nasa CR-168,009

NASA CR-168009
Douglas Report No. MDC J2548

Calculation of Compressible Flow In and About Three-Dimensional Inlets With and Without Auxiliary Inlets by a Higher-Order Panel Method

John L. Hess
Douglas M. Friedman

Douglas Aircraft Company
McDonnell Douglas Corporation
Long Beach, CA 90846

Contract NAS3-22147

October 1982

National Aeronautics and
Space Administration

Lewis Research Center
Cleveland, Ohio 44135
AC 216 433-4000

Report No. MDC J2548

CALCULATION OF COMPRESSIBLE FLOW IN AND ABOUT THREE-DIMENSIONAL INLETS WITH OR WITHOUT AUXILIARY INLETS BY A HIGHER-ORDER PANEL METHOD

by

John L. Hess

and

Douglas M. Friedman

October 1982

Prepared under

Contract No. NAS 3-22147

NASA, Lewis Research Center

Cleveland, Ohio

N83-12047#

Copy number Report number MDC J2548

CALCULATION OF COMPRESSIBLE FLOW IN AND ABOUT THREE-DIMENSIONAL INLETS WITH OR WITHOUT AUXILIARY INLETS BY A HIGHER-ORDER PANEL METHOD

Revision date Revision letter

Issue date October 1982 Contract number NAS 3-22147

Prepared by : John L. Hess
Douglas M. Friedman

Approved by :

Tuncer Cebeci
Chief Technology Engineer,
Research
Aerodynamics Subdivision

R. B. Harris
Director - Aerodynamics

DOUGLAS AIRCRAFT COMPANY

MCDONNELL DOUGLAS CORPORATION

1.0 ABSTRACT

A three-dimensional higher-order panel method has been specialized to the case of inlets with auxiliary inlets. The resulting program has a number of graphical input-output features to make it highly useful to the designer. This report describes the various aspects of the program and presents instructions for its use. Additionally, some calculated results are included.

2.0 TABLE OF CONTENTS

3.0 THEORY AND RESULTS

3.1 General Remarks

The program described in this report is a generalization of the three-dimensional inlet program of Ref. 1. While the provision of a capability to handle auxiliary inlets required substantial internal program changes, the overall logic of the calculation and most analytic expressions remain those of Ref. 1. For brevity, those results are not repeated. Instead, familiarity of the reader with Ref. 1 is assumed, and indeed reference will be made to specific equations and sections of that report, particularly Sections 6.0, 7.0, 10.0 and 11.0. The main purpose of the remaining subsections of Section 3.0 is to describe the present program by calling attention to similarities and differences between it and the program of Ref. 1. A few calculated results are also presented to illustrate the effectiveness of the method.

3.2 The Previous Inlet Program

The previous inlet program (Ref. 1) computes flow about three-dimensional inlets, with or without centerbody, but without auxiliary inlets or vanes. There must be one continuous, unbroken inlet. A panel method (Ref. 2) is used to compute four incompressible solutions: (1) zero angle of attack and zero yaw, (2) 90° angle of attack with zero yaw, (3) 90° yaw with zero angle of attack, and (4) a static solution. The first three have unit free-stream velocity. These four are known as the fundamental solutions, and the solution at any set of flow conditions is obtained as a linear combination of them in a relatively small amount of computer time. If the inlet has a symmetry plane, this can be accounted for in the calculations to reduce the computer time. The combination program is described in Section 10.0 of Ref. 1. There is a simple incompressible option and a relatively elaborate compressible option. Both require specification of flow quantities at infinity and at a control station inside the inlet (Fig. 1), and from these calculate the combination constants for the fundamental solutions.

The incompressible calculation is corrected for compressibility by the Lieblein-Stockman procedure. An elaborate scheme is used to calculate flow passage areas for all points, and these are used in the compressibility correction as described in Section 11.2 of Ref. 1.

A number of graphical output features exist. In particular, surface streamlines can be generated upstream or downstream from arbitrary prescribed points. Moreover, cross sections may be specified inside the inlet (Fig. 1) and isoplots of pressure, Mach number and flow inclination automatically generated.

While the first three fundamental solutions are straightforward, the static solution requires some care. Constant vorticity is used over the entire surface of the inlet to simulate this solution (Fig. 2). Thus, the static solution has both source and vorticity on all its panels, and indeed, logically, the inlet is a lifting wing "wrapped around into a circle."

3.3 General Nature of the Present Program for Auxiliary Inlets

An inlet with an auxiliary inlet is sketched in Fig. 3. The resulting "hole" in the side of the main inlet precludes the use of surface vorticity in the sense of Fig. 2 by interrupting it. Thus, a new means of generating the static solution is required, and it must make use of source panels alone. To minimize leakage problems, a higher-order formulation appeared highly desirable (Refs. 3 and 4). In the customary terms of panel methods, the method of Ref. 1 is a first-order lifting method, while the method of this report is a higher-order nonlifting method. In the combined solution, the flux through the control station (Fig. 3) induces a flow through the auxiliary inlet as shown. However, there is no attempt to model a Kutta condition on any corners of the auxiliary inlet. The fluid simply flows around such corners.

3.4 Comparison of Some Features of the Previous Inlet Program with the Present One

The present program retains essentially all the features and capabilities of the previous program. In particular, fundamental solutions are generated and combined by a similar combination program, and the capabilities of graphical output are retained. One plane of symmetry can be accounted for, and the Lieblein-Stockman compressibility correction is used. There are, however, some differences, and these are described in the following subsections.

3.4.1 Static Solution

The first attempt at simulation of a static solution used a suction surface near the downstream end of the inlet (Fig. 4a), but this led to a ficticious stagnation point on the exterior of the inlet, even with the higher-order procedure. Aft of this point the effect of mass flow at the control station on the external surface pressure would not only be of the wrong magnitude but would actually have the wrong sign.

Instead of the suction surface, the device that has been adopted to yield a qualitatively correct static solution is a "ring" vortex roughly coincident with the interior surface of the inlet at a downstream location (Fig. 4b). Actually, the "ring" is a polygon whose vertices, which lie on the input "N-lines," are input by the user. The resulting flow has the correct character as sketched in Fig. 4b.

3.4.2 Compressibility Correction

The Lieblein-Stockman correction, which is documented in Ref. 1, is used in the present program with one important change. The method of Ref. 1 contains a very elaborate procedure for calculating a so-called "flow passage area" at each on-body or cross-section point. The area A_{FP} is then used in equation (52) of Ref. 1 to calculate an "average incompressible velocity" at that point, which is used in the compressibility correction. In the present program the routine for calculating flow passage area has been eliminated. Instead, a <u>single</u> value of "average incompressible velocity" is input and used for <u>all</u> points where velocities are calculated.

Clearly, any value of velocity may be input. If compatibility of conditions at the control station is important, there is only <u>one</u> correct value - the so-called "equivalent incompressible average velocity" as given in equation

(50) of Ref. 1. To illustrate, suppose a control station Mach number is specified. If the input "average incompressible velocity" equals the above, then the computed Mach number at the control station will equal the specified one; otherwise, it will not. An input value incompatible with control-station parameters has been allowed in case a user's interest is exclusively elsewhere, say at the auxiliary inlet. The user can then input a velocity that maximizes the accuracy of the compressibility correction in his area of interest. However, the default value of "average incompressible velocity" equals the "equivalent incompressible average velocity" at the control station.

3.4.3 Graphical Output of Input Geometry

A feature has been added to the graphical output package that optimally eliminates from the plot all points further than an input distance from a specified point. By specifying the point in the vicinity of the auxiliary inlet and suitably adjusting the distance, the user may obtain a picture of the details of the auxiliary inlet uncluttered by "background" points on the main inlet without modification to his input geometry "deck" (or dataset).

3.4.4 Cross-Sections and Control Stations

In the method of Ref. 1, the program contained a routine for automatically generating points on a cross-section or control station where flow was to be computed, together with associated elemental areas for use in calculating velocity flux. This routine has been eliminated in the present program. Instead, cross-sections and control stations must be defined by input points, just as if they were part of the body surface. The program then forms panels and "control points" where flow is calculated. While requiring slightly more effort, this procedure has the advantage of complete flexibility. A user may input cross-sections at any location at any inclination (even nonplanar) and in particular across the auxiliary inlet.

3.4.5 Maximum Panel Number

The maximum number of input panels on the body has been raised from 1000 to 2000. If one plane of symmetry is used, there may be 2000 panels on the input half of the body. For information on other program limitations, see Section 4.5.

3.4.6 Iterative Matrix Solution

The direct matrix solution of the program of Ref. 1 has been replaced in the present program by an iterative matrix solution, which is an order of magnitude faster for panel numbers above 1000. However, the direct solution is still available if, for some reason, the iterative scheme should encounter convergence difficulties.

3.4.7 Sectioning of Input Data

In the method of Ref. 1, it was required that the input points be organized into exactly one lifting section - the inlet - and either one or no nonlifting sections depending on whether a centerbody is or is not present. In the present program, all panels are nonlifting, and they may therefore be divided into any number of sections in any way the user desires. A description of the section procedure is contained in the Appendix. It permits considerable flexibility in representing complex geometries. It is required, however, that in any given section all n-lines contain the same number of points. Therefore, all strips, which are defined by successive n-lines, on a given section contain the same number of panels. Also, the on-body streamline tracing routine cannot trace across section boundaries. Consider, for example, a round inlet, as shown in Fig. 5a, consisting of 6 strips on the half-body (one plane of symmetry will be assumed for this case) and 12 panels per strip, for a total of 72 panels. If each panel were loaded as a separate section, then all the panels would be flat and the geometry would look like Fig. 5b; this would effectively render all of the higher-order terms inoperative and produce first-order results. While it is, therefore, seen to be desirable to divide the body into as few sections as possible, it is, nevertheless, sometimes convenient from a panel-generating standpoint to use many sections. Errors introduced by "sectioning" cannot, in general, be quantified, but the user is encouraged to try to strike a balance between excessive sectioning and excessive geometry generation time and convenience.

3.5 Calculated Results

Fig. 6 shows the panelling of one-half of a symmetric nacelle-pylon configuration, which was analyzed by the present program as an actual design application. Because of the presence of the pylon, it would have been difficult or impossible to perform these calculations with the method of Ref. 1. Principal design interest centered on the effect of the pylon on nacelle surface pressures. Fig. 7 shows calculated pressure distributions on the nacelle in the area of its intersection with the pylon both with and without the pylon in place.

To exhibit the capability of the present program to calculate flow in configurations with auxiliary inlets, calculations were performed for the supersonic inlet geometry shown in Fig. 8. The rather complicated geometry dictated dividing the input into a relatively large number (32) of sections as shown in Fig. 8a. The complete set of 1188 panels is shown in Fig. 8b. Three automatically generated cross sections were employed, Figs. 8c and 8d. Cross section 1, which serves as the control station, is across the main inlet downstream of the auxiliary inlet, while cross section 2 is upstream. Cross section 3 is across the auxiliary inlet itself. Close-up views of the auxiliary inlet with and without the cross-section panels are given in Figs. 9 and 10. The four fundamental solutions were superposed to yield combined flows for four conditions:

1. Static, full throttle (Mach no. of fan face = 0.577).
2. 80 kts, $\alpha = \beta = 0$, full throttle.
3. 80 kts, $\alpha = 20°$, $\beta = 0$, full throttle.
4. 80 kts, $\alpha = 0$, $\beta = 20°$, full throttle.

These solutions contain surface conditions at the control points of all panels both on the surface and in the cross sections. Graphical output in the form of isoplots of pressure, Mach number, and flow inclination angles were obtained from each cross section. By way of illustration, Figure 11 shows unretouched, computer-drawn curves of constant Mach number and constant flow inclination in the auxiliary inlet for the yawed flow condition (No. 4). In all plots a heavy line is used for the curve corresponding to the smallest value of the quantity plotted, and a dotted line is used for the curve corresponding to the median value. With this choice the heavy line is sometimes a short curve in the corner as in Figure 11b. However, no choice is without difficulty.

4.0 INPUT INSTRUCTIONS

The computer program, itself, has been divided into four steps:

STEP 1 = Fit the geometry with parametric bi-cubic patches
STEP 2 = Obtain the fundamental source solutions
STEP 3 = Fit the control-stations with parametric bi-cubic patches
STEP 4 = Combine the fundamental solutions for selected operating conditions

4.1 STEP 1: Geometry Fitting Program

The user defines the input geometry to the program by a series of points (x,y,z-coordinates) in space, distributed on curves running along the surface of the body about which the flow is to be computed. The organization of these points is similar to, but more flexible than, that of the original first-order program (Ref. 1). In particular, while the outward unit normal convention is preserved, the lifting-strip requirements have been eliminated. This permits the user much greater flexibility in the organization of the input points. However, since this is now a higher-order code, curved surfaces are fitted through the input points one section at a time. Furthermore, source derivatives are fitted one section at a time. These two approaches suggest that the user give some careful thought to section "breaks" lest the effectiveness of the higher-order calculations be unnecessarily compromised (see the discussion in Section 3.4.7). It is required, however, that the number of points on each n-line of a section be constant from n-line to n-line, but may, of course, vary from section to section.

If the user plans to specify the inlet mass flow within STEP 4, in addition to the usual on-body surface points, he must also create the ring vortex discussed earlier (see Section 3.4.1). To do this, he must specify a doublet surface at the rear of the inlet. The doublet surface is nothing more than an extra "section" of panels which is included along with the input surface points (must be the last section of the input.) If the user enters ISFLOW=1 (see Section 4.2), STEP 2 (the fundamental solutions program) will automatically assume that the last input section is the doublet surface. This section should consist of exactly two n-lines, one around the "exit" of the body, and the other, a single point (repeated) at the center of the "exit."

This will produce "pie-shaped" panels at the exit of the body, which are considered to be constant strength doublet panels. The sum of their effect is equivalent to a ring vortex around the periphery of the section. It is the onset flow due to this ring vortex which is used to produce the static fundamental solution. An example of such a doublet surface is shown in Fig. 12a.

Unit 1 is the input geometry (and optional doublet surface) dataset (or card deck):

cc	1-10	X	
cc	11-20	Y	Cartesian coordinates
cc	21-30	Z	
cc	31	ISTAT	0 = this point is on the same n-line as previous point. 1 = this point starts a new n-line. 2 = this point starts a new section.

A sample of this kind of input is shown in Fig. 13.

The output from STEP 1 is limited to a few lines, as shown in Fig. 14.

4.2 STEP 2: Fundamental Solutions Program

Input to this STEP consists of the output from STEP 1 plus a set of control flags. The STEP 1 output is assumed to reside on Unit 1 for the purposes of STEP 2. The control flags are a card deck (or card-image dataset) which is assumed to reside on Unit 5 for this STEP. Output data for the combination program, STEP 4, will be placed by this STEP on Unit 2. Therefore, the user-generated input for this STEP is limited to the following set of formatted, card image control flags (on Unit 5):

Card 1 (Title Card)

cc 1-72 Alphanumeric run description.

Card (Set) 2

Parameters are input per "NAMELIST /A/" format. (See Fig. 15a for an example.) The available parameters are: (defaults are shown underlined)

ICUR:	0 =	flat panels.
	1 =	curved panels.
ISORD:	0 =	no source derivatives used. Source constant on panel.
	1 =	use source derivative effects. Source linear on panel.
NSYM:	0 =	no symmetry planes.
	1 =	one plane of symmetry (i.e. the X-Z plane).
ISFLOW:	0 =	no static fundamental solution.
	1 =	generate a static fundamental solution (Note: If ISFLOW=1, the last input "section" is assumed to be "the doublet section," as explained above.)
IZFLOW:	0 =	no α=90° fundamental solution
	1 =	generate an α=90° fundamental solution.
IYFLOW:	0 =	no β fundamental solution.
	1 =	generate a β=90° fundamental solution.
INPUTP:	0 =	do not print the basic input panel data.
	1 =	print the basic input panel data.
IFUNDP:	0 =	do not print the fundamental solutions.
	1 =	print the fundamental solutions.

For most inlet cases, all of the defaults will usually suffice, with the possible exception of NSYM. It should be noted that there are really four fundamental solutions: (1) static, (2) α=0°, (3) α=90°, and (4) β=90°. Of these, (1), (3) and (4) are optional (per ISFLOW, IZFLOW, and IYFLOW flags, as shown above), and need to be generated only if it is anticipated that they will be needed for a later combination case (STEP 4).

The output for STEP 2 for the normal inlet sample case is shown in Fig. 16. A brief summary of the print output data labelling system follows.

Fig. 16.1 A list of the values of the flags which were input by the user.

Figs. 16.2-16.7 Basic panel formation data:

PNL.NO.: Sequential panel number counter.

SECT.NO.: Sequential section number.

N:	Sequential strip number on the section.
M:	Sequential panel number on the strip.
PNL.TYPE:	Type of panel (NLIF=nonlifting, DBLT=doublet).
X,Y,Z:	Corner point coordinates from which the panel is formed.
NX,NY,NZ:	Panel unit normal vector components.
XCP,YCP,ZCP:	Control point coordinates.
AV.PROJ.DIST:	Average projection distance of the input corner points in the local panel system.
MAX.DIAG:	Maximum panel diagonal length.
PROJ.AREA:	Projected panel area.
P,Q,R:	Curvature quantities as used in the paraboloidal panel assumption in the panel coordinate system:

$$\zeta = P\xi^2 + 2Q\xi\eta + R\eta^2.$$

Fig. 16.8 Breakdown of the source/doublet induced velocity formulas that were used to generate the velocity influence coefficient matrix.

NEAR:	Number of near-field formulas that were used.
INTER:	Number of intermediate-field formulas that were used.
FAR:	Number of far-field formulas that were used.
SMALL LOGS:	Number of times that the small-logarithm expansions were used in the near-field calculations.

Figs. 16.9-16.10 Iterative matrix solution history

(first column):	Iteration number (maximum of 100 iterations permitted; if convergence is not reached satisfactorily by then, the program will automatically switch to use of the direct solution if the input flag ITERAT is set to 2).
R1,R2,R3:	Acceleration constants (R3 applies to the most recent iteration, R2 to the iteration before, and R1 to the iteration before that).
N1,N2,N3:	The panel numbers at which the three largest associated residuals (of the present iteration) apply.
RES1,RES2,RES3:	The three largest residuals of the present iteration.

Figs. 16.11-16.12 "Static-solution" results.

X,Y,Z: Control point coordinates.

VX,VY,VZ: Fundamental solution velocity vector components.

VT: Fundamental solution total velocity magnitude:

$$V_T = \sqrt{V_x^2 + V_y^2 + V_z^2}$$

CP: Pressure coefficient:

$$C_p = 1 - V_T^2$$

SIGMA: Value of the source density at the control point (see Eq. 16 of Ref. 3).

VN: Net normal velocity through the panel at the control point (should always be small for solid surfaces).

Figs. 16.13-16.14 "α=0 solution" results.

Figs. 16.15-16.16 "α=90 solution" results.

Figs. 16.17-16.18 "β=90 solution" results.

Figs. 16.19 Time usage summary.

4.3 STEP 3: Fit the Control-Station and/or Cross-Sections

Once the fundamental solution(s) have been generated, they must be combined to yield net results for a given α, β and mass flow. Furthermore, it may be desirable to examine the flow at particular places within the inlet for flux measurement, flow distortion, flow angularity, etc. To accomplish this, the user must input one or more sections of cross-section defining points. Each section constitutes one cross-section. Each cross-section generally "spans" the interior of the inlet or auxiliary inlet so that the integrated fluxes are valid mass flow calculations. However, this is not a requirement. The cross-section may have any size, shape or orientation; they may even be nonplanar, although such is not the typical case. STEP 3 uses the same program as STEP 1 to fit parametric bicubic patches to the input geometry data, and passes the patches on to STEP 4. For cases where a static fundamental solution was generated (which is assumed to be the vast majority of cases to which this program will be applied), the first input section (for STEP 3) is taken to be the "control-station" for which special additional parameters (such as mass-flow) will be defined in STEP 4. In any case, the data input for this STEP appears in exactly the same format as that of STEP 1.

A sample listing of the input data (for Unit 1) for a control-station with a cross-section following it is shown in Fig. 17. The output from STEP 3 is, of course, similar to that of STEP 1, but applies only to the input cross-sections, and is shown in Fig. 18.

4.4 STEP 4: Flow Combination/Geometry-Graphics Program

This STEP is the "workhorse" and most complex to input. It can be run in either of two modes:

1. Mode 1: Combine the fundamental solution for given freestream conditions (α, β, Mach number, etc.) and mass flow. Optional output then available consists of any, or all, of the following:

   (a) on-body surface velocities, pressures, etc.
   (b) on-body surface streamline calculations (and plots)
   (c) cross-section flux calculations
   (d) cross-section iso-plots (pressures, Mach number, etc.)
   (e) velocities, pressures, etc., at input off-body points

2. Mode 2: Draw the curved panel geometry that has been generated by the parametric bi-cubic patch-fitting program (from STEPS 1 or 3) for checkout of the input geometry data.

It will be seen that the user-generated input requirements for Mode 2 are simply a small subset of those of Mode 1.

4.4.1 STEP 4, MODE 1: Flow Combination

Three input units are required:

Unit 1: Geometry of the fitted panels of the control-station and cross-sections (output by STEP 3).

Unit 2: Fundamental solution data (output of STEP 2).

Unit 5: Combination control-flag data.

The input combination control flag data options follow:

Card 1 (Title Card)

cc 1-72 Alphanumeric run description

Card (Set) 2

Parameters are input per "NAMELIST /A/" format. (see Fig. 15b for an example.) The available parameters are: (defaults are shown underlined).

NCOMB:
- 0 = no combinations, draw geometry pictures only.
- n = the number of combination cases $(0 \leq NCOMB \leq 20)$

ICOMBP:
- 0 = do not print the net combined surface solution.
- 1 = print the net combined surface solution (i.e. velocity, pressure, etc.).

IFLUXP:
- 0 = do not print the combined solution at the cross-section points.
- 1 = print the net combined solution at the cross-section points.
- 2 = print details of the cross-section panels in addition to the net combined solution.

COMPRS: (INTEGER)
- 0 = incompressible.
- 1 = compressible (i.e. use the modified Lieblein/Stockman compressibility correction).

IOFF:
- 0 = no off-body points are input.
- 1 = off-body point input (X,Y,Z 3F10. similar to STEP 1 input but disregarding ISTAT flags) will appear on Unit 3. (Note: these off-body points are, in general, not necessarily related to the control-station or cross-section data.)

ISOP:
- 0 = do not generate isobar ("iso-pressure") plots.
- 1 = generate isobar ("iso-CP") plots at all cross-sections.
- 2 = generate iso-(P/PT) plots at all cross-sections.
- 3 = both 1 and 2.

DELCP: Increment in Cp value between adjacent constant Cp lines on iso-Cp plots.*

DELP: Increment in P/PT value between adjacent constant P/PT-lines on iso-P/PT plots.*

ISOM:
- 0 = do not generate iso-Mach number plots.
- 1 = generate iso-Mach number plots.

DELM: Increment in Mach number value between adjacent constant Mach-lines on iso-Mach plots.*

ISOA:
- 0 = do not generate iso-flow inclination plots.
- 1 = generate iso-flow inclination plots.

DELA: Increment in "flow inclination" between adjacent constant flow-angle lines on iso-flow-inclination plots.*

(Note: by flow inclination is meant the $\sin^{-1}(V_\xi/V_T)$ and $\sin^{-1}(V_\eta/V_T)$, where V_ξ and V_η are the flow velocity components in the local cross-section axis system and V_T is the total velocity, at each flux calculation point.)

NSL: The number of surface streamlines to be traced. (Default = 0) ($0 \leq$ NSL ≤ 50)

ISLP:**
- 0 = no print of streamline calculations.
- 1 = print streamline calculations (if any)**.

NVIEWS:**
- -1 = automatic program selection of 10 views for the geometry plus streamlines (if any).** (See Fig. 19 for a list of these views.)
- 0 = do not draw any geometry views.
- n = draw n views of the geometry plus streamlines (if any) (according to the associated n values of the geometry viewing data: PSI, THETA, PHI, X0, Y0, Z0, R0, DTHSEG, and IPERSP described below). ($-1 \leq$ NVIEWS ≤ 20)

---

*Default = 0.0 implies program will automatically select 20 appropriate values.

**Applicable if and only if NSL>0. (Note: If NCOMB=0 then NVIEWS and associated graphical control data are still applicable. See Section 4.4.2, Mode 2 for discussion.)

IHID:** <u>0</u> = only segments of the panel boundary curves which are facing the viewer will be drawn (with solid lines), i.e. no "hidden segments" drawn.
1 = all segments of the panel boundary curves will be drawn: those facing the viewer (with solid lines) and those facing away from the viewer, i.e. "hidden" (with dotted lines).
2 = all segments of the panel boundary curves will be drawn (with solid lines, only).

IPLOTP:** <u>0</u> = do not generate plots of pressure along the streamline(s).
1 = generate plots of CP vs either x and/or arc length s (according to the values of IVSX and IVSS, below) along the streamlines.
2 = generate plots of P/PT vs either x and/or arc length s (according to the values of IVSX and IVSS, below) along the streamlines.
3 = both 1 and 2.

IPLOTA:** <u>0</u> = do not generate plots of "flow angle" along the streamline(s).
1 = generates plots of flow angle vs either x and/or s (according to the values of IVSX and IVSS, below) along the streamline(s).

(Note: by flow angle is meant $\cos^{-1}(V_X/V_T)$, $\cos^{-1}(V_y/V_T)$ and $\cos^{-1}(V_Z/V_T)$.)

IVSS:** <u>0</u> = do not make plots vs arc length s (along the streamline).
1 = plot (i.e. pressure, Mach number and/or flow angle, depending upon values of IPLOTP, IPLOTM and IPLOTA) vs s.

IVSX:** <u>0</u> = do not make plots vs x (Cartesian x-coordinate).
1 = plot (pressure, Mach number and/or flow angles, depending upon values of IPLOTP, IPLOTM and IPLOTA) vs x.

<u>Freestream Combination Case Date: Incompressible (COMPRS=0)</u>

ALPHA(I),I=1,NCOMB: angle of attack (degrees, default = 0.0).

BETA(I),I=1,NCOMB: angle of yaw (degrees, default = 0.0).

VREF(I),I=1,NCOMB: reference speed for CP calculation (default = 1.0):

$$CP \equiv 1 - (V/VREF)^2$$

**Applicable if and only if NSL>0. (Note: If NCOMB=0 then NVIEWS and associated graphical control data are still applicable. See Section 4.4.2, Mode 2 for discussion.)

VINF(I),I=1,NCOMB: freestream speed for scaling the entire solution (default = 1.0).

VC(I),I=1,NCOMB: average speed at the control station (i.e. the requested value of this speed).

Freestream Combination Case Data: Compressible (COMPRS=1)

ALPHA(I),I=1,NCOMB: angle of attack (degrees, default = 0.0).

BETA(I),I=1,NCOMB: angle of yaw (degrees, default = 0.0).

VREF(I),I=1,NCOMB: reference speed for CP calculation (default = 1.0):

$$CP \equiv 1 - (V/VREF)^2$$

VIBAR(I),I=1,NCOMB: reference speed for the compressibility correction (default = $V_C \, \rho_C/\rho_T$).

