosity effects from the walls as it proceeds downstream, and being impeded by the line of resistance. The vorticity distribution along either side of the resistance can be obtained from the L arrays in Fig. 6.4. Note that L values along side 2 (LBEG = 12, LEND = 20) are matched in reverse order to L values along side 4 (LBEG = 25, LEND = 33). That is, perimeter point 13 is matched to perimeter point 32.

6.3 SAMPLE 3: Internal Object

Another experimental boundary condition model was developed. This is the internal object boundary condition. The essential concept behind this boundary condition is to determine the stream function value on the surface of an internal object. During each pass through the iterative sequence, a new approximation is made of the stream function value, based upon the flow field surrounding the object.

Use of the internal object boundary condition may be illustrated through an example. Consider the working diagram of Fig. 6.11. Flow enters a channel uniformly from the bottom and exits uniformly through the top. A cylindrical internal object is placed midway between the inlet and outlet and left of the channel centerline. Note the sequence of numbered vertices and sides used to specify the problem. While the outermost boundary is specified by numbering the vertices clockwise, the internal object is specified by numbering the vertices counter-clockwise. Note the dual points at vertices one and five and vertices six and fourteen. These dual points along with dummy sides five and fourteen are used to indicate the gap from the outer figure to the internal object. From this diagram, NAMELIST input was constructed and appears in Fig. 6.12.

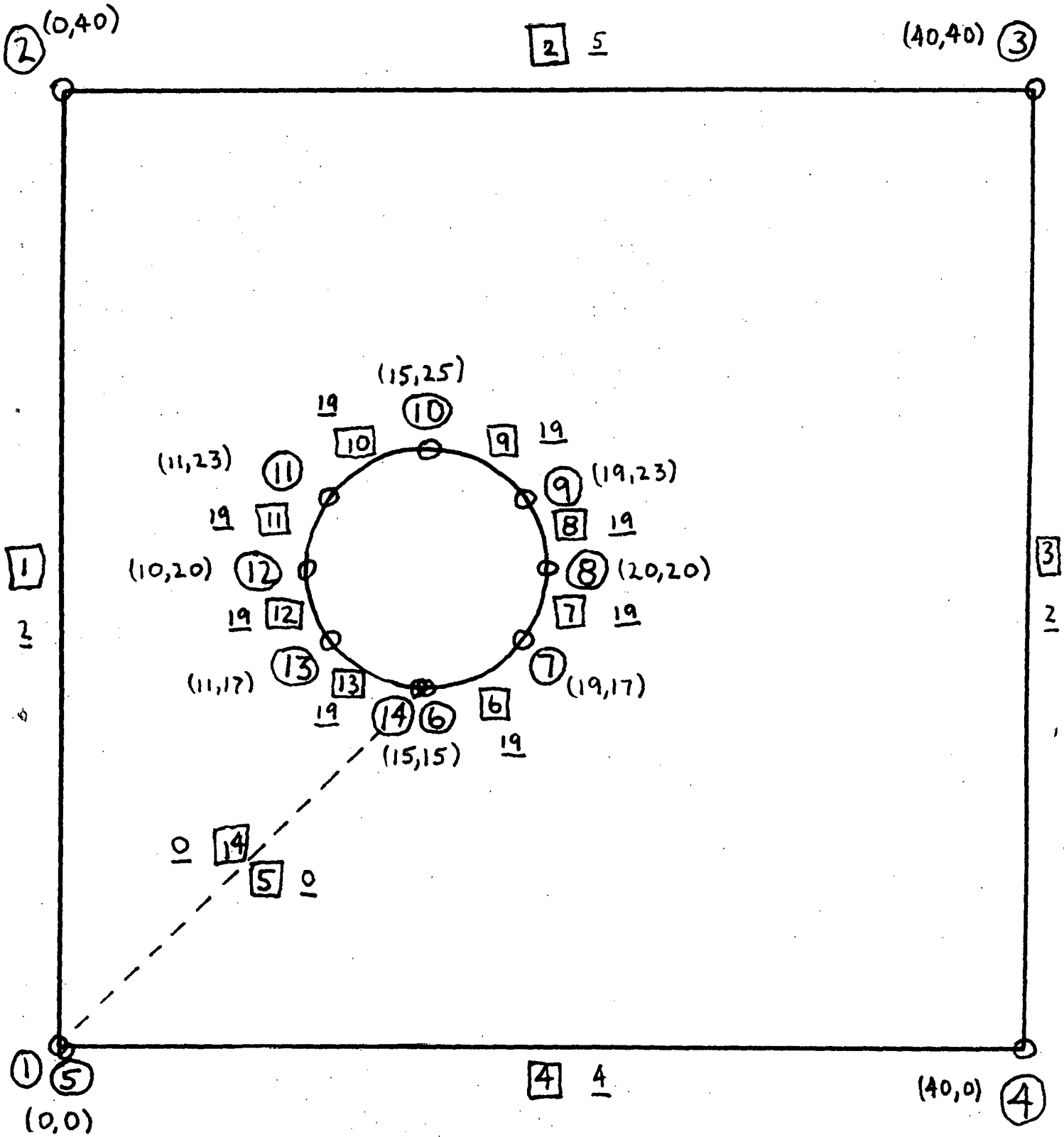

FIGURE 6.11: SAMPLE3 GEOMETRY

SAMPLE3.DATA

```
 &FLOW01
  NVERTX=14,
  XVERTX(1)=2*0,2*40,0,15,19,20,19,15,11,10,11,15,
  YVERTX(1)=0,2*40,2*0,15,17,20,23,25,23,20,17,15,
  KSIDE(1)=2,5,2,4,0,8*19,0,
  YTUBES=40,NGRID=10,
  CIN(1)=1,CON(1)=1,
  FL2=5.,FLOUT=1,
  &END
```

FIGURE 6.12: SAMPLE3 INPUT

Figures 6.13 to 6.21 contain the output from EVITS. Figure 6.15 indicates the nominally calculated values of EPSMAX and ITSMAX used to terminate the iterative solution sequence. Figure 6.17 indicates that the EPSMAX cutoff terminated the iterative solution sequence after 295 passes.

The internal object is specified by sides 6 to 13. The L and LN values covering these sides are shown in Fig. 6.13, where all L and LN points are collected and indicated as the first side of the internal object (side 6).

The stagnation point of the cylinder divides the channel into a ratio of .375 to .625. The amount of flow as computed by EVITS passing to the left and right of the cylinder is .3437 and .6563, respectively. These values are indicated in Fig. 6.16, where the stream function boundary values are tabulated from L = 54 to L = 79 on the internal object.

REFERENCES

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2. Roache, P. J., and Mueller, T. J., "Numerical Solutions of Laminar Separated Flows," AIAA Journal, Vol. 8, No. 3 (1970).

3. Roache, P. J., Computational Fluid Mechanics, Hermosa Publishers (1972).

4. Burton, R., Kistler, A., Groth, C., Rohde, R. R. and Domanus, H. M., "Flows in Heat Exchanger Plenums," ANL-CT-75-05 (Jan 1975).

```
*** GEOMETRY INPUT ***

N= 1    XVERTX=  0.0    YVERTX=  0.0    KSIDE= 2
N= 2    XVERTX=  0.0    YVERTX= 40.0    KSIDE= 5
N= 3    XVERTX= 40.0    YVERTX= 40.0    KSIDE= 2
N= 4    XVERTX= 40.0    YVERTX=  0.0    KSIDE= 0
N= 5    XVERTX=  0.0    YVERTX=  0.0    KSIDE= 0
N= 6    XVERTX= 15.0    YVERTX= 15.0    KSIDE=19
N= 7    XVERTX= 19.0    YVERTX= 17.0    KSIDE=19
N= 8    XVERTX= 20.0    YVERTX= 20.0    KSIDE=19
N= 9    XVERTX= 19.0    YVERTX= 23.0    KSIDE=19
N=10    XVERTX= 15.0    YVERTX= 25.0    KSIDE=19
N=11    XVERTX= 11.0    YVERTX= 23.0    KSIDE=19
N=12    XVERTX= 10.0    YVERTX= 20.0    KSIDE=19
N=13    XVERTX= 11.0    YVERTX= 17.0    KSIDE=19
N=14    XVERTX= 15.0    YVERTX= 15.0    KSIDE= 0

YTUBES= 40.0    NGRID=10


*** GRID GEOMETRY ***

N= 1    XV=  1.0    YV=  1.0
N= 2    XV=  1.0    YV= 11.0
N= 3    XV= 11.0    YV= 11.0
N= 4    XV= 11.0    YV=  1.0
N= 5    XV=  1.0    YV=  1.0
N= 6    XV=  4.8    YV=  4.8
N= 7    XV=  5.8    YV=  5.3
N= 8    XV=  6.0    YV=  6.0
N= 9    XV=  5.8    YV=  6.8
N=10    XV=  4.8    YV=  7.3
N=11    XV=  3.8    YV=  6.6
N=12    XV=  3.5    YV=  6.0
N=13    XV=  3.8    YV=  5.3
N=14    XV=  4.8    YV=  4.8

IMAXI=11    JMAX=11
N= 1  LBEG=  2  LEND= 14  LNBEG=  2  LNEND= 10
N= 2  LBEG= 15  LEND= 27  LNBEG= 11  LNEND= 19
N= 3  LBEG= 28  LEND= 40  LNBEG= 20  LNEND= 28
N= 4  LBEG= 41  LEND= 53  LNBEG= 29  LNEND= 37
N= 5  LBEG= 54  LEND= 53  LNBEG=  0  LNEND=  0
N= 6  LBEG= 54  LEND= 79  LNBEG= 38  LNEND= 51
N= 7  LBEG=  0  LEND= 60  LNBEG=  0  LNEND= 41
N= 8  LBEG=  0  LEND= 63  LNBEG=  0  LNEND= 43
N= 9  LBEG=  0  LEND= 67  LNBEG=  0  LNEND= 45
N=10  LBEG=  0  LEND= 70  LNBEG=  0  LNEND= 47
N=11  LBEG=  0  LEND= 73  LNBEG=  0  LNEND= 46
N=12  LBEG=  0  LEND= 76  LNBEG=  0  LNEND= 49
N=13  LBEG=  0  LEND= 79  LNBEG=  0  LNEND= 51
N=14  LBEG= 80  LEND= 79  LNBEG=  0  LNEND=  0
CHARL= 10.0000 PERB IN= 30.0000
CHARU=  1.0000


INLET SUMMARY


N= 1 PE= 1.000 AN=   0.0   BN=   0.0   CN=   1.000 DN=   0.0   EN=   1.000 AT=   0.0   BT=   0.0   CT=   0.0
 OUTL= 10.0000 CU=  1.0000 PERM=  10.0000
```

FIGURE 6.13 : SAMPLE3 OUTPUT

OUTLET SUMMARY

N= 1 P= 1.000 AN= 0.0 BN= 0.0 CN= -1.000 DN= 0.0 EN= 1.000 AT= 0.0 BT= 0.0 CT= 0.0

FIGURE 6.14

KPOINT DISTRIBUTION

```
      1 2 3 4 5 6 7 8 91011
 11 -1-1-1-1-1-1-1-1-1-1-1
 10 -1 6 3 3 3 3 3 3 3 8-1
  9 -1 2 1 1 1 1 1 1 1 4-1
  8 -1 2 1 5 5 1 1 1 1 4-1
  7 -1 2 4-1 0 7 1 1 1 4-1
  6 -1 2 4 0 0-1 2 1 1 4-1
  5 -1 2 4-1 0 6 1 1 1 4-1
  4 -1 2 1 3 3 1 1 1 1 4-1
  3 -1 2 1 1 1 1 1 1 1 4-1
  2 -1 7 5 5 5 5 5 5 5 9-1
  1 -1-1-1-1-1-1-1-1-1-1-1
```

EPSMAX= 0.24500-05 ITSMAX= 10814

OPTIMUM OVERRELAXATION FACTOR IS APPROXIMATELY=1.4072

MAXIMUM SOR ITERATIONS= 17

SOR RELAXATION FACTOR USED=1.4072

DTIME= 0.0333 REYNLD=0.4000000000 01 VISCOS= 1.0000000 TIME= 0.0

L= 2	PERP=	0.0	SS=	0.0	UB=	-19.5930UB=	0.0	VB=	0.0	XB=	1.0000	YB=	1.0000	
L= 3	PERP=	0.0	SB=	0.0	UB=	-19.5930UB=	0.0	VB=	0.0	XB=	1.0000	YB=	1.0000	
L= 4	PERP=	1.0000	SB=	0.0	UB=	-18.3903UB=	0.0	VB=	0.0	XB=	1.0000	YB=	2.0000	
L= 5	PERP=	2.0000	SB=	0.0	UB=	-17.0076UB=	0.0	VB=	0.0	XB=	1.0000	YB=	3.0000	
L= 6	PERP=	3.0000	SB=	0.0	UB=	-17.6038UB=	0.0	VB=	0.0	XB=	1.0000	YB=	4.0000	
L= 7	PERP=	4.0000	SB=	0.0	UB=	-20.2602UB=	0.0	VB=	0.0	XB=	1.0000	YB=	5.0000	
L= 8	PERP=	5.0000	SB=	0.0	UB=	-23.0688UB=	0.0	VB=	0.0	XB=	1.0000	YB=	6.0000	
L= 9	PERP=	6.0000	SB=	0.0	UB=	-21.9732UB=	0.0	VB=	0.0	XB=	1.0000	YB=	7.0000	
L= 10	PERP=	7.0000	SB=	0.0	UB=	-19.2604UB=	0.0	VB=	0.0	XB=	1.0000	YB=	8.0000	
L= 11	PERP=	8.0000	SB=	0.0	UB=	-17.0650UB=	0.0	VB=	0.0	XB=	1.0000	YB=	9.0000	
L= 12	PERP=	9.0000	SB=	0.0	UB=	-16.4552UB=	0.0	VB=	0.0	XB=	1.0000	YB=	10.0000	
L= 13	PERP=	10.0000	SB=	0.0	UB=	-16.8254UB=	-1.0000	VB=	0.0	XB=	1.0000	YB=	11.0000	
L= 14	PERP=	10.0000	SB=	0.0	UB=	-16.8254UB=	-1.0000	VB=	0.0	XB=	1.0000	YB=	11.0000	
L= 15	PERP=	10.0000	SB=	0.0	UB=	0.8636UB=	0.0	VB=	1.0000	XB=	1.0000	YB=	11.0000	
L= 16	PERP=	10.0000	SB=	0.0	UB=	0.8636UB=	0.0	VB=	1.0000	XB=	1.0000	YB=	11.0000	
L= 17	PERP=	11.0000	SB=	0.1000	UB=	3.0448UB=	0.0	VB=	1.0000	XB=	2.0000	YB=	11.0000	
L= 18	PERP=	12.0000	SB=	0.2000	UB=	-0.7740UB=	0.0	VB=	1.0000	XB=	3.0000	YB=	11.0000	
L= 19	PERP=	13.0000	SB=	0.3000	UB=	0.1749UB=	0.0	VB=	1.0000	XB=	4.0000	YB=	11.0000	
L= 20	PERP=	14.0000	SB=	0.4000	UB=	4.5010UB=	0.0	VB=	1.0000	XB=	5.0000	YB=	11.0000	
L= 21	PERP=	15.0000	SB=	0.5000	UB=	7.7210UB=	0.0	VB=	1.0000	XB=	6.0000	YB=	11.0000	
L= 22	PERP=	16.0000	SB=	0.6000	UB=	7.1197UB=	0.0	VB=	1.0000	XB=	7.0000	YB=	11.0000	
L= 23	PERP=	17.0000	SB=	0.7000	UB=	3.2310UB=	0.0	VB=	1.0000	XB=	8.0000	YB=	11.0000	
L= 24	PERP=	18.0000	SB=	0.8000	UB=	-1.7715UB=	0.0	VB=	1.0000	XB=	9.0000	YB=	11.0000	
L= 25	PERP=	19.0000	SB=	0.9000	UB=	-4.8286UB=	0.0	VB=	1.0000	XB=	10.0000	YB=	11.0000	
L= 26	PERP=	20.0000	SB=	1.0000	UB=	-7.8861UB=	0.0	VB=	1.0000	XB=	11.0000	YB=	11.0000	
L= 27	PERP=	20.0000	SB=	1.0000	UB=	-7.8861UB=	0.0	VB=	1.0000	XB=	11.0000	YB=	11.0000	
L= 28	PERP=	20.0000	SB=	1.0000	UB=	17.0667UB=	1.0000	VB=	0.0	XB=	11.0000	YB=	11.0000	
L= 29	PERP=	20.0000	SB=	1.0000	UB=	17.0667UB=	1.0000	VB=	0.0	XB=	11.0000	YB=	11.0000	
L= 30	PERP=	21.0000	SB=	1.0000	UB=	15.1712UB=	0.0	VB=	0.0	XB=	11.0000	YB=	10.0000	
L= 31	PERP=	22.0000	SB=	1.0000	UB=	13.2536UB=	0.0	VB=	0.0	XB=	11.0000	YB=	9.0000	
L= 32	PERP=	23.0000	SB=	1.0000	UB=	13.1594UB=	0.0	VB=	0.0	XB=	11.0000	YB=	8.0000	
L= 33	PERP=	24.0000	SB=	1.0000	UB=	13.7585UB=	0.0	VB=	0.0	XB=	11.0000	YB=	7.0000	
L= 34	PERP=	25.0000	SB=	1.0000	UB=	14.3342UB=	0.0	VB=	0.0	XB=	11.0000	YB=	6.0000	
L= 35	PERP=	26.0000	SB=	1.0000	UB=	14.7044UB=	0.0	VB=	0.0	XB=	11.0000	YB=	5.0000	

FIGURE 6.15

```
L= 36PERP= 27.0000SB= 1.0000UB=      15.1924UB= 0.0 VB= 0.0 XB= 11.0000 YB= 4.0000
L= 37PERP= 28.0000SB= 1.0000UB=      16.2992UB= 0.0 VB= 0.0 XB= 11.0000 YB= 3.0000
L= 38PERP= 29.0000SB= 1.0000UB=      18.1659UB= 0.0 VB= 0.0 XB= 11.0000 YB= 2.0000
L= 39PERP= 30.0000SB= 1.0000UB=      20.0286UB= -1.0000VB= 0.0 XB= 11.0000 YB= 1.0000
L= 40PERP= 30.0000SB= 1.0000UB=      20.0286UB= -1.0000VB= 0.0 XB= 11.0000 YB= 1.0000
L= 41PERP= 30.0000SB= 1.0000UB=      -3.0521UB= 0.0 VB= 1.0000 XB= 11.0000 YB= 1.0000
L= 42PERP= 30.0000SB= 1.0000UB=      -3.0521UB= 0.0 VB= 1.0000 XB= 11.0000 YB= 1.0000
L= 43PERP= 31.0000SB= 0.9000UB=      -1.8361UB= 0.0 VB= 1.0000 XB= 10.0000 YB= 1.0000
L= 44PERP= 32.0000SB= 0.8000UB=      -0.6201UB= 0.0 VB= 1.0000 XB= 9.0000 YB= 1.0000
L= 45PERP= 33.0000SB= 0.7000UB=       0.3848UB= 0.0 VB= 1.0000 XB= 8.0000 YB= 1.0000
L= 46PERP= 34.0000SB= 0.6000UB=       1.0316UB= 0.0 VB= 1.0000 XB= 7.0000 YB= 1.0000
L= 47PERP= 35.0000SB= 0.5000UB=       1.2234UB= 0.0 VB= 1.0000 XB= 6.0000 YB= 1.0000
L= 48PERP= 36.0000SB= 0.4000UB=       0.8081UB= 0.0 VB= 1.0000 XB= 5.0000 YB= 1.0000
L= 49PERP= 37.0000SB= 0.3000UB=       0.2002UB= 0.0 VB= 1.0000 XB= 4.0000 YB= 1.0000
L= 50PERP= 38.0000SB= 0.2000UB=       0.5418UB= 0.0 VB= 1.0000 XB= 3.0000 YB= 1.0000
L= 51PERP= 39.0000SB= 0.1000UB=       1.6997UB= 0.0 VB= 1.0000 XB= 2.0000 YB= 1.0000
L= 52PERP= 40.0000SB= 0.0 UB=         2.8575UB= 0.0 VB= 1.0000 XB= 1.0000 YB= 1.0000
L= 53PERP= 40.0000SB= 0.0 UB=         2.8575UB= 0.0 VB= 1.0000 XB= 1.0000 YB= 1.0000
L= 54PERP= 45.3333SB= 0.3437UB=       1.0950UB= 0.0 VB= 0.0 XB= 4.7500 YB= 4.7500
L= 55PERP= 45.5550SB= 0.3437UB=     -11.4139UB= 0.0 VB= 0.0 XB= 5.0000 YB= 4.7753
L= 56PERP= 46.1077SB= 0.3437UB=     -38.8610UB= 0.0 VB= 0.0 XB= 5.5000 YB= 5.0000
L= 57PERP= 46.4824SB= 0.3437UB=     -54.5703UB= 0.0 VB= 0.0 XB= 5.7500 YB= 5.2500
L= 58PERP= 46.4824SB= 0.3437UB=     -54.5703UB= 0.0 VB= 0.0 XB= 5.7500 YB= 5.2500
L= 59PERP= 47.2000SB= 0.3437UB=     -26.8447UB= 0.0 VB= 0.0 XB= 6.0000 YB= 6.0000
L= 60PERP= 47.2000SB= 0.3437UB=     -26.8447UB= 0.0 VB= 0.0 XB= 6.0000 YB= 6.0000
L= 61PERP= 47.2000SB= 0.3437UB=     -26.8447UB= 0.0 VB= 0.0 XB= 6.0000 YB= 6.0000
L= 62PERP= 47.2000SB= 0.3437UB=     -26.8447UB= 0.0 VB= 0.0 XB= 6.0000 YB= 6.0000
L= 63PERP= 48.0712SB= 0.3437UB=     -33.0633UB= 0.0 VB= 0.0 XB= 5.7500 YB= 6.7500
L= 64PERP= 48.0712SB= 0.3437UB=     -33.0633UB= 0.0 VB= 0.0 XB= 5.7500 YB= 6.7500
L= 65PERP= 48.4224SB= 0.3437UB=     -22.5992UB= 0.0 VB= 0.0 XB= 5.5000 YB= 7.0000
L= 66PERP= 48.4776SB= 0.3437UB=      -3.7514UB= 0.0 VB= 0.0 XB= 5.0000 YB= 7.2247
L= 67PERP= 48.2303SB= 0.3437UB=       1.4121UB= 0.0 VB= 0.0 XB= 4.7500 YB= 7.2500
L= 68PERP= 48.2303SB= 0.3437UB=       1.4121UB= 0.0 VB= 0.0 XB= 4.7500 YB= 7.2500
L= 69PERP= 50.0347SB= 0.3437UB=      14.5669UB= 0.0 VB= 0.0 XB= 4.0000 YB= 7.0000
L= 70PERP= 50.3694SB= 0.3437UB=      22.2697UB= 0.0 VB= 0.0 XB= 3.7500 YB= 6.7500
L= 71PERP= 50.3694SB= 0.3437UB=      22.2697UB= 0.0 VB= 0.0 XB= 3.7500 YB= 6.7500
L= 72PERP= 51.1936SB= 0.3437UB=      47.5997UB= 0.0 VB= 0.0 XB= 3.5000 YB= 6.0000
L= 73PERP= 51.1936SB= 0.3437UB=      47.5997UB= 0.0 VB= 0.0 XB= 3.5000 YB= 6.0000
L= 74PERP= 51.1936SB= 0.3437UB=      47.5997UB= 0.0 VB= 0.0 XB= 3.5000 YB= 6.0000
L= 75PERP= 51.1936SB= 0.3437UB=      47.5997UB= 0.0 VB= 0.0 XB= 3.5000 YB= 6.0000
L= 76PERP= 51.9982SB= 0.3437UB=      36.2814UB= 0.0 VB= 0.0 XB= 3.7500 YB= 5.2500
L= 77PERP= 51.9982SB= 0.3437UB=      36.2814UB= 0.0 VB= 0.0 XB= 3.7500 YB= 5.2500
L= 78PERP= 52.5529SB= 0.3437UB=      24.6204UB= 0.0 VB= 0.0 XB= 4.0000 YB= 5.0000
L= 79PERP= 53.1573SB= 0.3437UB=     -13.6160UB= 0.0 VB= 0.0 XB= 4.7500 YB= 4.7500

LN= 2 PERPN= 1.0000 SBN= 0.0 UBN=    -18.3005 XBN= 1.0000 YBN= 2.0000 IBN= 2 JBN= 2 DISTN= 0.005000
LN= 3 PERPN= 2.0000 SBN= 0.0 UBN=    -17.0076 XBN= 1.0000 YBN= 3.0000 IBN= 2 JBN= 3 DISTN= 0.005000
LN= 4 PERPN= 3.0000 SBN= 0.0 UBN=    -17.6036 XBN= 1.0000 YBN= 4.0000 IBN= 2 JBN= 4 DISTN= 0.005000
LN= 5 PERPN= 4.0000 SBN= 0.0 UBN=    -20.2602 XBN= 1.0000 YBN= 5.0000 IBN= 2 JBN= 5 DISTN= 0.005000
LN= 6 PERPN= 5.0000 SBN= 0.0 UBN=    -23.0688 XBN= 1.0000 YBN= 6.0000 IBN= 2 JBN= 6 DISTN= 0.005000
LN= 7 PERPN= 6.0000 SBN= 0.0 UBN=    -21.9732 XBN= 1.0000 YBN= 7.0000 IBN= 2 JBN= 7 DISTN= 0.005000
LN= 8 PERPN= 7.0000 SBN= 0.0 UBN=    -19.2804 XBN= 1.0000 YBN= 8.0000 IBN= 2 JBN= 8 DISTN= 0.005000
LN= 9 PERPN= 8.0000 SBN= 0.0 UBN=    -17.0850 XBN= 1.0000 YBN= 9.0000 IBN= 2 JBN= 9 DISTN= 0.005000
LN= 10 PERPN= 9.0000 SBN= 0.0 UBN=   -16.9552 XBN= 1.0000 YBN= 10.0000 IBN= 2 JBN= 10 DISTN= 0.005000
LN= 11 PERPN= 11.0000 SBN= 0.1000 UBN=  3.0446 XBN= 2.0000 YBN= 11.0000 IBN= 2 JBN= 10 DISTN= 0.005000
LN= 12 PERPN= 12.0000 SBN= 0.2000 UBN= -0.7740 XBN= 3.0000 YBN= 11.0000 IBN= 3 JBN= 10 DISTN= 0.005000
LN= 13 PERPN= 13.0000 SBN= 0.3000 UBN=  0.1749 XBN= 4.0000 YBN= 11.0000 IBN= 4 JBN= 10 DISTN= 0.005000
LN= 14 PERPN= 14.0000 SBN= 0.4000 UBN=  4.6010 XBN= 5.0000 YBN= 11.0000 IBN= 5 JBN= 10 DISTN= 0.005000
LN= 15 PERPN= 15.0000 SBN= 0.5000 UBN=  7.7210 XBN= 6.0000 YBN= 11.0000 IBN= 6 JBN= 10 DISTN= 0.005000
LN= 16 PERPN= 16.0000 SBN= 0.6000 UBN=  7.1197 XBN= 7.0000 YBN= 11.0000 IBN= 7 JBN= 10 DISTN= 0.005000
LN= 17 PERPN= 17.0000 SBN= 0.7000 UBN=  3.2510 XBN= 8.0000 YBN= 11.0000 IBN= 8 JBN= 10 DISTN= 0.005000
LN= 18 PERPN= 18.0000 SBN= 0.8000 UBN= -1.7715 XBN= 9.0000 YBN= 11.0000 IBN= 9 JBN= 10 DISTN= 0.005000
LN= 19 PERPN= 19.0000 SBN= 0.9000 UBN= -4.8288 XBN= 10.0000 YBN= 11.0000 IBN= 10 JBN= 10 DISTN= 0.005000
LN= 20 PERPN= 21.0000 SBN= 1.0000 UBN=  15.1712 XBN= 11.0000 YBN= 10.0000 IBN= 10 JBN= 10 DISTN= 0.005000
LN= 21 PERPN= 22.0000 SBN= 1.0000 UBN=  13.2536 XBN= 11.0000 YBN= 9.0000 IBN= 10 JBN= 9 DISTN= 0.005000
LN= 22 PERPN= 23.0000 SBN= 1.0000 UBN=  13.1594 XBN= 11.0000 YBN= 8.0000 IBN= 10 JBN= 8 DISTN= 0.005000
LN= 23 PERPN= 24.0000 SBN= 1.0000 UBN=  13.7565 XBN= 11.0000 YBN= 7.0000 IBN= 10 JBN= 7 DISTN= 0.005000
```

FIGURE 6.16

```
L=      PERPN= 25.0000 SBN= 1.0000 UBN=      14.3342 XBN= 11.0000 YBN=  6.0000 IBN= 10 JBN=  6 DISTN= 0.005000
LN= 25  PERPN= 26.0000 SBN= 1.0000 UBN=      14.7081 XBN= 11.0000 YBN=  5.0000 IBN= 10 JBN=  5 DISTN= 0.005000
LN= 26  PERPN= 27.0000 SBN= 1.0000 UBN=      15.1424 XBN= 11.0000 YBN=  4.0000 IBN= 10 JBN=  4 DISTN= 0.005000
LN= 27  PERPN= 28.0000 SBN= 1.0000 UBN=      16.2992 XBN= 11.0000 YBN=  3.0000 IBN= 10 JBN=  3 DISTN= 0.005000
LN= 28  PERPN= 29.0000 SBN= 1.0000 UBN=      18.1639 XBN= 11.0000 YBN=  2.0000 IBN= 10 JBN=  2 DISTN= 0.005000
LN= 29  PERPN= 31.0000 SBN= 0.9000 UBN=      -1.8301 XBN= 10.0000 YBN=  1.0000 IBN= 10 JBN=  2 DISTN= 0.005000
LN= 30  PERPN= 32.0000 SBN= 0.8000 UBN=      -0.6201 XBN=  9.0000 YBN=  1.0000 IBN=  9 JBN=  2 DISTN= 0.005000
LN= 31  PERPN= 33.0000 SBN= 0.7000 UBN=       0.3646 XBN=  8.0000 YBN=  1.0000 IBN=  8 JBN=  2 DISTN= 0.005000
LN= 32  PERPN= 34.0000 SBN= 0.6000 UBN=       1.0516 XBN=  7.0000 YBN=  1.0000 IBN=  7 JBN=  2 DISTN= 0.005000
LN= 33  PERPN= 35.0000 SBN= 0.5000 UBN=       1.2234 XBN=  6.0000 YBN=  1.0000 IBN=  6 JBN=  2 DISTN= 0.005000
LN= 34  PERPN= 36.0000 SBN= 0.4000 UBN=       0.8081 XBN=  5.0000 YBN=  1.0000 IBN=  5 JBN=  2 DISTN= 0.005000
LN= 35  PERPN= 37.0000 SBN= 0.3000 UBN=       0.2002 XBN=  4.0000 YBN=  1.0000 IBN=  4 JBN=  2 DISTN= 0.005000
LN= 36  PERPN= 38.0000 SBN= 0.2000 UBN=       0.5416 XBN=  3.0000 YBN=  1.0000 IBN=  3 JBN=  2 DISTN= 0.005000
LN= 37  PERPN= 39.0000 SBN= 0.1000 UBN=       1.6997 XBN=  2.0000 YBN=  1.0000 IBN=  2 JBN=  2 DISTN= 0.005000
LN= 38  PERPN= 45.4557 SBN= 0.3437 UBN=      -6.6303 XBN=  4.9050 YBN=  4.7597 IBN=  5 JBN=  4 DISTN= 0.002930
LN= 39  PERPN= 46.4234 SBN= 0.3437 UBN=     -54.5703 XBN=  5.7261 YBN=  5.2191 IBN=  6 JBN=  5 DISTN= 0.000615
LN= 40  PERPN= 46.5015 SBN= 0.3437 UBN=     -54.5703 XBN=  5.7261 YBN=  5.2191 IBN=  6 JBN=  5 DISTN= 0.000615
LN= 41  PERPN= 47.2668 SBN= 0.3437 UBN=     -26.8447 XBN=  6.0000 YBN=  6.0000 IBN=  7 JBN=  6 DISTN= 0.005000
LN= 42  PERPN= 47.2668 SBN= 0.3437 UBN=     -26.8447 XBN=  6.0000 YBN=  6.0000 IBN=  7 JBN=  6 DISTN= 0.005000
LN= 43  PERPN= 48.1102 SBN= 0.3437 UBN=     -33.3652 XBN=  5.7261 YBN=  6.7809 IBN=  6 JBN=  7 DISTN= 0.000615
LN= 44  PERPN= 48.1102 SBN= 0.3437 UBN=     -33.3652 XBN=  5.7261 YBN=  6.7809 IBN=  6 JBN=  7 DISTN= 0.000615
LN= 45  PERPN= 49.0748 SBN= 0.3437 UBN=      -0.4089 XBN=  4.9050 YBN=  7.2403 IBN=  5 JBN=  8 DISTN= 0.002930
LN= 46  PERPN= 49.0788 SBN= 0.3437 UBN=       6.8386 XBN=  4.3111 YBN=  7.1704 IBN=  4 JBN=  8 DISTN= 0.003925
LN= 47  PERPN= 50.5449 SBN= 0.3437 UBN=      25.6449 XBN=  3.6047 YBN=  6.6202 IBN=  3 JBN=  7 DISTN= 0.002930
LN= 48  PERPN= 51.1938 SBN= 0.3437 UBN=      47.5997 XBN=  3.5000 YBN=  6.0000 IBN=  3 JBN=  6 DISTN= 0.001250
LN= 49  PERPN= 51.1938 SBN= 0.3437 UBN=      47.5997 XBN=  3.5000 YBN=  6.0000 IBN=  3 JBN=  6 DISTN= 0.001250
LN= 50  PERPN= 52.1556 SBN= 0.3437 UBN=      34.0942 XBN=  3.6047 YBN=  5.3798 IBN=  3 JBN=  5 DISTN= 0.002930
LN= 51  PERPN= 52.7066 SBN= 0.3437 UBN=       7.7019 XBN=  4.3111 YBN=  4.8296 IBN=  4 JBN=  4 DISTN= 0.003925

CALCULATION HAS BEEN COMPLETED WITH NUMBER OF VORTICITY STEPS=  295  EPO=      0.242D-03
DTIME= 0.0333 REYNLD=0.4000000000 01 VISCOS=  1.0000000 TIME=    9.83
```

FIGURE 6.17

U-FIELD

***** FLOWOUT HAS BEEN WRITTEN *****

	1	2	3	4	5	6	7	8	9	10	11
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000
10	0.0	-0.073	0.078	0.012	-0.220	-0.385	-0.354	-0.175	0.039	0.169	0.0
9	0.0	0.058	0.175	0.088	-0.160	-0.350	-0.316	-0.177	-0.035	0.050	0.0
8	0.0	0.122	0.265	0.206	-0.058	-0.294	-0.240	-0.138	-0.061	-0.013	0.0
7	0.0	0.095	0.227	0.0	0.0	-0.238	-0.114	-0.057	-0.043	-0.029	0.0
6	0.0	-0.043	-0.124	0.0	0.0	0.0	0.116	0.056	0.005	-0.024	0.0
5	0.0	-0.137	-0.362	0.0	0.0	0.469	0.348	0.181	0.046	-0.021	0.0
4	0.0	-0.061	-0.229	-0.218	0.233	0.488	0.369	0.194	0.042	-0.040	0.0
3	0.0	0.017	-0.073	-0.072	0.164	0.282	0.237	0.124	0.003	-0.074	0.0
2	0.0	0.075	0.010	-0.000	0.079	0.126	0.108	0.050	-0.025	-0.093	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

FIGURE 6.18

FIGURE 6.19

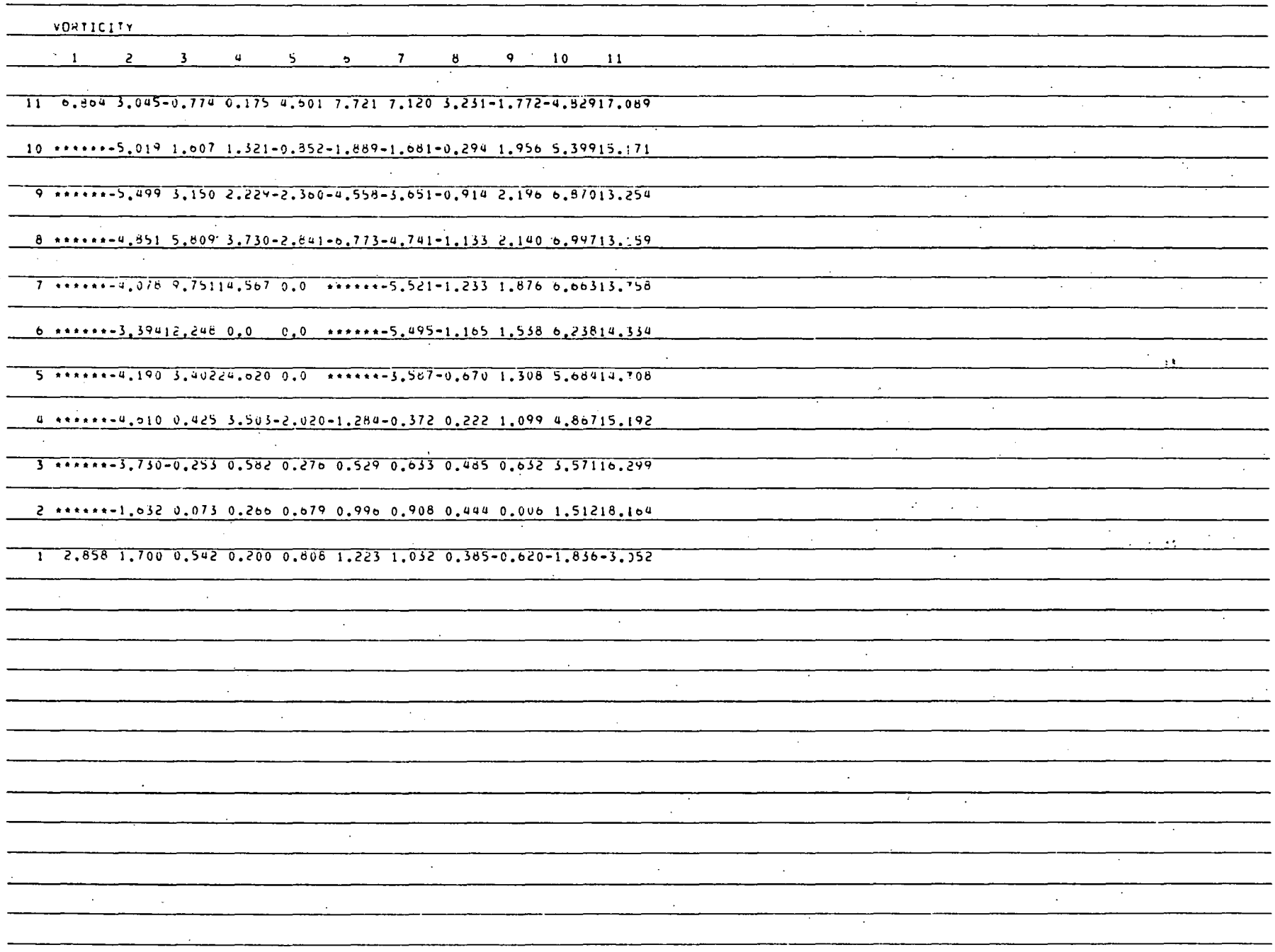
V-FIELD

	1	2	3	4	5	6	7	8	9	10	11
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.0
10	0.0	1.019	1.072	0.866	0.811	0.937	1.112	1.222	1.201	0.956	0.0
9	0.0	1.076	1.085	0.702	0.603	0.866	1.210	1.393	1.343	0.961	0.0
8	0.0	1.194	1.102	0.531	0.373	0.778	1.286	1.506	1.429	0.990	0.0
7	0.0	1.343	1.169	0.0	0.0	0.664	1.367	1.572	1.468	1.022	0.0
6	0.0	1.421	1.356	0.0	0.0	0.0	1.467	1.577	1.456	1.034	0.0
5	0.0	1.219	1.212	0.0	0.0	0.872	1.370	1.461	1.376	1.017	0.0
4	0.0	1.059	1.127	0.756	0.620	0.922	1.160	1.275	1.254	0.987	0.0
3	0.0	0.990	1.075	0.931	0.873	0.971	1.076	1.134	1.143	0.975	0.0
2	0.0	0.986	1.037	0.993	0.974	0.994	1.021	1.041	1.056	0.984	0.0
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

STREAM FUNCTION MAP

	1	2	3	4	5	6	7	8	9	10	11
11	0.0	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000
10	0.0	0.085	0.204	0.299	0.377	0.461	0.564	0.684	0.809	0.924	1.000
9	0.0	0.085	0.216	0.302	0.356	0.423	0.529	0.665	0.808	0.934	1.000
8	0.0	0.096	0.239	0.317	0.345	0.391	0.501	0.648	0.802	0.934	1.000
7	0.0	0.110	0.269	0.344*******		0.364	0.481	0.658	0.796	0.931	1.000
6	0.0	0.115	0.284**********			0.344	0.478	0.637	0.793	0.928	1.000
5	0.0	0.101	0.244	0.344*******		0.377	0.504	0.651	0.797	0.926	1.000
4	0.0	0.088	0.212	0.313	0.363	0.437	0.547	0.673	0.803	0.924	1.000
3	0.0	0.085	0.198	0.300	0.384	0.475	0.578	0.690	0.805	0.919	1.000
2	0.0	0.092	0.197	0.299	0.396	0.494	0.595	0.698	0.803	0.909	1.000
1	0.0	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000

FIGURE 6.20



VORTICITY

	1	2	3	4	5	6	7	8	9	10	11
11	6.864	3.045	-0.774	0.175	4.501	7.721	7.120	3.231	-1.772	-4.829	17.089
10	*******	-5.019	1.607	1.321	-0.352	-1.889	-1.681	-0.294	1.956	5.399	15.171
9	*******	-5.499	3.150	2.224	-2.360	-4.558	-3.651	-0.914	2.196	6.870	13.254
8	*******	-4.851	5.809	3.730	-2.841	-6.773	-4.741	-1.133	2.140	6.997	13.159
7	*******	-4.078	9.751	14.567	0.0	*******	-5.521	-1.233	1.876	6.663	13.758
6	*******	-3.394	12.248	0.0	0.0	*******	-5.495	-1.165	1.538	6.238	14.334
5	*******	-4.190	3.402	24.020	0.0	*******	-3.587	-0.670	1.308	5.684	14.708
4	*******	-4.010	0.425	3.503	-2.020	-1.284	-0.372	0.222	1.099	4.867	15.192
3	*******	-3.730	-0.253	0.582	0.276	0.529	0.633	0.485	0.632	3.571	16.299
2	*******	-1.632	0.073	0.266	0.679	0.996	0.908	0.444	0.006	1.512	18.164
1	2.858	1.700	0.542	0.200	0.808	1.223	1.032	0.385	-0.620	-1.836	-3.052

FIGURE 6.21

NOMENCLATURE

CHARU	Dimensional characteristic velocity
DEL2O	Viscous term in dimensionless vorticity transport equation
DUODX	$\hat{x}$ direction convective term
DVODY	$\hat{y}$ direction convective term
EPO	Measure of change in vorticity distribution
KPOINT	Coded grid point array
L	Perimeter point counter
LBEG	Beginning L value
LEND	Ending L value
LN	Normal perimeter point counter
LNBEG	Beginning LN value
LNEND	Ending LN value
L_{in}	Dimensional length of inlet
N	Normal velocity component
O	Dimensionless vorticity
ΔP	Pressure drop
S	Dimensionless stream function
s	Normalized position parameter
T	Tangential velocity component
t	Time
$\hat{t}$	Dimensionless time
u	Component of velocity in x-direction
U	Dimensionless velocity in $\hat{x}$-direction

v	Component of velocity in y-direction
V	Dimensionless velocity in y-direction
x,y	Cartesian right handed coordinates
$\hat{x},\hat{y}$	Dimensionless coordinates in grid units
ρ	Fluid density
ψ	Dimensional stream function
ω	Dimensional vorticity

APPENDIX A - Summary of NAMELIST Input Variables

		Section	Nominal
NVERTX	Number of vertices used to specify configuration	2.3	Necessary
XVERTX(I)	x-coordinate of i-th vertex	2.3	Necessary
YVERTX(I)	y-coordinate of i-th vertex	2.3	Necessary
KSIDE(I)	Coded value assigned to i-th side	3.2	Necessary
YTUBES	Dimensional length to be partitioned into NGRID number of grid spaces	2.4	Necessary
NGRID	Number of grid spaces in distance YTUBES	2.4	Necessary
NPIN	Number of points of discontinuity along inlet	3.3	0
PIN(I)	s value of i-th discontinuity along inlet	3.3	1.0
AIN(I) BIN(I) CIN(I) DIN(I) EIN(I)	Coefficients specifying normal velocity component profile in the i-th subregion along inlet of the form $N = AIN(I)*s^2 + BIN(I)*s + CIN(s) + \frac{DIN(I)}{s + EIN(I)}$	3.3	All 0.0 except CIN(1) = 1. EIN(1) = 1.
AIT(I) BIT(I) CIT(I)	Coefficients specifying tangential velocity component profile in the i-th region along inlet of the form $T = AIT(I)*s^2 + BIT(I)*s + CIT(I)$	3.3	All 0.0
NPOUT	Number of points of discontinuity along outlet	3.4	0
POUT(I)	s value of i-th discontinuity along outlet	3.4	1.0
AON(I) BON(I) CON(I) DON(I) EON(I)	Coefficients specifying normal velocity component profile in the i-th subregion along outlet of the form $N = AON(I)*s^2 + BON(I)*s + CON(I) + \frac{DON(I)}{s + EON(I)}$	3.4	All 0.0 except CON(1) = 1. EON(I) = 1.

		Section	Nominal
AOT(I) BOT(I) COT(I)	Coefficients specifying tangential velocity component profile in the i-th region along outlet of the form $T = AOT(I)*s^2 + BOT(I)*s + COT(I)$	3.4	All 0.0
CHARL	Characteristic length in grid units	3.3	$\frac{L_{in}*NGRID}{YTUBES}$
ITMAXS	Maximum number of S.O.R. sweeps	4.3	250
EPSMAX	Convergence criterion	4.2	Empirically determined
ITSMAX	Maximum number of passes through iterative sequence	4.2	Empirically determined
RELAX	Successive overrelaxation factor	4.3	Empirically determined
REYNLD	Cell Reynolds number	4.4	$\frac{CHARU*YTUBES}{VISCOS*NGRID}$
VISCOS	Kinematic viscosity	4.1	1.0
DTIME	Dimensionless time increment	4.4	Empirically determined
FL2	Printer output flag = 5. gives extended printer output	5.2	0.0
FLIN	Disc input flag, FLIN = 1. indicates data are to be read from logical record unit 9.	5.4	0.0
FLOUT	Disc output flag, FLOUT = 1. indicates data are to be written on logical record unit 10.	5.3	0.0
NMATCH	Number of line resistances	6.1	0
MATCH(M)	Side number of the M-th match	6.1	0
PRESSK(M)	Pressure drop coefficient of M-th resistance	6.1	0.0
BDFL(M)	Coefficient of flow deflection across M-th resistance	6.1	0.0

APPENDIX B - Summary of Operation at ANL

Up to the present time, all code development has been done on TSO (ANL version of IBM's time sharing option). Code utilization has been in the batch mode. The most recent version of EVITS has been compiled and stored on a long term disc. The compiled program is on a dataset called C114.B22684.EVITS. To use EVITS, the following card is included in the JCL:

```
//GO.SYSLINbDDbDSN = C114.B22684.EVITS,DISP = SHR
```

APPENDIX C - Listing of EVITS

This appendix includes a copy of the latest compilation of EVITS. The compiled program is written on dataset C114.B22684.EVITS.

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.54.26

            COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                               SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                  C     EVITS CODE ***** VERSION 4/28/76 *****                    00000010
                  C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***           00000020
                  C     EXPLICIT*VORTICITY*ITERATIVE*TIME*STEPPING***             00000030
                  C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***           00000040
                  C     EVITS HAS CAPABILITY OF HANDLING A VARIETY OF GEOMETRIES   00000050
                  C     THIS IS INPUT VIA SPECIFING NUMBER AND POSITION OF VERTICES 00000060
                  C     VERTICES AND SIDES ARE NUMBERED CLOCKWISE. SIDES ARE CODED 00000070
                  C     AS TO THEIR TYPE.                                          00000080
                  C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***           00000090
                  C     PROGRAM 2D STEADY FLOW                                     00000100
                  C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***           00000110
     ISN 0002           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                   00000120
     ISN 0003           COMMON /C/ XVERTX(50),YVERTX(50),YTUBES,NGRID              00000130
     ISN 0004           COMMON /BB/ AIN(10),BIN(10),CIN(10),AIT(10),BIT(10),CIT(10),PIN(10 00000140
                       1),DIN(10),EIN(10),NPIN                                    00000150
     ISN 0005           COMMON /CC/ AON(10),BON(10),CON(10),AOT(10),BOT(10),COT(10),POUT(1 00000160
                       10),DON(10),EON(10),NPOUT                                  00000170
     ISN 0006           COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX 00000180
     ISN 0007           COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50) 00000190
     ISN 0008           COMMON /A4/ RELAX,R1,R2,R3,EPSMAX,DTIME,REYNLD,VISCOS,TIMEX,ITMAXS 00000200
     ISN 0009           COMMON /GG/ CHARL,CHARU                                    00000210
     ISN 0010           COMMON /A7/ FLIN,FLOUT,SPD,FL1,FL2,ITSMAX                  00000220
     ISN 0011           COMMON /A1/ Q(41,41),S(41,41)                              00000230
     ISN 0012           COMMON /A2/ U(41,41),V(41,41)                              00000240
     ISN 0013           COMMON /A3/ KPOINT(41,41)                                  00000250
     ISN 0014           COMMON /A/ POINT(41,41),XB(300),YB(300),PERP               00000260
                       1(300),XNORM(300),YNORM(300),NL                            00000270
     ISN 0015           COMMON /DD/ SB(300),UB(300),VB(300),QB(300)                00000280
     ISN 0016           COMMON /EE/ SBN(280),QBN(280)                              00000290
     ISN 0017           COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280), 00000300
                       1IBN(280),JBN(280),NSIDE(280),NLN                          00000310
     ISN 0018           COMMON /B2/ PRESSK(11),BDFL(11),REF,KBLOCK(11)             00000320
     ISN 0019           NAMELIST /FLOW01/NVERTX,XVERTX,YVERTX,KSIDE                00000330
                       1,YTUBES,NGRID,AIN,BIN,CIN,AIT,BIT,CIT,PIN,NPIN,AON,BON,DIN,EIN 00000340
                       1,CON,AOT,BOT,COT,POUT,NPOUT,EPSMAX,ITMAXS,RELAX,DON,EON,REYNLD, 00000350
                       1VISCOS,DTIME,TIMEX,CHARL,FL1,FL2,ITSMAX,NOGO,FLIN,FLOUT,  00000360
                       1NMATCH,MATCH,PRESSK,BDFL,REF,KBLOCK                       00000370
     ISN 0020           REF=1.                                                     00000380
     ISN 0021           CHARL=0.                                                   00000390
     ISN 0022           NOGO=0                                                     00000400
     ISN 0023           FLIN=0.                                                    00000410
     ISN 0024           NMATCH=0                                                   00000420
     ISN 0025           FLOUT=0.                                                   00000430
     ISN 0026           READ(5,FLOW01)                                             00000440
     ISN 0027           CHARL=CHARL*NGRID/YTUBES                                   00000450
     ISN 0028           IF(FLIN.EQ.0.) GO TO 10                                    00000460
     ISN 0030           READ(9,203) NL,IMAXI,JMAX,NLN,NVERTX                       00000470
     ISN 0031           READ(9,204) (XB(L),YB(L),L=2,NL)                           00000480
     ISN 0032           READ(9,206) (QBN(L),PERPN(L),L=1,NLN)                      00000490
     ISN 0033           READ(9,206) (PERV(N),N=1,NVERTX)                           00000500
     ISN 0034           READ(9,205) (XBN(L),YBN(L),SBN(L),IBN(L),JBN(L),L=2,NLN)   00000510
     ISN 0035           READ(9,250) ((KPOINT(I,J),I=1,IMAXI),J=1,JMAX)             00000520
     ISN 0036           READ(9,200) ((S(I,J),I=1,IMAXI),J=1,JMAX)                  00000530
```

FIGURE C.1

```
ISN 0037          READ(9,200) ((Q(I,J),I=1,IMAXI),J=1,JMAX)                    00000540
ISN 0038          READ(9,200) ((U(I,J),I=1,IMAXI),J=1,JMAX)                    00000550
ISN 0039          READ(9,200) ((V(I,J),I=1,IMAXI),J=1,JMAX)                    00000560
ISN 0040          READ(9,200) (SB(I),QB(I),UB(I),VB(I),I=2,NL)                 00000570
ISN 0041          READ(9,200) RELAX,CHARL,CHARU                                00000580
ISN 0042      200 FORMAT(3E25.18)                                              00000590
ISN 0043          WRITE(6,201)                                                 00000600
ISN 0044      201 FORMAT(' ***** FLOWIN HAS BEEN READ *****',////)             00000610
ISN 0045       10 WRITE(6,24)                                                  00000620
ISN 0046       24 FORMAT('1   *** GEOMETRY INPUT ***',/)                       00000630
ISN 0047          WRITE(6,23) (N,XVERTX(N),YVERTX(N),KSIDE(N),N=1,NVERTX)      00000640
ISN 0048          WRITE(6,22) YTUBES,NGRID                                     00000650
ISN 0049       23 FORMAT(6X,'N=',I2,4X,'XVERTX=',F5.1,4X,'YVERTX=',F5.1,4X,    00000660
                 1'KSIDE=',I2)                                                 00000670
ISN 0050       22 FORMAT(/,4X,'YTUBES=',F5.1,4X,'NGRID=',I2)                   00000680
ISN 0051          CALL GRID                                                    00000690
ISN 0052          CALL MAXIJ                                                   00000700
ISN 0053          CALL GEOM                                                    00000710
ISN 0054          IF(NOGO.NE.2) CALL BOUND                                     00000720
ISN 0056          IF(NOGO.NE.1.AND.NOGO.NE.2) CALL ITERAT                      00000730
ISN 0058          IF(FLOUT.EQ.0.) GO TO 25                                     00000740
ISN 0060          WRITE(10,203) NL,IMAXI,JMAX,NLN,NVERTX                       00000750
ISN 0061          WRITE(10,204) (XB(L),YB(L),L=2,NL)                           00000760
ISN 0062          WRITE(10,206) (QBN(L),PERPN(L),L=1,NLN)                      00000770
ISN 0063          WRITE(10,206) (PSIV(N),N=1,NVERTX)                           00000780
ISN 0064          WRITE(10,205) (XBN(L),YBN(L),SBN(L),IBN(L),JBN(L),L=2,NLN)   00000790
ISN 0065          WRITE(10,250) ((KPOINT(I,J),I=1,IMAXI),J=1,JMAX)             00000800
ISN 0066      250 FORMAT(2X,35I2)                                              00000810
ISN 0067      205 FORMAT(4(2F5.2,F5.3,2I2))                                    00000820
ISN 0068      206 FORMAT(6E12.5)                                               00000830
ISN 0069          WRITE(10,200) ((S(I,J),I=1,IMAXI),J=1,JMAX)                  00000840
ISN 0070          WRITE(10,200) ((Q(I,J),I=1,IMAXI),J=1,JMAX)                  00000850
ISN 0071          WRITE(10,200) ((U(I,J),I=1,IMAXI),J=1,JMAX)                  00000860
ISN 0072          WRITE(10,200) ((V(I,J),I=1,IMAXI),J=1,JMAX)                  00000870
ISN 0073          WRITE(10,200) (SB(I),QB(I),UB(I),VB(I),I=2,NL)               00000880
ISN 0074          WRITE(10,200) RELAX,CHARL,CHARU                              00000890
ISN 0075      203 FORMAT(5I4)                                                  00000900
ISN 0076      204 FORMAT(16F5.2)                                               00000910
ISN 0077          WRITE(6,202)                                                 00000920
ISN 0078      202 FORMAT(' ***** FLOWOUT HAS BEEN WRITTEN *****',////)         00000930
ISN 0079       25 CONTINUE                                                     00000940
ISN 0080          CALL DISPLR(U,19,IMAXI,JMAX,4)                               00000950
ISN 0081          DO 570 J=1,JMAX                                              00000960
ISN 0082          DO 570 I=1,IMAXI                                             00000970
ISN 0083          IF(POINT(I,J).EQ.0.) S(I,J)=999.                             00000980
ISN 0085      570 POINT(I,J)=DSQRT(U(I,J)**2+V(I,J)**2)                        00000990
ISN 0086          WRITE(6,31)                                                  00001000
ISN 0087       31 FORMAT('1   V-FIELD')                                        00001010
ISN 0088          CALL DISPLR(V,19,IMAXI,JMAX,4)                               00001020
ISN 0089          WRITE(6,32)                                                  00001030
ISN 0090       32 FORMAT('1   STREAM FUNCTION MAP')                            00001040
ISN 0091          CALL DISPLR(S,19,IMAXI,JMAX,4)                               00001050
ISN 0092          WRITE(6,29)                                                  00001060
ISN 0093       29 FORMAT('1   VORTICITY')                                      00001070
ISN 0094          CALL DISPLR(Q,19,IMAXI,JMAX,4)                               00001080
```

FIGURE C.2