VINF(I) or MINF(I) (REAL) I=1,NCOMB: Either the freestream speed or the freestream Mach number may be specified (no default).

PT(I) or PS(I) I=1,NCOMB: Either the freestream total or the freestream static pressure may be specified (default: PT = 2116.23 lbs/ft^2).

TT(I) or TS(I) I=1,NCOMB: Either the freestream total or the freestream static temperature may be specified (default: TT = 518.67°R).

VC(I) or MC(I) (REAL) or WC(I) I=1,NCOMB: The requested control-station value of either the average speed or the average Mach number or the average weight flow may be specified (no default).

Streamline Tracing Case Data (NSL>0)

NSECTO(I)***,I=1,NSL: The section number upon which the streamline is to be traced.

***At least the first value must be specified (if NSL>0). The defaults for the remaining values will be the most recently specified previous value.

USTART(I)***,I=1,NSL: The "U-coordinate" of the start of the streamline on this section. (U is a parametric variable defined to be 1.0 at the first control point of each strip, and reaching the floating point equivalent of N at the end of each strip, where N = the number of panels in each strip of the section. Note that $1.0 \leq U \leq N$(real). U not restricted to integral values, e.g. U = 1.3 is acceptable. Non-integral values correspond to streamline starting points between control points.)

VSTART(I)***,I=1,NSL: The "V-coordinate" of the start of the streamline on this section. (V is a parametric variable defined to be 1.0 at all of the control points of the first strip of this section, and reaching the floating point value of M at the control points of the last strip of this section, where M = the number of strips in this section. Note that $1.0 \leq V \leq M$ (real). V not restricted to integral values.)

NDIREC(I)***,I=1,NSL: The "sense" of the streamline tracing direction.
+1 = along the direction of the flow
-1 = exactly opposite the direction of the flow (i.e. trace the streamline backwards).

XMAX(I)***,I=1,NSL: The maximum allowable x-value of the streamline after which the streamline tracing calculations will be terminated.

MAXPTS(I)***,I=1,NSL: The maximum allowable number of points on the streamline after which the streamline tracing calculations will be terminated. (Note: streamline tracing calculations will terminate on XMAX or MAXPTS, whichever is encountered first.) Maximum allowable value for MAXPTS is 200.

Geometry Viewing Case Data (NVIEWS > 0)

PSI(I),I=1,NVIEWS: The yaw angle to be used for viewing purposes (default = 0.0).

THETA(I),I=1,NVIEWS: The pitch angle to be used for viewing purposes (default = 0.0).

PHI(I),I=1,NVIEWS: The roll angle to be used for viewing purposes (default = 0.0).

***At least the first value must be specified (if NSL>0). The defaults for the remaining values will be the most recently specified previous value.

XO(I), YO(I), ZO(I), RO(I) I=1,NVIEWS:	The X,Y,Z and radius values to be used for centering and scaling the geometry viewing. Note that the default value of 0.0 for R will yield automatic scaling of the entire body. Usage of nonzero values of R thus allows the user to obtain "blow-ups" of selected parts of the geometry, such as the details, say, of an auxiliary inlet.
DTHSEG(I),I=1,NVIEWS:	The boundaries of the panels are curved lines, but the graphics machine can only draw straight-line segments which are therefore allowed to differ in angle from one to another by no more than DTHSEG (degrees). Thus, this parameter controls how many of the straight-line segments will be used to approximate the boundary curves for the purpose of drawing. The smaller the DTHSEG, the more segments will be used and the higher the cost. (Default = 5.0 degrees.)
IPERSP(I),I=1,NVIEWS:	0 = no perspective (viewing point at infinity) 1-10 = viewing point at various distances from the body. 1 = farthest, 10 = nearest

Using the input to STEP 4 shown in Fig. 15b, the output for the round inlet sample case is shown in Fig. 20. A brief summary of the print output data labelling system follows:

Fig. 20.1: The input Unit 5 control flag data are listed.

Fig. 20.2: The data that were generated by STEP 2 (fundamental solutions) are summarized first. Following this summary, cross-section (or flux-station) data that were produced by STEP 3 are also summarized.

FLUX-STATION NUMBER:	The sequential numbers assigned to the input cross-section.
TOTAL NUMBER OF PANELS:	The total number of panels found on each of the input cross-section.
NU:	The number of panels along the cross-section n-line direction.
NV:	The number of panels along the cross-section m-line direction.
TOTAL AREA:	The total wetted area of the cross-section.
NX,NY,NZ:	The wetted-area/averaged normal vector that was assigned to the cross-section.

Following the aforementioned two summaries, the number of times that NEAR-field, INTERMEDIATE-field, and FAR-field formulas were used in the computation of the induced velocity at the cross-section points (and off-body points, if any) is listed. Included in this table is the number of times that the small logarithm expansion was needed in the NEAR-field formulas.

Fig. 20.3: A summary of the integrated flux data (before compressibility correction, if any) is shown:

RAKE: The sequential cross-section counter.

AREA: A repeat of the calculated cross-section wetted area.

TOTAL FLUX: Integrated values of $(\vec{V} \cdot \vec{N})A$ for each of the fundamental solutions (STATIC, ALPHA=0, ALPHA=90, and BETA=90), where $\vec{V}$ = local velocity vector, $\vec{N}$ = the cross-section unit normal vector, and A = the local panel area.

AVG.SPEED: Simply the total flux of each cross-section divided by the total wetted area of each cross-section.

Following next is a table showing the four internally-computed combination constants which are used to obtain the net combined surface and off-body velocities.

Figs. 20.4,20.5: On-body results for the combination case.

PNL.: The on-body, sequential panel number (consistent with the output of STEP 2).

SECT: The on-body sequential section number (consistent with the output of STEP 2).

J,I: The on-body sequential strip and panel counters.

X,Y,Z: The on-body panel control points.

VX,VY,VZ: The net combined velocity vector components at the control point.

VT: The total velocity magnitude:

$$V_T = \sqrt{V_x^2 + V_y^2 + V_z^2}$$

(Note that if the case is compressible (i.e. COMPRS=1), then the velocity components have been corrected for compressibility effects as described in Section 3.4.2 of this report.)

CP: The pressure coefficient:

$$C_p = 1 - (V_T/V_{REF})^2$$

P/PT: The ratio of local static to total pressure (computed only for compressible cases).

MACH: The local Mach number (computed only for compressible cases).

Fig. 20.6-20.9: Streamline calculations.

X,Y,Z: The on-body coordinates of the streamline. Since only linear interpolation between control points for these coordinates is used, some streamlines may appear slightly unsmooth in regions of high surface curvature. Of course, if the on-body panels are properly concentrated in such regions, the apparent unsmoothness will disappear.

VX,VY,VZ: The local velocity vector components along the streamline.

U,V: The parametric variables associated with the X,Y,Z of the surface. (Note that the surface streamline tracing is performed by "mapping" X,Y,Z,VX,VY AND VZ of the on-body control points (of a section) to "parametric U-V space." The tracing is then performed in this parametric space using linear interpolation throughout. Extrapolation is not permitted, which explains part of the reason for the program's inability to trace streamlines across section boundaries.)

DUDS,DVDS: Parametric velocity vector components: dU/ds and dV/ds, where s = true surface arc length.

NH,ND: The number of times the "step-size" (for the streamline integration) is halved and/or doubled, respectively. The streamline tracing algorithm contains its own step-size optimization procedures.

DELS: The incremental step-size, in true surface arc length.

When either the input NPMAX value, or the input XMAX value, or the "edge" of the section, or an apparent "stagnation" region is reached, whichever comes first, the tracing will terminate and the appropriate message printed. If plots of any of the streamline quantities (CP, P/PT, MACH, and/or flow-angularity) were requested, the appropriate plots are then generated and a message to that effect is printed.

Figs. 20.10-20.11: Net results at the cross-section.

The output data labelling is virtually identical to that of Figs. 20.4-20.5. The only difference is that these points lie on the cross-section instead of on the body surface.

Fig. 20.12: Finally, a summary table of the net combined flux for each cross-section is printed.

RAKE:	The sequential cross-section counter. (Recall that each section input to STEP 3 will constitute its own cross-section.)
NU:	The number of panels on a strip (between two adjacent n-lines).
NV:	The number of strips in the cross-section.
X1,Y1,Z1:	A listing of the first flux-measuring point (similar in concept to the on-body control point which is associated with each on-body panel) on the cross-section. This point is chosen just to aid the user to discern which cross-section is which. The order of the cross-section, of course, is the same as the order in which the sections appeared on the input to STEP 3.
AREA:	A repeat of the cross-section wetted area.
TOTAL FLUX:	Integrated value of $(\vec{V}.\vec{N})A$, where $\vec{V}$ = local net velocity vector connected with each panel, $\vec{N}$ = the cross-section unit normal vector (one per cross-section), A = the local panel wetted area.
AVG.SPEED:	The total flux of the cross-section divided by the total wetted area.

(Note that the TOTAL FLUX (or AVG. SPEED) for the first cross-section should agree with the user-input requested values. In the sample case, for example, VC specified in Fig. 20.1 was -0.9, which agrees with the printed net combined AVG. SPEED shown in Fig. 20.12.)

For the sample case, iso-plots and streamline tracing plots were created. A sample isobar (iso-Cp) plot is shown in Fig. 21. A sample of the surface streamline drawing capability is shown in Fig. 22. A sample of the individual plots of Cp vs x for one of the streamlines is shown in Fig. 23.

4.4.2 STEP 4, MODE 2: Geometry Viewing

Only 1 input unit is required, namely Unit 1. The Unit 5 data is optional.

Unit 1: Fitted panels from STEP 1.

Unit 5 may, optionally, also be specified. The only reason to do so would be to override the 10 automatically generated views. This would probably be necessary in cases where, for example, detail blow-ups of certain regions of the geometry are needed; for example, in the vicinity of auxiliary inlets. In such situations, Unit 5 control flag data would be necessary. However, most of the available Unit 5 flags discussed in Section 4.4.1 are not needed. Instead, only the following data would be supplied:

Card 1 (Title Card)

cc 1-72 Alphanumeric run description.

Card (Set) 2

Parameters are input per "NAMELIST/A/" format. (Only supply the flags which are pertinent to the creation of the geometry views desired, e.g. NVIEWS, IHID, and any of the "Geometry Viewing Case Data" flags described in Section 4.4.1.)

A sample of the output drawings that may be expected is shown in Fig. 24. For this case, viz. the round inlet sample case, Unit 5 was "dummied out." The view was number 4 of the 10 that were automatically produced.

4.5 Program Limits

STEP 1: # panels/section $\leq$ 1700

STEP 2: a. total # on-body panels $\leq$ 2000
b. total # sections $\leq$ 100
c. total # strips/section $\leq$ 2000
d. total # panels/strip $\leq$ 2000

STEP 3: (Same as STEP 1)

STEP 4: a. total # (flux panels + off-body points) < 1000
b. total # panels/strip (on a rake) < 50
c. total # cross-sections (including the control station) < 20

Other limitations for STEP 4 parameters are listed along with the explanation of the variables themselves in Section 4.4.

4.6 JCL

Only STEP 2, the Fundamental Solutions program, is overlayed. The overlay directives (for an IBM system) are shown in Fig. 25a.

Normally, STEPS 1 and 2 are run back-to-back. A sample of the JCL for these steps is shown in Fig. 25b.

Also, in most cases, STEPS 3 and 4 are run back-to-back. A sample of the JCL for these steps is shown in Fig. 26.

Both sets of JCL shown in Figs. 25 and 26 were used for the generation of the round inlet sample case described throughout this report.

5.0 REFERENCES

1. Hess, J.L., Mack, D.P. and Stockman, N.O.: An Efficient User-Oriented Method for Calculating Compressible Flow in and About Three-Dimensional Inlets. NASA CR-159578, April 1979.

2. Hess, J.L.: Calculation of Potential Flow About Arbitrary Three-Dimensional Lifting Bodies. McDonnell Douglas Report No. MDC J5679-01, October 1972.

3. Hess, J.L.: A Higher-Order Panel Method for Three-Dimensional Potential Flow. McDonnell Douglas Report No. MDC J8519, June 1979.

4. Hess, J.L. and Friedman, D.M.: An Improved Higher-Order Panel Method for Three-Dimensional Lifting Potential Flow. McDonnell Douglas Report No. MDC J2162, December 1981.

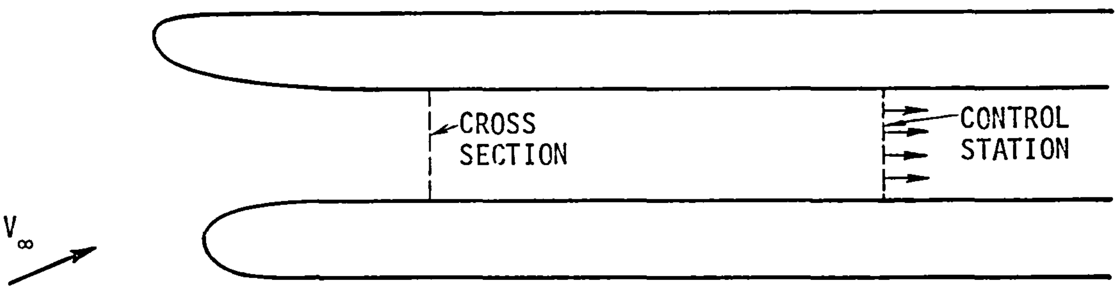


Fig. 1. Cross section and control station in an inlet.

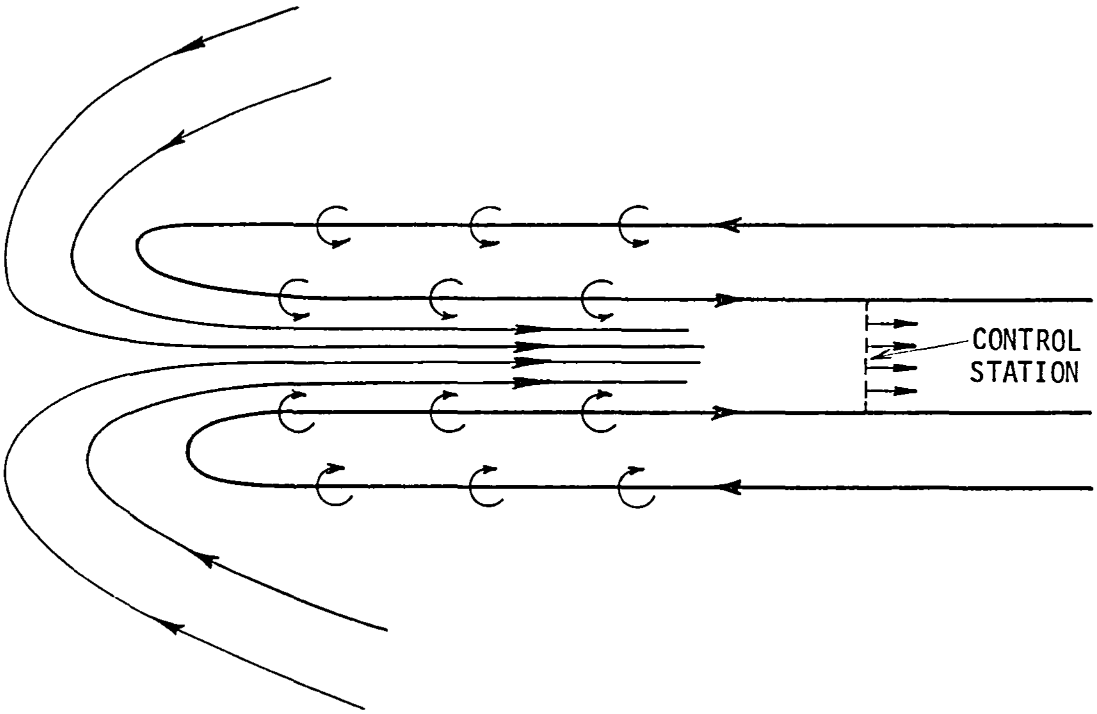


Fig. 2. Generation of a static solution by surface vorticity.

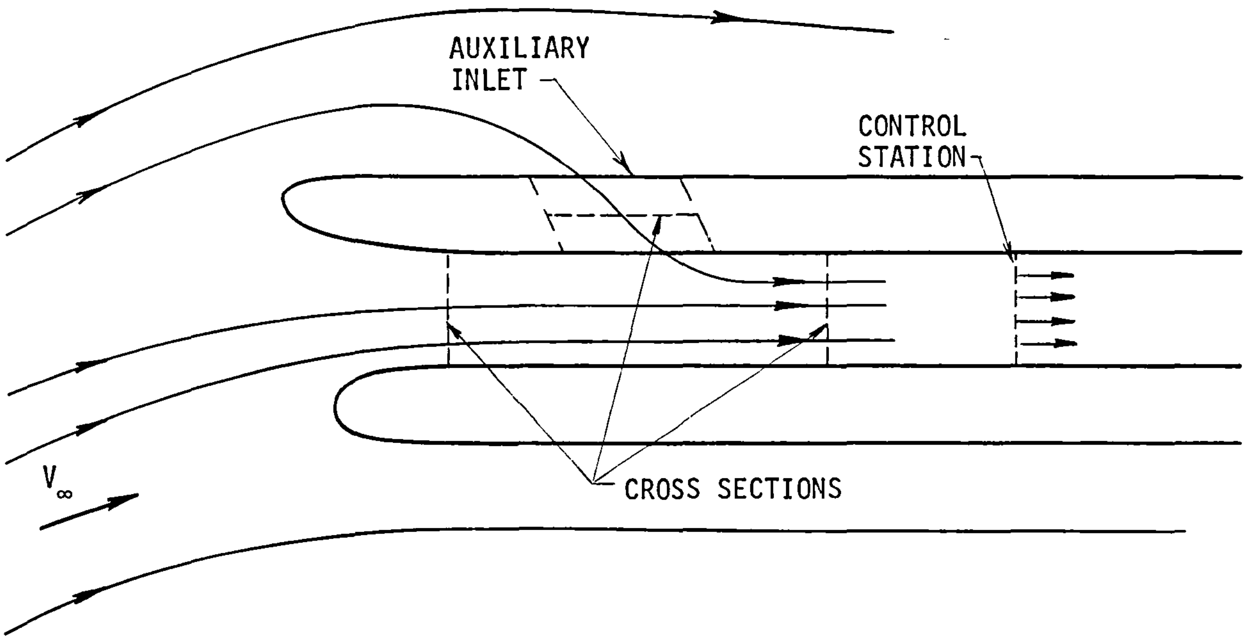
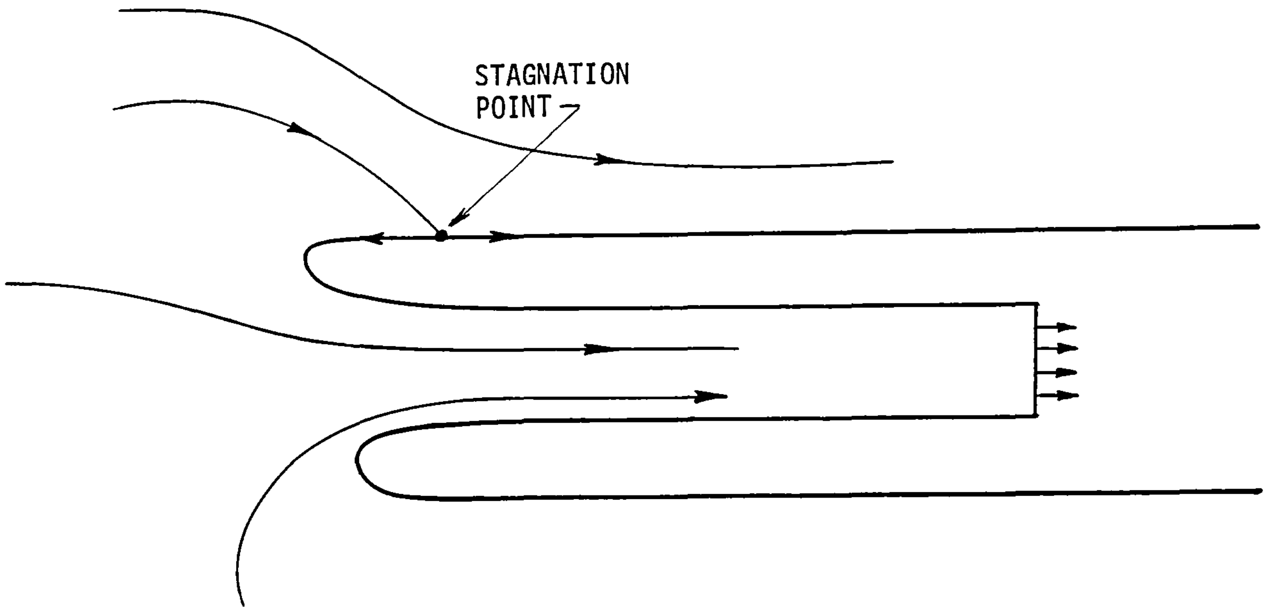
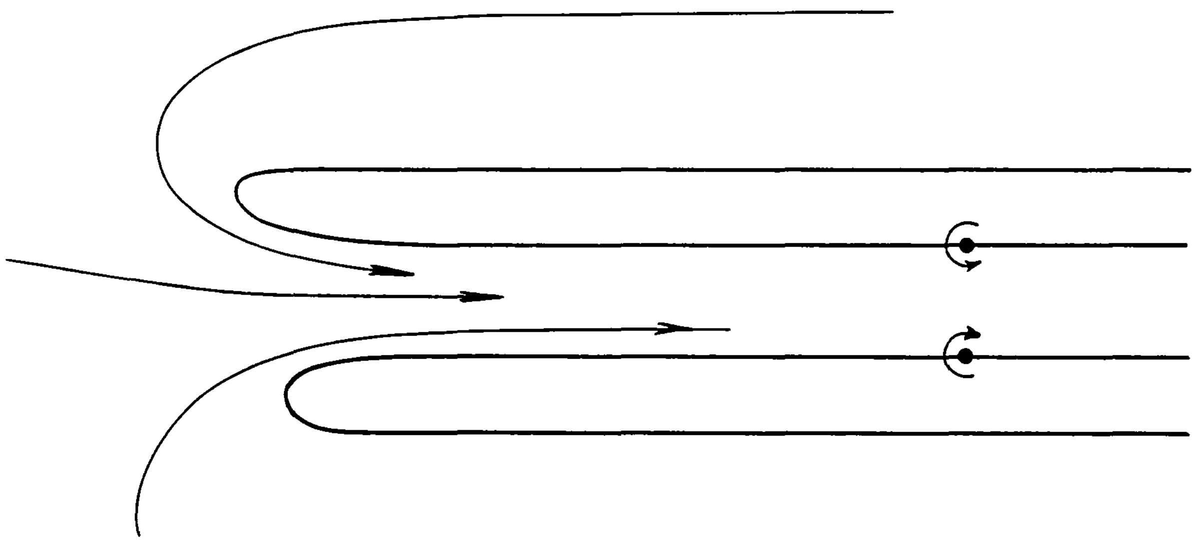


Fig. 3. An inlet with auxiliary inlet.



(a) Suction surface.



(b) Vortex ring.

Fig. 4. Two methods for generating the static solution.

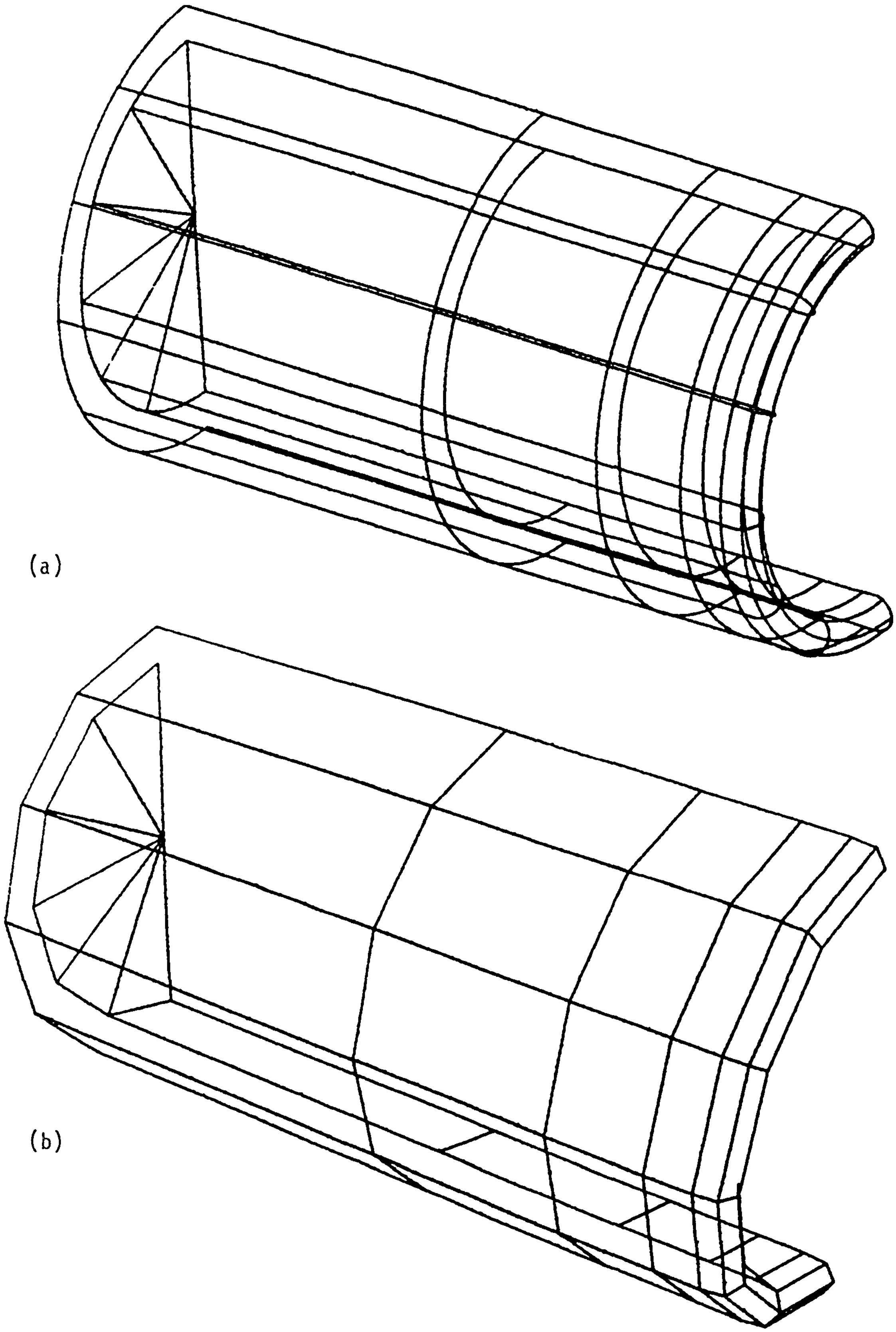


Fig. 5. The round inlet (with doublet surface) sample case showing: (a) curved panels (higher-order fit), and (b) flat panels (lower-order fit).