```
ISN 0095          WRITE(6,33)                                                    00001090
ISN 0096       33 FORMAT('1   VELOCITY MAGNITUDE MAP')                           00001100
ISN 0097          IF(FL2.EQ.0.) CALL DISPLR(POINT,19,IMAXI,JMAX,4)               00001110
ISN 0099          STOP                                                           00001120
ISN 0100          END                                                            00001130

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      99 ,PROGRAM SIZE =     4640

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  71K BYTES OF CORE NOT USED
```

FIGURE C.3

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.54.29

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00001140
     ISN 0002           SUBROUTINE GRID                                                 00001150
     ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00001160
     ISN 0004           COMMON /D/ LNREG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX  00001170
     ISN 0005           COMMON /C/ XVERTX(50),YVERTX(50),YTUBES,NGRID                   00001180
     ISN 0006           DO 20 N=1,NVERTX                                                00001190
     ISN 0007           YV(N)=YVERTX(N)*DFLOAT(NGRID)/YTUBES+1.                         00001200
     ISN 0008        20 XV(N)=XVERTX(N)*DFLOAT(NGRID)/YTUBES+1.                         00001210
     ISN 0009           WRITE(6,25)                                                     00001220
     ISN 0010        25 FORMAT(///,'    *** GRID GEOMETRY ***',/)                    00001230
     ISN 0011           WRITE(6,21) (I,XV(I),YV(I),I=1,NVERTX)                          00001240
     ISN 0012        21 FORMAT(4X,'N=',I2,4X,'XV=',F5.1,4X,'YV=',F5.1)                  00001250
     ISN 0013           RETURN                                                          00001260
     ISN 0014           END                                                             00001270

*OPTIONS IN EFFECT*       NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*       SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       13 ,PROGRAM SIZE =       536

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          115K BYTES OF CORE NOT USED
```

FIGURE C.4

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.54.31

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00001280
     ISN 0002            SUBROUTINE MAXIJ                                               00001290
     ISN 0003            IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                       00001300
     ISN 0004            COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX 00001310
     ISN 0005            YMAX=YV(1)                                                     00001320
     ISN 0006            XMAX=XV(1)                                                     00001330
     ISN 0007            DO 50 N=2,NVERTX                                               00001340
     ISN 0008            IF(YMAX.LT.YV(N)) YMAX=YV(N)                                   00001350
     ISN 0010            IF(XMAX.LT.XV(N)) XMAX=XV(N)                                   00001360
     ISN 0012         50 CONTINUE                                                       00001370
     ISN 0013            JMAX=YMAX                                                      00001380
     ISN 0014            IMAXI=XMAX                                                     00001390
     ISN 0015            WRITE(6,51) IMAXI,JMAX                                         00001400
     ISN 0016         51 FORMAT(/,4X,'IMAXI=',I2,4X,'JMAX=',I2)                         00001410
     ISN 0017            RETURN                                                         00001420
     ISN 0018            END                                                            00001430

 *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

 *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

 *STATISTICS*     SOURCE STATEMENTS =       17 ,PROGRAM SIZE =       448

 *STATISTICS*  NO  DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                              115K BYTES OF CORE NOT USED
```

FIGURE C.5

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.54.32

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=2000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76*****DOMANUS, H. ***  X3244  ***                    00001440
ISN 0002              SUBROUTINE GEOM                                                  00001450
ISN 0003              IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                         00001460
ISN 0004              COMMON /E/ IMIN(60),IMAX(60),JMX                                 00001470
ISN 0005              COMMON /A/ POINT(41,41),XB(300),YB(300),PERP                     00001480
                     1(300),XNORM(300),YNORM(300),NL                                   00001490
ISN 0006              COMMON /B/ XC,YC,RSQRD,SLOPE,SLOPE1,SGNX,SGNY,N,MSIDE,ARC,R      00001500
ISN 0007              COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX   00001510
ISN 0008              COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50) 00001520
ISN 0009              COMMON /G/ LN                                                    00001530
ISN 0010              COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DEIDP(280),  00001540
                     1IBN(280),JBN(280),NSIDE(280),NLN                                 00001550
ISN 0011              COMMON /A7/ FLIN,FLOUT,EPO,FL1,FL2,ITSMAX                        00001560
ISN 0012              FCENT(D1,D2,D3,Z1,Z2,Z3)=(D1*Z1**2+D2*Z2**2+D3*Z3**2             00001570
                     1-D1*D2*C3)/2/(D1*Z1+D2*Z2+D3*Z3)                                 00001580
ISN 0013              N1=NVERTX+1                                                      00001590
ISN 0014              XV(N1)=XV(1)                                                     00001600
ISN 0015              YV(N1)=YV(1)                                                     00001610
ISN 0016              DO 100 J=1,JMAX                                                  00001620
ISN 0017              DO 100 I=1,IMAXI                                                 00001630
ISN 0018          100 POINT(I,J)=0.                                                    00001640
ISN 0019              ARC=0.                                                           00001650
ISN 0020              L=1                                                              00001660
ISN 0021              NSIDE(1)=1                                                       00001670
ISN 0022              LN=1                                                             00001680
ISN 0023              DISTN(1)=0.D0                                                    00001690
ISN 0024              PERV(1)=0.                                                       00001700
ISN 0025              DO 199 N=1,NVERTX                                                00001710
ISN 0026              LNBEG(N)=0                                                       00001720
ISN 0027              LNEND(N)=0                                                       00001730
ISN 0028              LBEG(N)=L+1                                                      00001740
ISN 0029              IF(KSIDE(N).LT.10) ARC=0.                                        00001750
ISN 0031              IF(KSIDE(N).GT.10) ARC=ARC+1.                                    00001760
ISN 0033              IF(ARC.GT.2) ARC=1.                                              00001770
ISN 0035              IF(KSIDE(N).GT.10) MSIDE=KSIDE(N)-10                             00001780
ISN 0037              IF(KSIDE(N).LT.10) MSIDE=KSIDE(N)                                00001790
ISN 0039              IF(ARC-1.) 201,202,203                                           00001800
ISN 0040          202 XC=FCENT(YV(N+2)-YV(N+1),YV(N)-YV(N+2),YV(N+1)-YV(N),            00001810
                     1XV(N),XV(N+1),XV(N+2))                                           00001820
ISN 0041              YC=FCENT(XV(N+2)-XV(N+1),XV(N)-XV(N+2),XV(N+1)-XV(N),            00001830
                     1YV(N),YV(N+1),YV(N+2))                                           00001840
ISN 0042              RSQRD=(XV(N)-XC)**2+(YV(N)-YC)**2                                00001850
ISN 0043              R=DSQRT(RSQRD)                                                   00001860
ISN 0044              GO TO 203                                                        00001870
ISN 0045          201 IF((XV(N+1)-XV(N)).NE.0.) SLOPE=(YV(N+1)-YV(N))/(                00001880
                     1XV(N+1)-XV(N))                                                   00001890
ISN 0047              IF((YV(N+1)-YV(N)).NE.0.) SLOPE1=(XV(N+1)-XV(N))/                00001900
                     1(YV(N+1)-YV(N))                                                  00001910
ISN 0049          203 SGNX=-1.                                                         00001920
ISN 0050              SGNY=-1.                                                         00001930
ISN 0051              IF(XV(N).GT.(XC+.5).OR.XV(N+1).GT.(XC+.5)) SGNX=1.               00001940
ISN 0053              IF(YV(N).GT.(YC+.5).OR.YV(N+1).GT.(YC+.5)) SGNY=1.               00001950
ISN 0055          204 I=XV(N)                                                          00001960
```

FIGURE C.6

```
ISN 0056          J=YV(N)                                                    00001970
ISN 0057          DIST=DSQRT((XV(N+1)-XV(N))**2+(YV(N+1)-YV(N))**2)          00001980
ISN 0058          IF(ARC.EQ.0.) PERV(N+1)=PERV(N)+DIST                       00001990
ISN 0060          IF(ARC.GT.0.) PERV(N+1)=PERV(N)+2.*R*DARSIN(DIST/2./R)     00002000
ISN 0062          IF(KSIDE(N).EQ.0) GO TO 199                                00002010
ISN 0064          IF(YV(N+1)-YV(N)) 101,102,103                              00002020
                C  HORIZONTAL                                                00002030
ISN 0065        102 IF(DFLOAT(J).LT.YV(N)) J=J+1                             00002040
ISN 0067          IF(XV(N+1)-XV(N)) 104,105,106                              00002050
ISN 0068        105 WRITE (20,107)                                           00002060
ISN 0069        107 FORMAT(4X,'ERROR 2 VERTICES ARE COINCIDENT')             00002070
                C  LEFT HORIZONTAL                                           00002080
ISN 0070        104 CALL EDGER(L,0,-1,I,J)                                   00002090
ISN 0071          GO TO 199                                                  00002100
                C  RIGHT HORIZONTAL                                          00002110
ISN 0072        106 IF(DFLOAT(I).LT.XV(N)) I=I+1                             00002120
ISN 0074          CALL EDGER(L,0,1,I,J)                                      00002130
ISN 0075          GO TO 199                                                  00002140
                C  GOING UP                                                  00002150
ISN 0076        103 IF(DFLOAT(J).LT.YV(N)) J=J+1                             00002160
ISN 0078          IF(XV(N+1)-XV(N)) 109,110,111                              00002170
                C  UP RIGHT                                                  00002180
ISN 0079        111 IF(DFLOAT(I).LT.XV(N)) I=I+1                             00002190
ISN 0081          CALL EDGER(L,1,1,I,J)                                      00002200
ISN 0082          GO TO 199                                                  00002210
                C  UP LEFT                                                   00002220
ISN 0083        109 CALL EDGER(L,1,-1,I,J)                                   00002230
ISN 0084          GO TO 199                                                  00002240
                C  UP VERTICAL                                               00002250
ISN 0085        110 CALL EDGER(L,1,0,I,J)                                    00002260
ISN 0086          GO TO 199                                                  00002270
                C  GOING DOWN                                                00002280
ISN 0087        101 IF(XV(N+1)-XV(N)) 117,118,119                            00002290
                C  DOWN RIGHT                                                00002300
ISN 0088        119 IF(DFLOAT(I).LT.XV(N)) I=I+1                             00002310
ISN 0090          CALL EDGER(L,-1,1,I,J)                                     00002320
ISN 0091          GO TO 199                                                  00002330
                C  DOWN LEFT                                                 00002340
ISN 0092        117 CALL EDGER(L,-1,-1,I,J)                                  00002350
ISN 0093          GO TO 199                                                  00002360
                C  DOWN VERTICAL                                             00002370
ISN 0094        118 CALL EDGER(L,-1,0,I,J)                                   00002380
ISN 0095        199 LEND(N)=L                                                00002390
ISN 0096          NL=L                                                       00002400
ISN 0097          IF(FL1.NE.0.) CALL DISPLR(POINT,14,IMAXI,JMAX,2)           00002410
ISN 0099          NLN=LN                                                     00002420
ISN 0100          IF(FL1.EQ.0.) GO TO 51                                     00002430
ISN 0102          WRITE(6,221) (I,XBN(I),YBN(I),DISTN(I),PERPN(I),IBN(I),JBN(I),  00002440
                 1DFIDP(I),NSIDE(I),I=2,NLN)                                 00002450
ISN 0103         51 CALL POINT2                                              00002460
ISN 0104          LK=1                                                       00002470
ISN 0105          DO 130 LN=2,NLN                                            00002480
ISN 0106          IF(POINT(IBN(LN),JBN(LN))) 130,130,132                     00002490
ISN 0107        132 LK=LK+1                                                  00002500
ISN 0108          XBN(LK)=XBN(LN)                                            00002510
```

FIGURE C.7

```
ISN 0109          YBN(LK)=YBN(LN)                                          00002520
ISN 0110          NSIDE(LK)=NSIDE(LN)                                      00002530
ISN 0111          DISTN(LK)=DISTN(LN)                                      00002540
ISN 0112          PERPN(LK)=PERPN(LN)                                      00002550
ISN 0113          IBN(LK)=IBN(LN)                                          00002560
ISN 0114          JBN(LK)=JBN(LN)                                          00002570
ISN 0115          DFIDP(LK)=DFIDP(LN)                                      00002580
ISN 0116      130 CONTINUE                                                 00002590
ISN 0117          NLN=LK                                                   00002600
ISN 0118          N=1                                                      00002610
ISN 0119          LNBEG(N)=2                                               00002620
ISN 0120          DO 300 LN=3,NLN                                          00002630
ISN 0121          IF(NSIDE(LN).EQ.NSIDE(LN-1)) GO TO 301                   00002640
ISN 0123          N=NSIDE(LN)                                              00002650
ISN 0124          LNBEG(N)=LN                                              00002660
ISN 0125      301 LNEND(N)=LN                                              00002670
ISN 0126      300 CONTINUE                                                 00002680
ISN 0127      254 FORMAT('1    FILTERED POINT',/)                          00002690
ISN 0128          IF(EL2.NE.1.) GO TO 290                                  00002700
ISN 0130          WRITE(6,256)                                             00002710
ISN 0131      256 FORMAT('1    SURFACE-GRID INTERSECTION SUMMARY',/)       00002720
ISN 0132          WRITE(6,255) (I,XB(I),YB(I),XNORM(I),YNORM(I),PERP(I),I= 00002730
                 12,NL)                                                    00002740
ISN 0133          WRITE(6,220)                                             00002750
ISN 0134      220 FORMAT('1    ADJACENT INTERNAL NORMAL TO SURFACE SUMMARY',/) 00002760
ISN 0135          WRITE(6,221) (I,XBN(I),YBN(I),DISTN(I),PERPN(I),IBN(I),JBN(I), 00002770
                 1DFIDP(I),NSIDE(I),I=2,NLN)                               00002780
ISN 0136      221 FORMAT(' LN=',I3,' XBN=',F5.1,' YBN=',F5.1,' DISTN=',F5.2,' PERPN=00002790
                 1',F7.1,' IBN=',I2,' JBN=',I2,' DFIDP=',F7.3,' NSIDE=',I2)  00002800
ISN 0137      255 FORMAT(' L=',I3,' XB=',F5.1,' YB=',F5.1,' XNORM=',F5.2,'  00002810
                 1 YNORM=',F5.2,' PERP=',F7.1)                             00002820
ISN 0138          WRITE(6,570)                                             00002830
ISN 0139      570 FORMAT('1    POINT DISTRIBUTION')                        00002840
ISN 0140          CALL DISPLR(POINT,14,IMAXI,JMAX,2)                       00002850
ISN 0141      290 CONTINUE                                                 00002860
ISN 0142          RETURN                                                   00002870
ISN 0143          END                                                      00002880

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =     142 ,PROGRAM SIZE =     3838

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          75K BYTES OF CORE NOT USED
```

FIGURE C.8

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.54.40

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00002890
ISN 0002              SUBROUTINE EDGER(L,JUP,IRIGHT,I,J)                                00002900
ISN 0003              IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                          00002910
ISN 0004              COMMON /B/ XC,YC,RSQRD,SLOPE,SLOPE1,SGNX,SGNY,N,MSIDE,ARC,R       00002920
ISN 0005              COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX    00002930
ISN 0006              COMMON /A/ POINT(41,41),XB(300),YB(300),PERP                      00002940
                     1(300),XNORM(300),YNORM(300),NL                                   00002950
ISN 0007              COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50)  00002960
ISN 0008              COMMON /G/ LN                                                     00002970
ISN 0009              COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280),    00002980
                     1IBN(280),JBN(280),NSIDE(280),NLN                                 00002990
ISN 0010              NC=0                                                              00003000
ISN 0011              IF(JUP.EQ.0) SLOPE1=999.                                          00003010
ISN 0013              IF(IRIGHT.EQ.0) SLOPE=999.                                        00003020
ISN 0015              L=L+1                                                             00003030
ISN 0016              XB(L)=XV(N)                                                       00003040
ISN 0017              YB(L)=YV(N)                                                       00003050
ISN 0018              GO TO 1020                                                        00003060
ISN 0019         1010 IF(JUP.EQ.1.AND.(J-1).GE.YV(N+1)) GO TO 1009                      00003070
ISN 0021              IF(JUP.EQ.-1.AND.(J+1).LE.YV(N+1)) GO TO 1009                     00003080
ISN 0023              IF(IRIGHT.EQ.1.AND.(I-1).GE.XV(N+1)) GO TO 1009                   00003090
ISN 0025              IF(IRIGHT.EQ.-1.AND.(I+1).LE.XV(N+1)) GO TO 1009                  00003100
ISN 0027              IF(IRIGHT.EQ.1.AND.I.LE.XV(N+1)) GO TO 1001                       00003110
ISN 0029              IF(IRIGHT.EQ.-1.AND.I.GE.XV(N+1)) GO TO 1001                      00003120
ISN 0031              IF(JUP.EQ.1.AND.J.LE.YV(N+1)) GO TO 1001                          00003130
ISN 0033              IF(JUP.EQ.-1.AND.DFLOAT(J).GE.YV(N+1)) GO TO 1001                 00003140
ISN 0035              GO TO 1009                                                        00003150
ISN 0036         1001 L=L+1                                                             00003160
ISN 0037              IF(ARC.GT.0.) GO TO 1002                                          00003170
ISN 0039              IF(IRIGHT.NE.0) Y=SLOPE*(DFLOAT(I)-XV(N))+YV(N)                   00003180
ISN 0041              IF(JUP.NE.0) X=SLOPE1*(DFLOAT(J)-YV(N))+XV(N)                     00003190
ISN 0043              IF(IRIGHT.EQ.0) Y=DFLOAT(J)                                       00003200
ISN 0045              IF(JUP.EQ.0) X=DFLOAT(I)                                          00003210
ISN 0047              GO TO 1003                                                        00003220
ISN 0048         1002 RY=RSQRD-(DFLOAT(I)-XC)**2                                        00003230
ISN 0049              IF(RY.LT.0.) RY=0.                                                00003240
ISN 0051              RX=RSQRD-(DFLOAT(J)-YC)**2                                        00003250
ISN 0052              IF(RX.LT.0.) RX=0.                                                00003260
ISN 0054              Y=YC+SGNY*DSQRT(RY)                                               00003270
ISN 0055              X=XC+SGNX*DSQRT(RX)                                               00003280
ISN 0056         1003 IF(IRIGHT.EQ.0) GO TO 1004                                        00003290
ISN 0058              IF(JUP.EQ.-1) GO TO 1008                                          00003300
ISN 0060              IF(Y-DFLOAT(J)) 1005,1004,1007                                    00003310
ISN 0061         1004 IF(X-DFLOAT(I)) 1007,1006,1007                                    00003320
ISN 0062         1008 IF(Y-DFLOAT(J)) 1007,1004,1005                                    00003330
ISN 0063         1007 XB(L)=X                                                           00003340
ISN 0064              YB(L)=DFLOAT(J)                                                   00003350
ISN 0065              IM=X                                                              00003360
ISN 0066              IF(JUP.EQ.1) IM=IM+1                                              00003370
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                   00003380
                C   HERE IS X-CUTOFF ************************************             00003390
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                   00003400
ISN 0068              IF(DABS(X-IM).GT..1) GO TO 1021                                   00003410
```

FIGURE C.9

```
ISN 0070          I=IM                                                          00003420
ISN 0071          GO TO 1006                                                    00003430
ISN 0072       1021 IF(POINT(IM,J).NE.-1.AND.POINT(IM,J).LT.1.) POINT(IM,J)=L+POINT(IM00003440
                  1,J)                                                         00003450
ISN 0074          IF(IM.NE.IBN(LN).OR.J.NE.JBN(LN).OR.N.NE.NSIDE(LN-1)) CALL NORMAL 00003460
                  1(IM,J,L,IRIGHT,JUP)                                         00003470
ISN 0076          J=J+JUP                                                       00003480
ISN 0077          GO TO 1020                                                    00003490
ISN 0078       1005 XB(L)=DFLOAT(I)                                             00003500
ISN 0079          YB(L)=Y                                                       00003510
ISN 0080          JM=Y                                                          00003520
ISN 0081          IF(IRIGHT.EQ.-1) JM=JM+1                                      00003530
                C ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***            00003540
                C  HERE IS Y-CUTOFF  ************************************      00003550
                C ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***            00003560
ISN 0083          IF(DABS(Y-JM).GT..1) GO TO 1022                               00003570
ISN 0085          J=JM                                                          00003580
ISN 0086          GO TO 1006                                                    00003590
ISN 0087       1022 MP=POINT(I,JM)                                              00003600
ISN 0088          YPT=POINT(I,JM)-MP                                            00003610
ISN 0089          IF(MP.NE.-1.AND.YPT.EQ.0.) POINT(I,JM)=POINT(I,JM)            00003620
                  1+.001*L                                                     00003630
ISN 0091          IF(I.NE.IBN(LN).OR.JM.NE.JBN(LN).OR.N.NE.NSIDE(LN-1))         00003640
                  1 CALL NORMAL(I,JM,L,IRIGHT,JUP)                             00003650
ISN 0093          I=I+IRIGHT                                                    00003660
ISN 0094          GO TO 1020                                                    00003670
ISN 0095       1006 XB(L)=DFLOAT(I)                                             00003680
ISN 0096          YB(L)=DFLOAT(J)                                               00003690
ISN 0097          POINT(I,J)=-1                                                 00003700
ISN 0098          IM=I+JUP                                                      00003710
ISN 0099          JM=J+IRIGHT                                                   00003720
ISN 0100          IF(POINT(IM,J).NE.-1..AND.POINT(IM,J).LT.1.) POINT(IM,J)=POINT(IM 00003730
                  1,J)+L                                                       00003740
ISN 0102          MP=POINT(I,JM)                                                00003750
ISN 0103          YPT=POINT(I,JM)-MP                                            00003760
ISN 0104          IF(MP.NE.-1.AND.YPT.EQ.0.) POINT(I,JM)=                       00003770
                  1POINT(I,JM)+.001*L                                          00003780
ISN 0106          IF(JUP*IRIGHT) 1011,1011,1012                                 00003790
ISN 0107       1011 IF(IM.NE.IBN(LN).OR.J.NE.JBN(LN).OR.N.NE.NSIDE(LN-1))       00003800
                  1 CALL NORMAL(IM,J,L,IRIGHT,JUP)                             00003810
ISN 0109          CALL NORMAL(I,JM,L,IRIGHT,JUP)                                00003820
ISN 0110          GO TO 1013                                                    00003830
ISN 0111       1012 IF(I.NE.IBN(LN).OR.JM.NE.JBN(LN).OR.N.NE.NSIDE(LN-1))       00003840
                  1 CALL NORMAL(I,JM,L,IRIGHT,JUP)                             00003850
ISN 0113          CALL NORMAL(IM,J,L,IRIGHT,JUP)                                00003860
ISN 0114       1013 I=I+IRIGHT                                                  00003870
ISN 0115          J=J+JUP                                                       00003880
ISN 0116       1020 ADIST=DSQRT((XB(L)-XV(N))**2+(YB(L)-YV(N))**2)              00003890
ISN 0117          IF(ARC.EQ.0.) PERP(L)=PERV(N)+ADIST                           00003900
ISN 0119          IF(ARC.GT.0.) PERP(L)=PERV(N)+2.*R*DARSIN(ADIST/2./R)         00003910
ISN 0121          IF(PERP(L).GT.PERV(N+1)) L=L-1                                00003920
ISN 0123          IF(PERP(L).GT.PERV(N+1)) GO TO 1010                           00003930
ISN 0125          IF(ARC.LT..5) GO TO 1030                                      00003940
ISN 0127          IF((YB(L)-YC).NE.0.) SLOPE=(XB(L)-XC)/(YB(L)-YC)              00003950
ISN 0129          IF((XB(L)-XC).NE.0.) SLOPE1=(YB(L)-YC)/(XB(L)-XC)             00003960
```

FIGURE C.10

```
ISN 0131      1030 IF(SLOPE.NE.0.) GO TO 1031                          00003970
ISN 0133           XNORM(L)=0.                                         00003980
ISN 0134           YNORM(L)=-IRIGHT                                    00003990
ISN 0135           GO TO 1010                                          00004000
ISN 0136      1031 IF(SLOPE1.NE.0.) GO TO 1032                         00004010
ISN 0138           XNORM(L)=JUP                                        00004020
ISN 0139           YNORM(L)=0.                                         00004030
ISN 0140           GO TO 1010                                          00004040
ISN 0141      1032 XNORM(L)=JUP/DSQRT(1.+SLOPE1**2)                    00004050
ISN 0142           YNORM(L)=-IRIGHT/DSQRT(1.+SLOPE**2)                 00004060
ISN 0143           GO TO 1010                                          00004070
ISN 0144      1009 CONTINUE                                            00004080
ISN 0145           NC=NC+1                                             00004090
ISN 0146           IF(NC.GT.1) GO TO 990                               00004100
ISN 0148           L=L+1                                               00004110
ISN 0149           XB(L)=XV(N+1)                                       00004120
ISN 0150           YB(L)=YV(N+1)                                       00004130
ISN 0151           GO TO 1020                                          00004140
ISN 0152       990 CONTINUE                                            00004150
ISN 0153           RETURN                                              00004160
ISN 0154           END                                                 00004170

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =     153 ,PROGRAM SIZE =     4346

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          93K BYTES OF CORE NOT USED
```

FIGURE C.11

```
LEVEL 21.7 ( JAN 73 )          OS/360  FORTRAN H                    DATE  76.175/11.54.46

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                00004180
   ISN 0002          SUBROUTINE POINT2                                               00004190
   ISN 0003          IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00004200
   ISN 0004          COMMON /A/ POINT(41,41),XB(300),YB(300),PERP                    00004210
                    1(300),XNORM(300),YNORM(300),NL                                 00004220
   ISN 0005          COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX  00004230
   ISN 0006          COMMON /F/ IMIN(60),IMAX(60),JMX                                00004240
   ISN 0007          COMMON /A7/ ELIN,ELOUT,EPO,EL1,EL2,ITSMAX                       00004250
   ISN 0008          DO 9 J=1,JMAX                                                   00004260
   ISN 0009          NC=0                                                            00004270
   ISN 0010          N=0                                                             00004280
   ISN 0011          IMAX(J)=0                                                       00004290
   ISN 0012          IMIN(J)=0                                                       00004300
   ISN 0013          DO 10 I=1,IMAXI                                                 00004310
   ISN 0014          IF(POINT(I,J)) 10,11,13                                         00004320
   ISN 0015       13 LP=POINT(I,J)                                                   00004330
   ISN 0016          IF(LP.GT.1) XD=XB(LP)-(                                         00004340
   ISN 0018          IF(LP.LE.1) XD=0.                                               00004350
   ISN 0020          IF(NC.EQ.1.OR.XD.LT.0) GO TO 14                                 00004360
   ISN 0022          POINT(I,J)=0                                                    00004370
   ISN 0023          IF(XD.EQ.0.) GO TO 10                                           00004380
   ISN 0025          IF(XD.EQ.1.) POINT(I+2,J)=0                                     00004390
   ISN 0027          IF(XD.NE.1.) POINT(I+1,J)=0                                     00004400
   ISN 0029          GO TO 10                                                        00004410
   ISN 0030       14 IF(NC.EQ.1) GO TO 16                                            00004420
   ISN 0032          PY=(POINT(I,J)-LP)*1000.                                        00004430
                C  ****** PECULIARITY ******                                        00004440
   ISN 0033          LY=PY+1                                                         00004450
   ISN 0034          YD=0.                                                           00004460
   ISN 0035          IF(LY.GT.1) YD=YB(LY)-J                                         00004470
   ISN 0037          IF(J.EQ.1) GO TO 17                                             00004480
   ISN 0039          LP1=POINT(I,J-1)                                                00004490
   ISN 0040          PY1=(POINT(I,J-1)-LP1)*1000.                                    00004500
                C  ****** PECULIARITY ******                                        00004510
   ISN 0041          LY1=PY1+1                                                       00004520
   ISN 0042          YD1=0.                                                          00004530
   ISN 0043          IF(LY1.GT.1) YD1=YB(LY1)-(J-1)                                  00004540
   ISN 0045          IF(YD1.GT.0..AND.YD.GE.0.) POINT(I,J)=0.                        00004550
   ISN 0047       17 IF(J.EQ.JMAX) GO TO 18                                          00004560
   ISN 0049          LP2=POINT(I,J+1)                                                00004570
   ISN 0050          PY2=(POINT(I,J+1)-LP2)*1000.                                    00004580
                C  ****** PECULIARITY ******                                        00004590
   ISN 0051          LY2=PY2+1                                                       00004600
   ISN 0052          YD2=0.                                                          00004610
   ISN 0053          IF(LY2.GT.1) YD2=YB(LY2)-(J+1)                                  00004620
   ISN 0055          IF(YD2.LT.0..AND.YD.LE.0.) POINT(I,J)=0.                        00004630
   ISN 0057       18 IF(POINT(I,J).EQ.0.) GO TO 10                                   00004640
   ISN 0059       16 IF(I.EQ.IMAXI) GO TO 12                                         00004650
   ISN 0061          IF(DABS(XD).LE.1..AND.XD.NE.0.) GO TO 12                        00004660
   ISN 0063          IF(POINT(I-1,J).LT.0.OR.POINT(I+1,J).LT.0) GO TO 12             00004670
   ISN 0065          GO TO 10                                                        00004680
   ISN 0066       12 NC=(1+(-1)**NC)/2                                               00004690
   ISN 0067          N=N+1                                                           00004700
```

FIGURE C.12

```
ISN 0068          IF(N.EQ.1) IMIN(J)=I                                    00004710
ISN 0070          IMAX(J)=I                                               00004720
ISN 0071          GO TO 10                                                00004730
ISN 0072       11 IF(NC.EQ.1) POINT(I,J)=1                                00004740
ISN 0074       10 CONTINUE                                                00004750
ISN 0075          IF(IMAX(J).NE.0) JMX=J                                  00004760
ISN 0077        9 CONTINUE                                                00004770
ISN 0078          IF(FL2.NE.1.) GO TO 21                                  00004780
ISN 0080          WRITE(6,19)                                             00004790
ISN 0081       19 FORMAT('1   SWEEP SUMMARY',/)                           00004800
ISN 0082          WRITE(6,15) (J,IMIN(J),IMAX(J),J=2,JMX)                 00004810
ISN 0083       15 FORMAT('  J=',I2,4X,'IMIN=',I2,4X,'IMAX=',I2)           00004820
ISN 0084       21 CONTINUE                                                00004830
ISN 0085          RETURN                                                  00004840
ISN 0086          END                                                     00004850

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      85 ,PROGRAM SIZE =     1772

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          99K BYTES OF CORE NOT USED
```

FIGURE C.13

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.54.48

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
               C  ***EVITS  4/29/76******DOMANUS, H. ***  X3244  ***                    00004860
    ISN 0002           SUBROUTINE DISPLI(INT,INC,IMAXI,JMAX,ICO)                       00004870
    ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00004880
    ISN 0004           DIMENSION INT(41,41)                                            00004890
    ISN 0005           N=0                                                             00004900
    ISN 0006           IB=1-INC                                                        00004910
    ISN 0007       259 N=N+1                                                           00004920
    ISN 0008           IF(N.GT.1) WRITE(6,265)                                         00004930
    ISN 0010       265 FORMAT('1    ')                                                00004940
    ISN 0011           IB=IB+INC                                                       00004950
    ISN 0012           IE=IMAXI                                                        00004960
    ISN 0013           IF(IMAXI.GT.INC*N) IE=INC*N                                     00004970
    ISN 0015           IF(ICO.EQ.1) WRITE(6,263) (I,I=IB,IE)                           00004980
    ISN 0017           IF(ICO.EQ.2) WRITE(6,264) (I,I=IB,IE)                           00004990
    ISN 0019           IF(ICO.EQ.3) WRITE(20,263) (I,I=IB,IE)                          00005000
    ISN 0021           IF(ICO.EQ.4) WRITE(6,267) (I,I=IB,IE)                           00005010
    ISN 0023           DO 260 J=1,JMAX                                                 00005020
    ISN 0024           K=JMAX-J+1                                                      00005030
    ISN 0025           IF(ICO.EQ.1) WRITE(6,261) K,(INT(I,K),I=IB,IE)                  00005040
    ISN 0027           IF(ICO.EQ.2) WRITE(6,262) K,(INT(I,K),I=IB,IE)                  00005050
    ISN 0029           IF(ICO.EQ.3) WRITE(20,261) K,(INT(I,K),I=IB,IE)                 00005060
    ISN 0031           IF(ICO.EQ.4) WRITE(6,266) K,(INT(I,K),I=IB,IE)                  00005070
    ISN 0033       260 CONTINUE                                                        00005080
    ISN 0034       261 FORMAT(1X,I2,1X,55I2)                                           00005090
    ISN 0035       262 FORMAT(/,1X,I2,1X,14F8.3)                                       00005100
    ISN 0036       263 FORMAT(/,4X,55I2)                                               00005110
    ISN 0037       264 FORMAT(/,1X,14I8)                                               00005120
    ISN 0038       266 FORMAT(//,1X,I2,1X,19F6.3)                                      00005130
    ISN 0039       267 FORMAT(/,1X,19I6)                                               00005140
    ISN 0040           IF(IMAXI.GT.IE) GO TO 259                                       00005150
    ISN 0042           RETURN                                                          00005160
    ISN 0043           END                                                             00005170

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

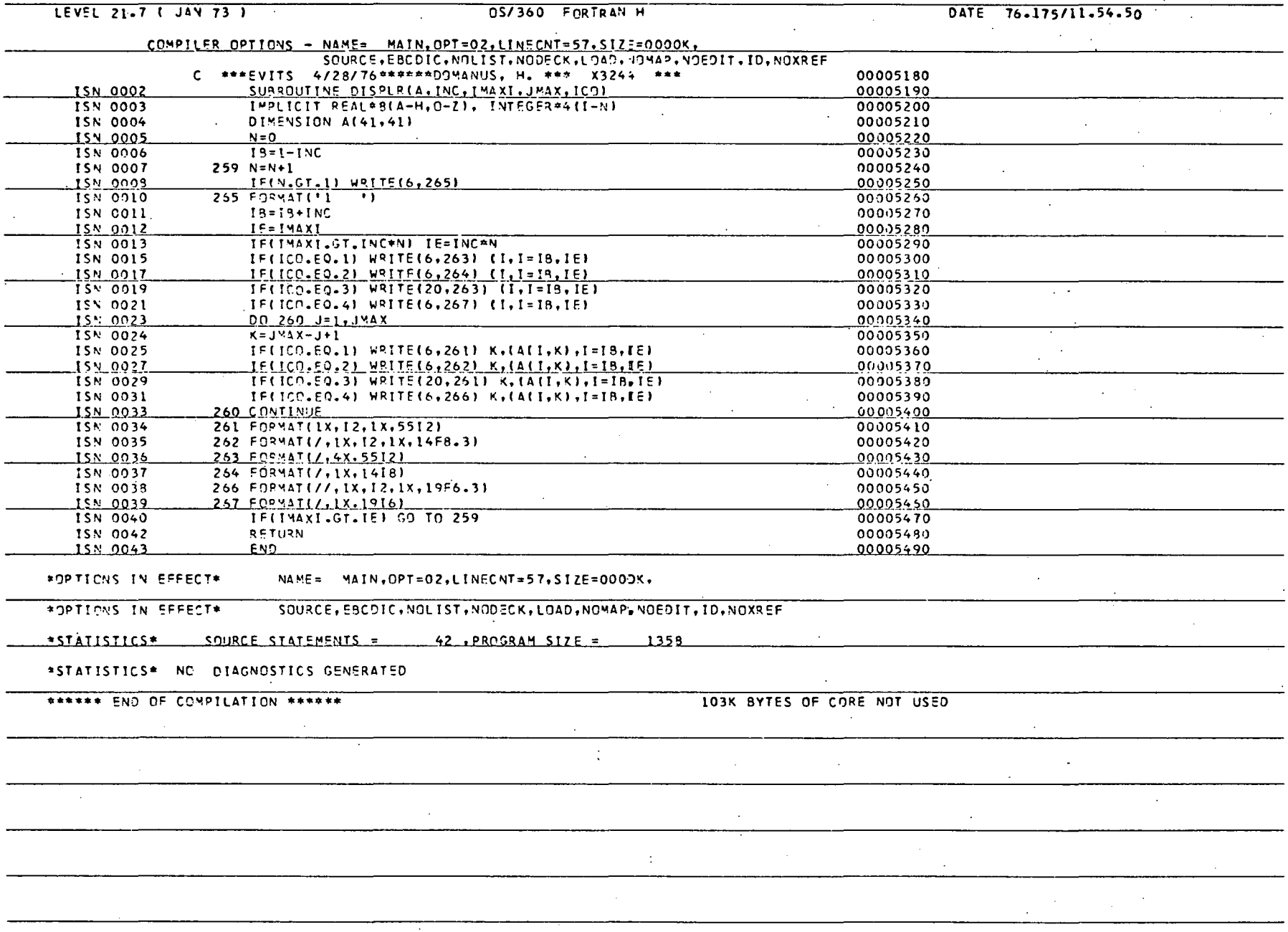
*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      42 ,PROGRAM SIZE =     1354

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          103K BYTES OF CORE NOT USED
```

FIGURE C.14



```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.54.50

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00005180
     ISN 0002           SUBROUTINE DISPLR(A,INC,IMAXI,JMAX,ICO)                         00005190
     ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00005200
     ISN 0004           DIMENSION A(41,41)                                              00005210
     ISN 0005           N=0                                                             00005220
     ISN 0006           IB=1-INC                                                        00005230
     ISN 0007       259 N=N+1                                                           00005240
     ISN 0008           IF(N.GT.1) WRITE(6,265)                                         00005250
     ISN 0010       265 FORMAT('1    ')                                                00005260
     ISN 0011           IB=IB+INC                                                       00005270
     ISN 0012           IE=IMAXI                                                        00005280
     ISN 0013           IF(IMAXI.GT.INC*N) IE=INC*N                                     00005290
     ISN 0015           IF(ICO.EQ.1) WRITE(6,263) (I,I=IB,IE)                           00005300
     ISN 0017           IF(ICO.EQ.2) WRITE(6,264) (I,I=IB,IE)                           00005310
     ISN 0019           IF(ICO.EQ.3) WRITE(20,263) (I,I=IB,IE)                          00005320
     ISN 0021           IF(ICO.EQ.4) WRITE(6,267) (I,I=IB,IE)                           00005330
     ISN 0023           DO 260 J=1,JMAX                                                 00005340
     ISN 0024           K=JMAX-J+1                                                      00005350
     ISN 0025           IF(ICO.EQ.1) WRITE(6,261) K,(A(I,K),I=IB,IE)                    00005360
     ISN 0027           IF(ICO.EQ.2) WRITE(6,262) K,(A(I,K),I=IB,IE)                    00005370
     ISN 0029           IF(ICO.EQ.3) WRITE(20,261) K,(A(I,K),I=IB,IE)                   00005380
     ISN 0031           IF(ICO.EQ.4) WRITE(6,266) K,(A(I,K),I=IB,IE)                    00005390
     ISN 0033       260 CONTINUE                                                        00005400
     ISN 0034       261 FORMAT(1X,I2,1X,55I2)                                           00005410
     ISN 0035       262 FORMAT(/,1X,I2,1X,14F8.3)                                       00005420
     ISN 0036       263 FORMAT(/,4X,55I2)                                               00005430
     ISN 0037       264 FORMAT(/,1X,14I8)                                               00005440
     ISN 0038       266 FORMAT(//,1X,I2,1X,19F6.3)                                      00005450
     ISN 0039       267 FORMAT(/,1X,19I6)                                               00005460
     ISN 0040           IF(IMAXI.GT.IE) GO TO 259                                       00005470
     ISN 0042           RETURN                                                          00005480
     ISN 0043           END                                                             00005490

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

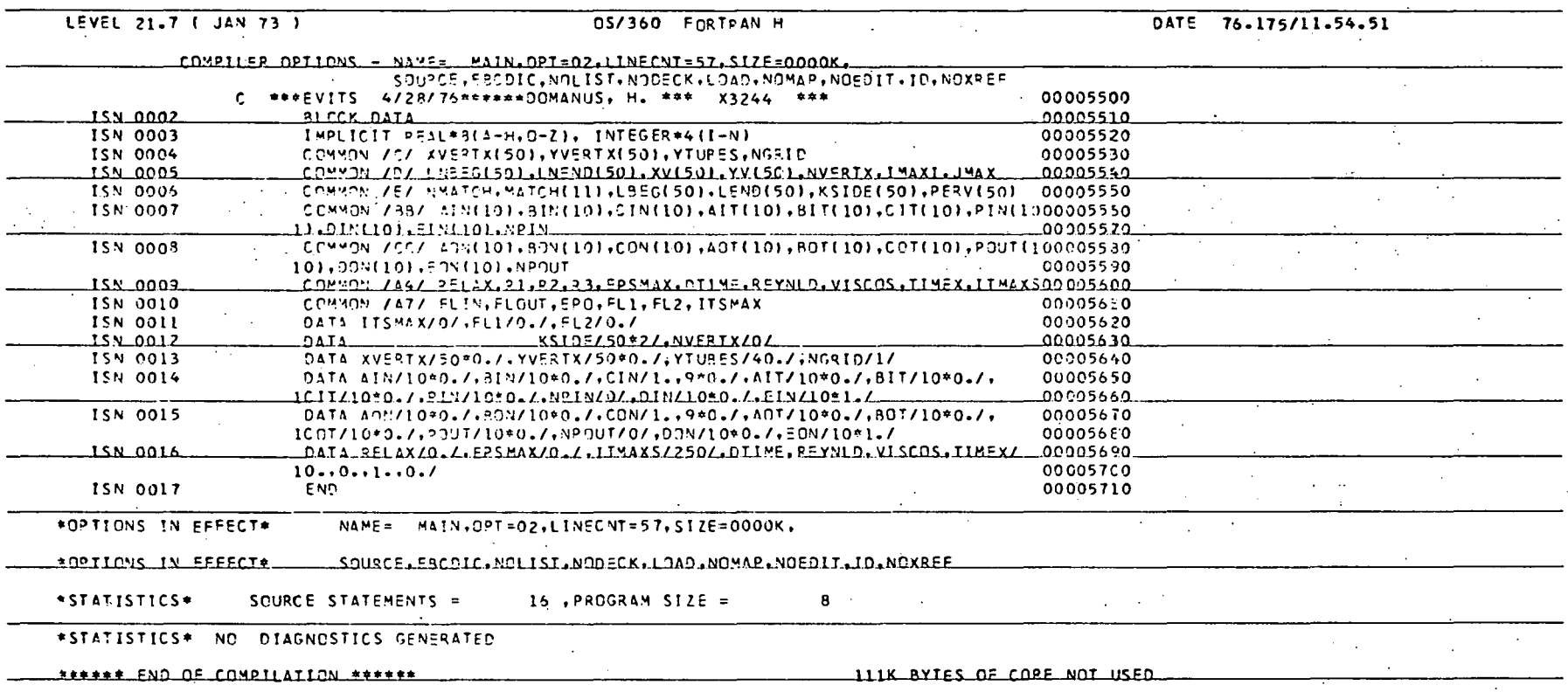
*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      42 ,PROGRAM SIZE =     1358

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          103K BYTES OF CORE NOT USED
```

FIGURE C.15



```
LEVEL 21.7 ( JAN 73 )                    OS/360 FORTRAN H                    DATE  76.175/11.54.51

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                                SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00005500
     ISN 0002            BLOCK DATA                                                     00005510
     ISN 0003            IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                       00005520
     ISN 0004            COMMON /C/ XVERTX(50),YVERTX(50),YTUBES,NGRID                  00005530
     ISN 0005            COMMON /D/ LNEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX  00005540
     ISN 0006            COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50) 00005550
     ISN 0007            COMMON /BB/ AIN(10),BIN(10),CIN(10),AIT(10),BIT(10),CIT(10),PIN(100005550
                        1),DIN(10),EIN(10),NPIN                                         00005570
     ISN 0008            COMMON /CC/ AON(10),BON(10),CON(10),AOT(10),BOT(10),COT(10),POUT(100005580
                        10),DON(10),EON(10),NPOUT                                       00005590
     ISN 0009            COMMON /A4/ RELAX,P1,P2,P3,EPSMAX,DTIME,REYNLD,VISCOS,TIMEX,ITMAXS00005600
     ISN 0010            COMMON /A7/ FLIN,FLOUT,EPO,FL1,FL2,ITSMAX                       00005610
     ISN 0011            DATA ITSMAX/0/,FL1/0./,FL2/0./                                  00005620
     ISN 0012            DATA                  KSIDE/50*2/,NVERTX/0/                     00005630
     ISN 0013            DATA XVERTX/50*0./,YVERTX/50*0./,YTUBES/40./,NGRID/1/           00005640
     ISN 0014            DATA AIN/10*0./,BIN/10*0./,CIN/1.,9*0./,AIT/10*0./,BIT/10*0./,  00005650
                        1CIT/10*0./,PIN/10*0./,NPIN/0/,DIN/10*0./,EIN/10*1./            00005660
     ISN 0015            DATA AON/10*0./,BON/10*0./,CON/1.,9*0./,AOT/10*0./,BOT/10*0./,  00005670
                        1COT/10*0./,POUT/10*0./,NPOUT/0/,DON/10*0./,EON/10*1./          00005680
     ISN 0016            DATA RELAX/0./,EPSMAX/0./,ITMAXS/250/,DTIME,REYNLD,VISCOS,TIMEX/ 00005690
                        10.,0.,1.,0./                                                   00005700
     ISN 0017            END                                                            00005710

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       16 ,PROGRAM SIZE =         8

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  111K BYTES OF CORE NOT USED
```

FIGURE C.16

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.54.52

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00005720
ISN 0002              SUBROUTINE NORMAL(I,J,L,IRIGHT,JUP)                               00005730
ISN 0003              IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                          00005740
ISN 0004              COMMON /G/ LN                                                     00005750
ISN 0005              COMMON /B/ XC,YC,RSQRD,SLOPE,SLOPE1,SGNX,SGNY,N,MSIDE,ARC,R       00005760
ISN 0006              COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX    00005770
ISN 0007              COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50)  00005780
ISN 0008              COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280),    00005790
                     1IBN(280),JBN(280),NSIDE(280),NLN                                  00005800
ISN 0009              IF (IRIGHT.NE.0) GO TO 301                                        00005810
ISN 0011              XN=XV(N)                                                          00005820
ISN 0012              YN=DFLOAT(J)                                                      00005830
ISN 0013              GO TO 302                                                         00005840
ISN 0014          301 IF(JUP.NE.0) GO TO 303                                            00005850
ISN 0016              XN=DFLOAT(I)                                                      00005860
ISN 0017              YN=YV(N)                                                          00005870
ISN 0018              GO TO 302                                                         00005880
ISN 0019          303 IF(ARC.GT..5) GO TO 304                                           00005890
ISN 0021              XN=(SLOPE*XV(N)+SLOPE1*DFLOAT(I)+DFLOAT(J)-YV(N))/(SLOPE+SLOPE1)  00005900
ISN 0022              YN=SLOPE*(XN-XV(N))+YV(N)                                         00005910
ISN 0023              GO TO 305                                                         00005920
ISN 0024          304 DENOM=DSQRT((DFLOAT(I)-XC)**2+(DFLOAT(J)-YC)**2)                  00005930
ISN 0025              XN=XC+R*(DFLOAT(I)-XC)/DENOM                                      00005940
ISN 0026              YN=YC+R*(DFLOAT(J)-YC)/DENOM                                      00005950
ISN 0027              IF(ARC.GT.1.5) GO TO 400                                          00005960
ISN 0029              IF((XN-XV(N+2))*(XN-XV(N)).GT.0.) GO TO 306                       00005970
ISN 0031              IF((YN-YV(N+2))*(YN-YV(N)).GT.0.) GO TO 306                       00005980
ISN 0033              GO TO 302                                                         00005990
ISN 0034          400 IF((XN-XV(N+1))*(XN-XV(N-1)).GT.0.) GO TO 306                     00006000
ISN 0036              IF((YN-YV(N+1))*(YN-YV(N-1)).GT.0.) GO TO 306                     00006010
ISN 0038              GO TO 302                                                         00006020
ISN 0039          305 IF(IRIGHT.EQ.1.AND.(XN.LT.XV(N).OR.XN.GT.XV(N+1))) GO TO 306      00006030
ISN 0041              IF(IRIGHT.EQ.-1.AND.(XN.GT.XV(N).OR.XN.LT.XV(N+1))) GO TO 306     00006040
ISN 0043              IF(JUP.EQ.1.AND.(YN.LT.YV(N).OR.YN.GT.YV(N+1))) GO TO 306         00006050
ISN 0045              IF(JUP.EQ.-1.AND.(YN.GT.YV(N).OR.YN.LT.YV(N+1))) GO TO 306        00006060
ISN 0047          302 LN=LN+1                                                           00006070
ISN 0048              DISTN(LN)=DSQRT((XN-I)**2+(YN-J)**2)                              00006080
                C  ********** HERE IS LN CUTOFF **********************                  00006090
ISN 0049              IF(DISTN(LN).GT..1) GO TO 307                                     00006100
ISN 0051              LN=LN-1                                                           00006110
ISN 0052              GO TO 306                                                         00006120
ISN 0053          307 XBN(LN)=XN                                                        00006130
ISN 0054              YBN(LN)=YN                                                        00006140
ISN 0055              NSIDE(LN)=N                                                       00006150
ISN 0056              IBN(LN)=I                                                         00006160
ISN 0057              JBN(LN)=J                                                         00006170
ISN 0058              DFIDP(LN)=0.                                                      00006180
ISN 0059              IF(ARC.LT..5) GO TO 308                                           00006190
ISN 0061              DFIDP(LN)=1./R                                                    00006200
ISN 0062              IF(DENOM.LT.R) DFIDP(LN)=-1./R                                    00006210
ISN 0064          308 ADIS=DSQRT((XN-XV(N))**2+(YN-YV(N))**2)                           00006220
ISN 0065              IF(ARC.LT..5) PERPN(LN)=PERV(N)+ADIS                              00006230
ISN 0067              IF(ARC.GT..5) PERPN(LN)=PERV(N)+2.*R*DARSIN(ADIS/2./R)            00006240
```

FIGURE C.17

```
ISN 0069        306 CONTINUE                                                    00006250
ISN 0070            RETURN                                                      00006260
ISN 0071            END                                                         00006270

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      70 ,PROGRAM SIZE =     1918

*STATISTICS*  NO  DIAGNOSTICS GENERATED

******* END OF COMPILATION ******                          103K BYTES OF CORE NOT USED
```

FIGURE C.18

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11-54.54

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00006280
ISN 0002                     SUBROUTINE BOUND                                           00006290
ISN 0003                     IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                   00006300
ISN 0004                     COMMON /A/ POINT(41,41),XB(300),YB(300),PERP               00006310
                            1(300),XNORM(300),YNORM(300),NL                            00006320
ISN 0005                     COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX  00006330
ISN 0006                     COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50)  00006340
ISN 0007                     COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280),  00006350
                            1IBN(280),JBN(280),NSIDE(280),NLN                          00006360
ISN 0008                     COMMON /BB/ AIN(10),BIN(10),CIN(10),AIT(10),BIT(10),CIT(10),PIN(10  00006370
                            1),DIN(10),EIN(10),NPIN                                    00006380
ISN 0009                     COMMON /CC/ AON(10),BON(10),CON(10),AOT(10),BOT(10),COT(10),POUT(10  00006390
                            10),DON(10),EON(10),NPOUT                                  00006400
ISN 0010                     COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                00006410
ISN 0011                     COMMON /EE/ SBN(280),OBN(280)                              00006420
ISN 0012                     COMMON /FF/ Q(10)                                          00006430
ISN 0013                     COMMON /GG/ CHARL,CHARU                                    00006440
ISN 0014                     COMMON /A1/ O(41,41),S(41,41)                              00006450
ISN 0015                     COMMON /A2/ U(41,41),V(41,41)                              00006460
ISN 0016                     COMMON /A3/ KPOINT(41,41)                                  00006470
ISN 0017                     COMMON /A5/ SX(280),SY(280),DX(280),DY(280),UX(280),VY(280),  00006480
                            1LDX(280),LDY(280),OX(280),OY(280),NK                      00006490
ISN 0018                     COMMON /A7/ ELIN,ELOUT,SPC,EL1,EL2,ITSMAX                  00006500
ISN 0019                     COMMON /B1/ VTBN(280),VTB(300),VNBN(280),VNB(300),DNDT(300)  00006510
ISN 0020                     IF(ELIN.NE.0.) GO TO 105                                   00006520
ISN 0022                     DO 100 L=1,NL                                              00006530
ISN 0023                     OB(L)=0.                                                   00006540
ISN 0024                     SB(L)=0.                                                   00006550
ISN 0025                     VNB(L)=0.                                                  00006560
ISN 0026                     VTB(L)=0.                                                  00006570
ISN 0027                     DNDT(L)=0.                                                 00006580
ISN 0028                     UB(L)=0.                                                   00006590
ISN 0029                100  VB(L)=0.                                                  00006600
ISN 0030                105  DO 101 LN=1,NLN                                          00006610
ISN 0031                     VTBN(LN)=0.                                                00006620
ISN 0032                     VNBN(LN)=0.                                                00006630
ISN 0033                101  OBN(LN)=0.                                                00006640
ISN 0034                     IF(EL1.GE.2) GO TO 591                                     00006650
ISN 0036                     NOB=0                                                      00006660
ISN 0037                     NIB=0                                                      00006670
ISN 0038                     NPI=NPIN+1                                                 00006680
ISN 0039                     NPO=NPOUT+1                                                00006690
ISN 0040                     DO 500 N=1,NVERTX                                          00006700
ISN 0041                     KS=KSIDE(N)                                                00006710
ISN 0042                400  FORMAT(' N=',I2,'  LBEG=',I3,'  LEND=',I3,'  LNBEG=',I3,'  LNEND='  00006720
                            1,I3)                                                      00006730
ISN 0043                401  IF(KS.EQ.4.OR.KS.EQ.14.OR.KS.EQ.7.OR.KS.EQ.17) GO TO 501  00006740
ISN 0045                     IF(KS.EQ.5.OR.KS.EQ.15.OR.KS.EQ.8.OR.KS.EQ.18) GO TO 502   00006750
ISN 0047                     GO TO 500                                                  00006760
ISN 0048                501  NIE=N+1                                                   00006770
ISN 0049                     IF(NIB.EQ.0) NIB=N                                         00006780
ISN 0051                     GO TO 500                                                  00006790
ISN 0052                502  NOE=N+1                                                   00006800
```