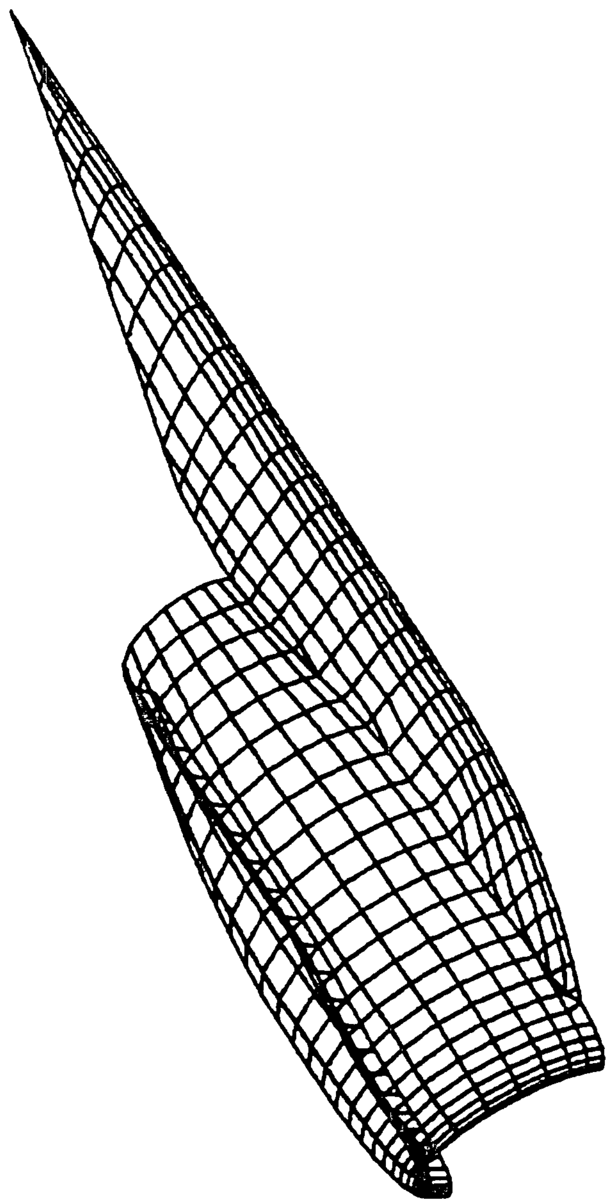


Fig. 6. Panelling of a nacelle-pylon.

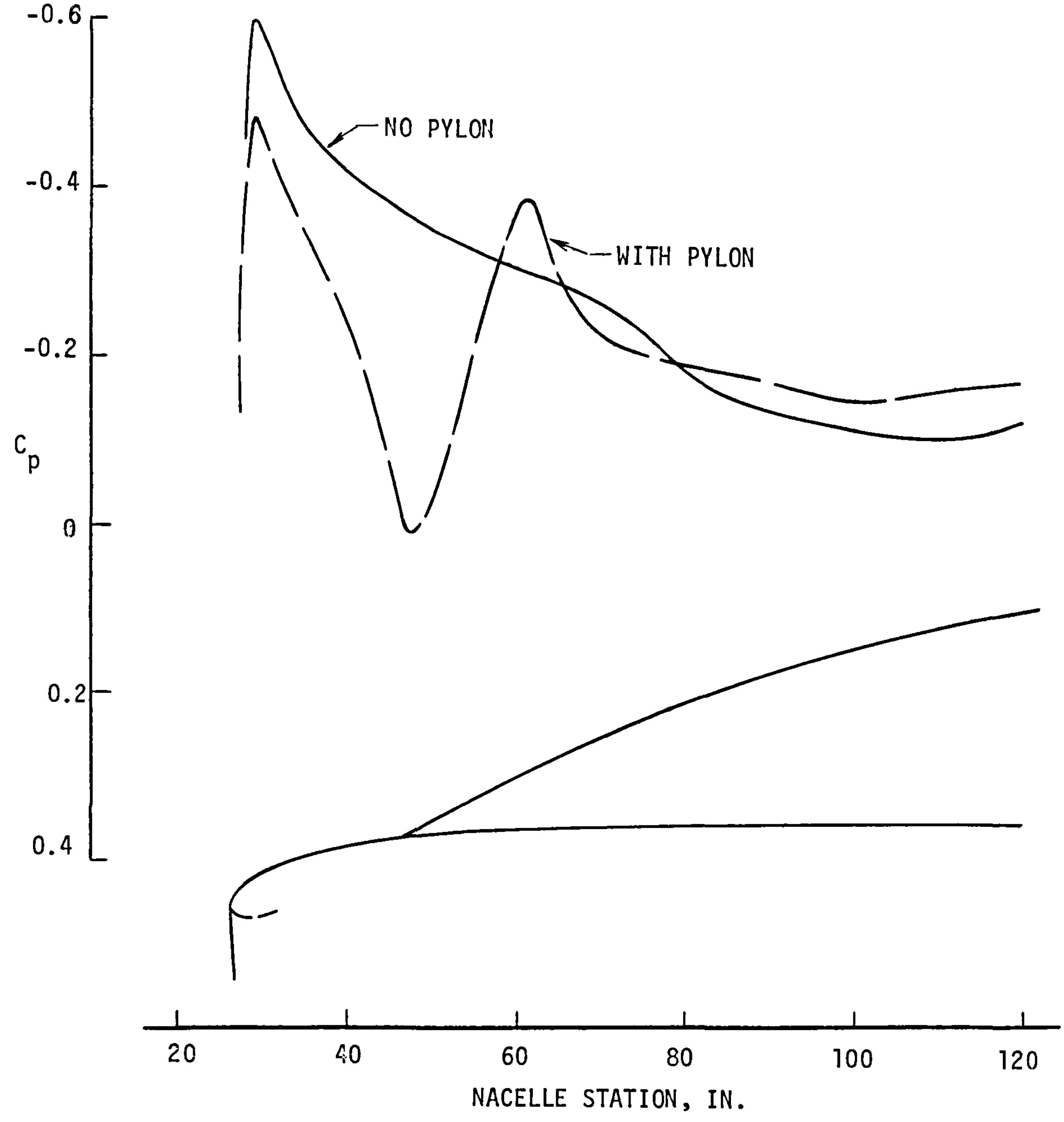


Fig. 7 . Incompressible pressure distributions on a nacelle, with and without pylon, α = 4°, V_c/V_∞ = 0.7.

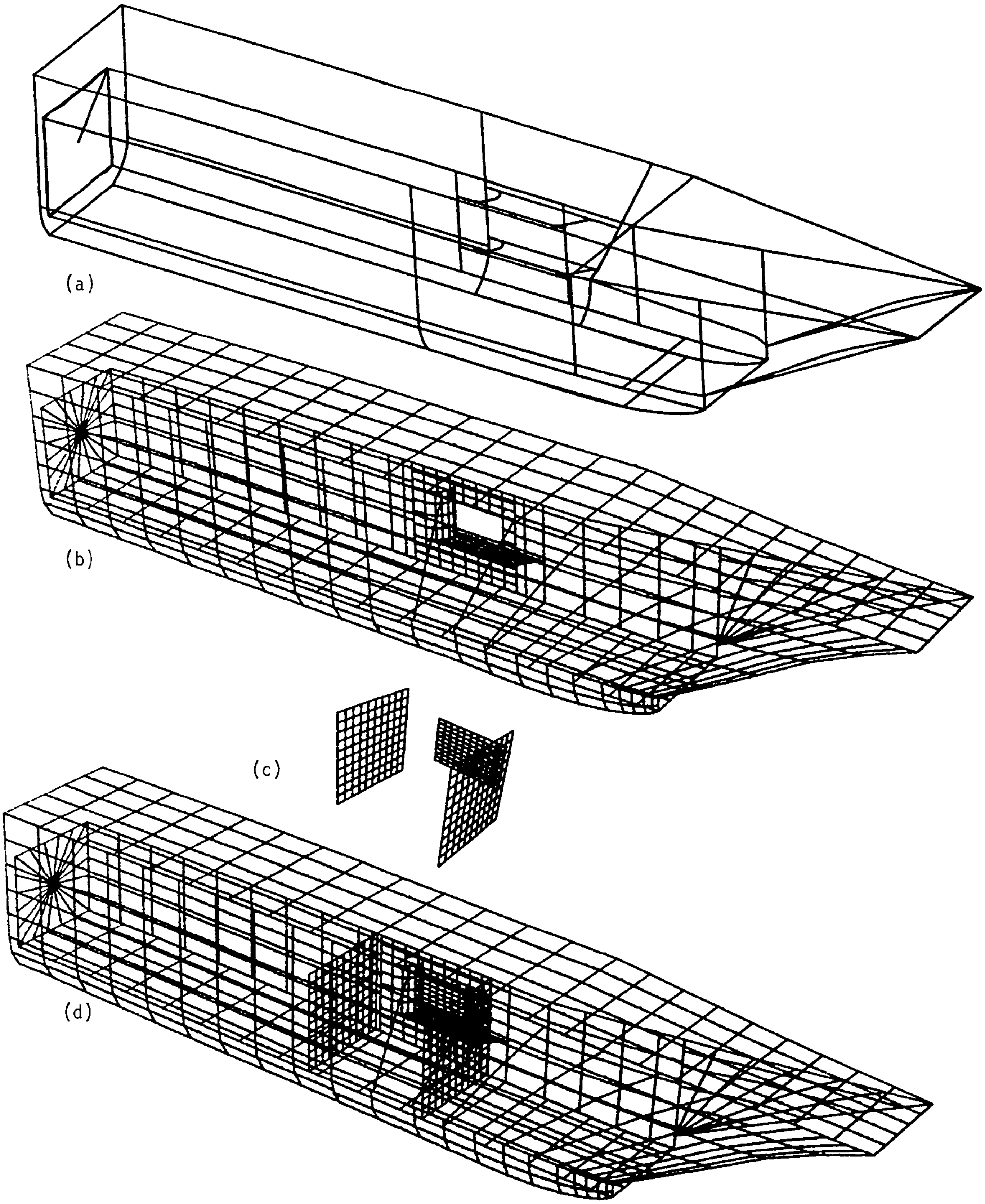


Fig. 8. Supersonic inlet with one side auxiliary inlet (32 sections, 1188 panels): (a) section edges, only, (b) full geometry + doublet surface (facing panels only), (c) three cross-sections, (d) geometry with cross-sections installed.

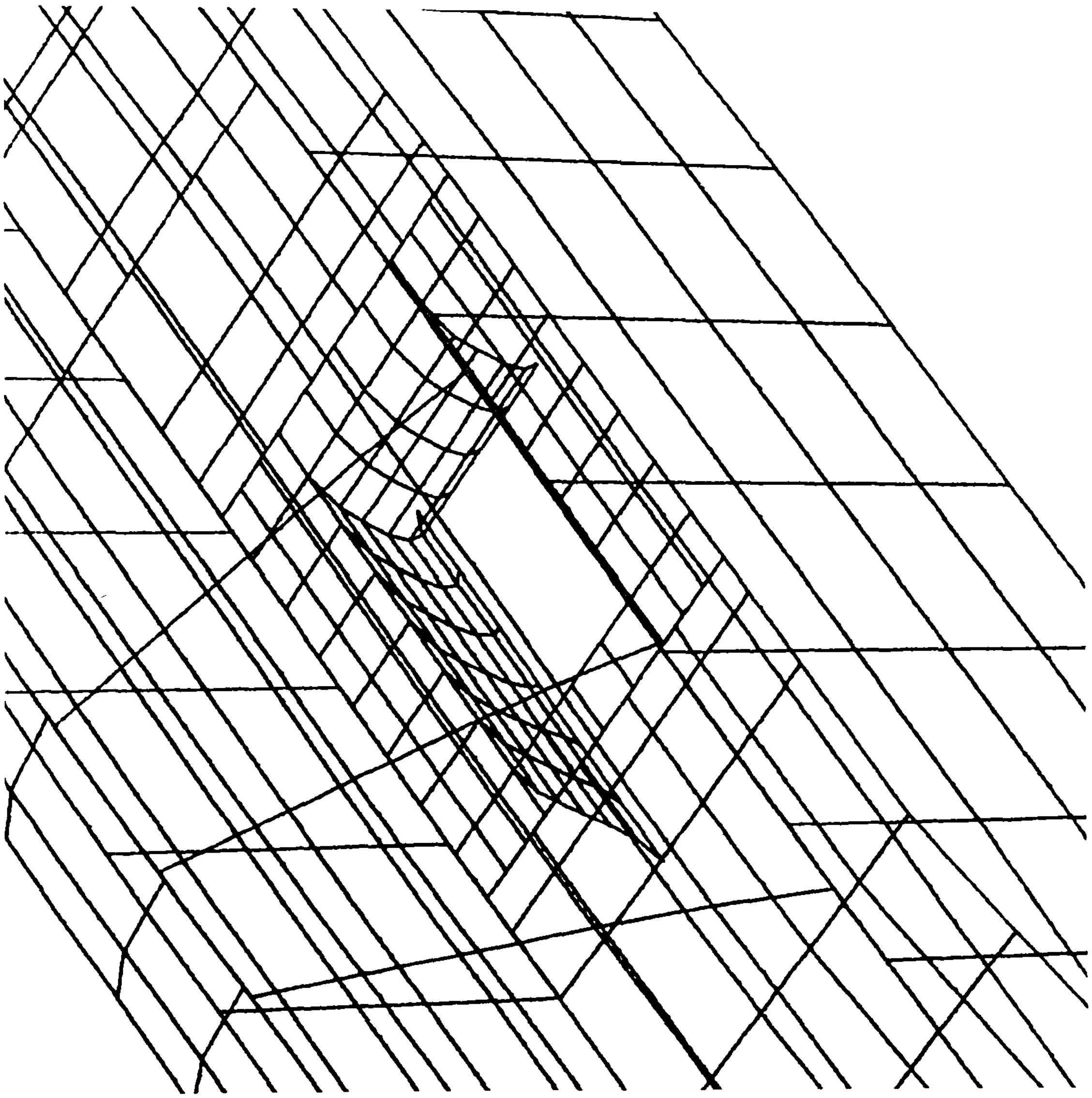


Fig. 9. Closeup of the side auxiliary inlet geometry.

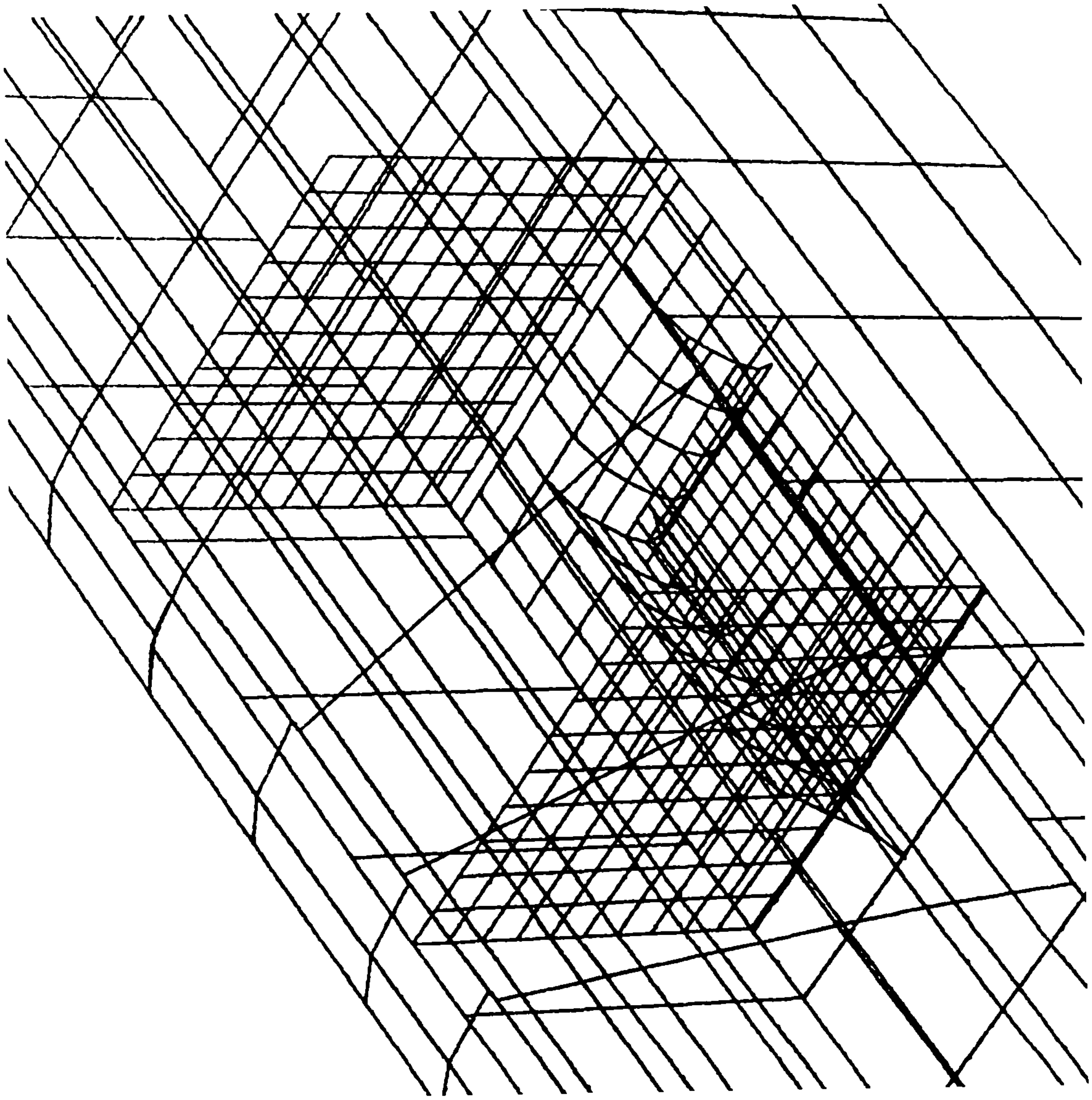
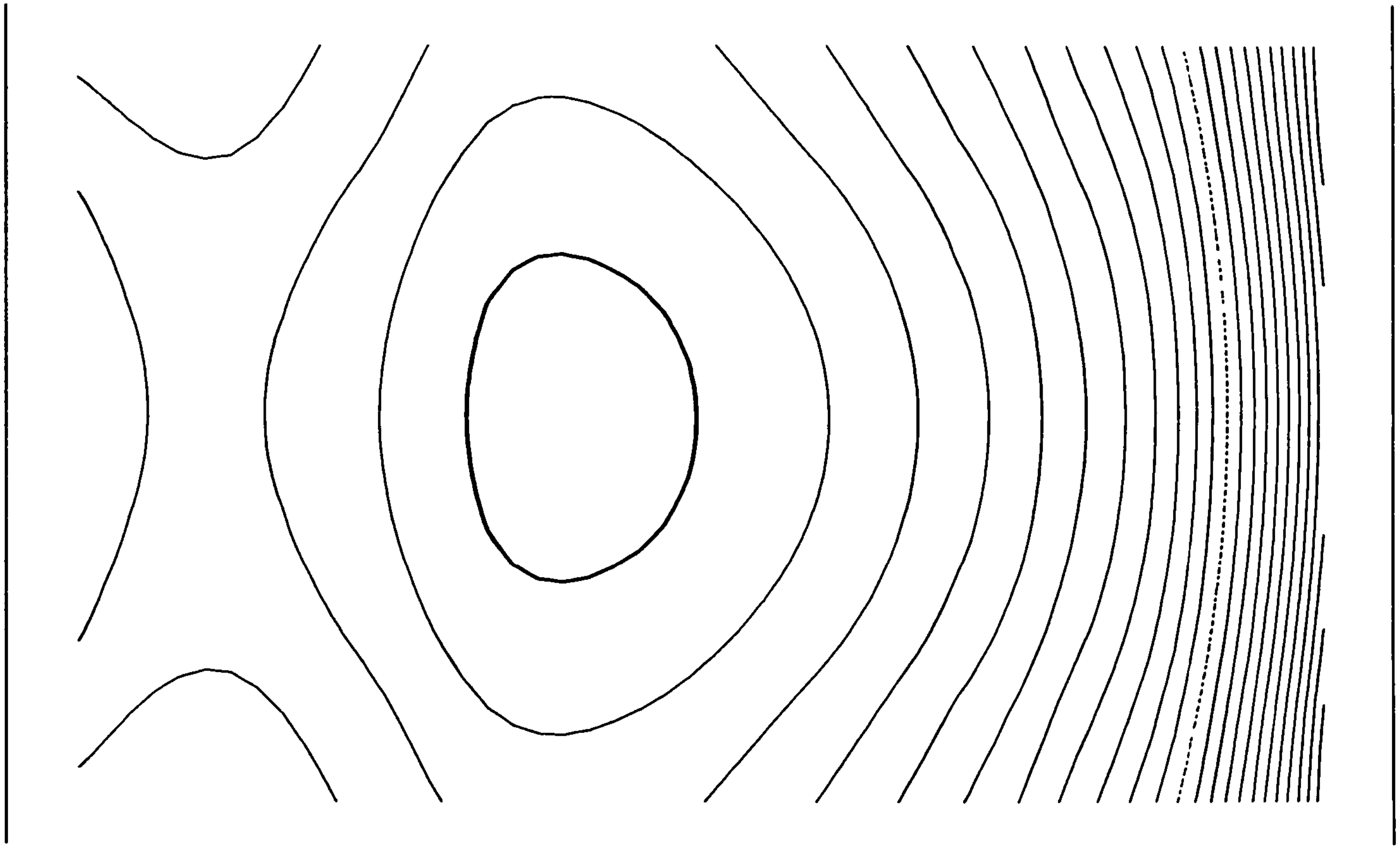


Fig. 10. Closeup of the side auxiliary inlet with the three cross-sections.



ISO-MACH LINES

H31HG028CT. 3 RAKES FOR SST INLET WITH SIDE AUX. INLET.

COMBINATION SOLUTION NUMBER 4 CROSS SECTION NUMBER 3

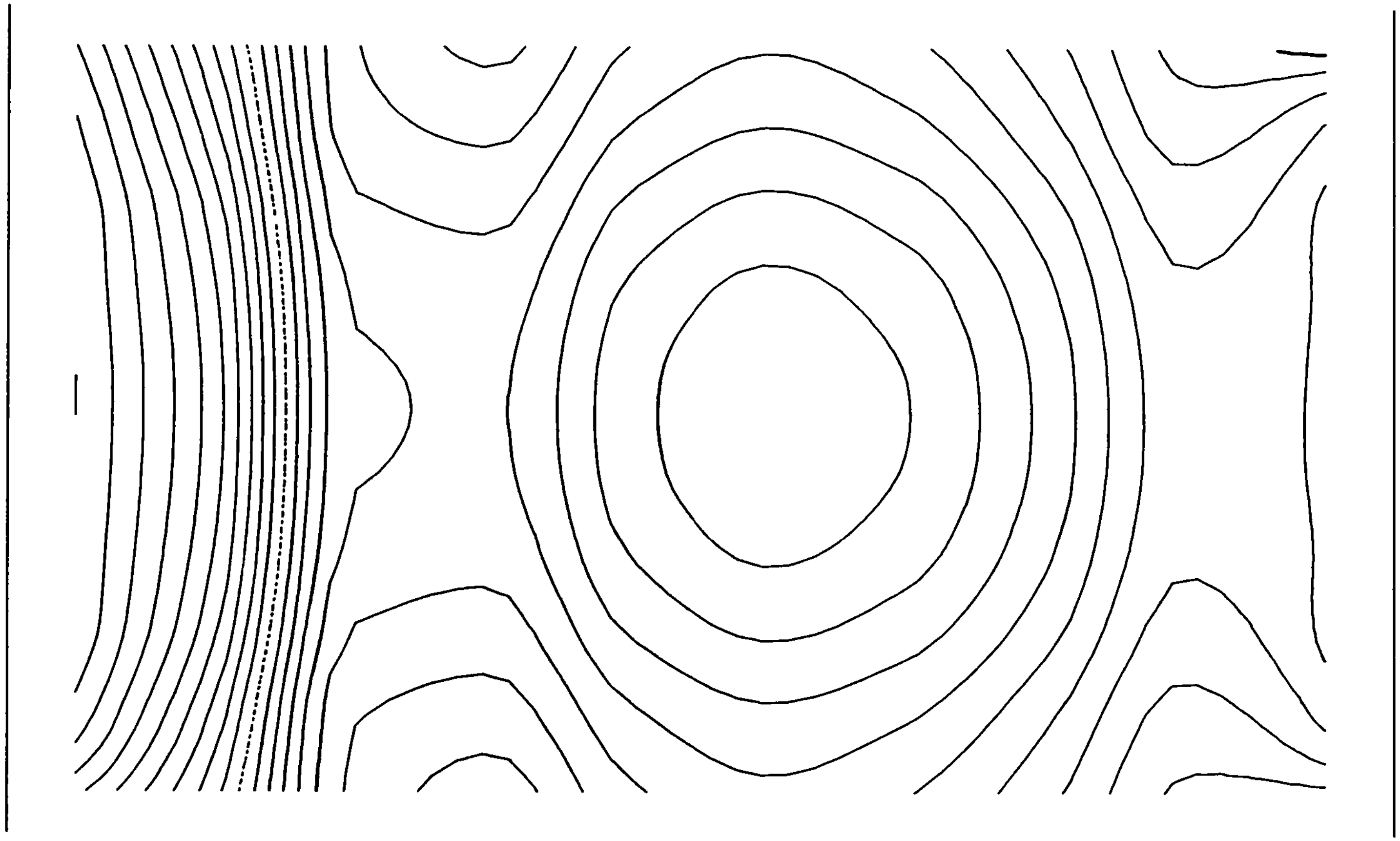
PLOTTING AXES: XI=(1.000, 0.0 , 0.0) ETA= (0.0 , 0.0 ,-1.000)

HEAVY LINE INDICATES ISOVALUE = 0.39000

DASHED LINE INDICATES ISOVALUE = 0.72000

INCREMENTS IN ISOVALUE = 0.03000

Fig. 11. Calculated results for an inlet with auxiliary inlets showing:
(a) iso-Mach lines.



ISO-ANGLE-XI LINES

H31HG028CT. 3 RAKES FOR SST INLET WITH SIDE AUX. INLET.

COMBINATION SOLUTION NUMBER 4 CROSS SECTION NUMBER 3

PLOTTING AXES· XI=(1.000, 0.0 , 0.0) ETA= (0.0 , 0.0 ,-1.000)

HEAVY LINE INDICATES ISOVALUE = 20.79998

DASHED LINE INDICATES ISOVALUE = 28.79986

INCREMENTS IN ISOVALUE = 0.80000

Fig. 11. (b) iso-angle ξ lines, across the auxiliary inlet.

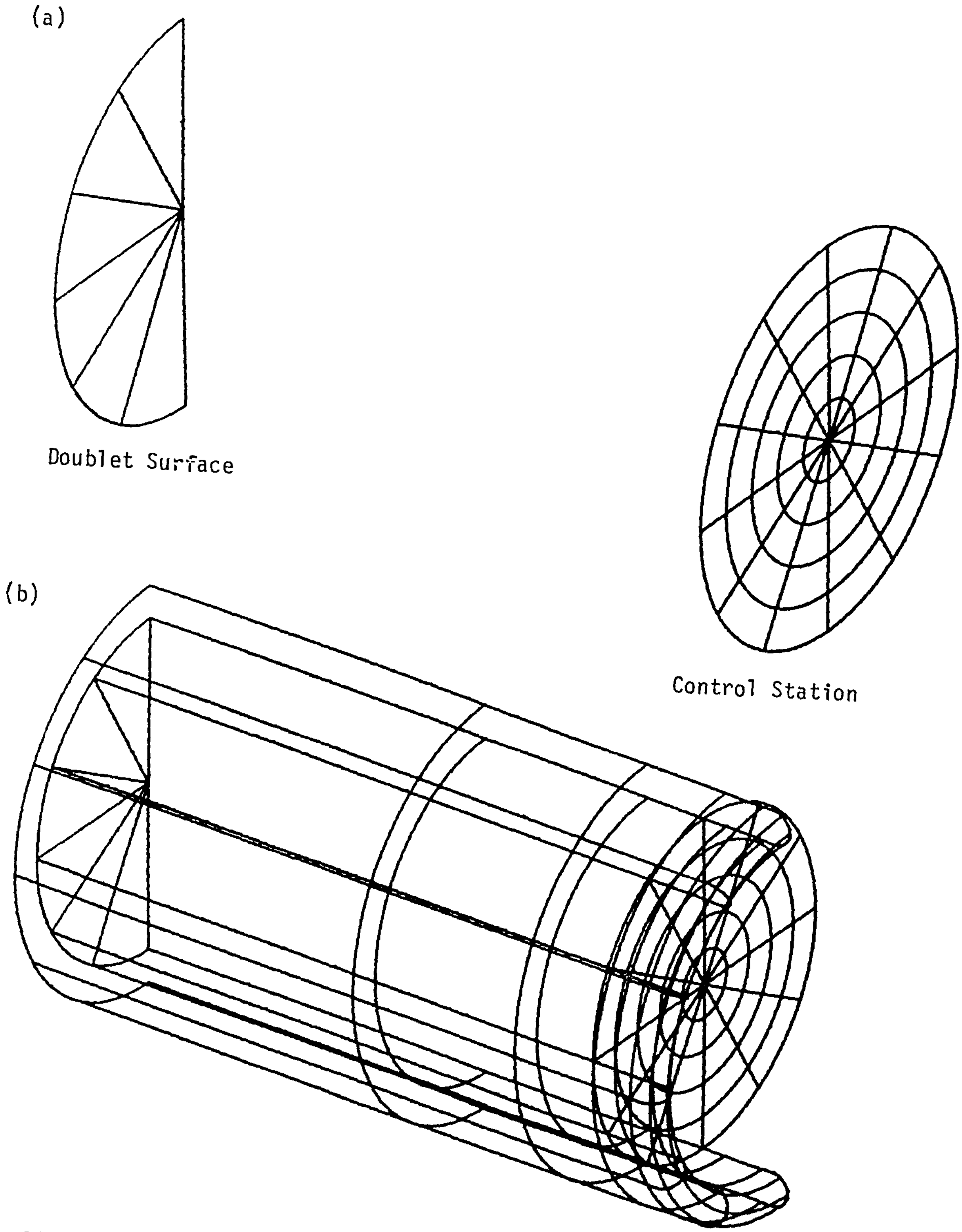


Fig. 12. The sample case round inlet showing: (a) doublet surface + control station, and (b) inlet with doublet surface and control station installed.

```
4.0790472 0.0       -1.199999820
4.0790472 0.6000010-1.039229400
4.0790472 1.0392303-0.599998000
4.0790472 1.1999998 0.000002000
4.0790472 1.0392284 0.600002000
4.0790472 0.5999980 1.039231300
4.0790472-0.0000020 1.199999800
1.9385128 0.0       -1.199999810
1.9385128 0.6000010-1.039229400
1.9385138 1.0392303-0.599998000
1.9385128 1.1999998 0.000002000
1.9385128 1.0392284 0.600002000
1.9385118 0.5999980 1.039231300
1.9385128-0.0000020 1.199999800
0.9062307 0.0       -1.199999810
0.9062316 0.6000010-1.039229400
0.9062312 1.0392303-0.599998000
0.9062307 1.1999998 0.000002000
0.9062304 1.0392284 0.600002000
0.9062304 0.5999980 1.039231300
0.9062307-0.0000020 1.199999800
0.4084057 0.0       -1.199999810
0.4084059 0.6000010-1.039229400
0.4084061 1.0392303-0.599998000
0.4084057 1.1999998 0.000002000
0.4084051 1.0392284 0.600002000
0.4084049 0.5999980 1.039231300
0.4084057-0.0000020 1.199999800
0.1683279 0.0       -1.199999810
0.1683283 0.6000007-1.039228400
0.1683283 1.0392303-0.599998000
0.1683279 1.1999998 0.000002000
0.1683279 1.0392275 0.600001600
0.1683269 0.5999978 1.039230300
0.1683279-0.0000020 1.199999800
0.0500000 0.0       -1.186600710
0.0499999 0.5933019-1.027626000
0.0500004 1.0276270-0.593299900
0.0500000 1.1866007 0.000002000
0.0499995 1.0276251 0.593302800
0.0499990 0.5932995 1.027627000
0.0500000-0.0000020 1.186600700
0.0       0.0       -1.099997510
0.0       0.5500007-0.952626500
0.0       0.9526286-0.549997300
0.0       1.0999975 0.000002000
0.0       0.9526258 0.550001000
0.0       0.5499979 0.952628000
0.0      -0.0000020 1.099997500
0.0500000 0.0       -1.013394410
0.0500000 0.5066988-0.877625600
0.0500004 0.8776278-0.506695700
0.0500000 1.0133944 0.000002000
0.0500004 0.8776255 0.506698800
0.0499992 0.5066960 0.877627100
0.0500000-0.0000020 1.013394400
0.1683279 0.0       -0.999998910
0.1683284 0.4999998-0.866024000
0.1683283 0.8660259-0.499997000
0.1683279 0.9999989 0.000002000
0.1683288 0.8660239 0.499999800
0.1683269 0.4999970 0.866024900
0.1683279-0.0000020 0.999998900
0.4084057 0.0       -0.999998910
0.4084059 0.4999998-0.866024000
0.4084057 0.8660259-0.499997000
0.4084057 0.9999989 0.000002000
0.4084064 0.8660240 0.499999800
0.4084049 0.4999970 0.866024900
0.4084057-0.0000020 0.999998900
0.9062307 0.0       -0.999998910
0.9062314 0.4999998-0.866024000
0.9062309 0.8660259-0.499997000
0.9062307 0.9999989 0.000002000
0.9062319 0.8660240 0.499999800
0.9062302 0.4999970 0.866024900
0.9062307-0.0000020 0.999998900
1.9385128 0.0       -0.999998910
1.9385128 0.4999998-0.866024000
1.9385138 0.8660259-0.499997000
1.9385128 0.9999989 0.000002000
1.9385128 0.8660240 0.499999800
1.9385118 0.4999970 0.866024900
1.9385128-0.0000020 0.999998900
4.0790472 0.0       -0.999998910
4.0790472 0.4999998-0.866024000
4.0790472 0.8660259-0.499997000
4.0790472 0.9999989 0.000002000
4.0790472 0.8660240 0.499999800
4.0790472 0.4999970 0.866024900
4.0790472-0.0000020 0.999998900
4.0790462 0.0       -1.000000020
4.0790462 0.5000010-0.866025000
4.0790462 0.8660260-0.499999000
4.0790462 1.0000000 0.000002000
4.0790462 0.8660240 0.500002000
4.0790462 0.4999990 0.866026000
4.0790462-0.0000020 1.000000000
4.0790462 0.0       0.0       10
4.0790462 0.0       0.0       00
4.0790462 0.0       0.0       00
4.0790462 0.0       0.0       00
4.0790462 0.0       0.0       00
4.0790462 0.0       0.0       00
4.0790462 0.0       0.0       00
```

Fig. 13. The formatted (3F10.7, 2I1) unit 1 geometry data that was used in Step 1 to define the inlet + doublet surface for the round inlet sample case.

```
SECTION #    # PATCHES    NU    NV    TITLE
---------    ---------    --    --    ------------------------------------------------------------
    1            72        6    12    NLIF NEUMANN SECTION   1
    2             6        6     1    NLIF NEUMANN SECTION   2

UNFORMATTED DATASET CREATION IN PROGRESS ...
UNFORMATTED PATCH DATA HAS BEEN CREATED.  NPAT =   78
TIME USAGE ... CPU=   0.19 SECONDS,  I/O =   2.40 SECONDS.
```

Fig. 14. Sample output for Step 1 (of 4 steps): the first geometry fitting step.

```
H31HG027B.  HIGHER-ORDER INLET PROGRAM SAMPLE CASE  (6 X 12 = 72).
 &A
  NSYM = 1,
 &END
```

(a)

```
H31HG027BZ.  INCOMPRESSIBLE COMBINATION SAMPLE CASE.
 &A
  NCOMB = 1,
  ISOP = 1,
  ISOA = 1,
  NSL = 4,
  IPLOTP = 1,
  IVSX = 1,
  ALPHA = 30.,
  BETA = 20.,
  VC =-0.9,
  NSECT0 = 1,
  USTART = 2.,3.,4.,5.,
  VSTART = 6.,
  NDIREC = 1,
  XMAX = 5.,
  MAXPTS = 20,
  NVIEWS = 1,
  PSI=30.,IPERSP=1,
 &END
```

(b)

Fig. 15. Control card inputs for the round inlet sample case for: (a) Step 2 (the fundamental solutions program), and (b) Step 4 (the combination program).

```
PROGRAM IV- HIGHER-ORDER FUNDAMENTAL SOLUTIONS FOR 3-D INLETS

INPUT FLAGS
-----------

TITLE  = H31HG027B.  HIGHER-ORDER INLET PROGRAM SAMPLE CASE  (6 X 12 = 72).
ICUR   =  1     CURVATURE FLAG
IFUNDP =  1     FUNDAMENTAL SOLUTIONS PRINT FLAG
INPUTP =  1     BASIC PANEL DATA PRINT FLAG
ISORD  =  1     SOURCE DERIVATIVE FLAG
NSYM   =  1     SYMMETRY FLAG
ISFLOW =  1     SUCTION SOLUTION FLAG
IZFLOW =  1     "Z-FLOW" SOLUTION FLAG
IYFLOW =  1     "Y-FLOW" ("YAW-FLOW") SOLUTION FLAG
ITERAT =  2     ITERATIVE SOLN. FLAG (0=DIRECT, 1=ITERATIVE, 2=DIRECT-ONLY-IF-ITERATIVE-FAILS)
```


Figs. 16.1-16.19. The Step 2 (fundamental solutions) output for the round inlet sample case.

* * * * * B A S I C   P A N E L   D A T A * * * * *

H31HG027B. HIGHER-ORDER INLET PROGRAM SAMPLE CASE (6 X 12 = 72).

PNL NO.	SECT NO.	N	M	PNL. TYPE	X Y Z	X Y Z	X Y Z	X Y Z	NX NY NZ	XCP YCP ZCP	AV.PROJ.DIST MAX. DIAG PROJ. AREA	P Q R
1	1	1	1	NLIF	4.079047	4.079047	1.938513	1.938513	0.000000	3.007473	0.42351E-01	-0.41997E+00
					0.0	0.600001	0.600001	0.0	0.258819	0.317024	0.22288E+01	0.27602E-06
					-1.200000	-1.039229	-1.039229	-1.200000	-0.965926	-1.158898	0.13296E+01	-0.15033E-02
2			2	NLIF	4.079047	4.079047	1.938514	1.938513	-0.000000	3.007473	0.41549E-01	-0.40007E+00
					0.600001	1.039230	1.039230	0.600001	0.705984	0.847973	0.22288E+01	0.15910E-06
					-1.039229	-0.599998	-0 599998	-1.039229	-0.708228	-0.850012	0.13296E+01	-0.15029E-02
3			3	NLIF	4.079047	4.079047	1.938513	1.938514	-0.000000	3.007473	0.42629E-01	-0.41348E+00
					1.039230	1.200000	1.200000	1.039230	0.966169	1.160850	0.22288E+01	-0.41232E-06
					-0.599998	0.000002	0.000002	-0.599998	-0.257913	-0.310813	0.13296E+01	-0.15031E-02
4			4	NLIF	4.079047	4.079047	1.938513	1.938513	-0.000000	3.007473	0.42629E-01	-0.41348E+00
					1.200000	1.039228	1.039228	1.200000	0.966168	1.160849	0.22288E+01	-0.14262E-06
					0 000002	0.600002	0.600002	0.000002	0.257914	C.310817	0.13296E+01	-0.15034E-02
5			5	NLIF	4.079047	4.079047	1.938512	1.938513	-0.000000	3.007472	0.41549E-01	-0.40007E+00
					1.039228	0.599993	0.599993	1.039228	0.705981	0.847971	0.22288E+01	-0.43492E-06
					0.600002	1.039231	1.039231	0.600002	0.708231	0.850015	0.13296E+01	-0.15030E-02
6			6	NLIF	4.079047	4.079047	1.938513	1.938512	-0.000000	3.007472	0.42350E-01	-0.41997E+00
					0.599998	-0.000002	-0.000002	0.599998	0.258817	0.317022	0.22288E+01	0.58699E-06
					1.039231	1.200000	1.200000	1.039231	0.965927	1.158898	0.13296E+01	-0.15032E-02
7		2	1	NLIF	1.938513	1.938513	0.906232	0.906231	-0.001194	1.423469	0.39181E-01	-0.42223E+00
					0.0	0.600001	0.600001	0.0	0.258821	0.316196	0.12048E+01	0.19839E-05
					-1.200000	-1.039229	-1.039229	-1.200000	-0.965925	-1.155840	0.64122E+00	0.54423E-02
8			2	NLIF	1.938513	1.938514	0.906231	0.906232	-0.001193	1.423470	0.38381E-01	-0.40220E+00
					0.600001	1.039230	1.039230	0.600001	0.705981	0.845736	0.12048E+01	-0.11353E-06
					-1.039229	-0.599998	-0.599998	-1.039229	-0.708230	-0.847771	0.64122E+00	0.54406E-02
9			3	NLIF	1.938514	1.938513	0.906231	0.906231	-0.001193	1.423469	0.39460E-01	-0.41569E+00
					1.039230	1.200000	1.200000	1.039230	0.966168	1.157790	0.12048E+01	-0.84256E-06
					-0.599998	0.000002	0.000002	-0.599998	-0.257911	-0.309993	0.64122E+00	0.54414E-02
10			4	NLIF	1.938513	1.938513	0.906230	0.906231	-0.001194	1.423469	0.39459E-01	-0.41569E+00
					1.200000	1.039228	1.039228	1.200000	0.966167	1.157788	0.12048E+01	0.65720E-06
					0.000002	0.600002	0.600002	0.000002	0.257915	0.309997	0.64122E+00	0.54427E-02
11			5	NLIF	1.938513	1.938512	0.906230	0.906230	-0.001193	1.423469	0.38381E-01	-0.40220E+00
					1.039228	0.599998	0.599998	1.039228	0.705979	0.845733	0.12048E+01	-0.21480E-06
					0.600002	1.039231	1.039231	0.600002	0.708232	0.847774	0.64121E+00	0.54414E-02
12			6	NLIF	1.938512	1.938513	0.906231	0.906230	-0.001193	1.423469	0.39181E-01	-0.42223E+00
					0.599998	-0.000002	-0.000002	0.599998	0.258818	0.316193	0.12048E+01	-0.15055E-05
					1.039231	1.200000	1.200000	1.039231	0.965925	1.155841	0.64122E+00	0.54418E-02
13		3	1	NLIF	0.906231	0.906232	0.408406	0.408406	0.003526	0.655896	0 42497E-01	-0.41986E+00
					0.0	0.600001	0.600001	0.0	0.258817	0.317064	0.79604E+00	-0.47334E-05
					-1.200000	-1.039229	-1.039229	-1.200000	-0.965920	-1.159044	0.30923E+00	-0.30004E-01

Fig. 16.2

***** BASIC PANEL DATA *****

H31HG027B. HIGHER-ORDER INLET PROGRAM SAMPLE CASE (6 X 12 = 72).

PNL. NO.	SECT NO.	N	M	PNL. TYPE	X / Y / Z	X / Y / Z	X / Y / Z	X / Y / Z	NX / NY / NZ	XCP / YCP / ZCP	AV.PROJ.DIST / MAX. DIAG / PROJ. AREA	P / Q / R
14	1	3	2	NLIF	0.906232	0.906231	0.408406	0.408406	0.003524	0.655897	0.41696E-01	-0.39996E+00
					0.600001	1.039230	1.039230	0.600001	0.705980	0.848081	0.79604E+00	0.11510E-05
					-1.039229	-0.599998	-0.599998	-1.039229	-0.708223	-0.850119	0.30923E+00	-0.29995E-01
15			3	NLIF	0.906231	0.906231	0.408406	0.408406	0.003525	0.655896	0.42776E-01	-0.41337E+00
					1.039230	1.200000	1.200000	1.039230	0.966163	1.160996	0.79604E+00	0.35629E-06
					-0.599998	0.000002	0.000002	-0.599998	-0.257911	-0.310852	0.30923E+00	-0.29999E-01
16			4	NLIF	0.906231	0.906230	0.408405	0.408406	0.003526	0.655896	0.42776E-01	-0.41337E+00
					1.200000	1.039228	1.039228	1.200000	0.966162	1.160995	0.79604E+00	-0.21671E-05
					0.000002	0.600002	0.600002	0.000002	0.257912	0.310856	0.30923E+00	-0.30006E-01
17			5	NLIF	0.906230	0.906230	0.408405	0.408405	0.003525	0.655895	0.41696E-01	-0.39996E+00
					1.039228	0.599998	0.599998	1.039228	0.705977	0.848079	0.79603E+00	-0.13988E-06
					0.600002	1.039231	1.039231	0.600002	0.708226	0.850122	0.30923E+00	-0.29999E-01
18			6	NLIF	0.906230	0.906231	0.408406	0.408405	0.003525	0.655895	0.42497E-01	-0.41986E+00
					0.599998	-0.000002	-0.000002	0.599998	0.258815	0.317061	0.79604E+00	0.55307E-05
					1.039231	1.200000	1.200000	1.039231	0.965921	1.159045	0.30923E+00	-0.30001E-01
19		4	1	NLIF	0.408406	0.408406	0.168328	0.168328	-0.009982	0.290277	0.38091E-01	-0.42297E+00
					0.0	0.600001	0.600001	0.0	0.258809	0.315916	0.66594E+00	0.17215E-04
					-1.200000	-1.039229	-1.039228	-1.200000	-0.965877	-1.154806	0.14912E+00	0.17863E+00
20			2	NLIF	0.408406	0.408406	0.168328	0.168328	-0.009977	0.290277	0.37290E-01	-0.40290E+00
					0.600001	1.039230	1.039230	0.600001	0.705945	0.844979	0.66594E+00	-0.61248E-05
					-1.039229	-0.599998	-0.599998	-1.039228	-0.708197	-0.847013	0.14912E+00	0.17858E+00
21			3	NLIF	0.408406	0.408406	0.168328	0.168328	-0.009977	0.290277	0.38369E-01	-0.41642E+00
					1.039230	1.200000	1.200000	1.039230	0.966121	1.156755	0.66594E+00	-0.21699E-05
					-0.599998	0.000002	0.000002	-0.599998	-0.257898	-0.309716	0.14912E+00	0.17862E+00
22			4	NLIF	0.408406	0.408405	0.168328	0.168328	-0.009981	0.290277	0.38369E-01	-0.41642E+00
					1.200000	1.039228	1.039227	1.200000	0.966119	1.156754	0.66594E+00	0.79584E-05
					0.000002	0.600002	0.600002	0.000002	0.257903	0.309720	0.14912E+00	0.17865E+00
23			5	NLIF	0.408405	0.408405	0.168327	0.168328	-0.009981	0.290277	0.37290E-01	-0.40290E+00
					1.039228	0.599998	0.599998	1.039227	0.705944	0.844976	0.66594E+00	-0.10822E-05
					0.600002	1.039231	1.039230	0.600002	0.708198	0.847016	0.14912E+00	0.17859E+00
24			6	NLIF	0.408405	0.408406	0.168328	0.168327	-0.009979	0.290277	0.38091E-01	-0.42298E+00
					0.599998	-0.000002	-0.000002	0.599998	0.258806	0.315913	0.66594E+00	-0.15910E-04
					1.039231	1.200000	1.200000	1.039230	0.965878	1.154807	0.14912E+00	0 17862E+00
25		5	1	NLIF	0.168328	0.168328	0.050000	0.050000	-0.056760	0.106220	0.48933E-01	-0.41686E+00
					0.0	0.600001	0.593302	0.0	0.258403	0 317014	0.62903E+00	0.22500E-03
					-1.200000	-1.039228	-1.027626	-1.186601	-0.964369	-1.158924	0.73427E-01	-0.23392E+01
26			2	NLIF	0.168328	0.168328	0.050000	0.050000	-0.056680	0.106220	0.48135E-01	-0.39716E+00
					0.600001	1.039230	1.027627	0.593302	0.704853	0.847994	0.62905E+00	0 42278E-04
					-1.039228	-0.599998	-0.593300	-1.027626	-0.707086	-0.850027	0.73426E-01	-0.23385E+01

Fig. 16.3

***** B A S I C   P A N E L   D A T A *****

H31HG027B. HIGHER-ORDER INLET PROGRAM SAMPLE CASE (6 X 12 = 72).

PNL. NO.	SECT NO.	N	M	PNL. TYPE	X Y Z	X Y Z	X Y Z	X Y Z	NX NY NZ	XCP YCP ZCP	AV.PROJ.DIST MAX. DIAG PROJ. AREA	P Q R
27	1	5	3	NLIF	0.168328	0.168328	0.050000	0.050000	-0.056794	0.106220	0.49211E-01	-0.41046E+00
					1.039230	1.200000	1.186601	1.027627	0.964608	1.160872	0.62904E+00	-0.33400E-04
					-0.599998	0.000002	0.000002	-0.593300	-0.257500	-0.310820	0.73427E-01	-0.23395E+01
28			4	NLIF	0.168328	0.168328	0.050000	0.050000	-0.056787	0.106220	0.49211E-01	-0.41046E+00
					1.200000	1.039227	1.027625	1.186601	0.964608	1.160871	0 62904E+00	0.25288E-04
					0.000002	0.600002	0.593303	0.000002	0.257503	0 310824	0.73427E-01	-0.23396E+01
29			5	NLIF	0.168328	0.168327	0.049999	0.050000	-0.056680	0.106219	0.48135E-01	-0.39716E+00
					1.039227	0.599998	0.593300	1.027625	0.704851	0.847992	0.62905E+00	-0.29965E-04
					0.600002	1.039230	1.027627	0.593303	0.707087	0.850030	0.73426E-01	-0.23385E+01
30			6	NLIF	0.168327	0.168328	0.050000	0.049999	-0.056765	0.106219	0.48933E-01	-0.41686E+00
					0.599998	-0.000002	-0.000002	0.593300	0.258401	0.317011	0.62903E+00	-0.22975E-03
					1.039230	1.200000	1.186601	1.027627	0.964369	1.158925	0.73427E-01	-0.23393E+01
31		6	1	NLIF	0.050000	0.050000	0.0	0.0	-0.862475	0.014387	0.32025E-01	-0.22118E+00
					0.0	0.593302	0.550001	0.0	0.130988	0.303310	0.59979E+00	0.11977E-02
					-1.186601	-1.027626	-0.952627	-1.099998	-0.488855	-1.108812	0.57674E-01	-0.44058E+01
32			2	NLIF	0.050000	0.050000	0.0	0.0	-0.862293	0.014387	0.31649E-01	-0.21085E+00
					0.593302	1.027627	0 952629	0.550001	0.357519	0.811328	0.59992E+00	0.11433E-03
					-1.027626	-0.593300	-0.549997	-0.952627	-0.358652	-0.813274	0.57674E-01	-0.44107E+01
33			3	NLIF	0.050000	0.050000	0.0	0.0	-0.862535	0.014387	0.32155E-01	-0.21774E+00
					1.027627	1.186601	1.099998	0.952629	0.488880	1.110677	0.59986E+00	-0.17818E-03
					-0.593300	0.000002	0.000002	-0.549997	-0.130504	-0.297380	0.57674E-01	-0.44040E+01
34			4	NLIF	0.050000	0.050000	0.0	0.0	-0.862538	0.014387	0.32155E-01	-0.21774E+00
					1.186601	1.027625	0.952626	1.099998	0.488873	1.110676	0.59986E+00	0.18742E-03
					0.000002	0.593303	0.550001	0.000002	0.130504	0.297384	0.57674E-01	-0.44040E+01
35			5	NLIF	0.050000	0.049999	0.0	0.0	-0.862298	0.014386	0.31649E-01	-0.21085E+00
					1.027625	0.593300	0.549998	0.952626	0.357512	0.811325	0.59991E+00	-0.11625E-03
					0.593303	1.027627	0.952628	0.550001	0.358647	0.813276	0.57673E-01	-0.44107E+01
36			6	NLIF	0.049999	0.050000	0.0	0.0	-0.862478	0.014386	0.32025E-01	-0.22118E+00
					0.593300	-0.000002	-0.000002	0.549998	0.130986	0.303303	0.59979E+00	-0.12043E-02
					1.027627	1.186601	1.099998	0.952628	0.488851	1 108813	0.57674E-01	-0.44058E+01
37		7	1	NLIF	0.0	0.0	0.050000	0.050000	-0.862478	0.014387	0.56722E-02	0.24513E+00
					0.0	0.550001	0.506699	0.0	-0.130986	0.277075	0.55560E+00	-0.13323E-02
					-1.099998	-0.952627	-0.877626	-1.013394	0.488850	-1.012783	0.53306E-01	-0.44057E+01
38			2	NLIF	0.0	0.0	0.050000	0.050000	-0.862298	0.014387	0.53272E-02	0.23362E+00
					0.550001	0.952629	0.877628	0.506699	-0.357508	0.741061	0.55573E+00	-0.12697E-03
					-0.952627	-0.549997	-0.506696	-0.877626	0.358652	-0.742847	0.53306E-01	-0.44106E+01
39			3	NLIF	0.0	0.0	0.050000	0.050000	-0.862538	0.014387	0.57920E-02	0.24126E+00
					0.952629	1.099998	1.013394	0.877628	-0.488876	1.014496	0.55568E+00	0.20472E-03
					-0.549997	0.000002	0.000002	-0.506696	0.130496	-0.271626	0.53305E-01	-0.44040E+01

Fig. 16.4

*** * * * * B A S I C   P A N E L   D A T A * * * * ***

H31HG027B. HIGHER-ORDER INLET PROGRAM SAMPLE CASE (6 X 12 = 72).