FIGURE C.19

```
ISN 0053          IF(NOB.EQ.0) NOB=N                                          00006810
ISN 0055      500 CONTINUE                                                    00006820
ISN 0056          DO 620 N=1,NVERTX                                           00006830
ISN 0057          KS=KSIDE(N)                                                 00006840
ISN 0058          IF(KS.EQ.6.OR.KS.EQ.1) GO TO 621                            00006850
ISN 0060          IF(KS.EQ.9.OR.KS.EQ.19) GO TO 622                           00006860
ISN 0062          GO TO 620                                                   00006870
ISN 0063      622 IF(KSIDE(N-1).NE.9.AND.KSIDE(N-1).NE.19) N9=0               00006880
ISN 0065          N9=N9+1                                                     00006890
ISN 0066          IF(N9.GT.1) LBEG(N)=0                                       00006900
ISN 0068          IF(N9.GT.1) LNBEG(N)=0                                      00006910
ISN 0070          IF(N9.EQ.1) N98=N                                           00006920
ISN 0072          LEND(N98)=LEND(N)                                           00006930
ISN 0073          DO 623 ILN=2,NLN                                            00006940
ISN 0074          IF(PERPN(ILN).GT.PERP(LEND(N))) GO TO 624                   00006950
ISN 0076      623 CONTINUE                                                    00006960
ISN 0077          ILN=ILN+1                                                   00006970
ISN 0078      624 LNEND(N98)=ILN-1                                            00006980
ISN 0079          IF(ILN-1.GT.NLN) LNEND(N98)=NLN                             00006990
ISN 0081          GO TO 620                                                   00007000
ISN 0082      621 LS1=LBEG(N)                                                 00007010
ISN 0083          LE1=LEND(N)                                                 00007020
ISN 0084          DO 90 L=LS1,LE1                                             00007030
ISN 0085          IF(PERP(L)-PERPN(LNBEG(N)).GT..9) GO TO 91                  00007040
ISN 0087       90 CONTINUE                                                    00007050
ISN 0089       91 LBEG(N)=L-1                                                 00007060
ISN 0089          LEND(N)=LBEG(N)+LNEND(N)-LNBEG(N)                           00007070
ISN 0090      620 CONTINUE                                                    00007080
ISN 0091          IF(FL2.NE.0.) WRITE(6,400) (N,LBEG(N),LEND(N),LNBEG(N),LNEND(N),N=00007090
                 11,NVERTX)                                                   00007100
ISN 0093          IF(FLIN.NE.0.) GO TO 591                                    00007110
ISN 0095          CALL LRANGE(NL,NIB,NIE,PERP,LINB,LINE)                      00007120
ISN 0096          CALL LRANGE(NL,NOB,NOE,PERP,LOUTB,LOUTE)                    00007130
ISN 0097          CALL LRANGE(NLN,NIB,NIE,PERPN,LNINB,LNINE)                  00007140
ISN 0098          CALL LRANGE(NLN,NOB,NOE,PERPN,LNOUTB,LNOUTE)                00007150
ISN 0099          PERB=PERP(NIB)                                              00007160
ISN 0100          CHARL1=PERP(NIE)-PERB                                       00007170
ISN 0101          IF(CHARL.EQ.0.) CHARL=CHARL1                                00007180
ISN 0103          IF(FL2.NE.1.) GO TO 590                                     00007190
ISN 0105          WRITE(6,551) LINB,LINE,LNINB,LNINE,LOUTB,LOUTE,LNOUTB,LNOUTE 00007200
ISN 0106      590 WRITE(6,552) CHARL,PERB                                     00007210
ISN 0107      552 FORMAT('  CHARL=',F8.4,' PERB IN=',F8.4)                    00007220
ISN 0108      551 FORMAT('1  LINB=',I3,' LINE=',I3,' LNINB=',I3,' LNINE=',I3,  00007230
                 1' LOUTB=',I3,' LOUTE=',I3,' LNOUTB=',I3,' LNOUTE=',I3)     00007240
ISN 0109          LIE1=LINE+1                                                 00007250
ISN 0110          LOE1=LOUTE+1                                                00007260
ISN 0111          LNIE1=LNINE+1                                               00007270
ISN 0112          LNOE1=LNOUTE+1                                              00007280
ISN 0113          LIB1=LINB-1                                                 00007290
ISN 0114          LOB1=LOUTB-1                                                00007300
ISN 0115          LNIB1=LNINB-1                                               00007310
ISN 0116          LNOB1=LNOUTB-1                                              00007320
ISN 0117          CALL NOSLIP(LIE1,LOB1,NL,0.00)                              00007330
ISN 0118          CALL NOSLIP(LOE1,LIB1,NL,1.00)                              00007340
ISN 0119          CALL NOSLPN(LNIE1,LNOB1,NLN,0.00)                           00007350
```

FIGURE C.20

```
ISN 0120          CALL NOSLPN(LNOE1,LNIB1,NLN,1.DO)                                00007360
ISN 0121          CALL OS(NPIN,PIN,AIN,BIN,CIN,DIN,EIN)                            00007370
ISN 0122          CHARU1=Q(NPIN+1)                                                 00007380
ISN 0123          CHARU=CHARU1*CHARL1/CHARL                                        00007390
ISN 0124          WRITE(6,553) CHARU                                               00007400
ISN 0125      553 FORMAT('  CHARU=',F8.4)                                          00007410
ISN 0126          CALL SBND(LINB,LINE,PERB,1.DO,CHARL1,CHARU1,AIN,BIN,CIN,AIT,BIT,CI00007420
                 1T,PIN,NPIN,DIN,EIN)                                              00007430
ISN 0127          CALL SBNDN(LNINB,LNINE,PERB,1.DO,CHARL1,CHARU1,AIN,BIN,CIN,AIT,BIT00007440
                 1,CIT,PIN,NPIN,DIN,EIN)                                           00007450
ISN 0128          WRITE(6,540)                                                     00007460
ISN 0129      540 FORMAT(//,'     INLET SUMMARY',///)                              00007470
ISN 0130          WRITE(6,541) (I,PIN(I),AIN(I),BIN(I),CIN(I),DIN(I),EIN(I),AIT(I),B00007480
                 1IT(I),CIT(I),I=1,NPI)                                            00007490
ISN 0131      541 FORMAT('  N=',I2,' P=',F6.3,' AN=',F8.3,' BN=',F8.3,' CN=',      00007500
                 1F8.3,' DN=',F8.3,' EN=',F8.3,' AT=',F8.3,' BT=',F8.3,' CT=',F8.3) 00007510
ISN 0132          DO 504 N=1,NPO                                                   00007520
ISN 0133          AON(N)=-AON(N)                                                   00007530
ISN 0134          BON(N)=-BON(N)                                                   00007540
ISN 0135          DON(N)=-DON(N)                                                   00007550
ISN 0136      504 CON(N)=-CON(N)                                                   00007560
ISN 0137          CALL OS(NPOUT,POUT,AON,BON,CON,DON,EON)                          00007570
ISN 0138          CU=-Q(NPOUT+1)                                                   00007580
ISN 0139          PERB=PERV(NOB)                                                   00007590
ISN 0140          OUTL=PERV(NOE)-PERB                                              00007600
ISN 0141          WRITE(6,554) OUTL,CU,PERB                                        00007610
ISN 0142      554 FORMAT('  OUTL=',F8.4,' CU=',F8.4,' PERB=',F9.4)                 00007620
ISN 0143          CALL SBND(LOUTB,LOUTE,PERB,0.DO,OUTL,CU,AON,BON,CON,AOT,BOT,     00007630
                 1COT,POUT,NPOUT,DON,EON)                                          00007640
ISN 0144          CALL SBNDN(LNOUTB,LNOUTE,PERB,0.DO,OUTL,CU,AON,BON,CON,AOT,BOT,  00007650
                 1COT,POUT,NPOUT,DON,EON)                                          00007660
ISN 0145          WRITE(6,542)                                                     00007670
ISN 0146      542 FORMAT(///,'     OUTLET SUMMARY',///)                            00007680
ISN 0147          WRITE(6,543) (I,POUT(I),AON(I),BON(I),CON(I),DON(I),EON(I),AOT(I),00007690
                 1BOT(I),COT(I),I=1,NPO)                                           00007700
ISN 0148      543 FORMAT('  N=',I2,' P=',F6.3,' AN=',F8.3,' BN=',F8.3,' CN=',F8.3  00007710
                 1,' DN=',F8.3,' EN=',F8.3,' AT=',F8.3,' BT=',F8.3,' CT=',F8.3)    00007720
ISN 0149          IF(FL2.NE.1.) GO TO 591                                          00007730
ISN 0151          WRITE(6,547)                                                     00007740
ISN 0152      547 FORMAT('1   NORMALIZED STREAM FUNCTION AND VELOCITY COMPONENT BOUN00007750
                 1DARY CONDITIONS')                                                00007760
ISN 0153          WRITE(6,544) (L,SB(L),UB(L),VB(L),L=2,NL)                        00007770
ISN 0154      544 FORMAT('  L=',I3,' SB=',F7.3,' UB=',F7.3,' VB=',F7.3)            00007780
ISN 0155          WRITE(6,545)                                                     00007790
ISN 0156      545 FORMAT('1   NORMALIZED STREAM FUNCTION NORMAL BOUNDARY CONDITIONS'00007800
                 1)                                                                00007810
ISN 0157          WRITE(6,546) (I,SBN(I),DISTN(I),I=2,NLN)                         00007820
ISN 0158      546 FORMAT('  LN=',I3,' SBN=',F8.3,' DISTN=',F9.4)                    00007830
ISN 0159      591 K=0                                                              00007840
ISN 0160          DO 300 L=1,NLN                                                   00007850
ISN 0161      300 DISTN(L)=.5*(DISTN(L)/CHARL)**2                                  00007860
ISN 0162          DO 505 J=1,JMAX                                                  00007870
ISN 0163          YJ=J                                                             00007880
ISN 0164          DO 505 I=1,IMAXI                                                 00007890
ISN 0165          XI=I                                                             00007900
```

FIGURE C.21

```
ISN 0166          IF(FLIN.EQ.1.) GO TO 610                                00007910
ISN 0168          U(I,J)=0.                                               00007920
ISN 0169          S(I,J)=.5                                               00007930
ISN 0170          V(I,J)=0.                                               00007940
ISN 0171          D(I,J)=0.                                               00007950
ISN 0172      610 IF(POINT(I,J).GT.0.) GO TO 506                          00007960
ISN 0174          KPOINT(I,J)=POINT(I,J)                                  00007970
ISN 0175          GO TO 505                                               00007980
ISN 0176      506 IF(POINT(I,J).NE.1.) GO TO 507                          00007990
ISN 0178          KPOINT(I,J)=1                                           00008000
ISN 0179          GO TO 505                                               00008010
ISN 0180      507 K=K+1                                                   00008020
ISN 0181          LDX(K)=0                                                00008030
ISN 0182          LDY(K)=0                                                00008040
ISN 0183          DX(K)=0.                                                00008050
ISN 0184          DY(K)=0.                                                00008060
ISN 0185          XD=0.                                                   00008070
ISN 0186          YD=0.                                                   00008080
ISN 0187          LX=POINT(I,J)                                           00008090
ISN 0188          PLY=1000.*(POINT(I,J)-LX)                               00008100
                C ****** PECULIARITY ******                               00008110
ISN 0189          LY=PLY+1                                                00008120
ISN 0190          IF(LX.GT.0) XD=XB(LX)-XI                                00008130
ISN 0192          IF(LY.GT.1) YD=YB(LY)-YJ                                00008140
ISN 0194          IF(XD) 508,509,510                                      00008150
ISN 0195      508 IF(LY.EQ.1) KPOINT(I,J)=2                               00008160
ISN 0197          IF(YD.GT.0.) KPOINT(I,J)=6                              00008170
ISN 0199          IF(YD.LT.0.) KPOINT(I,J)=7                              00008180
ISN 0201          GO TO 511                                               00008190
ISN 0202      509 IF(YD.GT.0.) KPOINT(I,J)=3                              00008200
ISN 0204          IF(YD.LT.0.) KPOINT(I,J)=5                              00008210
ISN 0206          GO TO 511                                               00008220
ISN 0207      510 IF(LY.EQ.1) KPOINT(I,J)=4                               00008230
ISN 0209          IF(YD.GT.0.) KPOINT(I,J)=8                              00008240
ISN 0211          IF(YD.LT.0.) KPOINT(I,J)=9                              00008250
ISN 0213      511 IF(LX.EQ.0) GO TO 512                                   00008260
ISN 0215          SX(K)=SB(LX)                                            00008270
ISN 0216          DX(K)=DABS(XD)                                          00008280
ISN 0217          UX(K)=UB(LX)                                            00008290
ISN 0218          LDX(K)=LX                                               00008300
ISN 0219      512 IF(LY.EQ.1) GO TO 505                                   00008310
ISN 0221          SY(K)=SB(LY)                                            00008320
ISN 0222          DY(K)=DABS(YD)                                          00008330
ISN 0223          VY(K)=VB(LY)                                            00008340
ISN 0224          LDY(K)=LY                                               00008350
ISN 0225      505 CONTINUE                                                00008360
ISN 0226          NK=K                                                    00008370
ISN 0227          IF(FL2.NE.1.) GO TO 592                                 00008380
ISN 0229          WRITE(6,548)                                            00008390
ISN 0230      548 FORMAT('1   SWEEP SEQUENTIAL GRID INTERSECTION STREAM FUNCTION BOU00008400
                 INDARY CONDITIONS',//)                                   00008410
ISN 0231          WRITE(6,549) (K,SX(K),DX(K),SY(K),DY(K),K=1,NK)         00008420
ISN 0232      549 FORMAT('  K=',I3,' SX=',F7.3,' DX=',F8.4,' SY=',F7.3,' DY=',F8.4) 00008430
ISN 0233      592 WRITE(6,550)                                            00008440
ISN 0234      550 FORMAT('1   KPOINT DISTRIBUTION',////)                  00008450
```

FIGURE C.22

```
ISN 0235          CALL DISPLI(KPOINT,55,IMAXI,JMAX,1)                    00008460
ISN 0236      593 CONTINUE                                               00008470
ISN 0237          RETURN                                                 00008480
ISN 0238          END                                                    00008490

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =     237 ,PROGRAM SIZE =     6266

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          59K BYTES OF CORE NOT USED
```

FIGURE C.23

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.02

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00008500
     ISN 0002           SUBROUTINE LRANGE(NL,NIB,NIE,PERP,LINB,LINE)                    00008510
     ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00008520
     ISN 0004           DIMENSION PERP(300)                                             00008530
     ISN 0005           COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50)  00008540
     ISN 0006           LINB=0                                                          00008550
     ISN 0007           LINE=0                                                          00008560
     ISN 0008           DO 601 L=2,NL                                                   00008570
     ISN 0009           IF(PERP(L).LT.PERV(NIB).OR.PERP(L).GT.PERV(NIE)) GO TO 601      00008580
     ISN 0011           IF(LINB.EQ.0) LINB=L                                            00008590
     ISN 0013       600 LINE=L                                                          00008600
     ISN 0014       601 CONTINUE                                                        00008610
     ISN 0015           RETURN                                                          00008620
     ISN 0016           END                                                             00008630

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       15 ,PROGRAM SIZE =      468

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          115K BYTES OF CORE NOT USED
```

FIGURE C.24

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.04

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00008640
  ISN 0002            SUBROUTINE NOSLIP(LINE,LOUTB,NL,W)                                00008650
  ISN 0003            IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                          00008660
  ISN 0004            COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                       00008670
  ISN 0005            IF(LOUTB.GT.LINE) GO TO 400                                       00008680
  ISN 0007            DO 401 L=1,LOUTB                                                  00008690
  ISN 0008            SB(L)=W                                                           00008700
  ISN 0009            UB(L)=0.                                                          00008710
  ISN 0010        401 VB(L)=0.                                                          00008720
  ISN 0011            NL1=NL+1                                                          00008730
  ISN 0012            DO 402 L=LINE,NL1                                                 00008740
  ISN 0013            SB(L)=W                                                           00008750
  ISN 0014            UB(L)=0.                                                          00008760
  ISN 0015        402 VB(L)=0.                                                          00008770
  ISN 0016            GO TO 403                                                         00008780
  ISN 0017        400 DO 404 L=LINE,LOUTB                                               00008790
  ISN 0018            SB(L)=W                                                           00008800
  ISN 0019            UB(L)=0.                                                          00008810
  ISN 0020        404 VB(L)=0.                                                          00008820
  ISN 0021        403 CONTINUE                                                          00008830
  ISN 0022            RETURN                                                            00008840
  ISN 0023            END                                                               00008850

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      22 ,PROGRAM SIZE =      474

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  115K BYTES OF CORE NOT USED
```

FIGURE C.25

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.06

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00008860
     ISN 0002           SUBROUTINE NOSLPN(LINE,LOUTB,NL,W)                              00008870
     ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00008880
     ISN 0004           COMMON /EE/ SBN(280),QPN(280)                                   00008890
     ISN 0005           COMMON /GG/ CHARL,CHARU                                         00008900
     ISN 0006           COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280),  00008910
                       1IBN(280),JBN(280),NSIDE(280),NLN                                00008920
     ISN 0007           IF(LOUTB.GT.LINE) GO TO 405                                     00008930
     ISN 0009           DO 406 L=1,LOUTB                                                00008940
     ISN 0010           SBN(L)=W                                                        00008950
     ISN 0011       406 CONTINUE                                                        00008960
     ISN 0012           NL1=NL+1                                                        00008970
     ISN 0013           DO 407 L=LINE,NL1                                               00008980
     ISN 0014           SBN(L)=W                                                        00008990
     ISN 0015       407 CONTINUE                                                        00009000
     ISN 0016           GO TO 408                                                       00009010
     ISN 0017       405 DO 409 L=LINE,LOUTB                                             00009020
     ISN 0018           SBN(L)=W                                                        00009030
     ISN 0019       409 CONTINUE                                                        00009040
     ISN 0020       408 CONTINUE                                                        00009050
     ISN 0021           RETURN                                                          00009060
     ISN 0022           END                                                             00009070

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       21 ,PROGRAM SIZE =       420

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          115K BYTES OF CORE NOT USED
```

FIGURE C.26

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.08

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                00009080
    ISN 0002            SUBROUTINE QS(NP,P,A,B,C,D,E)                               00009090
    ISN 0003            IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                    00009100
    ISN 0004            DIMENSION P(10),A(10),B(10),C(10),D(10),E(10)               00009110
    ISN 0005            COMMON /EE/ Q(10)                                           00009120
    ISN 0006            NP1=NP+1                                                    00009130
    ISN 0007            P(NP1)=1.                                                   00009140
    ISN 0008            Q(1)=QINT(0.D0,P(1),A(1),B(1),C(1),D(1),E(1))               00009150
    ISN 0009            IF(NP1.EQ.1) GO TO 602                                      00009160
    ISN 0011            DO 603 N=2,NP1                                              00009170
    ISN 0012        603 Q(N)=Q(N-1)+QINT(P(N-1),P(N),A(N),B(N),C(N),D(N),E(N))      00009180
    ISN 0013        602 CONTINUE                                                    00009190
    ISN 0014            RETURN                                                      00009200
    ISN 0015            END                                                         00009210

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      14 ,PROGRAM SIZE =      764

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          115K BYTES OF CORE NOT USED
```

FIGURE C.27

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.10

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00009220
   ISN 0002           FUNCTION QINT(P1,P2,A1,B1,C1,D1,E1)                               00009230
   ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                          00009240
   ISN 0004           QINT=A1*(P2**3-P1**3)/3.+B1*(P2**2-P1**2)/2.+C1*(P2-P1)           00009250
                     1+D1*DLOG((P2+E1)/(P1+E1))                                         00009260
   ISN 0005           RETURN                                                            00009270
   ISN 0006           END                                                               00009280

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =        5 ,PROGRAM SIZE =       518

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  115K BYTES OF CORE NOT USED
```

FIGURE C.28

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.12

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00009290
    ISN 0002          SUBROUTINE SBND(LINB,LINE,PERB,W,VL,VU,AIN,BIN,CIN,AIT,BIT,       00009300
                     1CIT,PIN,NPIN,DIN,EIN)                                             00009310
    ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                         00009320
    ISN 0004           DIMENSION AIN(10),BIN(10),CIN(10),AIT(10),BIT(10),CIT(10),PIN(10) 00009330
                      1,DIN(10),EIN(10),DIT(10),EIT(10)                                 00009340
    ISN 0005           COMMON /A/ POINT(41,41),XB(300),YB(300),PERP                     00009350
                      1(300),XNORM(300),YNORM(300),NL                                   00009360
    ISN 0006           COMMON /EE/ Q(10)                                                00009370
    ISN 0007           COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                      00009380
    ISN 0008           COMMON /GG/ CHARL,CHARU                                          00009390
    ISN 0009           DATA DIT/10*0./,EIT/10*1./                                       00009400
    ISN 0010           DO 605 L=LINB,LINE                                               00009410
    ISN 0011           ES=(PERP(L)-PERB)/VL                                             00009420
    ISN 0012           SB(L)=W-CINTS(ES,AIN,BIN,CIN,DIN,EIN,PIN,NPIN)/VU                00009430
    ISN 0013           VN=VELS(ES,AIN,BIN,CIN,DIN,EIN,PIN,NPIN)/VU*CHARL/VL             00009440
    ISN 0014           VT=VELS(ES,AIT,BIT,CIT,DIT,EIT,PIN,NPIN)/VU*CHARL/VL             00009450
    ISN 0015           UB(L)=XNORM(L)*VN-YNORM(L)*VT                                    00009460
    ISN 0016       605 VB(L)=YNORM(L)*VN+XNORM(L)*VT                                    00009470
    ISN 0017           RETURN                                                           00009480
    ISN 0018           END                                                              00009490

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       17 ,PROGRAM SIZE =      1204

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          111K BYTES OF CORE NOT USED
```

FIGURE C.29

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.15

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00009500
     ISN 0002          FUNCTION QINTS(P,A,B,C,D,E,PT,NM)                                00009510
     ISN 0003          IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                         00009520
     ISN 0004          DIMENSION A(10),B(10),C(10),D(10),E(10),PT(10)                   00009530
     ISN 0005          COMMON /EE/ Q(10)                                                00009540
     ISN 0006          NP=NM+1                                                          00009550
     ISN 0007          PT(NP)=1.                                                        00009560
     ISN 0008          DO 452 N=1,NP                                                    00009570
     ISN 0009          IF(P.LE.PT(N)) GO TO 453                                         00009580
     ISN 0011      452 CONTINUE                                                         00009590
     ISN 0012      453 QINTS=Q(N)+QINT(PT(N),P,A(N),B(N),C(N),D(N),E(N))                00009600
     ISN 0013          RETURN                                                           00009610
     ISN 0014          END                                                              00009620

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       13 ,PROGRAM SIZE =       660

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  115K BYTES OF CORE NOT USED
```

FIGURE C.30

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.17

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76*****DOMANUS, H. ***  X3244  ***                    00009630
    ISN 0002            FUNCTION VELS(S,A,B,C,D,E,P,NP)                               00009640
    ISN 0003            IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                      00009650
    ISN 0004            DIMENSION A(10),B(10),C(10),D(10),E(10),P(10)                 00009660
    ISN 0005            NP1=NP+1                                                      00009670
    ISN 0006            P(NP1)=1.                                                     00009680
    ISN 0007            DO 606 N=1,NP1                                                00009690
    ISN 0008            IF(S.LE.P(N)) GO TO 607                                       00009700
    ISN 0010        606 CONTINUE                                                      00009710
    ISN 0011        607 VELS=A(N)*S**2+B(N)*S+C(N)+D(N)/(S+E(N))                      00009720
    ISN 0012            RETURN                                                        00009730
    ISN 0013            END                                                           00009740

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       12 ,PROGRAM SIZE =       580

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  115K BYTES OF CORE NOT USED
```

FIGURE C.31

```
LEVEL 21.7 ( JAN 73 )                    OS/360 FORTRAN H                    DATE 76.175/11.55.18

          COMPILER OPTIONS - NAME= MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                              SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00009750
     ISN 0002           SUBROUTINE SBNDN(LB,LE,PERB,H,VL,VU,AN,BN,CN,AT,BT,CT,P,NP,DN,EN) 00009760
     ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                    00009770
     ISN 0004           DIMENSION AN(10),BN(10),CN(10),AT(10),BT(10),CT(10)         00009780
                       1,P(10),DN(10),EN(10),DT(10),ET(10)                          00009790
     ISN 0005           COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280), 00009800
                       1IBN(280),JBN(280),NSIDE(280),NLN                            00009810
     ISN 0006           COMMON /EE/ SBN(280),QBN(280)                               00009820
     ISN 0007           COMMON /FF/ Q(10)                                           00009830
     ISN 0008           COMMON /GG/ CHARL,CHARU                                     00009840
     ISN 0009           DATA DT/10*0./,ET/10*1./                                    00009850
     ISN 0010           DO 610 L=LB,LE                                              00009860
     ISN 0011           ES=(PERPN(L)-PERB)/VL                                       00009870
     ISN 0012           SB=H-QINTS(ES,AN,BN,CN,DN,EN,P,NP)/VU                       00009880
     ISN 0013           BETA=DISTN(L)/CHARL                                         00009890
     ISN 0014           VT=VELS(ES,AT,BT,CT,DT,ET,P,NP)/VU*CHARL/VL                 00009900
     ISN 0015           DVNDS=DVELDS(ES,AN,BN,DN,EN,P,NP)/VU*(CHARL/VL)**2          00009910
     ISN 0016           SBN(L)=SB+BETA*VT*(1.-DISTN(L)*DFIDP(L)/2.)+BETA**2*DVNDS/2. 00009920
     ISN 0017       610 CONTINUE                                                    00009930
     ISN 0018           RETURN                                                      00009940
     ISN 0019           END                                                         00009950

*OPTIONS IN EFFECT*      NAME= MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      18 ,PROGRAM SIZE =     1280

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  111K BYTES OF CORE NOT USED
```

FIGURE C.32

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.20

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00009960
    ISN 0002            FUNCTION DVELDS(S,A,B,D,E,P,NP)                                 00009970
    ISN 0003            IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00009980
    ISN 0004            DIMENSION A(10),B(10),D(10),E(10),P(10)                         00009990
    ISN 0005            NP1=NP+1                                                        00010000
    ISN 0006            P(NP1)=1.                                                       00010010
    ISN 0007            DO 608 N=1,NP1                                                  00010020
    ISN 0008            IF(S.LE.P(N)) GO TO 609                                         00010030
    ISN 0010        608 CONTINUE                                                        00010040
    ISN 0011        609 DVELDS=A(N)*2.*S+B(N)-D(N)/(S+E(N))**2                          00010050
    ISN 0012            RETURN                                                          00010060
    ISN 0013            END                                                             00010070

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       12 ,PROGRAM SIZE =      542