PNL. NO.	SECT NO.	N	M	PNL. TYPE	X Y Z	X Y Z	X Y Z	X Y Z	NX NY NZ	XCP YCP ZCP	AV.PROJ.DIST MAX. DIAG PROJ. AREA	P Q R
40	1	7	4	NLIF	0.0	0.0	0.050000	0.050000	-0.862537	0.014387	0.57919E-02	0.24126E+00
					1.099998	0.952626	0.877626	1.013394	-0.488877	1.014494	0.55568E+00	-0.20137E-03
					0.000002	0.550001	0.506699	0.000002	-0.130499	0.271630	0.53305E-01	-0.44040E+01
41			5	NLIF	0.0	0.0	0.049999	0.050000	-0.862299	0.014386	0.53270E-02	0.23362E+00
					0.952626	0.549998	0.506696	0.877626	-0.357504	0.741058	0.55573E+00	0.11564E-03
					0.550001	0.952628	0.877627	0.506699	-0.358652	0 742850	0.53306E-01	-0.44106E+01
42			6	NLIF	0.0	0.0	0.050000	0.049999	-0.862482	0.014386	0.56720E-02	0.24512E+00
					0.549998	-0.000002	-0.000002	0.506696	-0.130984	0.277072	0.55560E+00	0.13401E-02
					0.952628	1.099998	1.013394	0.877627	-0.488844	1.012784	0.53305E-01	-0.44057E+01
43		8	1	NLIF	0.050000	0.050000	0.168328	0.168328	-0.056743	0.106220	0.25432E-01	0.50994E+00
					0.0	0.506699	0.500000	0.0	-0 258402	0.263371	0.53449E+00	-0.30375E-03
					-1.013394	-0.877626	-0.866024	-0.999999	0.964370	-0.962672	0.61945E-01	-0.23393E+01
44			2	NLIF	0.050000	0.050000	0.168328	0.168328	-0.056677	0.106220	0.24765E-01	0.48568E+00
					0.506699	0.877628	0.866026	0.500000	-0.704839	0.704393	0.53451E+00	-0.48458E-04
					-0.877626	-0.506696	-0.499997	-0.866024	0.707100	-0.706093	0.61945E-01	-0.23385E+01
45			3	NLIF	0.050000	0.050000	0.168328	0.168328	-0.056767	0.106220	0.25664E-01	0.50198E+00
					0.877628	1.013394	0.999999	0.866026	-0.964613	0.964302	0.53450E+00	0.71048E-04
					-0.506696	0.000002	0.000002	-0.499997	0.257486	-0.258186	0.61944E-01	-0.23396E+01
46			4	NLIF	0.050000	0.050000	0.168329	0.168328	-0.056766	0.106220	0.25664E-01	0.50198E+00
					1.013394	0.877626	0.866024	0.999999	-0.964612	0.964301	0.53450E+00	-0.68659E-04
					0.000002	0.506699	0.500000	0.000002	-0.257490	0.258190	0.61944E-01	-0.23396E+01
47			5	NLIF	0.050000	0.049999	0.168327	0.168329	-0.056679	0.106220	0.24765E-01	0.48568E+00
					0.877626	0.506696	0.499997	0.866024	-0.704837	0.704390	0.53451E+00	0.37658E-04
					0.506699	0.877627	0.866025	0.500000	-0.707101	0.706095	0.61944E-01	-0.23385E+01
48			6	NLIF	0.049999	0.050000	0.168328	0.168327	-0.056748	0.106219	0.25432E-01	0.50994E+00
					0.506696	-0.000002	-0.000002	0.499997	-0.258400	0.263369	0.53449E+00	0.31167E-03
					0.877627	1.013394	0.999999	0.866025	-0.964370	0.962672	0.61944E-01	-0.23393E+01
49		9	1	NLIF	0.168328	0.168328	0.408406	0.408406	-0.009980	0.290277	0.36392E-01	0.50283E+00
					0.0	0.500000	0.500000	0.0	-0.258807	0.264469	0.57060E+00	-0.12070E-04
					-0.999999	-0.866024	-0.866024	-0.999999	0.965878	-0.966792	0.12427E+00	0.17867E+00
50			2	NLIF	0.168328	0.168328	0.408406	0.408406	-0.009975	0.290277	0.35723E-01	0.47902E+00
					0.500000	0.866026	0.866026	0.500000	-0.705949	0.707409	0.57060E+00	0.18844E-05
					-0.866024	-0.499997	-0.499997	-0.866024	0.708193	-0.709108	0.12427E+00	0.17859E+00
51			3	NLIF	0.168328	0.168328	0.408406	0.408406	-0.009981	0.290277	0.36624E-01	0.49508E+00
					0.866026	0.999999	0.999999	0.866026	-0.966121	0.968421	0.57060E+00	-0.13900E-05
					-0.499997	0.000002	0.000002	-0.499997	0.257899	-0.259290	0.12427E+00	0.17869E+00
52			4	NLIF	0.168328	0.168329	0.408406	0.408406	-0.009981	0.290278	0.36624E-01	0.49508E+00
					0.999999	0.866024	0.866024	0.999999	-0.966120	0.968419	0.57059E+00	0.27315E-05
					0.000002	0.500000	0.500000	0.000002	-0.257903	0.259293	0.12427E+00	0.17869E+00

Fig. 16.3

***** BASIC PANEL DATA *****

H31HG027B. HIGHER-ORDER INLET PROGRAM SAMPLE CASE (6 X 12 = 72).

PNL. NO.	SECT NO.	N	M	PNL. TYPE	X Y Z	X Y Z	X Y Z	X Y Z	NX NY NZ	XCP YCP ZCP	AV.PROJ.DIST MAX. DIAG PROJ. AREA	P Q R
53	1	9	5	NLIF	0.168329	0.168327	0.408405	0.408406	-0.009975	0.290277	0.35723E-01	0.47902E+00
					0.866024	0.499997	0.499997	0.866024	-0.705946	0.707407	0.57060E+00	-0.28583E-05
					0.500000	0.866025	0.866025	0.500000	-0.708196	0.709109	0.12427E+00	0.17858E+00
54			6	NLIF	0.168327	0.168328	0.408406	0.408405	-0.009980	0.290276	0.36391E-01	0.50282E+00
					0.499997	-0.000002	-0.000002	0.499997	-0.258806	0.264466	0.57060E+00	0.12305E-04
					0.866025	0.999999	0.999999	0.866025	-0.965878	0.966792	0.12427E+00	0.17866E+00
55		10	1	NLIF	0.408406	0.408406	0.906231	0.906231	0.003526	0.655896	0.31988E-01	0.50736E+00
					0.0	0.500000	0.500000	0.0	-0.258817	0.263321	0.71818E+00	0.48307E-05
					-0.999999	-0.866024	-0.866024	-0.999999	0.965920	-0.962553	0.25769E+00	-0.30007E-01
56			2	NLIF	0.408406	0.408406	0.906231	0.906231	0.003524	0.655896	0.31321E-01	0.48329E+00
					0.500000	0.866026	0.866026	0.500000	-0.705975	0.704307	0.71818E+00	-0.11122E-05
					-0.866024	-0.499997	-0.499997	-0.866024	0.708228	-0.706002	0.25769E+00	-0.29994E-01
57			3	NLIF	0.408406	0.408406	0.906231	0.906231	0.003526	0.655896	0.32220E-01	0.49950E+00
					0.866026	0.999999	0.999999	0.866026	-0.966164	0.964178	0.71817E+00	0.31626E-06
					-0.499997	0.000002	0.000002	-0.499997	0.257906	-0.258154	0.25769E+00	-0.30011E-01
58			4	NLIF	0.408406	0.408406	0.906232	0.906231	0.003526	0.655897	0.32220E-01	0.49950E+00
					0.999999	0.866024	0.866024	0.999999	-0.966163	0.964177	0.71817E+00	0.86016E-06
					0.000002	0.500000	0.500000	0.000002	-0.257909	0.258157	0.25769E+00	-0.30011E-01
59			5	NLIF	0.408406	0.408405	0.906230	0.906232	0.003524	0.655896	0.31321E-01	0.48329E+00
					0.866024	0.499997	0.499997	0.866024	-0.705973	0.704305	0.71818E+00	-0.19395E-05
					0.500000	0.866025	0.866025	0.500000	-0.708230	0.706004	0.25769E+00	-0.29992E-01
60			6	NLIF	0.408405	0.408406	0.906231	0.906230	0.003526	0.655895	0.31988E-01	0.50736E+00
					0.499997	-0.000002	-0.000002	0.499997	-0.258816	0.263319	0.71817E+00	-0.30600E-05
					0.866025	0.999999	0.999999	0.866025	-0.965920	0.962554	0.25769E+00	-0.30005E-01
61		11	1	NLIF	0.906231	0.906231	1.938513	1.938513	-0.001194	1.423469	0.35305E-01	0.50395E+00
					0.0	0.500000	0.500000	0.0	-0.258820	0.264189	0.11548E+01	-0.10770E-05
					-0.999999	-0.866024	-0.866024	-0.999999	0.965925	-0.965758	0.53435E+00	0.54429E-02
62			2	NLIF	0.906231	0.906231	1.938514	1.938513	-0.001193	1.423470	0.34637E-01	0.48007E+00
					0.500000	0.866026	0.866026	0.500000	-0.705982	0.706652	0.11548E+01	0.57819E-06
					-0.866024	-0.499997	-0.499997	-0.866024	0.708228	-0.708350	0.53435E+00	0.54404E-02
63			3	NLIF	0.906231	0.906231	1.938513	1.938514	-0.001194	1.423469	0 35537E-01	0.49617E+00
					0.866026	0.999999	0.999999	0.866026	-0.966168	0.967386	0.11548E+01	-0.10686E-05
					-0.499997	0.000002	0.000002	-0.499997	0.257910	-0.259013	0.53435E+00	0.54435E-02
64			4	NLIF	0.906231	0.906232	1.938513	1.938513	-0.001194	1.423469	0.35537E-01	0.49617E+00
					0.999999	0.866024	0.866024	0.999999	-0.966167	0.967385	0.11548E+01	0.98184E-06
					0.000002	0.500000	0.500000	0.000002	-0.257914	0.259016	0.53434E+00	0.54435E-02
65			5	NLIF	0.906232	0.906230	1.938512	1.938513	-0.001193	1.423469	0.34636E-01	0.48007E+00
					0.866024	0.499997	0.499997	0.866024	-0.705980	0.706650	0.11548E+01	-0.11272E-05
					0.500000	0.866025	0.866025	0.500000	-0.708231	0.708352	0.53435E+00	0.54402E-02

Fig. 16.6.

* * * * *   B A S I C   P A N E L   D A T A   * * * * *

H31HG027B. HIGHER-ORDER INLET PROGRAM SAMPLE CASE (6 X 12 = 72).

PNL. NO.	SECT NO.	N	M	PNL. TYPE	X Y Z	X Y Z	X Y Z	X Y Z	NX NY NZ	XCP YCP ZCP	AV.PROJ.DIST MAX. DIAG PROJ. AREA	P Q R
66	1	11	6	NLIF	0.906230	0.906231	1.938513	1.938512	-0.001194	1.423468	0.35304E-01	0.50394E+00
					0.499997	-0.000002	-0.000002	0.499997	-0.258819	0.264186	0.11548E+01	0.16413E-05
					0.866025	0.999999	0.999999	0.866025	-0.965925	0.965759	0.53435E+00	0.54426E-02
67		12	1	NLIF	1.938513	1.938513	4.079047	4.079047	-0.000000	3.007472	0.32135E-01	0.50721E+00
					0.0	0.500000	0.500000	0.0	-0.258819	0.263361	0.22022E+01	-0.69818E-07
					-0.999999	-0.866024	-0.866024	-0.999999	0.965926	-0.962700	0.11080E+01	-0.15035E-02
68			2	NLIF	1.938513	1.938514	4.079047	4.079047	-0.000000	3.007473	0.31469E-01	0.48315E+00
					0.500000	0.866026	0.866026	0.500000	-0.705980	0.704415	0.22022E+01	0.22426E-06
					-0.866024	-0.499997	-0.499997	-0.866024	0.708232	-0.706109	0.11080E+01	-0.15028E-02
69			3	NLIF	1.938514	1.938513	4.079047	4.079047	0.000000	3.007473	0.32367E-01	0.49935E+00
					0.866026	0.999999	0.999999	0.866026	-0.966170	0.964325	0.22022E+01	-0.80560E-07
					-0.499997	0.000002	0.000002	-0.499997	0.257908	-0.258193	0.11080E+01	-0.15037E-02
70			4	NLIF	1.938513	1.938513	4.079047	4.079047	-0.000000	3.007473	0.32367E-01	0.49935E+00
					0.999999	0.866024	0.866024	0.999999	-0.966169	0.964324	0.22022E+01	0.53853E-09
					0.000002	0.500000	0.500000	0.000002	-0.257911	0.258197	0.11080E+01	-0.15036E-02
71			5	NLIF	1.938513	1.938512	4.079047	4.079047	-0.000000	3.007472	0.31468E-01	0.48314E+00
					0.866024	0.499997	0.499997	0.866024	-0.705978	0.704412	0.22022E+01	-0.73717E-06
					0.500000	0.866025	0.866025	0.500000	-0.708235	0.706111	0.11080E+01	-0.15027E-02
72			6	NLIF	1.938512	1.938513	4.079047	4.079047	0.000000	3.007472	0.32135E-01	0.50721E+00
					0.499997	-0.000002	-0.000002	0.499997	-0.258818	0.263358	0.22022E+01	0.74004E-06
					0.866025	0.999999	0.999999	0.866025	-0.965927	0.962701	0.11080E+01	-0.15034E-02
73	2	1	1	DBLT	4.079046	4.079046	4.079046	4.079046	-1.000000	4.079046	0.0	0.0
					0.0	0.500001	0.0	0.0	0.0	0.131906	0.10000E+01	0.0
					-1.000000	-0.866025	0.0	0.0	0.0	-0.482182	0.25000E+00	0.0
74			2	DBLT	4.079046	4.079046	4.079046	4.079046	-1.000000	4.079046	0.0	0.0
					0.500001	0.866026	0.0	0.0	0.0	0.352816	0.10004E+01	0.0
					-0.866025	-0.499999	0.0	0.0	0.0	-0.353664	0.25000E+00	0.0
75			3	DBLT	4.079046	4.079046	4.079046	4.079046	-1.000000	4.079046	0.0	0.0
					0.866026	1.000000	0.0	0.0	0.0	0.482995	0.10002E+01	0.0
					-0.499999	0.000002	0.0	0.0	0.0	-0.129320	0.25000E+00	0.0
76			4	DBLT	4.079046	4.079046	4.079046	4.079046	-1.000000	4.079046	0.0	0.0
					1.000000	0.866024	0.0	0.0	0.0	0.482994	0.10002E+01	0.0
					0.000002	0.500002	0.0	0.0	0.0	0.129322	0.25000E+00	0.0
77			5	DBLT	4.079046	4.079046	4.079046	4.079046	-1.000000	4.079046	0.0	0.0
					0.866024	0.499999	0.0	0.0	0.0	0.352815	0.10004E+01	0.0
					0.500002	0.866026	0.0	0.0	0.0	0.353665	0.25000E+00	0.0
78			6	DBLT	4.079046	4.079046	4.079046	4.079046	-1.000000	4.079046	0.0	0.0
					0.499999	-0.000002	0.0	0.0	0.0	0.131905	0.10000E+01	0.0
					0.866026	1.000000	0.0	0.0	0.0	0.482182	0.25000E+00	0.0

Fig. 16.7

	NEAR	INTER.	FAR
SOURCE	5952	3180	1236
SMALL LOGS	0		

Fig. 16.8

I T E R A T I V E   M A T R I X   S O L U T I O N

	R1 R2 R3	N1 N2 N3	RES1 RES2 RES3	R1 R2 R3	N1 N2 N3	RES1 RES2 RES3	R1 R2 R3	N1 N2 N3	RES1 RES2 RES3
1	0.0	1	0.51E+01	0.0	18	0.64E-01	0.0	6	0.14E+01
	1.000	5	0.51E+01	1.000	16	0.64E-01	1.000	7	0.15E+01
	0.0	2	0.51E+01	0.0	17	0.65E-01	0.0	12	0.15E+01
2	0.0	3	0.40E+01	0.0	9	0.45E-01	0.0	6	0.93E+00
	0.0	5	0.40E+01	0.0	11	0.45E-01	0.0	7	0.97E+00
	1.000	2	0.40E+01	1.000	8	0.45E-01	1.000	12	0.98E+00
3	-3.541	16	0.25E+00	-1.599	6	0.37E-02	-0.795	14	0.17E-01
	11.813	15	0.25E+00	6.651	3	0.37E-02	3.859	17	0.29E-01
	9.272	14	0.25E+00	6.052	4	0.38E-02	4.064	18	0.41E-01
4	-0.020	10	0.47E-01	-0.004	6	0.25E-02	-0.001	24	0.77E-02
	1.453	7	0.50E-01	0.411	4	0.26E-02	0.172	6	0.85E-02
	2.432	12	0.50E-01	1.407	5	0.26E-02	1.171	1	0.10E-01
5	0.075	12	0.13E-01	0.277	1	0.10E-02	0.063	17	0.30E-02
	0.620	8	0.14E-01	0.814	5	0.10E-02	0.669	1	0.32E-02
	1.695	11	0.15E-01	2.091	2	0.10E-02	1.732	18	0.35E-02
6	-0.038	18	0.72E-02	-0.092	4	0.42E-03	0.007	12	0.91E-03
	1.509	15	0.78E-02	2.331	16	0.44E-03	1.364	11	0.97E-03
	2.471	17	0.95E-02	3.239	17	0.49E-03	2.372	24	0.99E-03
7	0.384	23	0.41E-02	0.219	23	0.16E-03	0.079	24	0.24E-03
	1.152	22	0.53E-02	0.241	18	0.16E-03	0.240	12	0.33E-03
	2.536	24	0.55E-02	1.460	17	0.17E-03	1.319	11	0.35E-03
8	0.006	2	0.88E-03	0.084	4	0.68E-04	0.060	12	0.97E-04
	0.254	6	0.89E-03	0.654	2	0.69E-04	0.413	18	0.12E-03
	1.259	5	0.90E-03	1.738	5	0.71E-04	1.473	17	0.13E-03
9	0.015	18	0.11E-03	0.0	0	0.0	-0.032	24	0.44E-04
	0.674	17	0.13E-03	0.0	0	0.0	0.594	11	0.50E-04
	1.688	1	0.16E-03	0.0	0	0.0	1.562	12	0.56E-04
10	0.0	1	0.23E-03	0.0	0	0.0	0.0	0	0.0
	0.0	6	0.24E-03	0.0	0	0.0	0.0	0	0.0
	1.000	5	0.24E-03	0.0	0	0.0	0.0	0	0.0
11	-0.196	2	0.77E-04	0.0	0	0.0	0.0	0	0.0
	2.841	3	0.81E-04	0.0	0	0.0	0.0	0	0.0
	3.644	1	0.10E-03	0.0	0	0.0	0.0	0	0.0
12	0.178	9	0.37E-04	0.0	0	0.0	0.0	0	0.0
	-0.377	5	0.38E-04	0.0	0	0.0	0.0	0	0.0
	0.801	7	0.38E-04	0.0	0	0.0	0.0	0	0.0

SATISFACTORY CONVERGENCE REACHED AFTER 12 ITERATIONS.

Fig. 16.9

I T E R A T I V E   M A T R I X   S O L U T I O N

	R1 R2 R3	N1 N2 N3	RES1 RES2 RES3
1	0.0	3	0.14E+01
	1.000	10	0.15E+01
	0.0	9	0.15E+01
2	0.0	3	0.93E+00
	0.0	10	0.98E+00
	1.000	9	0.98E+00
3	-0.780	17	0.32E-01
	3.828	15	0.42E-01
	4.048	16	0.46E-01
4	-0.001	22	0.79E-02
	0.131	3	0.85E-02
	1.130	4	0.85E-02
5	0.020	2	0.25E-02
	0.602	3	0.34E-02
	1.622	4	0.34E-02
6	0.020	9	0.41E-03
	1.679	16	0.46E-03
	2.699	10	0.47E-03
7	0.017	11	0.13E-03
	0.201	9	0.16E-03
	1.218	10	0.18E-03
8	0.068	17	0.45E-04
	0.539	15	0.58E-04
	1.607	16	0.69E-04

SATISFACTORY CONVERGENCE REACHED AFTER   8 ITERATIONS.

4 FUNDAMENTAL SOLUTIONS HAVE BEEN STORED ON UNIT 2.

Fig. 16.10

'SUCTION' FUNDAMENTAL SOLUTION

PNL. NO.	SECT NO.	N	M	X	Y	Z	VX	VY	VZ	VT	CP	SIGMA	VN
1	1	1	1	3.00747	0.31702	-1.15890	-0.05963	-0.22168	-0.05847	0.23689	0.9439	2.24901	-0.00090
2			2	3.00747	0.84797	-0.85001	-0.05545	0.01343	0.01433	0.05882	0.9965	2.27876	-0.00067
3			3	3.00747	1.16085	-0.31081	-0.07235	0.00905	0.03612	0.08137	0.9934	2.25968	-0.00058
4			4	3.00747	1.16085	0.31082	-0.07235	0.00910	-0.03622	0.08142	0.9934	2.25968	-0.00055
5			5	3.00747	0.84797	0.85001	-0.05550	0.01353	-0 01446	0.05893	0.9965	2.27876	-0.00069
6			6	3.00747	0.31702	1.15890	-0.05975	-0.22129	0.05876	0.23663	0.9440	2.24914	-0.00052
7		2	1	1.42347	0.31620	-1.15584	-0.07693	-0.14287	-0.03816	0.16669	0.9722	1.20534	-0.00003
8			2	1.42347	0.84574	-0.84777	-0.09129	0.00735	0.00754	0.09189	0.9916	1.22275	-0.00005
9			3	1.42347	1.15779	-0.30999	-0.07970	0.00546	0.02095	0.08259	0.9932	1.21194	-0.00003
10			4	1.42347	1.15779	0.31000	-0.07971	0.00547	-0.02098	0.08261	0.9932	1.21195	-0.00004
11			5	1.42347	0.84573	0.84777	-0.09131	0.00736	-0.00756	0.09192	0.9916	1.22275	-0.00005
12			6	1.42347	0.31619	1.15584	-0.07705	-0.14282	0.03813	0.16670	0.9722	1.20536	-0.00004
13		3	1	0.65590	0.31706	-1.15904	-0.13551	-0.05333	-0.01473	0.14637	0.9786	0.66822	-0.00005
14			2	0.65590	0.84808	-0.85012	-0.15109	0.00391	0.00321	0.15117	0.9771	0.67736	-0.00005
15			3	0.65590	1.16100	-0.31085	-0.14442	0.00337	0.01085	0.14487	0.9790	0.67171	-0.00005
16			4	0.65590	1.16100	0.31086	-0.14443	0.00336	-0.01087	0.14487	0.9790	0.67171	-0.00006
17			5	0.65590	0.84808	0.85012	-0.15111	0.00390	-0.00322	0.15119	0.9771	0.67736	-0.00006
18			6	0.65590	0.31706	1.15905	-0.13553	-0.05333	0.01471	0.14638	0.9786	0.66822	-0.00007
19		4	1	0.29028	0.31592	-1.15481	-0.33688	-0.11817	-0.02814	0.35811	0.8718	0.44877	-0.00004
20			2	0.29028	0.84498	-0.84701	-0.33641	0.00460	0.00944	0.33658	0.8867	0.45429	-0.00008
21			3	0.29028	1.15676	-0.30972	-0.33327	-0.00131	0.00820	0.33337	0.8889	0.45042	-0.00006
22			4	0.29028	1.15675	0.30972	-0.33328	-0.00131	-0.00821	0.33338	0.8889	0.45043	-0.00006
23			5	0.29028	0.84498	0.84702	-0.33644	0.00461	-0.00943	0.33660	0.8867	0 45429	-0.00007
24			6	0.29028	0.31591	1.15481	-0.33688	-0.11817	0.02812	0.35811	0.8718	0.44877	-0.00006
25		5	1	0.10622	0.31701	-1.15892	-0.64768	-0.16580	-0.00625	0.66859	0.5530	0 24315	-0.00005
26			2	0.10622	0.84799	-0.85003	-0.67826	-0.01618	0.03832	0.67954	0.5382	0.24521	-0.00006
27			3	0.10622	1.16087	-0.31082	-0.67172	-0.03563	0.01494	0.67283	0.5473	0.24360	-0.00007
28			4	0.10622	1.16087	0.31082	-0.67171	-0.03561	-0.01495	0.67282	0.5473	0 24360	-0 00006
29			5	0.10622	0.84799	0.85003	-0.67826	-0.01619	-0.03833	0.67954	0.5382	0 24521	-0.00007
30			6	0.10622	0.31701	1.15893	-0.64768	-0.16580	0.00623	0.66859	0.5530	0.24315	-0.00007
31		6	1	0.01439	0.30331	-1.10881	-0.99590	-0.74198	1.55835	1.99269	-2.9708	0.13324	-0.00006
32			2	0.01439	0.81133	-0.81327	-0.93259	-1.10978	1.13615	1.84178	-2.3922	0 13352	-0.00008
33			3	0.01439	1.11068	-0.29738	-0.92475	-1.52191	0.41124	1.82770	-2.3405	0.13293	-0.00007
34			4	0.01439	1.11068	0.29738	-0.92476	-1.52194	-0.41126	1.82773	-2.3406	0.13293	-0.00007
35			5	0.01439	0.81133	0.81328	-0.93260	-1.10981	-1.13615	1.84181	-2.3923	0.13352	-0.00006
36			6	0.01439	0.30331	1.10881	-0.99589	-0.74197	-1.55837	1.99269	-2.9708	0.13324	-0.00006
37		7	1	0.01439	0.27707	-1.01278	1.58027	-1.06572	2.50242	3.14565	-8.8951	-0.01269	-0.00005
38			2	0.01439	0.74106	-0.74285	1.45628	-1.74177	1.76499	2.87570	-7.2697	-0 01327	-0.00004
39			3	0.01439	1.01450	-0.27163	1.44450	-2.37777	0.63970	2.85474	-7.1496	-0 01280	-0.00002
40			4	0.01439	1.01449	0.27163	1.44453	-2.37777	-0.63972	2.85476	-7.1497	-0.01280	-0.00004
41			5	0.01439	0.74106	0.74285	1.45630	-1.74176	-1.76500	2.87572	-7.2698	-0 01327	-0.00006
42			6	0.01439	0.27707	1.01278	1.58025	-1.06571	-2.50245	3.14566	-8.8951	-0.01268	-0.00003
43		8	1	0.10622	0.26337	-0.96267	2.43793	-0.10441	0.11552	2.44290	-4.9678	-0 30452	0.00004
44			2	0.10622	0.70439	-0.70609	2.47975	-0.09561	0.10350	2.48375	-5.1690	-0.30710	0.00003
45			3	0.10622	0.96430	-0.25819	2.46668	-0.13444	0.04031	2.47067	-5.1042	-0.30542	0.00004
46			4	0.10622	0.96430	0.25819	2.46670	-0.13444	-0.04031	2.47069	-5.1043	-0.30542	0.00003
47			5	0.10622	0.70439	0.70610	2.47976	-0.09561	-0.10351	2.48376	-5.1691	-0.30710	0.00003

Fig. 16.11

'SUCTION' FUNDAMENTAL SOLUTION

PNL. NO.	SECT NO.	N	M	X	Y	Z	VX	VY	VZ	VT	CP	SIGMA	VN
48	1	8	6	0.10622	0.26337	0.96267	2.43795	-0.10440	-0.11552	2.44292	-4.9679	-0.30452	0.00004
49		9	1	0.29028	0.26447	-0.96679	1.85395	0.02271	0.02527	1.85426	-2.4383	-0.53920	0.00003
50			2	0.29028	0.70741	-0.70911	1.86584	-0.01845	0.00793	1.86595	-2.4818	-0.54306	0.00003
51			3	0.29028	0.96842	-0.25929	1.85702	-0.01650	0.01012	1.85713	-2.4489	-0.54079	0.00002
52			4	0.29028	0.96842	0.25929	1.85703	-0.01649	-0.01013	1.85713	-2.4489	-0.54079	0.00001
53			5	0.29028	0.70741	0.70911	1.86585	-0.01845	-0.00791	1.86595	-2.4818	-0.54307	0.00001
54			6	0.29028	0.26447	0.96679	1.85396	0.02272	-0.02526	1.85427	-2.4383	-0.53920	0.00001
55		10	1	0.65590	0.26332	-0.96255	1.64752	-0.00802	-0.00814	1.64755	-1.7144	-0.80570	0.00002
56			2	0.65590	0.70431	-0.70600	1.65877	-0.00810	-0.01632	1.65887	-1.7519	-0.81091	0.00001
57			3	0.65590	0.96418	-0.25815	1.65405	0.00800	0.00739	1.65409	-1.7360	-0.80847	0.00001
58			4	0.65590	0.96418	0.25816	1.65405	0.00800	-0.00738	1.65409	-1.7360	-0.80848	0.00001
59			5	0.65590	0.70430	0.70600	1.65877	-0.00810	0.01632	1.65887	-1.7518	-0.81091	0.00000
60			6	0.65590	0.26332	0.96255	1.64753	-0.00802	0.00816	1.64757	-1.7145	-0.80571	0.00001
61		11	1	1.42347	0.26419	-0.96576	1.77571	0.03864	0.01256	1.77618	-2.1548	-1.44411	0.00001
62			2	1.42347	0.70665	-0.70835	1.77786	-0.02272	-0.01962	1.77812	-2.1617	-1.45468	0.00002
63			3	1.42347	0.96739	-0.25901	1.77640	0.00209	0.01606	1.77647	-2.1559	-1.44938	0.00000
64			4	1.42347	0.96738	0.25902	1.77641	0.00210	-0.01606	1.77648	-2.1559	-1.44938	-0.00001
65			5	1.42347	0.70665	0.70835	1.77787	-0.02274	0.01964	1.77812	-2.1617	-1.45468	0.00002
66			6	1.42347	0.26419	0.96576	1.77569	0.03860	-0.01255	1.77615	-2.1547	-1.44413	0.00001
67		12	1	3.00747	0.26336	-0.96270	1.84203	0.05245	0.01404	1.84283	-2.3960	-2.71051	-0.00001
68			2	3.00747	0.70441	-0.70611	1.84535	-0.04282	-0.04272	1.84634	-2.4090	-2.72639	-0.00002
69			3	3.00747	0.96432	-0.25819	1.84064	0.00794	0.02975	1.84090	-2.3889	-2.71824	0.00000
70			4	3.00747	0.96432	0.25820	1.84062	0.00794	-0.02972	1.84088	-2.3888	-2.71825	-0.00001
71			5	3.00747	0.70441	0.70611	1.84536	-0.04281	0.04271	1.84635	-2.4090	-2.72640	-0.00002
72			6	3.00747	0.26336	0.96270	1.84205	0.05234	-0.01401	1.84285	-2.3961	-2.71063	-0.00002

Fig. 16.12

'ALPHA=0' FUNDAMENTAL SOLUTION

PNL. NO.	SECT NO.	N	M	X	Y	Z	VX	VY	VZ	VT	CP	SIGMA	VN
1	1	1	1	3.00747	0.31702	-1.15890	1.00622	0.00137	0.00030	1.00622	-0.0125	-0 01347	0.00007
2			2	3.00747	0.84797	-0.85001	1.00588	-0.00002	-0.00012	1.00588	-0.0118	-0.01365	0.00007
3			3	3.00747	1.16085	-0.31081	1.00609	0.00001	-0.00023	1.00609	-0.0122	-0.01354	0.00007
4			4	3.00747	1 16085	0.31082	1.00609	0.00001	0.00023	1.00609	-0.0122	-0.01354	0.00007
5			5	3.00747	0.84797	0.85001	1.00588	-0.00002	0.00012	1.00588	-0.0118	-0.01365	0.00007
6			6	3.00747	0.31702	1.15890	1.00622	0.00137	-0.00029	1.00622	-0.0125	-0.01347	0.00007
7		2	1	1.42347	0.31620	-1.15584	1.01532	0.00486	0.00000	1.01534	-0.0309	-0.02358	0.00004
8			2	1.42347	0.84574	-0.84777	1.01505	0.00086	-0.00089	1.01505	-0.0303	-0.02408	0.00002
9			3	1.42347	1.15779	-0.30999	1.01504	0.00108	-0.00075	1.01504	-0.0303	-0.02384	0.00003
10			4	1.42347	1.15779	0.31000	1.01505	0.00108	0.00075	1.01505	-0.0303	-0.02384	0.00003
11			5	1.42347	0.84573	0.84777	1.01506	0.00085	0.00089	1.01506	-0.0304	-0.02409	0.00001
12			6	1.42347	0.31619	1.15584	1.01534	0.00487	-0.00002	1.01535	-0.0309	-0.02358	0.00003
13		3	1	0.65590	0.31706	-1.15904	1.04271	0.00241	0.00447	1.04272	-0.0873	-0.02422	-0.00002
14			2	0.65590	0.84808	-0.85012	1.04206	-0.00266	0.00251	1.04207	-0.0859	-0.02472	0.00002
15			3	0.65590	1.16100	-0.31085	1.04226	-0.00362	0.00048	1.04226	-0.0863	-0.02449	0.00005
16			4	0.65590	1.16100	0.31086	1.04226	-0.00360	-0.00049	1.04226	-0.0863	-0.02449	0.00007
17			5	0.65590	0.84808	0.85012	1.04206	-0.00262	-0.00248	1.04207	-0.0859	-0.02471	0.00007
18			6	0.65590	0.31706	1.15905	1.04272	0.00242	-0.00440	1.04273	-0.0873	-0.02421	0.00005
19		4	1	0.29028	0.31592	-1.15481	1.11359	0.01421	-0.00770	1.11371	-0.2403	-0.02375	-0.00000
20			2	0.29028	0.84498	-0.84701	1.11422	0.00689	-0.00884	1.11428	-0.2416	-0.02427	0.00001
21			3	0.29028	1.15676	-0.30972	1.11463	0.01058	-0.00342	1.11469	-0.2425	-0.02407	-0.00002
22			4	0.29028	1.15675	0.30972	1.11462	0.01059	0.00342	1.11467	-0.2425	-0.02407	-0.00001
23			5	0.29028	0.84498	0.84702	1.11419	0.00688	0.00883	1.11424	-0.2415	-0.02428	-0.00001
24			6	0.29028	0.31591	1.15481	1.11355	0.01420	0.00767	1.11366	-0.2402	-0.02375	-0.00003
25		5	1	0.10622	0.31701	-1.15892	1.39984	0.08773	-0.05889	1.40382	-0.9707	-0.02963	0.00000
26			2	0.10622	0.84799	-0.85003	1.38800	0.05476	-0.05669	1.39024	-0.9328	-0.02991	0.00001
27			3	0.10622	1.16087	-0.31082	1.38650	0.07597	-0.02117	1.38874	-0.9286	-0.02973	-0.00001
28			4	0.10622	1.16087	0.31082	1.38649	0.07596	0.02117	1.38873	-0.9286	-0.02973	-0.00001
29			5	0.10622	0.84799	0.85003	1.38801	0.05474	0.05668	1.39024	-0.9328	-0.02991	-0.00001
30			6	0.10622	0.31701	1.15893	1.39984	0.08773	0.05887	1.40382	-0.9707	-0.02963	-0.00002
31		6	1	0.01439	0.30331	-1.10881	0.52174	0.28514	-0.84412	1.03250	-0.0661	0.10442	0.00002
32			2	0.01439	0.81133	-0.81327	0.49082	0.59035	-0.59164	0.96925	0.0605	0 10428	0.00002
33			3	0.01439	1.11068	-0.29738	0.48803	0.80349	-0.21566	0.96451	0.0697	0.10428	0.00001
34			4	0.01439	1.11068	0.29738	0.48802	0.80348	0.21566	0.96450	0.0697	0.10428	0.00001
35			5	0.01439	0.81133	0.81328	0.49081	0.59034	0.59163	0.96924	0.0606	0.10428	0.00001
36			6	0.01439	0.30331	1.10881	0.52174	0.28514	0.84411	1.03249	-0.0660	0.10442	0.00001
37		7	1	0.01439	0.27707	-1.01278	0.36192	-0.21355	0.58135	0.71733	0.4854	0.11821	0.00001
38			2	0.01439	0.74106	-0.74285	0.30972	-0.37206	0.37383	0.61163	0.6259	0.11836	0.00002
39			3	0.01439	1.01450	-0.27163	0.30874	-0.50865	0.13517	0.61018	0.6277	0.11827	0.00001
40			4	0.01439	1.01449	0.27163	0.30874	-0.50865	-0.13518	0.61018	0.6277	0.11827	0.00001
41			5	0.01439	0.74106	0.74285	0.30972	-0.37205	-0.37382	0.61163	0.6259	0.11836	0.00001
42			6	0.01439	0.27707	1.01278	0.36192	-0.21355	-0.58134	0.71732	0.4855	0.11820	0.00001
43		8	1	0.10622	0.26337	-0.96267	1.27838	0.01582	0.07945	1.28094	-0.6408	0.00102	-0.00001
44			2	0.10622	0.70439	-0.70609	1.27510	-0.05132	0.05104	1.27715	-0.6311	0.00158	-0.00000
45			3	0.10622	0.96430	-0.25819	1.27465	-0.07013	0.01827	1.27671	-0.6300	0.00147	-0.00001
46			4	0.10622	0.96430	0.25819	1.27465	-0.07013	-0.01827	1.27671	-0.6300	0.00147	-0.00000
47			5	0.10622	0.70439	0.70610	1.27509	-0.05133	-0.05104	1.27714	-0.6311	0.00158	-0.00000

Fig. 16.13

'ALPHA=0' FUNDAMENTAL SOLUTION

PNL. NO.	SECT NO.	N	M	X	Y	Z	VX	VY	VZ	VT	CP	SIGMA	VN
48	1	8	6	0.10622	0.26337	0.96267	1.27837	0.01582	-0.07946	1.28094	-0.6408	0.00102	-0.00001
49		9	1	0.29028	0.26447	-0.96679	1.05860	-0.00622	0.00927	1.05866	-0.1208	0.02305	-0.00001
50			2	0.29028	0.70741	-0.70911	1.05980	-0.00789	0.00706	1.05986	-0.1233	0.02357	-0.00000
51			3	0.29028	0.96842	-0.25929	1.06050	-0.01030	0.00244	1.06055	-0.1248	0.02340	-0.00000
52			4	0.29028	0.96842	0.25929	1.06050	-0.01030	-0.00244	1.06055	-0.1248	0.02340	-0.00000
53			5	0.29028	0.70741	0.70911	1.05980	-0.00789	-0.00706	1.05986	-0.1233	0.02357	-0.00000
54			6	0.29028	0.26447	0.96679	1.05860	-0.00622	-0.00927	1.05866	-0.1208	0.02305	-0.00000
55		10	1	0.65590	0.26332	-0.96255	1.03690	-0.00248	-0.00445	1.03691	-0.0752	0.02708	-0.00000
56			2	0.65590	0.70431	-0.70600	1.03662	0.00301	-0.00216	1.03662	-0.0746	0.02747	-0.00000
57			3	0.65590	0.96418	-0.25815	1.03685	0.00346	-0.00123	1.03686	-0.0751	0.02735	-0.00000
58			4	0.65590	0.96418	0.25816	1.03685	0.00346	0.00123	1.03686	-0.0751	0.02735	-0.00000
59			5	0.65590	0.70430	0.70600	1.03661	0.00300	0.00216	1.03662	-0.0746	0.02746	-0.00000
60			6	0.65590	0.26332	0.96255	1.03689	-0.00247	0.00445	1.03691	-0.0752	0.02707	-0.00000
61		11	1	1.42347	0.26419	-0.96576	1.02641	-0.00633	-0.00043	1.02643	-0.0536	0.02836	-0.00000
62			2	1.42347	0.70665	-0.70835	1.02685	-0.00029	0.00144	1.02685	-0.0544	0.02873	-0.00000
63			3	1.42347	0.96739	-0.25901	1.02685	-0.00125	0.00006	1.02685	-0.0544	0.02861	0.00000
64			4	1.42347	0.96738	0.25902	1.02685	-0.00125	-0.00006	1.02685	-0.0544	0.02861	0.00000
65			5	1.42347	0.70665	0.70835	1.02685	-0.00028	-0.00145	1.02685	-0.0544	0.02873	-0.00000
66			6	1.42347	0.26419	0.96576	1.02642	-0.00633	0.00043	1.02644	-0.0536	0.02836	0.00000
67		12	1	3.00747	0.26336	-0.96270	1.02438	-0.00031	-0.00008	1.02438	-0.0494	0.01617	0.00000
68			2	3.00747	0.70441	-0.70611	1.02451	0.00025	0.00025	1.02451	-0.0496	0.01627	-0.00000
69			3	3.00747	0.96432	-0.25819	1.02448	-0.00005	-0.00018	1.02448	-0.0496	0.01623	-0.00000
70			4	3.00747	0.96432	0.25820	1.02448	-0.00005	0.00018	1.02448	-0.0496	0.01623	-0.00000
71			5	3.00747	0.70441	0.70611	1.02452	0.00025	-0.00025	1.02452	-0.0496	0.01627	0.00000
72			6	3.00747	0.26336	0.96270	1.02438	-0.00031	0.00008	1.02438	-0.0494	0.01617	0.00000

Fig. 16.14

'ALPHA=90' FUNDAMENTAL SOLUTION

PNL. NO.	SECT NO.	N	M	X	Y	Z	VX	VY	VZ	VT	CP	SIGMA	VN
1	1	1	1	3.00747	0.31702	-1.15890	0.05566	0.52888	0.14178	0.55037	0.6971	0.73797	-0.00007
2			2	3.00747	0.84797	-0.85001	0.07589	0.88890	0.88615	1.25744	-0.5812	0.54352	-0.00005
3			3	3.00747	1.16085	-0.31081	0.02657	0.44289	1.65930	1.71760	-1.9501	0.19711	-0.00005
4			4	3.00747	1.16085	0.31082	-0.02655	-0.44291	1.65931	1.71761	-1.9502	-0.19712	0.00003
5			5	3.00747	0.84797	0.85001	-0.07586	-0.88891	0.88614	1.25744	-0.5811	-0.54353	0.00004
6			6	3.00747	0.31702	1.15890	-0.05562	-0.52890	0.14176	0.55039	0.6971	-0.73798	0.00004
7		2	1	1.42347	0.31620	-1.15584	-0.07223	0.44467	0.11930	0.46602	0.7828	0.76234	-0.00006
8			2	1.42347	0.84574	-0.84777	-0.05730	0.89764	0.89494	1.26884	-0.6100	0.56603	-0.00004
9			3	1.42347	1.15779	-0.30999	-0.02049	0.44862	1.68081	1.73977	-2.0268	0.20520	-0.00003
10			4	1.42347	1.15779	0.31000	0.02052	-0.44859	1.68081	1.73976	-2.0268	-0.20519	0.00007
11			5	1.42347	0.84573	0.84777	0.05732	-0.89761	0.89497	1.26884	-0.6100	-0.56602	0.00008
12			6	1.42347	0.31619	1.15584	0.07226	-0.44466	0.11934	0.46603	0.7828	-0.76233	0.00010
13		3	1	0.65590	0.31706	-1.15904	-0.24840	0.45387	0.12076	0.53131	0.7177	0.63653	-0.00005
14			2	0.65590	0.84808	-0.85012	-0.19111	0.83816	0.83459	1.19816	-0.4356	0.47115	-0.00003
15			3	0.65590	1.16100	-0.31085	-0.07000	0.41801	1.56497	1.62134	-1.6288	0.17075	-0.00000
16			4	0.65590	1.16100	0.31086	0.06999	-0.41796	1.56499	1.62135	-1.6288	-0.17074	0.00006
17			5	0.65590	0.84808	0.85012	0.19111	-0.83814	0.83460	1.19815	-0.4356	-0.47114	0.00005
18			6	0.65590	0.31706	1.15905	0.24840	-0.45386	0.12078	0.53130	0.7177	-0.63653	0.00007
19		4	1	0.29028	0.31592	-1.15481	-0.73961	0.32046	0.09354	0.81146	0.3415	0.53593	-0.00003
20			2	0.29028	0.84498	-0.84701	-0.53897	0.77520	0.78035	1.22490	-0.5004	0.39568	-0.00001
21			3	0.29028	1.15676	-0.30972	-0.19793	0.38277	1.44154	1.50457	-1.2637	0.14333	0.00000
22			4	0.29028	1.15675	0.30972	0.19791	-0.38273	1.44154	1.50456	-1.2637	-0.14332	0.00004
23			5	0.29028	0.84498	0.84702	0.53898	-0.77516	0.78040	1.22491	-0.5004	-0.39567	0.00007
24			6	0.29028	0.31591	1.15481	0.73960	-0.32044	0.09359	0.81145	0.3416	-0.53591	0.00009
25		5	1	0.10622	0.31701	-1.15892	-1.47102	0.12919	0.12122	1.48165	-1.1953	0.34269	-0.00002
26			2	0.10622	0.84799	-0.85003	-1.09614	0.66174	0.74751	1.48263	-1.1982	0.25183	0.00001
27			3	0.10622	1.16087	-0.31082	-0.39942	0.32287	1.29757	1.39552	-0.9475	0.09144	0.00001
28			4	0.10622	1.16087	0.31082	0.39938	-0.32285	1.29756	1.39550	-0.9474	-0.09144	0.00002
29			5	0.10622	0.84799	0.85003	1.09609	-0.66170	0.74754	1.48259	-1.1981	-0.25182	0.00005
30			6	0.10622	0.31701	1.15893	1.47100	-0.12918	0.12126	1.48163	-1.1952	-0.34268	0 00005
31		6	1	0.01439	0.30331	-1.10881	-1.73357	-0.90239	2.81676	3.42837	-10.7537	0.12561	-0.00003
32			2	0.01439	0.81133	-0.81327	-1.17994	-0.80847	2.03100	2.48412	-5.1709	0.09225	-0.00001
33			3	0.01439	1.11068	-0.29738	-0.42772	-0.40748	1.30047	1.42836	-1.0402	0.03343	0.00000
34			4	0.01439	1.11068	0.29738	0.42769	0.40749	1.30047	1.42835	-1.0402	-0.03343	0.00003
35			5	0.01439	0.81133	0.81328	1.17986	0.80849	2.03101	2.48410	-5.1707	-0.09224	0.00007
36			6	0.01439	0.30331	1.10881	1.73350	0.90238	2.81676	3.42833	-10.7534	-0.12560	0.00007
37		7	1	0.01439	0.27707	-1.01278	1.87228	-1.05610	3.02021	3.70708	-12.7424	-0.11947	-0.00004
38			2	0.01439	0.74106	-0.74285	1.27488	-1.05604	2.01240	2.60582	-5.7903	-0.08787	-0.00003
39			3	0.01439	1.01450	-0.27163	0.46120	-0.52777	1.07117	1.28010	-0.6387	-0.03189	-0.00000
40			4	0.01439	1.01449	0.27163	-0.46122	0.52776	1.07118	1 28011	-0.6387	0.03189	0.00002
41			5	0.01439	0.74106	0.74285	-1.27489	1.05601	2.01238	2.60579	-5.7902	0.08787	0 00006
42			6	0.01439	0.27707	1.01278	-1.87226	1.05607	3.02017	3.70703	-12.7421	0.11947	0.00007
43		8	1	0.10622	0.26337	-0.96267	1.85108	-0.03987	0.09821	1.85412	-2.4377	-0.39385	-0.00002
44			2	0.10622	0.70439	-0.70609	1.39648	0.27257	0.38361	1.47363	-1.1716	-0.29055	-0.00001
45			3	0.10622	0.96430	-0.25819	0.50489	0.13318	0.61019	0.80311	0.3550	-0.10541	-0.00001
46			4	0.10622	0.96430	0.25819	-0.50492	-0.13318	0.61021	0.80314	0.3550	0.10541	0.00000
47			5	0.10622	0.70439	0.70610	-1.39645	-0.27256	0.38363	1.47361	-1.1715	0.29054	-0.00000

Fig. 16.15

'ALPHA=90' FUNDAMENTAL SOLUTION

PNL. NO.	SECT NO.	N	M	X	Y	Z	VX	VY	VZ	VT	CP	SIGMA	VN
48	1	8	6	0.10622	0.26337	0.96267	-1.85107	0.03989	0.09823	1.85410	-2.4377	0.39385	0.00001
49		9	1	0.29028	0.26447	-0.96679	0.96365	0.03147	0.01837	0.96434	0.0701	-0.62788	-0.00002
50			2	0.29028	0.70741	-0.70911	0.72296	0.18553	0.19510	0.77146	0.4048	-0.46206	-0.00002
51			3	0.29028	0.96842	-0.25929	0.26069	0.09520	0.36672	0.45990	0.7885	-0.16796	0.00000
52			4	0.29028	0.96842	0.25929	-0.26071	-0.09521	0.36674	0.45992	0.7885	0.16796	0.00001
53			5	0.29028	0.70741	0.70911	-0.72296	-0.18551	0.19511	0.77146	0.4048	0.46205	-0.00000
54			6	0.29028	0.26447	0.96679	-0.96367	-0.03145	0.01838	0.96436	0.0700	0.62786	0.00000
55		10	1	0.65590	0.26332	-0.96255	0.30812	-0.06226	-0.01780	0.31485	0.9009	-0.75129	0.00000
56			2	0.65590	0.70431	-0.70600	0.24087	0.07423	0.07280	0.26235	0.9312	-0.55269	0.00000
57			3	0.65590	0.96418	-0.25815	0.08740	0.04312	0.16036	0.18765	0.9648	-0.20136	0.00000
58			4	0.65590	0.96418	0.25816	-0.08740	-0.04313	0.16036	0.18765	0.9648	0.20135	-0.00000
59			5	0.65590	0.70430	0.70600	-0.24087	-0.07423	0.07280	0.26235	0.9312	0.55269	-0.00001
60			6	0.65590	0.26332	0.96255	-0.30813	0.06226	-0.01781	0.31486	0.9009	0.75129	0.00000
61		11	1	1.42347	0.26419	-0.96576	0.05922	-0.05520	-0.01473	0.08229	0.9932	-0.89775	-0.00001
62			2	1.42347	0.70665	-0.70835	0.04629	-0.00487	-0.00476	0.04679	0.9978	-0.66229	0.00001
63			3	1.42347	0.96739	-0.25901	0.01717	0.00474	0.01786	0.02522	0.9994	-0.24138	0.00001
64			4	1.42347	0.96738	0.25902	-0.01716	-0.00472	0.01786	0.02522	0.9994	0.24137	-0.00002
65			5	1.42347	0.70665	0.70835	-0.04628	0.00487	-0.00477	0.04678	0.9978	0.66228	-0.00001
66			6	1.42347	0.26419	0.96576	-0.05919	0.05522	-0.01473	0.08228	0.9932	0.89774	0.00001
67		12	1	3.00747	0.26336	-0.96270	-0.01157	-0.16525	-0.04428	0.17147	0.9706	-0.87146	-0.00000
68			2	3.00747	0.70441	-0.70611	-0.04186	-0.00860	-0.00857	0.04359	0.9981	-0.63787	0.00000
69			3	3.00747	0.96432	-0.25819	-0.01682	0.00314	0.01183	0.02080	0.9996	-0.23253	0.00002
70			4	3.00747	0.96432	0.25820	0.01682	-0.00314	0.01184	0.02080	0.9996	0.23254	-0.00002
71			5	3.00747	0.70441	0.70611	0.04187	0.00859	-0.00855	0.04359	0.9981	0.63787	-0.00000
72			6	3.00747	0.26336	0.96270	0.01158	0.16528	-0.04428	0.17150	0.9706	0.87147	-0.00000