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  115K BYTES OF CORE NOT USED
```

FIGURE C.33

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.55.21

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00010080
ISN 0002              SUBROUTINE SITER                                                  00010090
ISN 0003              IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                          00010100
ISN 0004              COMMON /A1/ O(41,41),S(41,41)                                     00010110
ISN 0005              COMMON /A3/ KPOINT(41,41)                                         00010120
ISN 0006              COMMON /A4/ RELAX,R1,R2,R3,EPSMAX,DTIME,REYNLD,VISCOS,TIMEX,ITMAXS00010130
ISN 0007              COMMON /A5/ SX(280),SY(280),DX(280),DY(280),UX(280),VY(280),       00010140
                     1UDX(280),UDY(280),QX(280),QY(280),NK                              00010150
ISN 0008              COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX    00010160
ISN 0009              COMMON /E/ IMIN(60),IMAX(60),JMX                                  00010170
ISN 0010              COMMON /A6/ EPS,IT                                                00010180
ISN 0011              IT=0                                                              00010190
ISN 0012           72 K=0                                                               00010200
ISN 0013              EPS=0.                                                            00010210
ISN 0014              DO 70 J=2,JMX                                                     00010220
ISN 0015              IB=IMIN(J)                                                        00010230
ISN 0016              IE=IMAX(J)                                                        00010240
ISN 0017              DO 70 I=IB,IE                                                     00010250
ISN 0018              KP=KPOINT(I,J)                                                    00010260
ISN 0019              GO TO (61,62,63,62,63,66,66,66,66), KP                            00010270
ISN 0020              GO TO 70                                                          00010280
ISN 0021           62 K=K+1                                                             00010290
ISN 0022              SIJ=S(I,J)                                                        00010300
ISN 0023              D=(DX(K)+1.)/2.                                                   00010310
ISN 0024              R4=R2*DX(K)/D                                                     00010320
ISN 0025              IF(KP.EQ.4) GO TO 64                                              00010330
ISN 0027              S(I,J)=R1*S(I,J)+R4*((SX(K)/DX(K)+S(I+1,J))/D                     00010340
                     1+S(I,J+1)+S(I,J-1)+R3*O(I,J))                                     00010350
ISN 0028              GO TO 71                                                          00010360
ISN 0029           63 K=K+1                                                             00010370
ISN 0030              SIJ=S(I,J)                                                        00010380
ISN 0031              D=(DY(K)+1.)/2.                                                   00010390
ISN 0032              R4=R2*DY(K)/D                                                     00010400
ISN 0033              IF(KP.EQ.5) GO TO 65                                              00010410
ISN 0035              S(I,J)=R1*S(I,J)+R4*(S(I-1,J)+S(I+1,J)                            00010420
                     1+(SY(K)/DY(K)+S(I,J-1))/D+R3*O(I,J))                              00010430
ISN 0036              GO TO 71                                                          00010440
ISN 0037           64 S(I,J)=R1*S(I,J)+R4*((S(I-1,J)+SX(K)/DX(K))/D                     00010450
                     1+S(I,J+1)+S(I,J-1)+R3*O(I,J))                                     00010460
ISN 0038              GO TO 71                                                          00010470
ISN 0039           65 S(I,J)=R1*S(I,J)+R4*(S(I-1,J)+S(I+1,J)                            00010480
                     1+(S(I,J+1)+SY(K)/DY(K))/D+R3*O(I,J))                              00010490
ISN 0040              GO TO 71                                                          00010500
ISN 0041           66 K=K+1                                                             00010510
ISN 0042              SIJ=S(I,J)                                                        00010520
ISN 0043              D1=(DX(K)+1.)/2.                                                  00010530
ISN 0044              D2=(DY(K)+1.)/2.                                                  00010540
ISN 0045              R4=2.*R2*DX(K)*DY(K)/(DX(K)+DY(K))                                00010550
ISN 0046              IF(KP.EQ.6) S(I,J)=R1*S(I,J)+R4*((SX(K)/DX(K)+S(I+1,J))/D1        00010560
                     1+(SY(K)/DY(K)+S(I,J-1))/D2+R3*O(I,J))                             00010570
ISN 0048              IF(KP.EQ.7) S(I,J)=R1*S(I,J)+R4*((SX(K)/DX(K)+S(I+1,J))/D1        00010580
                     1+(S(I,J+1)+SY(K)/DY(K))/D2+R3*O(I,J))                             00010590
ISN 0050              IF(KP.EQ.8) S(I,J)=R1*S(I,J)+R4*((S(I-1,J)+SX(K)/DX(K))/D1        00010600
```

FIGURE C.34

```
                    1+(SY(K)/DY(K)+S(I,J-1))/D2+R3*D(I,J))                    00010610
ISN 0052              IF(KP.EQ.9) S(I,J)=R1*S(I,J)+R4*((S(I-1,J)+SX(K)/DX(K))/D1  00010620
                    1+(S(I,J+1)+SY(K)/DY(K))/D2+R3*D(I,J))                    00010630
ISN 0054              GO TO 71                                                00010640
ISN 0055            61 SIJ=S(I,J)                                             00010650
ISN 0056              S(I,J)=R1*S(I,J)+R2*(S(I-1,J)+S(I+1,J)                  00010660
                    1+S(I,J+1)+S(I,J-1)+R3*D(I,J))                            00010670
ISN 0057            71 EPS=EPS+DABS(SIJ-S(I,J))                               00010680
ISN 0058            70 CONTINUE                                               00010690
ISN 0059              IT=IT+1                                                 00010700
ISN 0060              IF(EPS.GT.EPSMAX.AND.IT.LT.ITMAXS) GO TO 72             00010710
ISN 0062              RETURN                                                  00010720
ISN 0063              END                                                     00010730

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      62 ,PROGRAM SIZE =     1930

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          95K BYTES OF CORE NOT USED
```

FIGURE C.35

FIGURE C.36

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.24

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                                SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00010740
ISN 0002              SUBROUTINE ITERAT                                                 00010750
ISN 0003              IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                          00010760
ISN 0004              COMMON /A/ POINT(41,41),XB(300),YB(300),PERP                      00010770
                     1(300),XNORM(300),YNORM(300),NL                                   00010780
ISN 0005              COMMON /C/ XVER(100),YTUBES,NGRID                                 00010790
ISN 0006              COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX    00010800
ISN 0007              COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50)  00010810
ISN 0008              COMMON /F/ IMIN(60),IMAX(60),JMX                                  00010820
ISN 0009              COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280),    00010830
                     1IBN(280),JBN(280),NSIDE(280),NLN                                 00010840
ISN 0010              COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                       00010850
ISN 0011              COMMON /EE/ SBN(280),OBN(280)                                     00010860
ISN 0012              COMMON /GG/ CHARL,CHARU                                           00010870
ISN 0013              COMMON /A1/ O(41,41),S(41,41)                                     00010880
ISN 0014              COMMON /A2/ U(41,41),V(41,41)                                     00010890
ISN 0015              COMMON /A4/ RELAX,R1,R2,R3,EPSMAX,DTIME,REYNLD,VISCOS,TIMEX,ITMAXS00010900
ISN 0016              COMMON /A7/ FLIN,FLOUT,EPO,FL1,FL2,ITSMAX                         00010910
ISN 0017              COMMON /B2/ PRESSK(11),BOFL(11),REF,KBLOCK(11)                    00010920
ISN 0018              TIME=0.                                                           00010930
ISN 0019              IF(EPSMAX.EQ.0.) EPSMAX=(IMAXI-2.)*(JMAX-2.)*3.E-06               00010940
ISN 0021              IF(REF.EQ.1.) REF=EPSMAX/(IMAXI-2.)/4.                            00010950
ISN 0023              IF(FLIN.NE.0.) GO TO 150                                          00010960
ISN 0025              MAT=0                                                             00010970
ISN 0026              DO 151 N=1,NVERTX                                                 00010980
ISN 0027              IF(KSIDE(N).NE.6) GO TO 151                                       00010990
ISN 0029              MAT=MAT+1                                                         00011000
ISN 0030              CALL SIDE6(N,MAT)                                                 00011010
ISN 0031          151 CONTINUE                                                          00011020
ISN 0032          150 CALL SEQUE                                                        00011030
ISN 0033              ITS=0                                                             00011040
ISN 0034              IF(REYNLD.EQ.0.) REYNLD=CHARU*YTUBES/VISCOS/NGRID                 00011050
ISN 0036              IF(DTIME.EQ.0.) DTIME=.2/(2.*NGRID/REYNLD+1.)                     00011060
ISN 0038              IF(ITSMAX.LE.0) ITSMAX=1200000/(IMAXI-2)/(JMAX-2)                 00011070
ISN 0040           40 FORMAT('  DTIME=',E7.4,' REYNLD=',E15.9,' VISCOS=',E11.7,' TIME=',00011080
                     1F8.2)                                                            00011090
ISN 0041           41 FORMAT(//,'  EPSMAX=',E12.4,'     ITSMAX=',I9,//)               00011100
ISN 0042              R3=1./(CHARL**2)                                                  00011110
ISN 0043              R1=1.-RELAX                                                       00011120
ISN 0044              R2=RELAX/4.                                                       00011130
ISN 0045              EPO=10.                                                           00011140
ISN 0046              WRITE(6,41) EPSMAX,ITSMAX                                         00011150
ISN 0047              IF(RELAX.EQ.0.) CALL ORELAX                                       00011160
ISN 0049              WRITE(6,34) RELAX                                                 00011170
ISN 0050              WRITE(6,40) DTIME,REYNLD,VISCOS,TIME                              00011180
ISN 0051           34 FORMAT(/,'  SOR RELAXATION FACTOR USED=',F6.4)                    00011190
ISN 0052          101 TIME=TIME+DTIME                                                   00011200
ISN 0053              ITS=ITS+1                                                         00011210
ISN 0054              CALL SITER                                                        00011220
ISN 0055              CALL VELOCS                                                       00011230
ISN 0056              CALL BNDIT                                                        00011240
ISN 0057              CALL SEQUE                                                        00011250
ISN 0058              CALL ISTEP0                                                       00011260
```

```
ISN 0059          IF(EPO.LE.EPSMAX) GO TO 100                                    00011270
ISN 0061          IF(ITS.GE.ITSMAX) GO TO 100                                    00011280
ISN 0063       50 FORMAT('  TIME=',F8.4,' RELAX=',F5.3,' EPSMAX=',E15.9)         00011290
ISN 0064          GO TO 101                                                      00011300
ISN 0065      100 IF(FL2.EQ.0) GO TO 105                                         00011310
ISN 0067          WRITE(6,91) (L,PERP(L),SB(L),OB(L),UB(L),VB(L),XB(L),YB(L),L=2,NL)00011320
ISN 0069       91 FORMAT('  L=',I3,'PERP=',F9.4,'SB=',F9.4,'OB=',F15.4,'UB=',F9.4,'V00011330
                 1B=',F9.4,' XB=',F9.4,' YB=',F9.4)                             00011340
ISN 0069          WRITE(6,92) (LN,PERPN(LN),SBN(LN),OBN(LN),XBN(LN),YBN(LN),IBN(LN),00011350
                 1JBN(LN),DISTN(LN),LN=2,NLN)                                   00011360
ISN 0070       92 FORMAT('  LN=',I3,'  PERPN=',F8.4,' SBN=',F8.4,' OBN=',F15.4,  00011370
                 1' XBN=',F9.4,' YBN=',F9.4,' IBN=',I4,' JBN=',I4,' DISTN=',F9.6) 00011380
ISN 0071      105 WRITE(6,35) ITS,EPO                                            00011390
ISN 0072       35 FORMAT(//,'  CALCULATION HAS BEEN COMPLETED WITH NUMBER OF VORTICI00011400
                 1TY STEPS=',I5,'  EPO=',E15.3)                                 00011410
ISN 0073          WRITE(6,40) DTIME,REYNLD,VISCOS,TIME                           00011420
ISN 0074          WRITE(6,30)                                                    00011430
ISN 0075       30 FORMAT('1    U-FIELD')                                         00011440
ISN 0076          DO 560 L=2,NL                                                  00011450
                C ****** PECULIARITY ******                                      00011460
ISN 0077          IB=XB(L)+.001                                                  00011470
ISN 0078          JB=YB(L)+.001                                                  00011480
ISN 0079          XIB=DFLOAT(IB)-XB(L)                                           00011490
ISN 0080          YJB=DFLOAT(JB)-YB(L)                                           00011500
ISN 0081          IF(DSQRT(XIB**2+YJB**2).GT..01) GO TO 560                      00011510
ISN 0083          IF(POINT(IB,JB).NE.-1.)  GO TO 560                             00011520
ISN 0085          S(IB,JB)=SB(L)                                                 00011530
ISN 0086          O(IB,JB)=OB(L)                                                 00011540
ISN 0087          U(IB,JB)=UB(L)                                                 00011550
ISN 0088          V(IB,JB)=VB(L)                                                 00011560
ISN 0089      560 CONTINUE                                                       00011570
ISN 0090          RETURN                                                         00011580
ISN 0091          END                                                            00011590

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      90 ,PROGRAM SIZE =     2632

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  95K BYTES OF CORE NOT USED
```

FIGURE C.37

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.55.26

          COMPILER OPTIONS - NAME= MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00011600
ISN 0002              SUBROUTINE VELOCS                                                 00011610
ISN 0003              IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                          00011620
ISN 0004              COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280),   00011630
                     1IBN(280),JBN(280),NSIDE(280),NLN                                 00011640
ISN 0005              COMMON /EE/ SBN(280),OBN(280)                                     00011650
ISN 0006              COMMON /A1/ O(41,41),S(41,41)                                     00011660
ISN 0007              COMMON /A7/ POINT(41,41),XB(300),YB(300),PERP                     00011670
                     1(300),XNORM(300),YNORM(300),NL                                   00011680
ISN 0008              COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                       00011690
ISN 0009              COMMON /A5/ SX(280),SY(280),DX(280),DY(280),UX(280),VY(280),      00011700
                     1LDX(280),LOY(280),OX(280),OY(280),NK                             00011710
ISN 0010              COMMON /F/ IMIN(60),IMAX(60),JMX                                  00011720
ISN 0011              COMMON /A3/ KPOINT(41,41)                                         00011730
ISN 0012              COMMON /A2/ U(41,41),V(41,41)                                     00011740
ISN 0013              COMMON /GG/ CHARL,CHARU                                           00011750
ISN 0014              K=0                                                               00011760
ISN 0015              DO 170 J=2,JMX                                                    00011770
ISN 0016              IB=IMIN(J)                                                        00011780
ISN 0017              IE=IMAX(J)                                                        00011790
ISN 0018              DO 170 I=IB,IE                                                    00011800
ISN 0019              KP=KPOINT(I,J)                                                    00011810
ISN 0020              GO TO (161,162,163,164,165,162,162,163,164), KP                   00011920
ISN 0021              GO TO 170                                                         00011830
ISN 0022          162 K=K+1                                                             00011840
ISN 0023              V(I,J)=CHARL*((DX(K)*S(I+1,J)-SX(K)/DX(K))                        00011850
                     1/(1.+DX(K))+(1./DX(K)-1.)*S(I,J))                                00011860
ISN 0024              IF(KP.EQ.6) GO TO 172                                             00011870
ISN 0026              IF(KP.EQ.7) GO TO 176                                             00011880
ISN 0028          174 U(I,J)=-CHARL*(S(I,J+1)-S(I,J-1))/2.                              00011890
ISN 0029              GO TO 170                                                         00011900
ISN 0030          163 K=K+1                                                             00011910
ISN 0031          172 U(I,J)=-CHARL*((SY(K)/DY(K)-DY(K)*S(I,J-1))                     00011920
                     1/(1.+DY(K))+(1.-1./DY(K))*S(I,J))                                00011930
ISN 0032              IF(KP.EQ.6) GO TO 170                                             00011940
ISN 0034              IF(KP.EQ.8) GO TO 173                                             00011950
ISN 0036          175 V(I,J)=CHARL*(S(I+1,J)-S(I-1,J))/2.                               00011960
ISN 0037              GO TO 170                                                         00011970
ISN 0038          164 K=K+1                                                             00011980
ISN 0039          173 V(I,J)=CHARL*((SX(K)/DX(K)-DX(K)*S(I-1,J))                      00011990
                     1/(1.+DX(K))+(1.-1./DX(K))*S(I,J))                                00012000
ISN 0040              IF(KP.EQ.8) GO TO 170                                             00012010
ISN 0042              IF(KP.EQ.9) GO TO 176                                             00012020
ISN 0044              GO TO 174                                                         00012030
ISN 0045          165 K=K+1                                                             00012040
ISN 0046          176 U(I,J)=-CHARL*((DY(K)*S(I,J+1)-SY(K)/DY(K))                     00012050
                     1/(1.+DY(K))+(1./DY(K)-1.)*S(I,J))                                00012060
ISN 0047              IF(KP.EQ.5) GO TO 175                                             00012070
ISN 0049              GO TO 170                                                         00012090
ISN 0050          161 U(I,J)=-CHARL*(S(I,J+1)-S(I,J-1))/2.                              00012090
ISN 0051              V(I,J)=CHARL*(S(I+1,J)-S(I-1,J))/2.                               00012100
ISN 0052          170 CONTINUE                                                          00012110
ISN 0053              RETURN                                                            00012120
```

FIGURE C.38

```
 ISN 0054          END                                                    00012130
 *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
 *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
 *STATISTICS*     SOURCE STATEMENTS =      53 ,PROGRAM SIZE =     1362
 *STATISTICS*  NO  DIAGNOSTICS GENERATED
 ****** END OF COMPILATION ******                          103K BYTES OF CORE NOT USED
```

FIGURE C.39

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.29

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                                SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00012140
ISN 0002              SUBROUTINE TSTEPO                                                 00012150
ISN 0003              IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                          00012160
ISN 0004              COMMON /F/ IMIN(60),IMAX(60),JMX                                  00012170
ISN 0005              COMMON /A3/ KPOINT(41,41)                                         00012180
ISN 0006              COMMON /A2/ U(41,41),V(41,41)                                     00012190
ISN 0007              COMMON /A1/ O(41,41),S(41,41)                                     00012200
ISN 0008              COMMON /A5/ SX(280),SY(280),DX(280),DY(280),UX(280),VY(280),       00012210
                     1LOX(280),LOY(280),OX(280),OY(280),NK                              00012220
ISN 0009              COMMON /C/ XVERTX(50),YVERTX(50),YTUBES,NGRID                     00012230
ISN 0010              COMMON /A4/ RELAX,R1,P2,P3,EPSMAX,DTIME,REYNLD,VISCOS,TIMEX,ITMAXS00012240
ISN 0011              COMMON /A7/ FLIN,FLOUT,EPO,FL1,FL2,ITSMAX                         00012250
ISN 0012              K=0                                                               00012260
ISN 0013              EPO=0.                                                            00012270
ISN 0014              DO 270 J=2,JMX                                                    00012280
ISN 0015              IB=IMIN(J)                                                        00012290
ISN 0016              IE=IMAX(J)                                                        00012300
ISN 0017              DO 270 I=IB,IE                                                    00012310
ISN 0018              KP=KPOINT(I,J)                                                    00012320
ISN 0019              GO TO (271,272,271,274,271,272,272,274,274), KP                   00012330
ISN 0020              GO TO 270                                                         00012340
ISN 0021          272 K=K+1                                                             00012350
ISN 0022              OIJ=O(I,J)                                                        00012360
ISN 0023              IF(U(I,J).LE.0.) DUODX=U(I+1,J)*O(I+1,J)-U(I,J)*O(I,J)            00012370
ISN 0025              IF(U(I,J).GT.0.) DUODX=(U(I,J)*O(I,J)-UX(K)*OX(K))/DX(K)          00012380
ISN 0027              IF(KP.EQ.2) GO TO 292                                             00012390
ISN 0029              IF(KP.EQ.7) GO TO 297                                             00012400
ISN 0031              DEL2O=2.*((OX(K)/DX(K)+O(I+1,J))/(1.+DX(K))                       00012410
                     1+(OY(K)/DY(K)+O(I,J-1))/(1.+DY(K))-(1./DX(K)+1./DY(K))*O(I,J))    00012420
ISN 0032              GO TO 283                                                         00012430
ISN 0033          297 DEL2O=2.*((OX(K)/DX(K)+O(I+1,J))/(1.+DX(K))                       00012440
                     1+(O(I,J+1)+OY(K)/DY(K))/(1.+DY(K))                               00012450
                     1-(1./DX(K)+1./DY(K))*O(I,J))                                     00012460
ISN 0034              GO TO 281                                                         00012470
ISN 0035          292 DEL2O=2.*(OX(K)/DX(K)+O(I+1,J))/(1.+DX(K))                        00012480
                     1+O(I,J+1)+O(I,J-1)-2.*(1./DX(K)+1.)*O(I,J)                       00012490
ISN 0036          280 IF(V(I,J).LE.0.) DVODY=V(I,J+1)*O(I,J+1)-V(I,J)*O(I,J)          00012500
ISN 0038          292 IF(V(I,J).GT.0.) DVODY=V(I,J)*O(I,J)-V(I,J-1)*O(I,J-1)          00012510
ISN 0040              IF(KP.EQ.1) GO TO 291                                             00012520
ISN 0042              GO TO 300                                                         00012530
ISN 0043          271 K=K+1                                                             00012540
ISN 0044              OIJ=O(I,J)                                                        00012550
ISN 0045              IF(U(I,J).LE.0.) DUODX=U(I+1,J)*O(I+1,J)-U(I,J)*O(I,J)            00012560
ISN 0047              IF(U(I,J).GT.0.) DUODX=U(I,J)*O(I,J)-U(I-1,J)*O(I-1,J)            00012570
ISN 0049              IF(KP.EQ.1) K=K-1                                                 00012580
ISN 0051              IF(KP.EQ.1) GO TO 280                                             00012590
ISN 0053              IF(KP.EQ.5) GO TO 295                                             00012600
ISN 0055              DEL2O=O(I-1,J)+O(I+1,J)+2.*(OY(K)/DY(K)+O(I,J-1))/                00012610
                     1(1.+OY(K))-2.*(1.+1./DY(K))*O(I,J)                               00012620
ISN 0056              GO TO 283                                                         00012630
ISN 0057          295 DEL2O=O(I-1,J)+O(I+1,J)+2.*(O(I,J+1)+OY(K)/DY(K))/              00012640
                     1(1.+OY(K))-2.*(1.+1./DY(K))*O(I,J)                               00012650
ISN 0058          291 IF(V(I,J).LE.0.) DVODY=V(I,J+1)*O(I,J+1)-V(I,J)*O(I,J)          00012660
```

FIGURE C.40

```
ISN 0060          IF(V(I,J).GT.0.) DVDDY=(V(I,J)*Q(I,J)-VY(K)*QY(K))/DY(K)          00012670
ISN 0062          GO TO 300                                                         00012680
ISN 0063      274 K=K+1                                                             00012690
ISN 0064          QIJ=Q(I,J)                                                        00012700
ISN 0065          IF(U(I,J).LE.0.) DUDDX=(UX(K)*QX(K)-U(I,J)*Q(I,J))/DX(K)          00012710
ISN 0067          IF(U(I,J).GT.0.) DUDDX=U(I,J)*Q(I,J)-U(I-1,J)*Q(I-1,J)            00012720
ISN 0069          IF(KP.EQ.4) GO TO 294                                             00012730
ISN 0071          IF(KP.EQ.8) GO TO 298                                             00012740
ISN 0073          DEL2D=2.*((Q(I-1,J)+QX(K)/DX(K))/(1.+DX(K))                       00012750
                 1+(Q(I,J+1)+QY(K)/QY(K))/(1.+QY(K))                                00012760
                 1-(1./DX(K)+1./DY(K))*Q(I,J))                                      00012770
ISN 0074          GO TO 281                                                         00012780
ISN 0075      298 DEL2D=2.*((Q(I-1,J)+QX(K)/DX(K))/(1.+DX(K))                       00012790
                 1+(QY(K)/DY(K)+Q(I,J-1))/(1.+QY(K))                                00012800
                 1-(1./DX(K)+1./DY(K))*Q(I,J))                                      00012810
ISN 0076      283 IF(V(I,J).LE.0.) DVDDY=(VY(K)*QY(K)-V(I,J)*Q(I,J))/DY(K)          00012820
ISN 0078          IF(V(I,J).GT.0.) GO TO 282                                        00012830
ISN 0080          GO TO 300                                                         00012840
ISN 0081      294 DEL2D=2.*(Q(I-1,J)+QX(K)/DX(K))/(1.+DX(K))+Q(I,J+1)+Q(I,J-1)      00012850
                 1-2.*(1.+1./DX(K))*Q(I,J)                                          00012860
ISN 0082          GO TO 280                                                         00012870
ISN 0083      291 DEL2D=Q(I-1,J)+Q(I+1,J)+Q(I,J+1)+Q(I,J-1)-4.*Q(I,J)               00012880
ISN 0084      300 Q(I,J)=Q(I,J)+DTIME*(DEL2D/REYNLD                                 00012890
                 1-DUDDX-DVDDY)                                                     00012900
ISN 0085          EPS=EPS+DABS(QIJ-Q(I,J))                                          00012910
ISN 0086      270 CONTINUE                                                          00012920
ISN 0087          RETURN                                                            00012930
ISN 0088          END                                                               00012940

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*    SOURCE STATEMENTS =      87 ,PROGRAM SIZE =     2656

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  87K BYTES OF CORE NOT USED
```

FIGURE C.41

```
LEVEL 21.7 ( JAN 73 )          OS/360  FORTRAN H                    DATE  76.175/11.55.33

        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NOCECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
              C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                  00012950
ISN 0002            SUBROUTINE ORELAX                                               00012960
ISN 0003            IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00012970
ISN 0004            COMMON /A4/ RELAX,R1,R2,R3,EPSMAX,DTIME,REYNLD,VISCOS,TIMEX,ITMAXS00012980
ISN 0005            COMMON /A6/ EPS,IT                                              00012990
ISN 0006            COMMON /A1/ O(41,41),S(41,41)                                   00013000
ISN 0007            COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX  00013010
ISN 0008            RL=1.                                                           00013020
ISN 0009            RR=2.                                                           00013030
ISN 0010            RELAX=RL                                                        00013040
ISN 0011            R1=1.-RL                                                        00013050
ISN 0012            R2=RL/4.                                                        00013060
ISN 0013            CALL SITER                                                      00013070
ISN 0014            ITL=IT                                                          00013080
ISN 0015            DO 80 J=1,JMAX                                                  00013090
ISN 0016            DO 80 I=1,IMAXI                                                 00013100
ISN 0017         80 S(I,J)=.5                                                       00013110
ISN 0018            RELAX=RR                                                        00013120
ISN 0019            R1=1.-RR                                                        00013130
ISN 0020            R2=RR/4.                                                        00013140
ISN 0021            CALL SITER                                                      00013150
ISN 0022            ITR=IT                                                          00013160
ISN 0023            DO 100 J=1,JMAX                                                 00013170
ISN 0024            DO 100 I=1,IMAXI                                                00013180
ISN 0025        100 S(I,J)=.5                                                       00013190
ISN 0026            RM=1.5                                                          00013200
ISN 0027            RELAX=1.5                                                       00013210
ISN 0028            R1=-.5                                                          00013220
ISN 0029            R2=1.5/4.                                                       00013230
ISN 0030            DO 50 K=1,20                                                    00013240
ISN 0031            CALL SITER                                                      00013250
ISN 0032            ITM=IT                                                          00013260
ISN 0033            DO 70 J=1,JMAX                                                  00013270
ISN 0034            DO 70 I=1,IMAXI                                                 00013280
ISN 0035         70 S(I,J)=.5                                                       00013290
ISN 0036            IF(ITR-ITL) 1,1,3                                               00013300
ISN 0037          1 IF(ITR-ITM) 2,4,4                                               00013310
ISN 0038          2 RR=2.*RR-RM                                                     00013320
ISN 0039            IF(RR.GT.2.) RR=2.                                              00013330
ISN 0041            R1=1.-RR                                                        00013340
ISN 0042            R2=RR/4.                                                        00013350
ISN 0043            RELAX=RR                                                        00013360
ISN 0044            CALL SITER                                                      00013370
ISN 0045            ITR=IT                                                          00013380
ISN 0046            DO 60 J=1,JMAX                                                  00013390
ISN 0047            DO 60 I=1,IMAXI                                                 00013400
ISN 0048         60 S(I,J)=.5                                                       00013410
ISN 0049          4 RL=RM                                                           00013420
ISN 0050            ITL=ITM                                                         00013430
ISN 0051            GO TO 10                                                        00013440
ISN 0052          3 IF(ITL-ITM) 5,7,7                                               00013450
ISN 0053          5 RL=2*RL-RM                                                      00013460
ISN 0054            IF(RL.LT.1.) RL=1.                                              00013470
```

FIGURE C.42