Fig. 16.16

'B E T A = 9 0' F U N D A M E N T A L S O L U T I O N

PNL. NO.	SECT NO.	N	M	X	Y	Z	VX	VY	VZ	VT	CP	SIGMA	VN
1	1	1	1	3.00747	0.31702	-1.15890	-0.01751	1.64098	0.43965	1.69895	-1.8864	-0.20167	0.00005
2			2	3.00747	0.84797	-0.85001	-0.07594	0.88306	0.88021	1.24913	-0.5603	-0.54238	0.00003
3			3	3.00747	1.16085	-0.31081	-0.09955	0.11653	0.43631	0.46244	0.7861	-0.73770	0.00005
4			4	3.00747	1.16085	0.31082	-0.09955	0.11651	-0.43630	0.46243	0.7862	-0.73770	0.00004
5			5	3.00747	0.84797	0.85001	-0.07594	0.88307	-0.88023	1.24915	-0.5604	-0.54237	0.00003
6			6	3.00747	0.31702	1.15890	-0.01751	1.64097	-0.43965	1.69894	-1.8864	-0.20167	0.00004
7		2	1	1.42347	0.31620	-1.15584	0.01944	1.68362	0.45105	1.74310	-2.0384	-0.21066	0.00005
8			2	1.42347	0.84574	-0.84777	0.05657	0.89318	0.89016	1.26228	-0.5934	-0.56592	0.00006
9			3	1.42347	1.15779	-0.30999	0.07610	0.11786	0.44081	0.46260	0.7860	-0.76888	0.00009
10			4	1.42347	1.15779	0.31000	0.07612	0.11784	-0.44081	0.46259	0.7860	-0.76888	0.00007
11			5	1.42347	0.84573	0.84777	0.05657	0.89319	-0.89016	1.26229	-0.5934	-0.56592	0.00007
12			6	1.42347	0.31619	1.15584	0.01944	1.68362	-0.45105	1.74311	-2.0384	-0.21066	0.00004
13		3	1	0.65590	0.31706	-1.15904	0.06949	1.55591	0.41712	1.61235	-1.5997	-0.17485	0.00004
14			2	0.65590	0.84808	-0.85012	0.19441	0.83174	0.82999	1.19100	-0.4185	-0.47014	0.00006
15			3	0.65590	1.16100	-0.31085	0.26365	0.10907	0.41177	0.50096	0.7490	-0.63900	0.00010
16			4	0.65590	1.16100	0.31086	0.26366	0.10908	-0.41177	0.50097	0.7490	-0.63900	0.00012
17			5	0.65590	0.84808	0.85012	0.19440	0.83176	-0.82998	1.19100	-0.4185	-0.47013	0 00007
18			6	0.65590	0.31706	1.15905	0.06949	1.55590	-0.41710	1.61234	-1.5996	-0.17485	0.00005
19		4	1	0.29028	0.31592	-1.15481	0.20167	1.45374	0.38744	1.51794	-1.3041	-0.14655	0.00001
20			2	0.29028	0.84498	-0.84701	0.54478	0.76936	0.75919	1.21040	-0.4651	-0.39432	0.00004
21			3	0.29028	1.15676	-0.30972	0.74152	0.10854	0.37764	0.83919	0.2958	-0.53621	0.00007
22			4	0.29028	1.15675	0.30972	0.74152	0.10854	-0.37764	0.83919	0.2958	-0.53621	0 00007
23			5	0.29028	0.84498	0.84702	0.54478	0.76937	-0.75917	1.21040	-0.4651	-0.39431	0.00005
24			6	0.29028	0.31591	1.15481	0.20166	1.45373	-0.38743	1.51793	-1.3041	-0.14655	0.00002
25		5	1	0.10622	0.31701	-1.15892	0.40145	1.34012	0.33545	1.43862	-1.0696	-0.09303	0.00000
26			2	0.10622	0.84799	-0.85003	1.09806	0.72987	0.63950	1.46540	-1.1474	-0.25126	0.00003
27			3	0.10622	1.16087	-0.31082	1.49450	0.17308	0.31857	1.53785	-1.3650	-0.34216	0.00005
28			4	0.10622	1.16087	0.31082	1.49449	0.17308	-0.31858	1.53784	-1.3650	-0.34216	0.00005
29			5	0.10622	0.84799	0.85003	1.09804	0.72987	-0.63949	1.46538	-1.1473	-0.25125	0.00003
30			6	0.10622	0.31701	1.15893	0.40144	1.34012	-0.33545	1.43861	-1.0696	-0.09303	0.00001
31		6	1	0.01439	0.30331	-1.10881	0.47083	1.42418	-0.44908	1.56577	-1.4516	-0.03404	0.00001
32			2	0.01439	0.81133	-0.81327	1.17696	2.00599	-0.83018	2.46950	-5.0984	-0.09175	0.00004
33			3	0.01439	1.11068	-0.29738	1.60090	2.71455	-0.41215	3.17829	-9.1015	-0.12510	0.00004
34			4	0.01439	1.11068	0.29738	1.60089	2.71457	0.41216	3.17830	-9.1016	-0.12509	0.00004
35			5	0.01439	0.81133	0.81328	1.17694	2.00599	0.83020	2.46949	-5.0984	-0.09175	0.00004
36			6	0.01439	0.30331	1.10881	0.47081	1.42417	0.44907	1.56576	-1.4516	-0.03404	0.00001
37		7	1	0.01439	0.27707	-1.01278	-0.51203	1.20436	-0.58066	1 43172	-1.0498	0.03235	0 00001
38			2	0.01439	0.74106	-0.74285	-1.26672	1.98473	-1.06703	2.58501	-5.6823	0.08761	0 00004
39			3	0.01439	1.01450	-0.27163	-1.72431	2.90006	-0.53234	3.41570	-10.6670	0.11931	0.00005
40			4	0.01439	1.01449	0.27163	-1.72432	2.90005	0.53235	3.41569	-10.6669	0.11931	0.00005
41			5	0.01439	0.74106	0.74285	-1.26671	1.98472	1.06703	2.58500	-5.6822	0.08761	0 00004
42			6	0.01439	0.27707	1.01278	-0.51202	1.20435	0.58065	1.43171	-1.0498	0.03235	0.00001
43		8	1	0.10622	0.26337	-0.96267	-0.51386	0.64414	0.14237	0.83620	0.3008	0.10795	0.00001
44			2	0.10622	0.70439	-0.70609	-1.38280	0.37727	0.26523	1.45767	-1.1248	0.28864	0.00000
45			3	0.10622	0.96430	-0.25819	-1.88799	0.14498	0.12691	1.89780	-2.6016	0.39409	0.00000
46			4	0.10622	0.96430	0.25819	-1.88800	0.14497	-0.12691	1.89781	-2.6017	0.39409	0.00001
47			5	0.10622	0.70439	0.70610	-1.38278	0.37727	-0.26523	1.45765	-1.1248	0.28864	0.00001

Fig. 16.17

'B E T A = 9 0' F U N D A M E N T A L S O L U T I O N

PNL. NO.	SECT NO.	N	M	X	Y	Z	VX	VY	VZ	VT	CP	SIGMA	VN
48	1	8	6	0.10622	0.26337	0.96267	-0.51384	0.64414	-0.14236	0.83619	0.3008	0.10794	0.00001
49		9	1	0.29028	0.26447	-0.96679	-0.27087	0.37676	0.09816	0.47429	0.7750	0.17240	0.00001
50			2	0.29028	0.70741	-0.70911	-0.71601	0.20348	0.19276	0.76891	0.4088	0.45980	0.00000
51			3	0.29028	0.96842	-0.25929	-0.97598	0.03337	0.08724	0.98044	0.0387	0.62797	-0.00000
52			4	0.29028	0.96842	0.25929	-0.97599	0.03338	-0.08723	0.98045	0.0387	0.62797	-0.00001
53			5	0.29028	0.70741	0.70911	-0.71601	0.20349	-0.19275	0.76892	0.4088	0.45979	-0.00001
54			6	0.29028	0.26447	0.96679	-0.27086	0.37675	-0.09815	0.47428	0.7751	0.17239	-0.00000
55		10	1	0.65590	0.26332	-0.96255	-0.08845	0.18446	0.04974	0.21053	0.9557	0.20687	-0.00000
56			2	0 65590	0.70431	-0.70600	-0.24182	0.08972	0.09061	0.27338	0.9253	0.55134	-0.00002
57			3	0.65590	0.96418	-0.25815	-0.32977	0.00749	0.03256	0.33146	0.8901	0.75307	-0.00000
58			4	0.65590	0.96418	0.25816	-0.32978	0.00749	-0.03256	0.33146	0.8901	0.75307	-0.00000
59			5	0.65590	0.70430	0.70600	-0.24184	0.08971	-0.09062	0.27339	0.9253	0.55133	-0.00001
60			6	0.65590	0.26332	0.96255	-0.08845	0.18445	-0.04974	0.21052	0.9557	0.20687	-0.00000
61		11	1	1.42347	0.26419	-0.96576	-0.01666	0.02833	0.00754	0.03372	0.9989	0.24856	-0.00002
62			2	1.42347	0.70665	-0.70835	-0.04785	0.01394	0.01379	0.05171	0.9973	0.66208	-0.00002
63			3	1.42347	0.96739	-0.25901	-0.06692	-0.00211	-0.00823	0.06746	0.9954	0.90393	0.00000
64			4	1.42347	0.96738	0.25902	-0.06693	-0.00211	0.00822	0.06746	0.9954	0.90394	-0.00000
65			5	1.42347	0.70665	0.70835	-0.04784	0.01394	-0.01380	0.05171	0.9973	0.66208	-0.00001
66			6	1.42347	0.26419	0.96576	-0.01665	0.02832	-0.00755	0.03371	0.9989	0.24855	-0.00002
67		12	1	3.00747	0.26336	-0.96270	0.00753	0.05045	0.01350	0.05277	0.9972	0.23870	-0.00002
68			2	3.00747	0.70441	-0.70611	0.04943	0.01060	0.01055	0.05164	0.9973	0.63627	-0.00001
69			3	3.00747	0.96432	-0.25819	0.07095	-0.00258	-0.00967	0.07166	0.9949	0.86972	0.00000
70			4	3.00747	0.96432	0.25820	0.07095	-0.00259	0.00967	0.07165	0.9949	0.86972	0.00001
71			5	3.00747	0.70441	0.70611	0.04944	0.01059	-0.01054	0.05165	0.9973	0.63626	-0.00001
72			6	3.00747	0.26336	0.96270	0.00753	0.05047	-0.01350	0.05279	0.9972	0.23870	-0.00002

Fig. 16.18

*** T I M E   U S A G E   S U M M A R Y ***

ROUTINE	CPU USED (SECONDS)	PERCENT OF TOTAL CPU USED	I/O USED (SECONDS)	PERCENT OF TOTAL I/O USED
PCPAN	0.5	5.59	1.1	9.85
VFORM	6.3	64.55	3.4	31.39
AFORM	0.3	2.87	0.8	7.30
ITSOLV	2.2	22.78	4.4	39.78
FUND	0.4	4.21	1.3	11.68

Fig. 16.19

```
0.549048  0.0       -0.9999992
0.549048  0.500000 -0.8660240
0.549048  0.866026 -0.4999970
0.549048  0.999999  0.0000020
0.549048  0.866024  0.5000000
0.549048  0.499997  0.8660250
0.549048 -0.000002  0.9999990
0.549048 -0.499997  0.8660250
0.549048 -0.866024  0.5000000
0.549048 -0.999999  0.0000020
0.549048 -0.866026 -0.4999970
0.549048 -0.500000 -0.8660240
0.549048  0.0       -0.9999990
0.549048  0.0       -0.7999991
0.549048  0.400000 -0.6928190
0.549048  0.692821 -0.3999980
0.549048  0.799999  0.0000020
0.549048  0.692819  0.4000000
0.549048  0.399998  0.6928200
0.549048 -0.000002  0.7999990
0.549048 -0.399998  0.6928200
0.549048 -0.692819  0.4000000
0.549048 -0.799999  0.0000020
0.549048 -0.692821 -0.3999980
0.549048 -0.400000 -0.6928190
0.549048  0.0       -0.7999990
0.549048  0.0       -0.5999991
0.549048  0.300000 -0.5196140
0.549048  0.519615 -0.2999980
0.549048  0.599999  0.0000010
0.549048  0.519614  0.3000000
0.549048  0.299998  0.5196150
0.549048 -0.000001  0.5999990
0.549048 -0.299998  0.5196150
0.549048 -0.519614  0.3000000
0.549048 -0.599999  0.0000010
0.549048 -0.519615 -0.2999980
0.549048 -0.300000 -0.5196140
0.549048  0.0       -0.5999990
0.549048  0.0       -0.4000001
0.549048  0.200000 -0.3464100
0.549048  0.346410 -0.1999990
0.549048  0.400000  0.0000010
0.549048  0.346410  0.2000000
0.549048  0.199999  0.3464100
0.549048 -0.000001  0.4000000
0.549048 -0.199999  0.3464100
0.549048 -0.346410  0.2000000
0.549048 -0.400000  0.0000010
0.549048 -0.346410 -0.1999990
0.549048 -0.200000 -0.3464100
0.549048  0.0       -0.4000000
0.549048  0.0       -0.2000001
0.549048  0.100000 -0.1732050
0.549048  0.173205 -0.0999990
0.549048  0.200000  0.0000000
0.549048  0.173205  0.1000000
0.549048  0.099999  0.1732050
0.549048 -0.000000  0.2000000
0.549048 -0.099999  0.1732050
0.549048 -0.173205  0.1000000
0.549048 -0.200000  0.0000000
0.549048 -0.173205 -0.0999990
```

```
0.549048 -0.100000 -0.1732050
0.549048  0.0       -0.2000000
0.549048  0.0        0.0      1
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
0.549048  0.0        0.0      0
```

Fig. 17. The formatted (3F10.6,I1) unit 1 geometry data that was used to define the control station in Step 3 for the round inlet sample case.

```
SECTION #   # PATCHES   NU    NV    TITLE
---------   ---------   --    --    ------------------------------------------------------------
    1           60      12     5    NLIF NEUMANN SECTION   1

UNFORMATTED DATASET CREATION IN PROGRESS ...
UNFORMATTED PATCH DATA HAS BEEN CREATED.  NPAT =   60
TIME USAGE ... CPU=   0.16 SECONDS,  I/O =   0.28 SECONDS.
```

Fig. 18. Step 3 output for the round inlet sample case.

*** NO UNIT 5 INPUT FOUND. DEFAULT BODY GEOMETRY PICTURES WILL BE CREATED.

*** 10 DEFAULT VIEWS WILL BE GENERATED.

G E O M E T R Y   V I E W I N G   D A T A

VIEW	PSI	THETA	PHI	X0	Y0	Z0	R0	DTHSEG	IPERSP
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.00	0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.00	1
3	10.0	0.0	0.0	0.0	0.0	0.0	0.0	5.00	1
4	-10.0	0.0	0.0	0.0	0.0	0.0	0.0	5.00	1
5	0.0	10.0	0.0	0.0	0.0	0.0	0.0	5.00	1
6	0.0	-10.0	0.0	0.0	0.0	0.0	0.0	5.00	1
7	90.0	0.0	0.0	0.0	0.0	0.0	0.0	5.00	0
8	-90.0	0.0	0.0	0.0	0.0	0.0	0.0	5.00	0
9	0.0	90.0	0.0	0.0	0.0	0.0	0.0	5.00	0
10	0.0	-90.0	0.0	0.0	0.0	0.0	0.0	5.00	0

VIEW NUMBER 1 COMPLETED.
VIEW NUMBER 2 COMPLETED.
VIEW NUMBER 3 COMPLETED.
VIEW NUMBER 4 COMPLETED.
VIEW NUMBER 5 COMPLETED.
VIEW NUMBER 6 COMPLETED.
VIEW NUMBER 7 COMPLETED.
VIEW NUMBER 8 COMPLETED.
VIEW NUMBER 9 COMPLETED.
VIEW NUMBER 10 COMPLETED.

Fig. 19. Sample output from Step 4 of the ten default views that are supplied if NVIEWS=-1 and either NCOMB=0 or NSL>0.

UNIT 5 INPUT FLAGS

```
TITLE  =H31HG027BZ.  INCOMPRESSIBLE COMBINATION SAMPLE CASE.
NCOMB  =  1        ICOMBP =  1       IFLUXP =  1
COMPRS =  0
IOFF   =  0
ISO P  =  1        DELCP  =  0.0     DELP   =  0.0
ISO M  =  0        DELM   =  0.0
ISO A  =  1        DELA   =  0.0

NSL    =  4        ISLP   =  1
NVIEWS =  1        IHID   =  0
IPLOTP =  1
IPLOTM =  0
IPLOTA =  0
I VS S =  0
I VS X =  1
```

INPUT COMBINATION CASE DATA

CASE	ALPHA	BETA	VREF	VINF	VC
1	30.000	20.000	1.00000	1.00000	-0.90000

STREAMLINE CASE DATA

STREAMLINE NUMBER	NSECTO	USTART	VSTART	NDIREC	XMAX	MAXPTS
1	1	2.000	6.000	1	5.00	20
2	1	3.000	6.000	1	5.00	20
3	1	4.000	6.000	1	5.00	20
4	1	5.000	6.000	1	5.00	20

GEOMETRY VIEWING DATA

VIEW	PSI	THETA	PHI	X0	Y0	Z0	R0	DTHSEG	IPERSP
1	30.0	0.0	0.0	0.0	0.0	0.0	0.0	5.00	1

Figs. 20.1-20.12. The step 4 (combination) program output for the round inlet sample case.

```
SUMMARY OF DATA READ FROM FUNDAMENTAL SOLUTION DATASET ...

TITLE  =H31HG027B.  HIGHER-ORDER INLET PROGRAM SAMPLE CASE (6 X 12 = 72).
NSYM   =  1
ICUR   =  1
ISORD  =  1
ISFLOW =  1
IZFLOW =  1
IYFLOW =  1

SECTION
 NUMBER     NU      NV
-------    ----    ----
    1        6      12
    2        6       1


4 SIGMA-SOLUTIONS HAVE BEEN RETRIEVED.

         S U M M A R Y   O F   C O M P U T E D   F L U X - S T A T I O N   D A T A

FLUX-STATION    TOTAL NUMBER
  NUMBER         OF PANELS     NU     NV     TOTAL AREA      NX          NY          NZ
------------    ------------  ----   ----   -----------  ---------   ---------   ---------
      1              60        12      5         3.1405  -1.000000    0.0         0.0

                  NEAR    INTER.    FAR
                -------  -------  -------
SOURCE             7296     1344        0
SMALL LOGS            0
```


Fig. 20.2

I N C O M P R E S S I B L E   R A K E   C A L C U L A T I O N S

RAKE	AREA	'STATIC' SOLUTION TOTAL FLUX	'STATIC' SOLUTION AVG. SPEED	'ALPHA=0' SOLUTION TOTAL FLUX	'ALPHA=0' SOLUTION AVG. SPEED	'ALPHA=90' SOLUTION TOTAL FLUX	'ALPHA=90' SOLUTION AVG. SPEED	'BETA=90' SOLUTION TOTAL FLUX	'BETA=90' SOLUTION AVG. SPEED
1	3.1405	-5.0956	-1.62258	-3.2317	-1.02905	0.0003	0.00009	0.0	0.0

C O M P U T E D   C O M B I N A T I O N   C O N S T A N T S

CASE	SUCTION	ALPHA=0	ALPHA=90	BETA=90
1	0.03858	0.81380	0.50000	0.29620

Fig. 20.3

ON-BODY RESULTS FOR COMBINATION CASE 1

PNL.	SECT	J	I	X	Y	Z	VX	VY	VZ	VT	CP	P/PT	MACH
1	1	1	1	3.007473	0.317024	-1.158898	0.839204	0.743054	0.199098	1.138433	-0.296030	0.0	0.0
2			2	3.007473	0.847973	-0.850012	0.831892	0.706514	0.704248	1.298911	-0.687170	0.0	0.0
3			3	3.007473	1.160850	-0.310813	0.799758	0.256318	0.960093	1.275575	-0.627090	0.0	0.0
4			4	3.007473	1.160849	0.310817	0.773199	-0.186584	0.699214	1.059032	-0.121550	0.0	0.0
5			5	3.007472	0.847971	0.850015	0.756017	-0.182380	0.181887	0.798691	0.362093	0.0	0.0
6			6	3.007472	0.317022	1.158898	0.783554	0.214179	-0.057315	0.814318	0.336886	0.0	0.0
7		2	1	1.423469	0.316196	-1.155840	0.792942	0.719462	0.191783	1.087733	-0.183164	0.0	0.0
8			2	1.423470	0.845736	-0.847771	0.810628	0.714359	0.710701	1.293260	-0.672520	0.0	0.0
9			3	1.423469	1.157790	-0.309993	0.835260	0.260310	0.971169	1.307131	-0.708591	0.0	0.0
10			4	1.423469	1.157788	0.309997	0.855773	-0.188299	0.709637	1.127559	-0.271388	0.0	0.0
11			5	1.423469	0.845733	0.847774	0.867948	-0.183273	0.184252	0.906019	0.179129	0.0	0.0
12			6	1.423469	0.316193	1.155841	0.865200	0.274808	-0.072481	0.910683	0.170656	0.0	0.0
13		3	1	0.655896	0.317064	-1.159044	0.739709	0.687697	0.186999	1.027164	-0.055064	0.0	0.0
14			2	0.655897	0.848081	-0.850119	0.804227	0.663426	0.665304	1.236748	-0.529545	0.0	0.0
15			3	0.655896	1.160996	-0.310852	0.885709	0.238494	0.905259	1.288741	-0.660853	0.0	0.0
16			4	0.655896	1.160995	0.310856	0.955701	-0.179471	0.659712	1.175072	-0.380793	0.0	0.0
17			5	0.655895	0.848079	0.850122	0.995333	-0.174685	0.169319	1.024632	-0.049871	0.0	0.0
18			6	0.655895	0.317061	1.159045	0.988117	0.233836	-0.066170	1.017562	-0.035432	0.0	0.0
19		4	1	0.290277	0.315916	-1.154806	0.583168	0.597826	0.154179	0.849266	0.278748	0.0	0.0
20			2	0.290277	0.844979	-0.847013	0.785650	0.621269	0.608215	1.171813	-0.373145	0.0	0.0
21			3	0.290277	1.156755	-0.309716	1.014897	0.232091	0.830153	1.331553	-0.773034	0.0	0.0
22			4	0.290277	1.156754	0.309720	1.212805	-0.150649	0.611383	1.366521	-0.867379	0.0	0.0
23			5	0.290277	0.844976	0.847016	1.324594	-0.153922	0.172157	1.344573	-0.807877	0.0	0.0
24			6	0.290277	0.315913	1.154807	1.322732	0.277372	-0.060628	1.352859	-0.830229	0.0	0.0
25		5	1	0.106220	0.317014	-1.158924	0.497595	0.526539	0.111808	0.733038	0.462655	0.0	0.0
26			2	0.106220	0.847994	-0.850027	0.880555	0.590992	0.518518	1.180470	-0.393508	0.0	0.0
27			3	0.106220	1.160872	-0.310820	1.345371	0.273155	0.726492	1.553199	-1.412426	0.0	0.0
28			4	0.106220	1.160871	0.310824	1.744762	-0.049714	0.571066	1.836514	-2.372782	0.0	0.0
29			5	0.106219	0.847992	0.850030	1.976667	-0.070737	0.228996	1.991144	-2.964655	0.0	0.0
30			6	0.106219	0.317011	1.158925	1.968606	0.397349	0.009420	2.008328	-3.033382	0.0	0.0
31		6	1	0.014387	0.303310	-1.108812	-0.341162	0.174060	0.648547	0.753194	0.432699	0.0	0.0
32			2	0.014387	0.811328	-0.813274	0.122088	0.627539	0.331964	0.720354	0.481090	0.0	0.0
33			3	0.014387	1.110677	-0.297380	0.621803	1.195462	0.368519	1.396987	-0.951572	0.0	0.0
34			4	0.014387	1.110676	0.297384	1.049500	1.602943	0.931953	2.130589	-3.539412	0.0	0.0
35			5	0.014386	0.811325	0.813276	1.301978	1.436011	1.699041	2.577599	-5.644014	0.0	0.0
36			6	0.014386	0.303308	1.108813	1.392365	1.076446	2.168200	2.792581	-6.798506	0.0	0.0
37		7	1	0.014387	0.277075	-1.012783	1.139979	-0.386224	1.907763	2.255721	-4.088277	0.0	0.0
38			2	0.014387	0.741061	-0.742847	0.570473	-0.310131	1.062466	1.245172	-0.550451	0.0	0.0
39			3	0.014387	1.014496	-0.271626	0.026843	0.089427	0.512592	0.521026	0.728532	0.0	0.0
40			4	0.014387	1.014494	0.271630	-0.434368	0.617188	0.558583	0.938942	0.118389	0.0	0.0
41			5	0.014386	0.741058	0.742850	-0.704404	0.745901	0.949925	1.398181	-0.954909	0.0	0.0
42			6	0.014386	0.277072	1.012784	-0.732289	0.669860	1.112424	1.490788	-1.222446	0.0	0.0
43		8	1	0.106220	0.263371	-0.962672	1.907742	0.179703	0.160391	1.922887	-2.697494	0.0	0.0
44			2	0.106220	0.704393	-0.706093	1.422004	0.202574	0.315896	1.470687	-1.162919	0.0	0.0
45			3	0.106220	0.964302	-0.258186	0.825700	0.047275	0.359110	0.901652	0.187024	0.0	0.0
46			4	0.106220	0.964301	0.258190	0.320797	-0.085906	0.251089	0.416337	0.826664	0.0	0.0
47			5	0.106220	0.704390	0.706095	0.025541	-0.069993	0.067724	0.100687	0.989862	0.0	0.0

Fig. 20.4

ON-BODY RESULTS FOR COMBINATION CASE 1

PNL.	SECT	J	I	X	Y	Z	VX	VY	VZ	VT	CP	P/PT	MACH
48	1	8	6	0.106219	0.263369	0.962672	0.056665	0.219582	-0.062172	0.235144	0.944707	0.0	0.0
49		9	1	0.290277	0.264469	-0.966792	1.334612	0.123148	0.046778	1.341097	-0.798540	0.0	0.0
50			2	0.290277	0.707409	-0.709108	1.083855	0.145900	0.160690	1.105372	-0.221848	0.0	0.0
51			3	0.290277	0.968421	-0.259290	0.775945	0.048462	0.211578	0.805732	0.350795	0.0	0.0
52			4	0.290278	0.968419	0.259293	0.515238	-0.046742	0.155152	0.540118	0.708273	0.0	0.0
53			5	0.290277	0.707407	0.709109	0.360893	-0.039618	0.034416	0.364689	0.867002	0.0	0.0
54			6	0.290276	0.264466	0.966792	0.370955	0.091684	-0.028399	0.383171	0.853180	0.0	0.0
55		10	1	0.655896	0.263321	-0.962553	1.035258	0.021182	0.001896	1.035476	-0.072209	0.0	0.0
56			2	0.655896	0.704307	-0.706002	0.956403	0.065823	0.060847	0.960594	0.077259	0.0	0.0
57			3	0.655896	0.964178	-0.258154	0.853628	0.026899	0.089105	0.858688	0.262655	0.0	0.0
58			4	0.655897	0.964177	0.258157	0.766228	-0.016224	0.071257	0.769705	0.407554	0.0	0.0
59			5	0.655896	0.704305	0.706004	0.715524	-0.008409	0.011950	0.715673	0.487812	0.0	0.0
60			6	0.655895	0.263319	0.962554	0.727125	0.083440	-0.019702	0.732162	0.463939	0.0	0.0
61		11	1	1.423469	0.264189	-0.965758	0.928476	-0.022869	-0.004991	0.928771	0.137384	0.0	0.0
62			2	1.423470	0.706652	-0.708350	0.913213	0.000588	0.002126	0.913216	0.166037	0.0	0.0
63			3	1.423469	0.967386	-0.259013	0.892945	0.000802	0.007160	0.892974	0.202598	0.0	0.0
64			4	1.423469	0.967385	0.259016	0.875784	-0.003925	0.010699	0.875858	0.232872	0.0	0.0
65			5	1.423469	0.706650	0.708352	0.866933	0.005458	-0.006891	0.866978	0.248349	0.0	0.0
66			6	1.423468	0.264186	0.965759	0.869277	0.032337	-0.009736	0.869933	0.243217	0.0	0.0
67		12	1	3.007472	0.263361	-0.962700	0.901152	-0.065913	-0.017668	0.903732	0.183269	0.0	0.0
68			2	3.007473	0.704415	-0.706109	0.898654	-0.002606	-0.002601	0.898661	0.192408	0.0	0.0
69			3	3.007473	0.964325	-0.258193	0.917348	0.001070	0.004054	0.917357	0.158456	0.0	0.0
70			4	3.007473	0.964324	0.258197	0.934161	-0.002069	0.007782	0.934195	0.127279	0.0	0.0
71			5	3.007472	0.704412	0.706111	0.940525	0.005986	-0.005959	0.940563	0.115342	0.0	0.0
72			6	3.007472	0.263358	0.962701	0.912728	0.099353	-0.026615	0.918506	0.156347	0.0	0.0

Fig. 20.5

CALCULATIONS FOR STREAMLINE NUMBER 1 FOLLOW ...