```
ISN 0056            R1=1.-RL                                                00013480
ISN 0057            R2=RL/4.                                                00013490
ISN 0058            RELAX=RL                                                00013500
ISN 0059            CALL SITER                                              00013510
ISN 0060            ITL=IT                                                  00013520
ISN 0061            DO 90 J=1,JMAX                                          00013530
ISN 0062            DO 90 I=1,IMAXI                                         00013540
ISN 0063         90 S(I,J)=.5                                               00013550
ISN 0064          7 RR=RM                                                   00013560
ISN 0065            ITP=ITM                                                 00013570
ISN 0066         10 RM=(RL+RR)/2.                                           00013580
ISN 0067            RELAX=RM                                                00013590
ISN 0068            R1=1.-RM                                                00013600
ISN 0069            R2=RM/4.                                                00013610
ISN 0070         50 CONTINUE                                                00013620
ISN 0071            WRITE(6,20) RELAX,IT                                    00013630
ISN 0072         20 FORMAT(' OPTIMUM OVERRELAXATION FACTOR IS APPROXIMATELY=',F6.4,  00013640
                   1//,' MAXIMUM SOR ITERATIONS=',I3)                       00013650
ISN 0073            RETURN                                                  00013660
ISN 0074            END                                                     00013670

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      73 ,PROGRAM SIZE =     1356

*STATISTICS* NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                          103K BYTES OF CORE NOT USED
```

FIGURE C.43

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.55.35

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00013680
     ISN 0002             SUBROUTINE BNDIT                                              00013690
     ISN 0003             IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                      00013700
     ISN 0004             COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX 00013710
     ISN 0005             COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50) 00013720
     ISN 0006             MAT=0                                                         00013730
     ISN 0007             DO 20 N=1,NVERTX                                              00013740
     ISN 0008             KS=KSIDE(N)                                                   00013750
     ISN 0009             GO TO (20,2,3,2,2,6,7,7,9,20,20,2,3,2,2,6,7,7,9), KS         00013760
     ISN 0010             GO TO 20                                                      00013770
     ISN 0011           2 CALL SIDE2(N)                                                 00013780
     ISN 0012             GO TO 20                                                      00013790
     ISN 0013           3 CALL SIDE3(N)                                                 00013800
     ISN 0014             GO TO 20                                                      00013810
     ISN 0015           6 MAT=MAT+1                                                     00013820
     ISN 0016             CALL SIDE6(N,MAT)                                             00013830
     ISN 0017             GO TO 20                                                      00013840
     ISN 0018           7 CALL SIDE7(N)                                                 00013850
     ISN 0019             GO TO 20                                                      00013860
     ISN 0020           9 CALL SIDE9(N)                                                 00013870
     ISN 0021          20 CONTINUE                                                      00013880
     ISN 0022             RETURN                                                        00013890
     ISN 0023             END                                                           00013900

*OPTIONS IN EFFECT*       NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*       SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       22 ,PROGRAM SIZE =       480

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  111K BYTES OF CORE NOT USED
```

FIGURE C.44

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.55.36

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00013910
     ISN 0002           SUBROUTINE SIDE2(N)                                             00013920
     ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00013930
     ISN 0004           COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DEIDP(280),  00013940
                       1IBN(280),JBN(280),NSIDE(280),NLN                                00013950
     ISN 0005           COMMON /EE/ SBN(280),OBN(280)                                   00013960
     ISN 0006           COMMON /A1/ O(41,41),S(41,41)                                   00013970
     ISN 0007           COMMON /A/ POINT(41,41),XB(300),YB(300),PERP                    00013980
                       1(300),XNORM(300),YNORM(300),NL                                  00013990
     ISN 0008           COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                     00014000
     ISN 0009           COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX  00014010
     ISN 0010           COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50) 00014020
     ISN 0011           LB=LBEG(N)                                                      00014030
     ISN 0012           LE=LEND(N)                                                      00014040
     ISN 0013           IF(LE.LT.LB) GO TO 101                                          00014050
     ISN 0015           IF(LB.LE.1) GO TO 101                                           00014060
     ISN 0017           IF(LE.GT.NL) GO TO 101                                          00014070
     ISN 0019           LNB=LNBEG(N)                                                    00014080
     ISN 0020           LNE=LNEND(N)                                                    00014090
     ISN 0021           IF(LNB.LE.1) GO TO 101                                          00014100
     ISN 0023           DO 100 LN=LNB,LNE                                               00014110
     ISN 0024           IF(DISTN(LN).NE.0.) OBN(LN)=(SBN(LN)-S(IBN(LN),JBN(LN)))/DISTN(LN)00014120
     ISN 0026       100 CONTINUE                                                        00014130
     ISN 0027           LN=LNB+1                                                        00014140
     ISN 0028           DO 150 L=LB,LE                                                  00014150
     ISN 0029           PL=PERP(L)                                                      00014160
     ISN 0030       152 PE=PERPN(LN)                                                    00014170
     ISN 0031           PB=PERPN(LN-1)                                                  00014180
     ISN 0032           IF(PE.EQ.PB) GO TO 153                                          00014190
     ISN 0034           IF(PE.GE.PL.AND.PL.GE.PB) GO TO 151                             00014200
     ISN 0036           IF((LN.EQ.LNB+1.AND.PL.LT.PB).OR.LN.EQ.LNE) GO TO 151           00014210
     ISN 0038       153 LN=LN+1                                                         00014220
     ISN 0039           GO TO 152                                                       00014230
     ISN 0040       151 OB(L)=((PE-PL)*OBN(LN-1)+(PL-PB)*OBN(LN))/(PE-PB)               00014240
     ISN 0041       150 CONTINUE                                                        00014250
     ISN 0042       101 CONTINUE                                                        00014260
     ISN 0043           RETURN                                                          00014270
     ISN 0044           END                                                             00014280

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =      43 ,PROGRAM SIZE =      824

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  111K BYTES OF CORE NOT USED
```

FIGURE C.45

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.55.38

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00014290
     ISN 0002           SUBROUTINE SIDE3(N)                                             00014300
     ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00014310
     ISN 0004           COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280),  00014320
                       1IBN(280),JBN(280),NSIDE(280),NLN                                00014330
     ISN 0005           COMMON /BE/ SBN(280),QBN(280)                                   00014340
     ISN 0006           COMMON /A1/ Q(41,41),S(41,41)                                   00014350
     ISN 0007           COMMON /A/ POINT(41,41),XP(300),YP(300),PERP                    00014360
                       1(300),XNORM(300),YNORM(300),NL                                  00014370
     ISN 0008           COMMON /DD/ SB(300),UB(300),VB(300),QB(300)                     00014380
     ISN 0009           COMMON /B1/ VTBN(280),VTB(300),VNBN(280),VNB(300),DNDT(300)     00014390
     ISN 0010           COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX  00014400
     ISN 0011           COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50) 00014410
     ISN 0012           LB=LBEG(N)                                                      00014420
     ISN 0013           LE=LEND(N)                                                      00014430
     ISN 0014           LNB=LNBEG(N)                                                    00014440
     ISN 0015           LNE=LNEND(N)                                                    00014450
     ISN 0016           IF(LNB.LE.1) GO TO 101                                          00014460
     ISN 0018           DO 100 LN=LNB,LNE                                               00014470
     ISN 0019       100 VTBN(LN)=(S(IBN(LN),JBN(LN))-SBN(LN))/DSQRT(2.*DISTN(LN))       00014480
     ISN 0020           LN=LNB+1                                                        00014490
     ISN 0021           DO 150 L=LB,LE                                                  00014500
     ISN 0022           PL=PERP(L)                                                      00014510
     ISN 0023       152 PE=PERPN(LN)                                                    00014520
     ISN 0024           PB=PERPN(LN-1)                                                  00014530
     ISN 0025           IF(PE.GE.PL.AND.PL.GE.PB) GO TO 151                             00014540
     ISN 0027           IF((LN.EQ.LNB+1.AND.PL.LT.PB).OR.LN.EQ.LNE) GO TO 151           00014550
     ISN 0029           LN=LN+1                                                         00014560
     ISN 0030           GO TO 152                                                       00014570
     ISN 0031       151 VTB(L)=((PE-PL)*VTBN(LN-1)+(PL-PB)*VTBN(LN))/(PE-PB)            00014580
     ISN 0032           UB(L)=-YNORM(L)*VTB(L)                                          00014590
     ISN 0033           VB(L)=XNORM(L)*VTB(L)                                           00014600
     ISN 0034       150 CONTINUE                                                        00014610
     ISN 0035       101 CONTINUE                                                        00014620
     ISN 0036           RETURN                                                          00014630
     ISN 0037           END                                                             00014640

 *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

 *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

 *STATISTICS*     SOURCE STATEMENTS =       36 ,PROGRAM SIZE =       886

 *STATISTICS*  NO  DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                                  111K BYTES OF CORE NOT USED
```

FIGURE C.46

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.40

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00014650
  ISN 0002            SUBROUTINE SIDE6(N,MAT)                                          00014660
  ISN 0003            IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                         00014670
  ISN 0004            COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280),  00014680
                     1IBN(280),JBN(280),NSIDE(280),NLN                                 00014690
  ISN 0005            COMMON /EE/ SBN(280),OBN(280)                                    00014700
  ISN 0006            COMMON /A1/ O(41,41),S(41,41)                                    00014710
  ISN 0007            COMMON /A2/ POINT(41,41),XB(300),YB(300),PERP                    00014720
                     1(300),XNORM(300),YNORM(300),NL                                   00014730
  ISN 0008            COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                      00014740
  ISN 0009            COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX   00014750
  ISN 0010            COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50) 00014760
  ISN 0011            COMMON /B1/ VTBN(280),VTB(300),VNBN(280),VNB(300),DNDT(300)      00014770
  ISN 0012            COMMON /GG/ CHARL,CHARU                                          00014780
  ISN 0013            COMMON /B2/ PRESSK(11),BDFL(11),REF,KBLOCK(11)                   00014790
  ISN 0014            COMMON /A2/ U(41,41),V(41,41)                                    00014800
  ISN 0015            COMMON /A6/ RELAX,R1,R2,R3,EPSMAX,DTIME,REYNLD,VISCOS,TIMEX,ITMAXS00014810
  ISN 0016            A=PRESSK(MAT)                                                    00014820
  ISN 0017            B=BDFL(MAT)                                                      00014830
  ISN 0018            M=MATCH(MAT)                                                     00014840
  ISN 0019            LB1=LBEG(N)                                                      00014850
  ISN 0020            LE1=LEND(N)                                                      00014860
  ISN 0021            LB2=LBEG(M)                                                      00014870
  ISN 0022            LE2=LEND(M)                                                      00014880
  ISN 0023            LNB1=LNBEG(N)                                                    00014890
  ISN 0024            LNE1=LNEND(N)                                                    00014900
  ISN 0025            LNB2=LNBEG(M)                                                    00014910
  ISN 0026            LNE2=LNEND(M)                                                    00014920
  ISN 0027         91 L1=LB1-1                                                         00014930
  ISN 0028            D1=CHARL*DSQRT(2.*DISTN(LNB1))                                   00014940
  ISN 0029            D2=CHARL*DSQRT(2.*DISTN(LNB2))                                   00014950
  ISN 0030            DO 101 L1=LB1,LE1                                                00014960
  ISN 0031            IF(L1.EQ.LB1) VNB(L1)=-CHARL*(SB(L1+1)-SB(L1))                   00014970
  ISN 0033            IF(L1.EQ.LE1) VNB(L1)=-CHARL*(SB(L1)-SB(L1-1))                   00014980
  ISN 0035            IF(L1.GT.LB1.AND.L1.LT.LE1) VNB(L1)=-CHARL*(SB(L1+1)-SB(L1-1))/2. 00014990
  ISN 0037        101 CONTINUE                                                         00015000
  ISN 0038            L1=LB1-1                                                         00015010
  ISN 0039            DO 100 LN1=LNB1,LNE1                                             00015020
  ISN 0040            BL=B                                                             00015030
  ISN 0041            BR=B                                                             00015040
  ISN 0042            L1=L1+1                                                          00015050
  ISN 0043            L2=LE2+LB1-L1                                                    00015060
  ISN 0044            VNB(L2)=-VNB(L1)                                                 00015070
  ISN 0045            LN2=LNE2+LNB1-LN1                                                00015080
  ISN 0046            IF(VNB(L2).LT.0.) BL=1.                                          00015090
  ISN 0048            IF(VNB(L2).GE.0.) BR=1.                                          00015100
  ISN 0050            S1=S(IBN(LN1),JBN(LN1))                                          00015110
  ISN 0051            S2=S(IBN(LN2),JBN(LN2))                                          00015120
  ISN 0052            X1=XNORM(L1)                                                     00015130
  ISN 0053            Y1=YNORM(L1)                                                     00015140
  ISN 0054            DELT=D1*BR+D2*BL                                                 00015150
  ISN 0055            VN1=X1*U(IBN(LN1),JBN(LN1))+Y1*V(IBN(LN1),JBN(LN1))             00015160
  ISN 0056            VN2=X1*U(IBN(LN2),JBN(LN2))+Y1*V(IBN(LN2),JBN(LN2))             00015170
```

FIGURE C.47

```
ISN 0057        31 FORMAT(I6)                                                    00015180
ISN 0058           DTDT=(VN2-VN1)/DELT                                           00015190
ISN 0059           IF(LN1.EQ.LNB1) DNDT1=(VNB(L1+1)-VNB(L1))                     00015200
ISN 0061           IF(LN1.EQ.LNE1) DNDT1=(VNB(L1)-VNB(L1-1))                     00015210
ISN 0063           IF(LN1.GT.LNB1.AND.LN1.LT.LNE1) DNDT1=(VNB(L1+1)-VNB(L1-1))/2 00015220
                   1.                                                            00015230
ISN 0065           IF(VNB(L2).LT.0.) GO TO 300                                   00015240
ISN 0067       153 VTB(L1)=CHARL/D1*(S1-SB(L1))                                  00015250
ISN 0068           VTB(L2)=-BL*VTB(L1)                                           00015260
ISN 0069           DELO=CHARL*A*DNDT1                                            00015270
ISN 0070           DNODN=(VN1*O(IBN(LN1),JBN(LN1))-VNB(L1)*OB(L1))/D1            00015280
ISN 0071           IF(VTB(L1).LT.0.) GO TO 201                                   00015290
ISN 0073           IF(L1.EQ.LB1) VTB(L1-1)=0.                                    00015300
ISN 0075           DTODT=VTB(L1)*OB(L1)-VTB(L1-1)*OB(L1-1)                       00015310
ISN 0076           GO TO 202                                                     00015320
ISN 0077       201 IF(L1.EQ.LE1) GO TO 202                                       00015330
ISN 0079           DTODT=VTB(L1+1)*OB(L1+1)-VTB(L1)*OB(L1)                       00015340
ISN 0080       202 OB(L1)=OB(L1)-DTIME*(DNODN+DTODT)                             00015350
ISN 0081           OB(L2)=OB(L1)-DELO                                            00015360
ISN 0082           GO TO 301                                                     00015370
ISN 0083       300 VTB(L2)=CHARL/D2*(S2-SB(L2))                                  00015380
ISN 0084           VTB(L1)=-BR*VTB(L2)                                           00015390
ISN 0085           DELO=CHARL*A*DNDT1                                            00015400
ISN 0086           DNODN=(VNB(L1)*OB(L2)-VN2*O(IBN(LN2),JBN(LN2)))/D2            00015410
ISN 0087           IF(VTB(L1).LT.0.) GO TO 211                                   00015420
ISN 0089           IF(L1.EQ.LB1) VTB(L2+1)=0.                                    00015430
ISN 0091           DTODT=VTB(L2+1)*OB(L2+1)-VTB(L2)*OB(L2)                       00015440
ISN 0092           GO TO 212                                                     00015450
ISN 0093       211 IF(L1.EQ.LE1) GO TO 212                                       00015460
ISN 0095           DTODT=VTB(L2)*OB(L2)-VTB(L2-1)*OB(L2-1)                       00015470
ISN 0096       212 OB(L2)=OB(L2)-DTIME*(DNODN+DTODT)                             00015480
ISN 0097           OB(L1)=OB(L2)-DELO                                            00015490
ISN 0098       301 CONTINUE                                                      00015500
ISN 0099           SP=(D2*BL*S1+D1*BR*S2)/DELT                                   00015510
ISN 0100           SB(L1)=SB(L1)+REF*(SP-SB(L1))                                 00015520
ISN 0101           SB(L2)=SB(L1)                                                 00015530
ISN 0102           SBN(LN1)=SB(L1)                                               00015540
ISN 0103           SBN(LN2)=SB(L1)                                               00015550
ISN 0104           UB(L1)=XNORM(L1)*VNB(L1)-YNORM(L1)*VTB(L1)                    00015560
ISN 0105       157 VB(L1)=YNORM(L1)*VNB(L1)+XNORM(L1)*VTB(L1)                    00015570
ISN 0106           UB(L2)=XNORM(L2)*VNB(L2)-YNORM(L2)*VTB(L2)                    00015580
ISN 0107       100 VB(L2)=YNORM(L2)*VNB(L2)+XNORM(L2)*VTB(L2)                    00015590
ISN 0108       190 CONTINUE                                                      00015600
ISN 0109           RETURN                                                        00015610
ISN 0110           END                                                           00015620

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =     109 ,PROGRAM SIZE =     2438

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  87K BYTES OF CORE NOT USED
```

FIGURE C.48

```
      COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                         SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                00015630
ISN 0002              SUBROUTINE SIDE7(N)                                           00015640
ISN 0003              IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                      00015650
ISN 0004              COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIDP(280),00015660
                     1IBN(280),JBN(280),NSIDE(280),NLN                             00015670
ISN 0005              COMMON /EE/ SBN(280),OBN(280)                                 00015680
ISN 0006              COMMON /A1/ O(41,41),S(41,41)                                 00015690
ISN 0007              COMMON /A2/ POINT(41,41),XB(300),YB(300),PERP                 00015700
                     1(300),XNORM(300),YNORM(300),NL                               00015710
ISN 0008              COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                   00015720
ISN 0009              COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX 00015730
ISN 0010              COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50)00015740
ISN 0011              COMMON /B1/ VTBN(280),VTB(300),VNBN(280),VNB(300),DNDT(300)   00015750
ISN 0012              COMMON /GG/ CHARL,CHARU                                       00015760
ISN 0013              LB=LBEG(N)                                                    00015770
ISN 0014              LE=LEND(N)                                                    00015780
ISN 0015              LNB=LNBEG(N)                                                  00015790
ISN 0016              LNE=LNEND(N)                                                  00015800
ISN 0017              IF(LE.NE.NLN) GO TO 160                                       00015810
ISN 0019              SBN(LE+1)=SBN(2)                                              00015820
ISN 0020              PERPN(LE+1)=PERP(NL)                                          00015830
ISN 0021          160 IF(LNB.LE.1) GO TO 101                                        00015840
ISN 0023              SBN(LNB)=S(IBN(LNB),JBN(LNB))                                 00015850
ISN 0024              DO 100 LN=LNB,LNE                                             00015860
ISN 0025               IF(LN.NE.LNE) SBN(LN+1)=S(IBN(LN+1),JBN(LN+1))               00015870
ISN 0027              D1=PERPN(LN)-PERPN(LN-1)                                      00015880
ISN 0028              D2=PERPN(LN+1)-PERPN(LN)                                      00015890
ISN 0029              IF(LN.EQ.LNB) D1=PERPN(LNB)-PERV(N)                           00015900
ISN 0031              IF(LN.EQ.LNE) D2=PERV(N+1)-PERPN(LNE)                         00015910
ISN 0033              OBN(LN)=2./D1/D2/(D1+D2)*((D1+D2)*SBN(LN)-D1*SBN(LN+1)-D2*SBN(LN-100015920
                     1))*CHARL**2                                                  00015930
ISN 0034          100 VNBN(LN)=(D2**2*SBN(LN-1)-D1**2*SBN(LN+1)+(D1**2-D2**2)*SBN(LN))/D00015940
                     11/D2/(D1+D2)*CHARL                                           00015950
ISN 0035              LN=LNB+1                                                      00015960
ISN 0036              IF(LNB.EQ.2) LN=3                                             00015970
ISN 0038              DO 150 L=LB,LE                                                00015980
ISN 0039              PL=PERP(L)                                                    00015990
ISN 0040          152 PE=PERPN(LN)                                                  00016000
ISN 0041              PB=PERPN(LN-1)                                                00016010
ISN 0042              IF(LN.GE.LNE) GO TO 151                                       00016020
ISN 0044              IF(PE.GE.PL) GO TO 151                                        00016030
ISN 0046              IF(LN.EQ.3.OR.LN.EQ.NLN) GO TO 151                            00016040
ISN 0048              LN=LN+1                                                       00016050
ISN 0049              GO TO 152                                                     00016060
ISN 0050          151 IF(PL.EQ.PERP(LB).OR.PL.EQ.PERP(LE)) GO TO 153                00016070
ISN 0052              SB(L)=((PE-PL)*SBN(LN-1)+(PL-PB)*SBN(LN))/(PE-PB)             00016080
ISN 0053              VNB(L)=((PE-PL)*VNBN(LN-1)+(PL-PB)*VNBN(LN))/(PE-PB)          00016090
ISN 0054          153 OB(L)=((PE-PL)*OBN(LN-1)+(PL-PB)*OBN(LN))/(PE-PB)             00016100
ISN 0055              UB(L)=XNORM(L)*VNB(L)                                         00016110
ISN 0056              VB(L)=YNORM(L)*VNB(L)                                         00016120
ISN 0057          150 CONTINUE                                                      00016130
ISN 0058          101 CONTINUE                                                      00016140
ISN 0059              RETURN                                                        00016150
```

FIGURE C.49

```
                                                                    PAGE 002
   ISN 0060          END                                                    00016160
*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
*STATISTICS*     SOURCE STATEMENTS =      59 ,PROGRAM SIZE =     1522
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                          103K BYTES OF CORE NOT USED
```

FIGURE C.50

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                    DATE  76.175/11.55.45

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00016170
     ISN 0002           SUBROUTINE SIDE9(N)                                             00016180
     ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00016190
     ISN 0004           COMMON /AA/ XBN(280),YBN(280),DISTN(280),PERPN(280),DFIOP(280),  00016200
                       1IBN(280),JBN(280),NSIDE(280),NLN                                00016210
     ISN 0005           COMMON /EE/ SBN(280),OBN(280)                                   00016220
     ISN 0006           COMMON /A1/ O(41,41),S(41,41)                                   00016230
     ISN 0007           COMMON /AA/ POINT(41,41),XB(300),YB(300),PERP                   00016240
                       1(300),XNORM(300),YNORM(300),NL                                  00016250
     ISN 0008           COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                     00016260
     ISN 0009           COMMON /D/ LNBEG(50),LNEND(50),XV(50),YV(50),NVERTX,IMAXI,JMAX  00016270
     ISN 0010           COMMON /E/ NMATCH,MATCH(11),LBEG(50),LEND(50),KSIDE(50),PERV(50) 00016280
     ISN 0011           LB=LBEG(N)                                                      00016290
     ISN 0012           IF(LB.EQ.0) GO TO 150                                           00016300
     ISN 0014           LE=LEND(N)                                                      00016310
     ISN 0015           IF(LE.LT.LB) GO TO 150                                          00016320
     ISN 0017           LNB=LNBEG(N)                                                    00016330
     ISN 0019           IF(LNB.EQ.0) GO TO 150                                          00016340
     ISN 0020           CALL SIDE2(N)                                                   00016350
     ISN 0021           LNE=LNEND(N)                                                    00016360
     ISN 0022           SSBN=0.                                                         00016370
     ISN 0023           WEIGHT=0.                                                       00016380
     ISN 0024           DO 100 LN=LNB,LNE                                               00016390
     ISN 0025           IF(PERPN(LN)-PERPN(LN-1).LT..2) GO TO 100                       00016400
     ISN 0027           SSBN=SSBN+S(IBN(LN),JBN(LN))/DISTN(LN)                          00016410
     ISN 0028           WEIGHT=WEIGHT+1./DISTN(LN)                                      00016420
     ISN 0029       100 CONTINUE                                                        00016430
     ISN 0030           SSBN=SSBN/WEIGHT                                                00016440
     ISN 0031           DO 101 LN=LNB,LNE                                               00016450
     ISN 0032       101 SBN(LN)=SSBN                                                    00016460
     ISN 0033           DO 102 L=LB,LE                                                  00016470
     ISN 0034       102 SB(L)=SSBN                                                      00016480
     ISN 0035       150 CONTINUE                                                        00016490
     ISN 0036           RETURN                                                          00016500
     ISN 0037           END                                                             00016510

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       36 ,PROGRAM SIZE =       734

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  111K BYTES OF CORE NOT USED
```

FIGURE C.51

```
LEVEL 21.7 ( JAN 73 )                    OS/360  FORTRAN H                              DATE  76.175/11.55.46

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                C  ***EVITS  4/28/76******DOMANUS, H. ***  X3244  ***                    00016520
     ISN 0002           SUBROUTINE SEQUE                                                00016530
     ISN 0003           IMPLICIT REAL*8(A-H,O-Z), INTEGER*4(I-N)                        00016540
     ISN 0004           COMMON /DD/ SB(300),UB(300),VB(300),OB(300)                     00016550
     ISN 0005           COMMON /A5/ SX(280),SY(280),DX(280),DY(280),UX(280),VY(280),    00016560
                       1LDX(280),LDY(280),OX(280),OY(280),NK                           00016570
     ISN 0006           COMMON /F/ IMIN(60),IMAX(60),JMX                                00016580
     ISN 0007           COMMON /A3/ KPOINT(41,41)                                       00016590
     ISN 0008           K=0                                                             00016600
     ISN 0009           DO 170 J=2,JMX                                                  00016610
     ISN 0010           IB=IMIN(J)                                                      00016620
     ISN 0011           IE=IMAX(J)                                                      00016630
     ISN 0012           IF(IB.EQ.0.OR.IE.EQ.0) GO TO 170                                00016640
     ISN 0014           DO 170 I=IB,IE                                                  00016650
     ISN 0015           IF(KPOINT(I,J).GT.1) GO TO 171                                  00016660
     ISN 0017           GO TO 170                                                       00016670
     ISN 0018       171 K=K+1                                                           00016680
     ISN 0019           LX=LDX(K)                                                       00016690
     ISN 0020           LY=LDY(K)                                                       00016700
     ISN 0021           IF(LX.LT.2) GO TO 172                                           00016710
     ISN 0023           OX(K)=OB(LX)                                                    00016720
     ISN 0024           SX(K)=SB(LX)                                                    00016730
     ISN 0025           UX(K)=UB(LX)                                                    00016740
     ISN 0026       172 IF(LY.LT.2) GO TO 170                                           00016750
     ISN 0028           OY(K)=OB(LY)                                                    00016760
     ISN 0029           SY(K)=SB(LY)                                                    00016770
     ISN 0030           VY(K)=VB(LY)                                                    00016780
     ISN 0031       170 CONTINUE                                                        00016790
     ISN 0032           RETURN                                                          00016800
     ISN 0033           END                                                             00016810

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=57,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       32 ,PROGRAM SIZE =       584

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                  111K BYTES OF CORE NOT USED

*STATISTICS*  NO  DIAGNOSTICS THIS STEP
```

FIGURE C.52

APPENDIX D - Streamline Plotting

To plot the streamlines (S = constant) of an EVITS run, a computer program, B22684.PLOTS.FORT, was developed. The code is designed to use EVITS disc output along with interactive user supplied input of streamline spacing. The code is run via TSO using the TEKTRONIX #4014 CRT computer terminal and a full duplex, 1200 baud line. To facilitate the running of the PLOTS program, a LOAD module dataset has been created and stored on disc. The LOAD module is named B22684.PLOTS.LOAD.

To obtain the streamline plot:

1) have EVITS disc output available on a data set (e.g., S1.DATA),
2) log on TSO and assign the EVITS output dataset to logical record unit 9 [i.e., ALLOCbDA(S1.DATA)bFILE(FT09F001)] and
3) execute the PLOTS program (i.e., CALLbPLOTS).

After the load module has been called, the first two lines of Fig. D.1 appear on the screen. Enter 0. for a streamline plot. The program provides for three streamline regions, each with a different spacing. Region 1 is for dimensionless streamline values between SBEG and SBEGM. Streamline values are between SBEGM and SENDM in Region 2 and between SENDM and SEND in Region 3. Note: SBEG$\leq$SBEGM$\leq$SENDM$\leq$SEND. After the 0. value, indicating a streamline plot, has been sent to the computer, line 4 appears on the screen, asking for the SBEG value. After the desired value has been typed in, the computer asks for the next piece of information. This continues until all bounds and streamline spacings of each region have been input to the computer. After the spacing in the third region has been sent to the computer, the streamlines are

```
TEMPNAME ASSUMED AS A MEMBER NAME
IF TEMPERATURE ENTER 1,STREAM FUNCTION 0
0
ENTER SBEG
-.05
ENTER SPACING FROM SBEG TO SBEGM
.01
ENTER SBEGM (PROBABLY 0.0)
0.0
ENTER SENDM (PROBABLY 1.0)
1.0
ENTER SPACING FROM SBEGM TO SENDM
0.05
ENTER SEND
1.0
ENTER SPACING FROM SENDM TO SEND
1.0
```

FIGURE D.1 : PLOTS INTERACTIVE INPUT

plotted as in Fig. D.2. In the region and spacing specification of Fig. D.1, two possible regions have been specified: Region 1, $-.05<S<0$, with spacing .01 (i.e., 1% streamlines in a possible recirculating region) and Region 2, $0<S<1.0$, with spacing .05 (i.e., 5% streamlines in the main flow). Region 3 does not exist since $1.0<S<1.0$ was specified. Figs. D.2, D.3 and D.4 are streamline plots of examples SAMPLE1, SAMPLE2 and SAMPLE3, respectively. The streamline spacing is 5%.

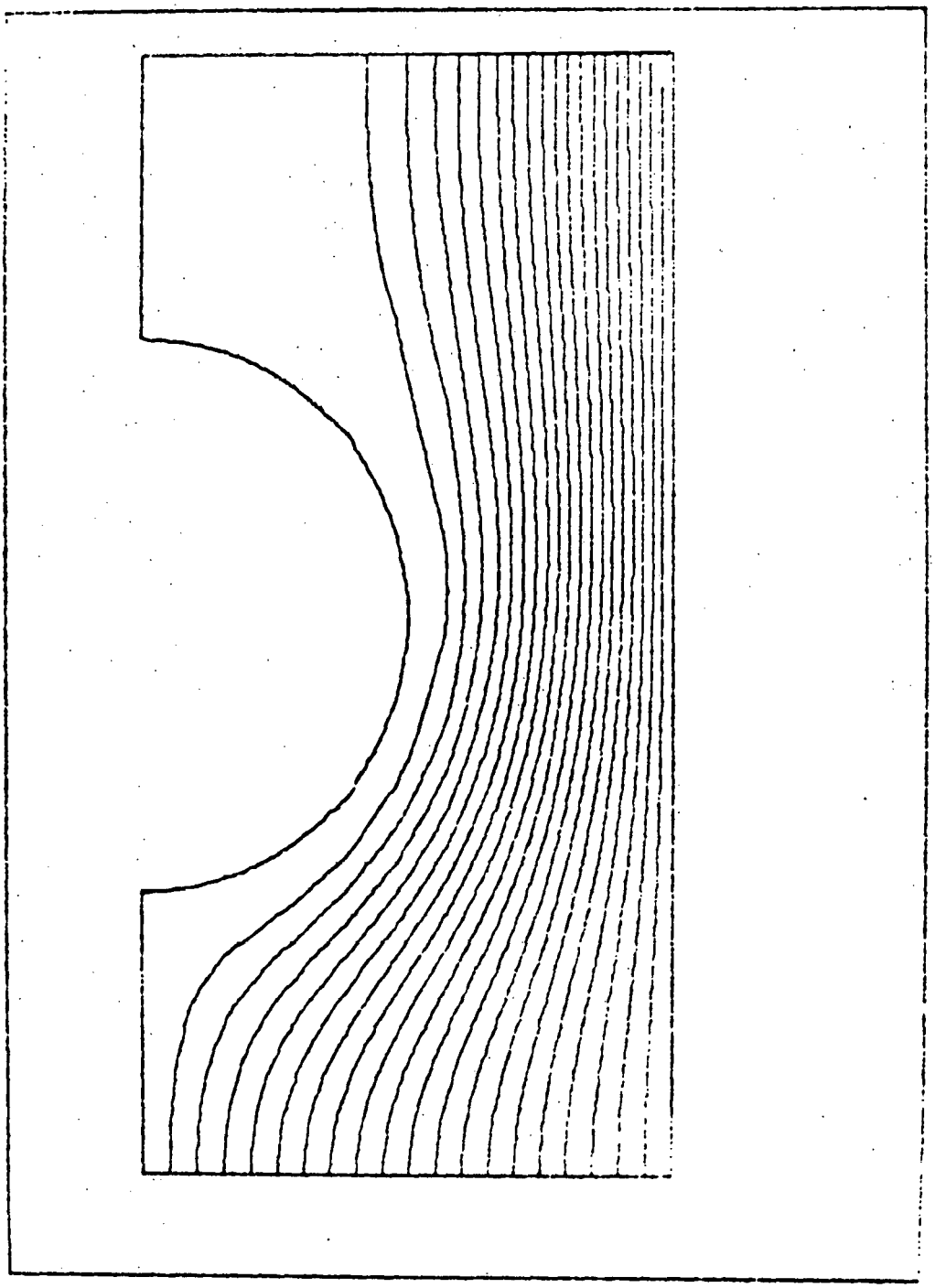


FIGURE D.2 : SAMPLE1 STREAMLINES

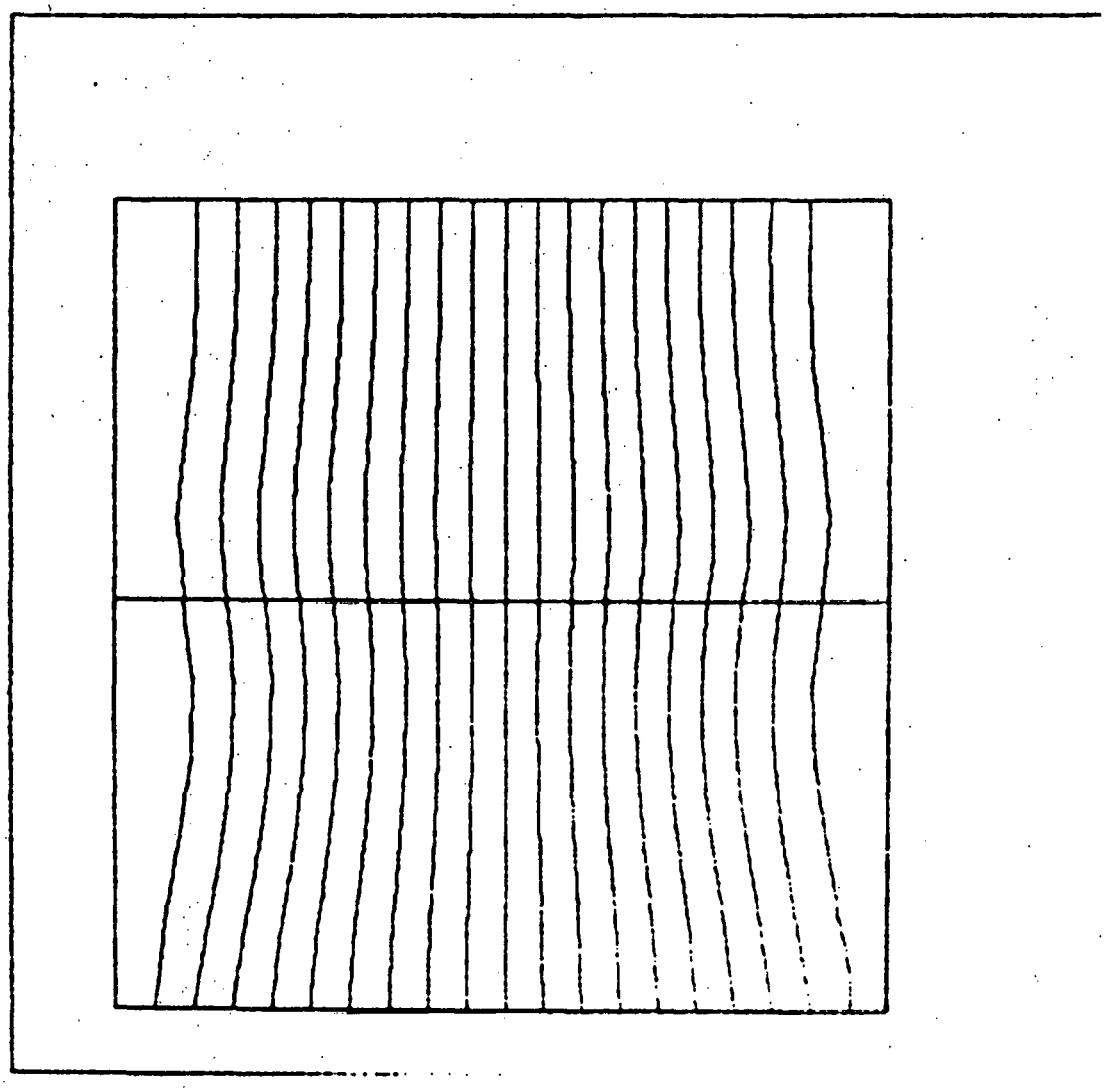


FIGURE D.3: SAMPLE 2 STREAMLINES

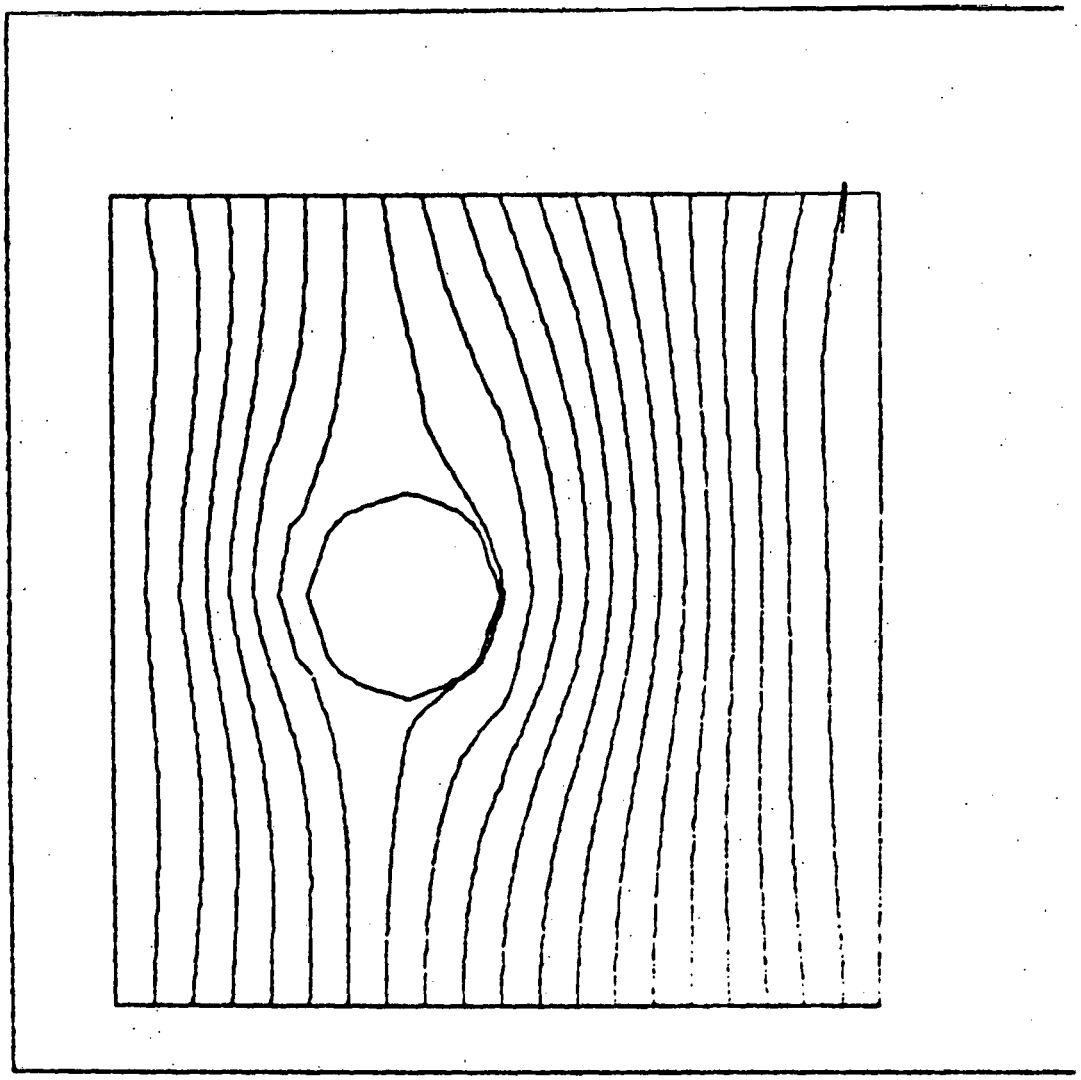


FIGURE D.4 : SAMPLE3 STREAMLINES

APPENDIX E - Listing of PLOTS

```
      C   PROGRAM PLOTS
      C
          DIMENSION X1(400),Y1(400),XB(400),YB(400)
          COMMON /A/ XBN(400),YBN(400),SBN(400),IBN(400),JBN(400),S(41,41),I
         1MAXI,JMAX,NLN
          COMMON /A3/ KPOINT(41,41)
          READ(9,203) NL,IMAXI,JMAX,NLN,NVERTX
      203 FORMAT(5I4)
      906 FORMAT(6E12.5)
          READ(9,204) (XB(L),YB(L),L=2,NL)
          READ(9,906) (UBN,PERPN,L=1,NLN)
          READ(9,906) (PERV,N=1,NVERTX)
          READ(9,205) (XBN(L),YBN(L),SBN(L),IBN(L),JBN(L),L=2,NLN)
          READ(9,250) ((KPOINT(I,J),I=1,IMAXI),J=1,JMAX)
      250 FORMAT(2x,3512)
      205 FORMAT(4(2F5.2,F5.3,2I2))
      204 FORMAT(16F5.2)
          WRITE(6,210)
      210 FORMAT(' IF TEMPERATURE ENTER 1,STREAM FUNCTION 0')
          READ(5,211) IFLG
      211 FORMAT(I1)
          IF(IFLG.EQ.1) READ(9,906) ((S(I,J),I=1,IMAXI),J=1,JMAX)
          IF(IFLG.EQ.0) READ(9,200) ((S(I,J),I=1,IMAXI),J=1,JMAX)
      200 FORMAT(3E25.18)
          WRITE(6,300)
      300 FORMAT(' ENTER SBEG')
          READ(5,301) SBEG
      301 FORMAT(F10.5)
          WRITE(6,302)
      302 FORMAT(' ENTER SPACING FROM SBEG TO SBEGM')
          READ(5,301) SPACE1
          WRITE(6,306)
      306 FORMAT(' ENTER SBEGM (PROBABLY 0.0)')
          READ(5,301) SBEGM
          WRITE(6,307)
      307 FORMAT(' ENTER SENDM (PROBABLY 1.0)')
          READ(5,301) SENDM
          WRITE(6,303)
      303 FORMAT(' ENTER SPACING FROM SBEGM TO SENDM')
          READ(5,301) SPACE
          WRITE(6,304)
      304 FORMAT(' ENTER SEND')
          READ(5,301) SEND
          WRITE(6,305)
      305 FORMAT(' ENTER SPACING FROM SENDM TO SEND')
          READ(5,301) SPACE2
          CALL STRTPL
          XMAX=FLOAT(IMAXI-1)
          YMAX=FLOAT(JMAX-1)
          IF(YMAX.GE.1.5*XMAX) CALL TITLE('  $',2,'  $',0,'  $',0,6.5,9.75)
          IF(YMAX.GE.1.5*XMAX) CALL GRAF(1.,1.,2./3.*YMAX+1.,1.,1.,YMAX+1.)
          IF(YMAX.LT.1.5*XMAX) CALL TITLE('  $',-2,'  $',0,'  $',0,9.75,6.5)
          IF(1.5*YMAX.LE.XMAX) CALL GRAF(1.,1.,XMAX+1.,1.,1.,2./3.*XMAX+1.)
```

FIGURE E.1

```
      IF(YMAX.LT.1.5*XMAX.AND.1.5*YMAX.GT.XMAX) CALL GRAF(1.,1.,3./2.*YM
     1AX+1.,1.,1.,YMAX+1.)
      LB=2
      CALL POLY3
      DO 100 L=3,NL
      D=SQRT((XB(L)-XB(L-1))**2+(YB(L)-YB(L-1))**2)
      IF(D.LT.1.5.AND.L.LT.NL) GO TO 100
      LE=L-1
      IF(L.EQ.NL) LE=NL
      M=LE-LB+1
      CALL CURVE(XB(LB),YB(LB),M,0)
      LB=L
  100 CONTINUE
      DO 4 IV =1,5
      IF(IV.NE.1) GO TO 105
      V=.005
      GO TO 109
  105 IF(IV.NE.2) GO TO 106
      V=.995
      GO TO 109
  106 IF(IV.NE.3) GO TO 107
      V=SBEG-SPACE1
  108 V=V+SPACE1
      IF(V.GE.SBEGM) GO TO 109
      GO TO 104
  107 IF(IV.NE.4) GO TO 110
      V=SBEGM
  111 V=V+SPACE
      IF(V.GE.SENDM) GO TO 109
      GO TO 104
  110 V=SENDM
  112 V=V+SPACE2
      IF(V.GT.SEND) GO TO 109
  104 WRITE(10,207) V
  207 FORMAT('  V=',F7.3,/)
      CALL STREAM(V,XI,YI,M)
      IF(M.LT.4) GO TO 4
  206 FORMAT('  I=',I3,' XI=',F7.3,' YI=',F7.3)
    3 CONTINUE
      LB=1
      DO 101 L=2,M
      D=SQRT((XI(L)-XI(L-1))**2+(YI(L)-YI(L-1))**2)
      IF(D.LT.1.5.AND.L.LT.M) GO TO 101
      LE=L-1
      IF(L.EQ.M) LE=M
      LM=LE-LB+1
      IF(LM.LT.4) GO TO 102
      CALL CURVE(XI(LB),YI(LB),LM,0)
  102 LB=L
  101 CONTINUE
      IF(IV.EQ.3) GO TO 108
      IF(IV.EQ.4) GO TO 111
      IF(IV.EQ.5) GO TO 112
```

FIGURE E.2

```
1020    109 CONTINUE
1030      4 CONTINUE
1040        CALL ENDPL(0)
1050        CALL DONEPL
1060        STOP
1070        END
1080 C
1090 C
1100        SUBROUTINE STREAM(V,X1,Y1,M)
1110        COMMON /A/ XBN(400),YBN(400),SBN(400),IBN(400),JBN(400),S(41,41),I
1120       1MAXI,JMAX,NLN
1130        COMMON /A3/ KPOINT(41,41)
1140        DIMENSION XL(400),YL(400),X1(400),Y1(400),KR(50)
1150        M=0
1160 C
1170 C    KL COUNTS NUMBER OF POINTS
1180 C
1190        KL=0
1200 C   POINTS X FOR J LEVEL ************
1210        DO 100 J=1,JMAX
1220        DO 100 I=2,IMAXI
1230        IF(KPOINT(I,J).EQ.1) GO TO 102
1240        KP1=KPOINT(I-1,J)
1250        KP2=KPOINT(I,J)
1260        IF(KP1.EQ.0.OR.KP2.EQ.0) GO TO 101
1270        IF(KP1.NE.4.AND.KP1.NE.8.AND.KP1.NE.9) GO TO 102
1280        IF(KP2.EQ.2.OR.KP2.EQ.6.OR.KP2.EQ.7) GO TO 101
1290    102 A1=S(I-1,J)-V
1300        A2=S(I,J)-V
1310        IF(A1.GT.9..OR.A2.GT.9.) GO TO 100
1320        IF((A1*A2).GT.0.) GO TO 100
1330        KL=KL+1
1340        YL(KL)=FLOAT(J)
1350        XL(KL)=FLOAT(I)
1360        IF(A1.EQ.0..AND.A2.EQ.0.) GO TO 100
1370        XL(KL)=FLOAT(I)-ABS(A2)/(ABS(A1)+ABS(A2))
1380    101 CONTINUE
1390    100 CONTINUE
1400 C   POINTS Y FOR I VALUE *************
1410        DO 110 I=1,IMAXI
1420        DO 110 J= 2,JMAX
1430        IF(KPOINT(I,J).EQ.1) GO TO 112
1440        KP1=KPOINT(I,J-1)
1450        KP2=KPOINT(I,J)
1460        IF(KP1.EQ.0.OR.KP2.EQ.0) GO TO 111
1470        IF(KP1.NE.3.AND.KP1.NE.6.AND.KP1.NE.8) GO TO 112
1480        IF(KP2.EQ.5.OR.KP2.EQ.7.OR.KP2.EQ.9) GO TO 111
1490    112 A1=S(I,J-1)-V
1500        A2=S(I,J)-V
1510        IF(A1.GT.9..OR.A2.GT.9.) GO TO 110
1520        IF(A1*A2.GE.0.) GO TO 110
1530        KL=KL+1
1540        XL(KL)=FLOAT(I)
```

FIGURE E.3

```
      YL(KL)=FLOAT(J)
      IF(A1.EQ.0..AND.A2.EQ.0.) GO TO 110
      YL(KL)=FLOAT(J)-ABS(A2)/(ABS(A1)+ABS(A2))
  111 CONTINUE
  110 CONTINUE
      KBI=KL+1
C  POINTS BETWEEN SURFACE & INTERNAL
      DO 301 L=2,NLN
      A2=SBN(L)-V
      A3=S(IBN(L),JBN(L))-V
      IF(A2*A3.GE.0.) GO TO 301
      KL=KL+1
      H=-A2/(A3-A2)
      XL(KL)=XBN(L)+H*(FLOAT(IBN(L))-XBN(L))
      YL(KL)=YBN(L)+H*(FLOAT(JBN(L))-YBN(L))
  301 CONTINUE
C
C   NKL=TOTAL NUMBER OF INTERNAL POINTS
C
      NKL=KL
      IF(KL.LT.5) GO TO 201
      KB=KL+1
C  POINTS ON SURFACE  **************
      DO 300 L=3,NLN
      D=SQRT((XBN(L)-XBN(L-1))**2+(YBN(L)-YBN(L-1))**2)
      IF(D.GT.2.) GO TO 300
      A1=SBN(L-1)-V
      A2=SBN(L)-V
      IF(A1*A2.GT.0.) GO TO 300
      IF(A1.EQ.0..AND.A2.EQ.0.) GO TO 300
      KL=KL+1
      H=-A1/(A2-A1)
      XL(KL)=XBN(L-1)+H*(XBN(L)-XBN(L-1))
      YL(KL)=YBN(L-1)+H*(YBN(L)-YBN(L-1))
  300 CONTINUE
      WRITE(10,5) (I,XL(I),YL(I),I=1,KL)
    5 FORMAT('  I=',I3,'  XL=',F6.2,'  YL=',F6.2)
C
C   KEND=TOTAL NUMBER OF POINTS
C
      KEND=KL
      M=0
      JC=0
      IF(NKL.LT.4) GO TO 200
C
C   DETERMINE STARTING POINT
C
  801 JC=JC+1
      IF(JC.GT.20) GO TO 201
      IF(KB.GE.KEND) GO TO 161
      DO 350 KI=KB,KEND
      IF(XL(KI).GE.1.) GO TO 140
  350 CONTINUE
```

FIGURE E.4

```
2080   161 DO 120 K1=1,NKL
2090   121 IF(XL(K1).EQ.1.OR.YL(K1).EQ.1..OR.XL(K1).EQ.IMAXI
2100      1.OR.YL(K1).EQ.JMAX) GO TO 140
2110       NCOUNT=0
2120       DO 130 K2=1,NKL
2130       IF(K1.EQ.K2) GO TO 130
2140       IF(XL(K2).LT.1.) GO TO 130
2150       D=SQRT((XL(K1)-XL(K2))**2+(YL(K1)-YL(K2))**2)
2160       IF(D.GE.1.415) GO TO 130
2170       NCOUNT=NCOUNT+1
2180       KR(NCOUNT)=K2
2190   130 CONTINUE
2200       GO TO (140,141), NCOUNT
2210       GO TO 120
2220   141 IF(SQRT((XL(KR(1))-XL(KR(2)))**2+(YL(KR(1))-YL(KR(2)))**2).LT.1.)
2230      1 GO TO 140
2240   120 CONTINUE
2250       GO TO 160
2260 C
2270 C    SEQUENCE POINT FROM STARTING POINT
2280 C
2290   140 IF(XL(K1).LT.1..OR.YL(K1).LT.1.) GO TO 142
2300       M=M+1
2310       X1(M)=XL(K1)
2320       Y1(M)=YL(K1)
2325       KINT=K1
2330       I=X1(M)+.01
2340       J=Y1(M)+.01
2350       XI=FLOAT(I)
2360       YI=FLOAT(J)
2370       XMIN=XI-.01
2380       XMAX=XI+1.01
2390       IF(X1(M).LE.XI) XMIN=XI-1.01
2400       YMIN=YI-.01
2410       YMAX=YI+1.01
2420       IF(Y1(M).LE.YI) YMIN=YI-1.01
2430   142 XL(K1)=0.
2440       K1=0
2450       IF(M.EQ.0) GO TO 801
2460       D1=1.5
2570 C    FIND CLOSEST POINT
2580 C
2590       DO 150 K2=1,KEND
2600       IF(XL(K2).EQ.0.) GO TO 150
2603       IF(KINT.GE.KBI) GO TO 701
2606       IF(K2.GE.KBI) GO TO 701
2609       IF(XL(K2).LT.XMIN.OR.XL(K2).GT.XMAX) GO TO 150
2612       IF(YL(K2).LT.YMIN.OR.YL(K2).GT.YMAX) GO TO 150
2614   700 IF(K2.LT.KBI.OR.K2.GT.NKL) GO TO 701
2618       IF(KINT.EQ.NKL.AND.K2.EQ.KBI) GO TO 701
2622       IF(KINT.EQ.KBI.AND.K2.EQ.NKL) GO TO 701
2626       IF(ABS(FLOAT(K2-KINT)).GT.1.5) GO TO 150
2640   701 D=SQRT((XL(K2)-X1(M))**2+(YL(K2)-Y1(M))**2)
```

FIGURE E.5

```
      IF(D.GT.D1) GO TO 150
      D1=D
      K1=K2
  150 CONTINUE
      IF(K1.NE.0) GO TO 140
      GO TO 171
  160 DO 170 K1=1,KEND
      IF(XL(K1).EQ.0.) GO TO 170
      GO TO 140
  170 CONTINUE
  171 IF(M.LT.4) GO TO 200
      D=SQRT((X1(1)-X1(M))**2+(Y1(1)-Y1(M))**2)
      IF(D.GT.1.415) GO TO 199
      M=M+1
      X1(M)=X1(1)
      Y1(M)=Y1(1)
      GO TO 200
  199 D=SQRT((X1(2)-X1(M))**2+(Y1(2)-Y1(M))**2)
      IF(D.GT.1.415) GO TO 200
      M=M+1
      X1(M)=X1(2)
      Y1(M)=Y1(2)
  200 CONTINUE
      IF(NKL.LT.4) GO TO 201
      IC=0
      DO 800 I=1,KEND
      IF(XL(I).NE.0.) IC=IC+1
  800 CONTINUE
      IF(IC.GT.4) GO TO 801
  201 CONTINUE
      RETURN
      END
```

FIGURE E.6