	X	Y	Z	VX	VY	VZ	U	V	DUDS	DVDS	NH	ND	DELS
1	0.014387	0.811328	-0.813274	0.122088	0.627539	0.331964	2.000000	6.000000	1.177717	-3.913503	0	1	0.10000
2	0.030860	0.833864	-0.792363	0.284236	0.642614	0.368987	2.052883	5.820621	0.920883	-3.095139	1	1	0.10000
3	0.048561	0.856251	-0.773046	0.454352	0.638427	0.411698	2.102760	5.627871	1.108885	-4.947584	1	0	0.05000
4	0.076610	0.886760	-0.750993	0.714060	0.597490	0.483405	2.163975	5.322437	1.390779	-7.775624	0	0	0.05000
5	0.107131	0.918280	-0.728858	0.984265	0.519646	0.565708	2.224694	4.995051	1.023526	-5.347597	0	0	0.05000
6	0.155869	0.933948	-0.699681	0.966342	0.505590	0.601489	2.277585	4.730255	1.092361	-5.250222	0	0	0.05000
7	0.203597	0.950691	-0.668699	0.943951	0.488262	0.637894	2.333955	4.470942	1.162597	-5.128573	0	0	0.05000
8	0.250089	0.968531	-0.635881	0.916925	0.467508	0.674843	2.393870	4.218349	1.234066	-4.981737	0	1	0.10000
9	0.284195	0.987909	-0.600967	0.897362	0.443080	0.706701	2.458065	4.033047	1.295723	-4.875450	0	0	0.10000
10	0.411790	1.031669	-0.528087	0.898964	0.396741	0.762751	2.594770	3.667652	1.426723	-2.458746	0	0	0.10000
11	0.501860	1.078581	-0.449322	0.903044	0.341567	0.813653	2.741941	3.421302	1.518682	-2.469904	0	0	0.10000
12	0.591855	1.128549	-0.365289	0.897453	0.279817	0.868097	2.898621	3.175159	1.616886	-2.454613	0	1	0.20000
13	0.659963	1.160978	-0.278899	0.889025	0.217122	0.892985	3.051389	2.994702	1.434925	-1.158230	0	0	0.20000
14	0.838212	1.160233	-0.105950	0.892914	0.103572	0.838764	3.329467	2.762477	1.349463	-1.163297	0	0	0.20000
15	1.016502	1.159488	0.056383	0.889626	-0.006698	0.786717	3.590805	2.530197	1.267346	-1.159012	0	0	0.20000
16	1.193475	1.158749	0.208526	0.879921	-0.113612	0.736769	3.836056	2.299636	1.183437	-1.146368	0	0	0.20000
17	1.367852	1.133296	0.352666	0.864136	-0.187263	0.664604	4.079211	2.072456	1.237633	-1.125802	0	0	0.20000
18	1.571592	1.063616	0.472857	0.850905	-0.186641	0.549897	4.302622	1.906487	1.021037	-0.537186	0	1	0.40000
19	1.740920	1.006433	0.572054	0.842286	-0.185589	0.452611	4.486734	1.799589	0.839694	-0.531746	0	0	0.40000
20	2.073717	0.922632	0.717752	0.821968	-0.184047	0.310262	4.756778	1.589490	0.574482	-0.518919	0	0	0.40000

NPMAX = 20 HAS BEEN REACHED. COMPUTATIONS TERMINATING FOR THIS STREAMLINE.

SD-4060 PLOT COMPLETED FOR THE FOLLOWING TITLE ...
STREAMLINE 1. PRESSURE COEFFICIENT VS. X.

Fig. 20.6

CALCULATIONS FOR STREAMLINE NUMBER 2 FOLLOW ...

	X	Y	Z	VX	VY	VZ	U	V	DUDS	DVDS	NH	ND	DELS
1	0.014387	1.110677	-0.297380	0.621803	1.195462	0.368519	3.000000	6.000000	1.157808	-12.429318	1	0	0.02500
2	0.039389	1.124342	-0.284739	0.830170	0.950004	0.475935	3.027073	5.727741	0.981352	-9.039988	0	0	0.02500
3	0.062312	1.136871	-0.271820	1.021507	0.715542	0.565409	3.053505	5.478126	1.148031	-11.123520	0	0	0.02500
4	0.090505	1.152281	-0.256577	1.255578	0.414325	0.662506	3.084180	5.171124	1.321341	-13.672394	0	0	0.02500
5	0.122826	1.160499	-0.239158	1.359450	0.231648	0.717288	3.115154	4.909775	1.144127	-7.386017	0	1	0.05000
6	0.156120	1.159754	-0.221066	1.305436	0.213178	0.729734	3.144039	4.728890	1.166033	-7.092553	0	0	0.05000
7	0.218603	1.158357	-0.184026	1.199779	0.175003	0.750320	3.203322	4.389415	1.202732	-6.518504	0	0	0.05000
8	0.275882	1.157076	-0.146093	1.097196	0.135415	0.765552	3.264214	4.078212	1.230531	-5.961161	0	0	0.05000
9	0.342214	1.157355	-0.107703	1.055177	0.106513	0.768215	3.326214	3.857947	1.241377	-2.886003	0	1	0.10000
10	0.394607	1.157964	-0.069405	1.040668	0.081488	0.763721	3.388068	3.714648	1.232808	-2.846322	0	0	0.10000
11	0.496900	1.159150	0.006445	1.006001	0.030207	0.753218	3.510380	3.434869	1.213353	-2.751505	0	0	0.10000
12	0.595373	1.160292	0.081148	0.964583	-0.022457	0.740779	3.630600	3.165535	1.190982	-2.638224	0	1	0.20000
13	0.676566	1.160908	0.154567	0.935751	-0.074438	0.722888	3.748631	2.973070	1.163667	-1.219104	0	0	0.20000
14	0.862900	1.160130	0.294643	0.927294	-0.170887	0.679604	3.974276	2.730312	1.095522	-1.208086	0	0	0.20000
15	1.046584	1.099030	0.414391	0.909792	-0.183017	0.587002	4.193075	2.491006	1.092576	-1.185284	0	0	0.20000
16	1.226467	1.035993	0.521529	0.888967	-0.184084	0.494055	4.392655	2.256654	0.921153	-1.158154	0	0	0.20000
17	1.401934	0.982931	0.611514	0.865833	-0.185238	0.414263	4.560535	2.028055	0.773819	-1.128014	0	1	0.40000
18	1.642108	0.939801	0.686503	0.850058	-0.184625	0.341390	4.699652	1.861970	0.632776	-0.536651	0	0	0.40000
19	1.977798	0.876780	0.796401	0.828592	-0.183420	0.234058	4.903105	1.650045	0.432787	-0.523100	0	0	0.40000
20	2.304804	0.822148	0.863466	0.806330	-0.162931	0.171372	5.046821	1.443603	0.309315	-0.509046	0	0	0.40000

NPMAX = 20 HAS BEEN REACHED. COMPUTATIONS TERMINATING FOR THIS STREAMLINE.

SD-4060 PLOT COMPLETED FOR THE FOLLOWING TITLE ...
STREAMLINE 2. PRESSURE COEFFICIENT VS. X.

Fig. 20.7

CALCULATIONS FOR STREAMLINE NUMBER 3 FOLLOW ...

	X	Y	Z	VX	VY	VZ	U	V	DUDS	DVDS	NH	ND	DELS
1	0.014387	1.110676	0.297384	1.049500	1.602943	0.931953	4.000000	6.000000	0.843467	-19.290894	1	0	0.02500
2	0.053905	1.125063	0.315595	1.354446	0.889298	0.783501	4 023631	5.569673	1.097401	-14.749029	0	0	0.02500
3	0.091049	1.138216	0.333353	1.640786	0.221209	0.623339	4.046231	5.165195	0.679329	-17.867065	0	0	0.02500
4	0.137016	1.138932	0.347256	1.670148	-0.067829	0.553463	4.067950	4.832682	1.047818	-9.074060	0	0	0.02500
5	0.177298	1.129879	0.361064	1.556787	-0.090026	0.550919	4.094093	4.613823	1.043279	-8.458163	0	0	0.02500
6	0.214834	1.120946	0.374788	1.450182	-0.110544	0.546894	4.120087	4.409886	1.035900	-7.878968	0	1	0.05000
7	0.249788	1.112146	0.388395	1.349983	-0.129492	0.541565	4.145863	4.219979	1.026010	-7.334580	0	0	0.05000
8	0.306766	1.095841	0.415069	1.222475	-0.152519	0.527046	4.195946	3.954902	0.971288	-3.343581	0	1	0.10000
9	0.366873	1.081581	0.441035	1.182507	-0.157073	0.511825	4.243770	3.790503	0.942138	-3.234262	0	0	0.10000
10	0.481027	1.054351	0.490599	1.103499	-0.165374	0.480559	4.334904	3.478281	0.882624	-3.018171	0	0	0.10000
11	0.587364	1.028352	0.537002	1.026219	-0.172693	0.448697	4.420040	3.187441	0 822393	-2.806804	0	0	0.10000
12	0.667992	1.004501	0.580445	0.973724	-0.177215	0.415044	4.499966	2.984240	0.773451	-1.268575	0	1	0.20000
13	0.764782	0.980945	0.620239	0.962044	-0.177956	0.382379	4.574162	2.858141	0.713337	-1.253357	0	0	0.20000
14	0.954703	0.939391	0.690270	0.937203	-0.179468	0.323840	4.704953	2.610711	0.605493	-1.220995	0	0	0.20000
15	1.139499	0.904160	0.749447	0.910959	-0.181006	0.273152	4.815735	2.369956	0.511981	-1.186804	0	0	0.20000
16	1.318950	0.874393	0.799253	0.883848	-0.182557	0.229483	4.909215	2.136167	0.431301	-1.151484	0	1	0.40000
17	1.475912	0.849934	0.840733	0.864093	-0.183310	0.191119	4.986773	1.966891	0.353103	-0.545512	0	0	0.40000
18	1.816820	0.790381	0.880855	0.840656	-0.136332	0.157036	5.105508	1.751673	0.259377	-0.530716	0	0	0.40000
19	2.148697	0.744528	0.908273	0.818844	-0.099969	0.135214	5.192819	1.542154	0.190472	-0.516946	0	0	0.40000
20	2.472113	0.710444	0.928825	0.798308	-0.075077	0.119485	5.257828	1.337978	0.143309	-0.503981	0	1	0.80000

NPMAX = 20 HAS BEEN REACHED. COMPUTATIONS TERMINATING FOR THIS STREAMLINE.

SD-4060 PLOT COMPLETED FOR THE FOLLOWING TITLE ...
STREAMLINE 3. PRESSURE COEFFICIENT VS. X.

Fig. 20.8

CALCULATIONS FOR STREAMLINE NUMBER 4 FOLLOW ...

	X	Y	Z	VX	VY	VZ	U	V	DUDS	DVDS	NH	ND	DELS
1	0.014386	0.811325	0.813276	1.301978	1.436011	1.699041	5.000000	6.000000	0.322841	-22.770477	2	0	0.01250
2	0.036795	0.821173	0.820689	1.465873	1.068733	1.338849	4.997019	5.755986	1.444212	-15.962472	0	0	0.01250
3	0 055969	0.825633	0.831253	1.607683	0.753815	1.034092	5.004426	5.547194	-0.219275	-17.506683	0	0	0.01250
4	0.076986	0.832996	0.840263	1.762045	0.410194	0.696943	5.006347	5.318323	0.554853	-19.187607	0	0	0.01250
5	0 100022	0.835889	0.853151	1.931115	0.038429	0.325039	5.018187	5.067475	1.367217	-21.028671	0	1	0.02500
6	0.129547	0.833166	0.858050	1.893823	-0.068668	0.215771	5.027215	4.873259	0.071922	-10.289286	0	0	0.02500
7	0.174796	0.831189	0.858028	1.733543	-0.088295	0.201180	5.029569	4.627416	0.113946	-9.418480	0	0	0.02500
8	0.216216	0.828749	0.858375	1.586829	-0.105766	0.187540	5.032916	4.402379	0.151571	-8.621370	0	0	0.02500
9	0.254130	0.825899	0.859051	1.452537	-0.121294	0.174767	5.037151	4.196387	0.185204	-7.891751	0	1	0.05000
10	0.280620	0.822414	0.860392	1.358710	-0.130957	0.165174	5.042935	4.052466	0.206553	-7.381983	0	0	0.05000
11	0.369072	0.816480	0.864652	1.253466	-0.134911	0.158691	5.055080	3.784486	0.274191	-3.428342	0	1	0.10000
12	0.430332	0.809786	0 869370	1.198195	-0.132861	0.155015	5.068664	3.616935	0.269132	-3.277172	0	0	0.10000
13	0.544743	0.796692	0.878524	1.094900	-0.128865	0.147865	5.095099	3.304011	0.259415	-2.994651	0	0	0.10000
14	0.649286	0.783993	0.887316	1.000426	-0.124998	0.140979	5.120587	3.018077	0.250183	-2.736256	0	1	0.20000
15	0.795129	0.771367	0.894076	0.971305	-0.116234	0.137626	5.143732	2.818605	0.213912	-1.265423	0	0	0.20000
16	0.986160	0.749924	0.905627	0.939553	-0.099649	0.130937	5.183162	2.569729	0.183093	-1.224056	0	0	0.20000
17	1.170957	0.731624	0.915379	0.908940	-0.084695	0.125209	5.216744	2.328974	0.155269	-1.184173	0	0	0.20000
18	1.349741	0.716145	0.923520	0.879405	-0.071350	0.120398	5.245078	2.096052	0.130412	-1.145694	0	1	0.40000
19	1.538140	0.702969	0.931085	0.859695	-0.060796	0.115143	5.269854	1.927607	0.116690	-0.542735	0	0	0.40000
20	1.877570	0.682079	0.943997	0.837699	-0.046469	0.105538	5.310024	1.713321	0.089484	-0.528849	0	0	0.40000

NPMAX = 20 HAS BEEN REACHED. COMPUTATIONS TERMINATING FOR THIS STREAMLINE.

SD-4060 PLOT COMPLETED FOR THE FOLLOWING TITLE ...
STREAMLINE 4. PRESSURE COEFFICIENT VS. X.
VIEW NUMBER 1 COMPLETED.

Fig. 20.9

N E T   R E S U L T S   A T   F L U X   S T A T I O N S

RAKE	J	I	X	Y	Z	VX	VY	VZ	VT	CP	MACH	P/PT
1	1	1	0.54905	0.23744	-0.86793	1.0826	0.0854	0.0289	1.0864	-0.1802	0.0	0.0
		2	0.54905	0.63504	-0.63659	0.9732	0.0966	0.1050	0.9836	0.0326	0.0	0.0
		3	0.54905	0.86948	-0.23280	0.8396	0.0335	0.1414	0.8521	0.2739	0.0	0.0
		4	0.54905	0.86906	0.23287	0.7255	-0.0281	0.1064	0.7338	0.4616	0.0	0.0
		5	0.54905	0.63629	0.63627	0.6597	-0.0195	0.0199	0.6602	0.5641	0.0	0.0
		6	0.54905	0.23288	0.86915	0.6668	0.0578	-0.0213	0.6697	0.5516	0.0	0.0
		7	0.54905	-0.23288	0.86915	0.7354	0.0911	0.0187	0.7412	0.4506	0.0	0.0
		8	0 54905	-0.63628	0.63627	0.8459	0.1039	0.0980	0.8579	0.2640	0.0	0.0
		9	0.54905	-0.86906	0.23287	0.9793	0.0435	0.1387	0.9900	0.0199	0.0	0.0
		10	0.54905	-0.86948	-0.23280	1.0934	-0.0183	0.1091	1.0990	-0.2078	0.0	0.0
		11	0.54905	-0.63504	-0.63659	1.1593	-0.0117	0.0271	1.1596	-0.3448	0.0	0.0
		12	0.54905	-0.23744	-0.86793	1.1524	0.0631	-0.0116	1.1542	-0.3321	0.0	0.0
	2	1	0.54905	0.18468	-0.67506	1.0597	0.0961	0.1086	1.0695	-0.1439	0.0	0.0
		2	0.54905	0.49392	-0.49512	0.9580	0.0925	0.1425	0.9729	0.0535	0.0	0.0
		3	0.54905	0.67626	-0.18107	0.8373	0.0592	0.1569	0.8539	0.2708	0.0	0.0
		4	0.54905	0.67594	0.18112	0.7338	0.0309	0.1350	0.7467	0.4424	0.0	0.0
		5	0.54905	0.49489	0.49488	0.6745	0.0357	0.0900	0.6815	0.5356	0.0	0.0
		6	0.54905	0.18113	0.67600	0.6785	0.0695	0.0692	0.6856	0.5300	0.0	0.0
		7	0.54905	-0.18113	0.67600	0.7407	0.1020	0.0888	0.7529	0.4331	0.0	0.0
		8	0.54905	-0.49489	0.49488	0.8433	0.1075	0.1278	0.8597	0.2609	0.0	0.0
		9	0.54905	-0.67594	0.18112	0.9638	0.0796	0.1515	0.9788	0.0419	0.0	0.0
		10	0.54905	-0.67626	-0.18107	1.0674	0.0511	0.1404	1.0778	-0.1616	0.0	0.0
		11	0.54905	-0.49392	-0.49512	1.1265	0.0509	0.1048	1.1325	-0.2825	0.0	0.0
		12	0.54905	-0.18468	-0.67506	1.1230	0.0753	0.0888	1.1290	-0.2746	0.0	0.0
	3	1	0.54905	0.13191	-0.48218	1.0100	0.0978	0.1493	1.0257	-0.0520	0.0	0.0
		2	0.54905	0.35280	-0.35366	0.9346	0.0930	0.1623	0.9532	0.0915	0.0	0.0
		3	0.54905	0.48304	-0.12933	0.8464	0.0780	0.1658	0.8660	0.2501	0.0	0.0
		4	0.54905	0.48281	0.12937	0.7705	0.0666	0.1533	0.7885	0.3783	0.0	0.0
		5	0.54905	0.35349	0.35348	0.7275	0.0700	0.1325	0.7427	0.4483	0.0	0.0
		6	0.54905	0.12938	0.48286	0.7296	0.0864	0.1218	0.7447	0.4454	0.0	0.0
		7	0.54905	-0.12938	0.48286	0.7750	0.1032	0.1298	0.7925	0.3720	0.0	0.0
		8	0.54905	-0.35349	0.35348	0.8511	0.1077	0.1480	0.8706	0.2421	0.0	0.0
		9	0.54905	-0.48281	0.12937	0.9391	0.0980	0.1605	0.9578	0.0827	0.0	0.0
		10	0.54905	-0.48304	-0.12933	1.0151	0.0865	0.1586	1.0310	-0.0630	0.0	0.0
		11	0.54905	-0.35280	-0.35366	1.0580	0.0847	0.1468	1.0715	-0.1481	0.0	0.0
		12	0.54905	-0.13191	-0.48218	1.0563	0.0917	0.1411	1.0696	-0.1440	0.0	0.0
	4	1	0.54905	0.07915	-0.28931	0.9578	0.1001	0.1677	0.9775	0.0445	0.0	0.0
		2	0.54905	0.21168	-0.21220	0.9125	0.0968	0.1710	0.9334	0.1287	0.0	0.0
		3	0.54905	0.28983	-0.07760	0.8599	0.0912	0.1706	0.8814	0.2232	0.0	0.0
		4	0.54905	0.28969	0.07762	0.8147	0.0877	0.1646	0.8358	0.3014	0.0	0.0
		5	0.54905	0.21210	0.21209	0.7892	0.0897	0.1565	0.8095	0.3447	0.0	0.0
		6	0.54905	0.07763	0.28972	0.7901	0.0965	0.1520	0.8104	0.3433	0.0	0.0
		7	0.54905	-0.07763	0.28972	0.8171	0.1037	0.1545	0.8381	0.2977	0.0	0.0
		8	0.54905	-0.21209	0.21209	0.8629	0.1067	0.1613	0.8843	0.2180	0.0	0.0
		9	0.54905	-0.28969	0.07762	0.9154	0.1047	0.1670	0.9364	0.1232	0.0	0.0
		10	0.54905	-0.28983	-0.07760	0.9606	0.1011	0.1682	0.9804	0.0388	0.0	0.0
		11	0.54905	-0.21168	-0.21220	0.9861	0.0996	0.1661	1.0050	-0.0099	0.0	0.0
		12	0.54905	-0.07915	-0.28931	0.9854	0.10[illegible]	0.1652	1.0041	-0.0082	0.0	0.0
	5	1	0.54905	0.02638	-0.09644	0.9085	0.102[illegible]	0.1728	0.9304	0.1344	0.0	0.0
		2	0.54905	0.07056	-0.07073	0.8935	[illegible]	0.1728	0.9156	0.1617	0.0	0.0
		3	0.54905	0.09661	-0.02587	0.8761	[illegible]	0.1718	0.8983	0.1930	0 0	0.0

Fig. 20.10

NET RESULTS AT FLUX STATIONS

RAKE	J	I	X	Y	Z	VX	VY	VZ	VT	CP	MACH	P/PT
1	5	4	0.54905	0.09656	0.02587	0.8611	0.0996	0.1705	0.8835	0.2194	0.0	0.0
		5	0.54905	0.07070	0.07070	0.8527	0.1004	0.1689	0.8751	0.2343	0.0	0.0
		6	0.54905	0.02588	0.09657	0.8529	0.1019	0.1680	0.8753	0.2339	0.0	0.0
		7	0.54905	-0.02587	0.09657	0.8619	0.1031	0.1683	0.8842	0.2182	0.0	0.0
		8	0.54905	-0.07070	0.07070	0.8771	0.1043	0.1695	0.8993	0.1912	0.0	0.0
		9	0.54905	-0.09656	0.02587	0.8944	0.1046	0.1708	0.9165	0.1599	0.0	0.0
		10	0.54905	-0.09661	-0.02587	0.9094	0.1042	0.1716	0.9313	0.1327	0 0	0.0
		11	0.54905	-0.07056	-0.07073	0.9178	0.1036	0.1723	0.9396	0.1172	0.0	0.0
		12	0.54905	-0.02638	-0.09644	0.9176	0.1029	0.1725	0.9393	0.1177	0.0	0.0

Fig. 20.11

N E T   R A K E   C A L C U L A T I O N S

RAKE	NU	NV	NTOT	F I R S T P O I N T O N R A K E X1	Y1	Z1	AREA	TOTAL FLUX	AVG. SPEED
1	12	5	60	0.54905	0.23744	-0.86793	3.1405	-2.8264	-0.90000

BEGINNING ISO-PLOT CREATION FOR RAKE NUMBER 1, ISO-CP LINES
CONTOUR PLOT FOR RAKE NUMBER 1 COMPLETED.
VALUES OF ISO-LINES FOLLOW ...

-0.30000	-0.25000	-0.20000	-0.15000	-0.10000	-0.05000	0.00000	0.05000	0.10000	0.15000
0.20000	0.25000	0.30000	0.35000	0.40000	0.45000	0.50000	0.55000		

BEGINNING ISO-PLOT CREATION FOR RAKE NUMBER 1, ISO-ANGLE-XI LINES
CONTOUR PLOT FOR RAKE NUMBER 1 COMPLETED.
VALUES OF ISO-LINES FOLLOW ...

-2.00000	-1.50000	-1.00000	-0.50000	0.0	0.50000	1.00000	1.50000	2.00000	2.50000
3.00000	3.50000	4.00000	4.50000	5.00000	5.50000	6.00000	6.50000	7.00000	7.50000

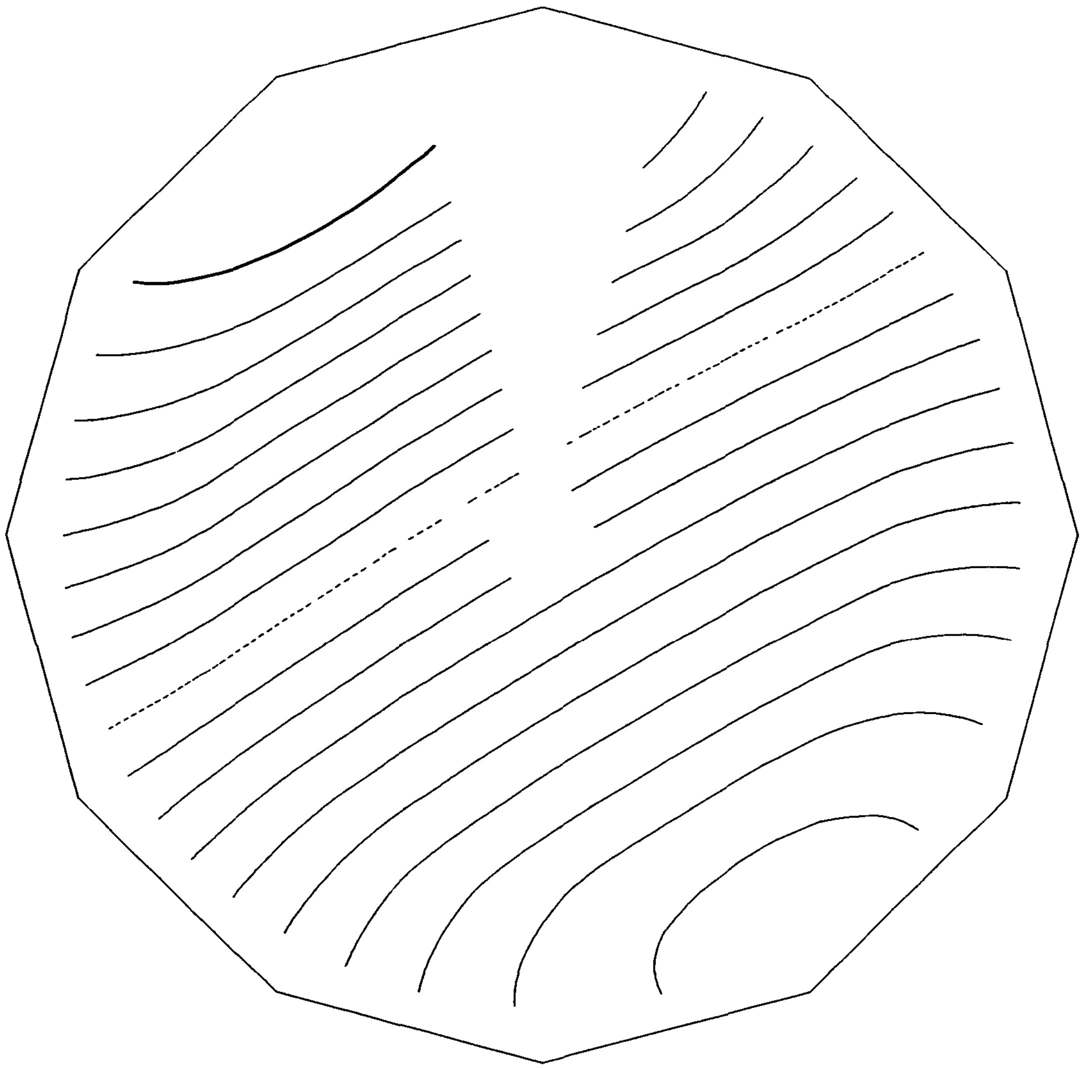
BEGINNING ISO-PLOT CREATION FOR RAKE NUMBER 1, ISO-ANGLE-ETA LINES
CONTOUR PLOT FOR RAKE NUMBER 1 COMPLETED.
VALUES OF ISO-LINES FOLLOW ...

-11.20000	-10.50000	-9.80000	-9.10000	-8.40000	-7.70000	-7.00000	-6.29999	-5.59999	-4.89999
-4.19999	-3.49999	-2.79999	-2.09999	-1.39999	-0.69999	0.00001	0.70001	1.40001	

NORMAL PROGRAM TERMINATION.

Fig. 20.12

Fig. 21. Sample iso-Cp plot for the round inlet sample case.



ISO-CP LINES

H31HG027BZ. INCOMPRESSIBLE COMBINATION SAMPLE CASE.

COMBINATION SOLUTION NUMBER 1 CROSS SECTION NUMBER 1

PLOTTING AXES XI=(0.0 , 1.000, 0.0) ETA= (0 0 , 0 0 ,-1 000)

HEAVY LINE INDICATES ISOVALUE = -0 30000

DASHED LINE INDICATES ISOVALUE = 0 10000

INCREMENTS IN ISOVALUE = 0.05000

Fig. 22. Sample of the surface streamline drawing capability as applied to the round inlet sample case.

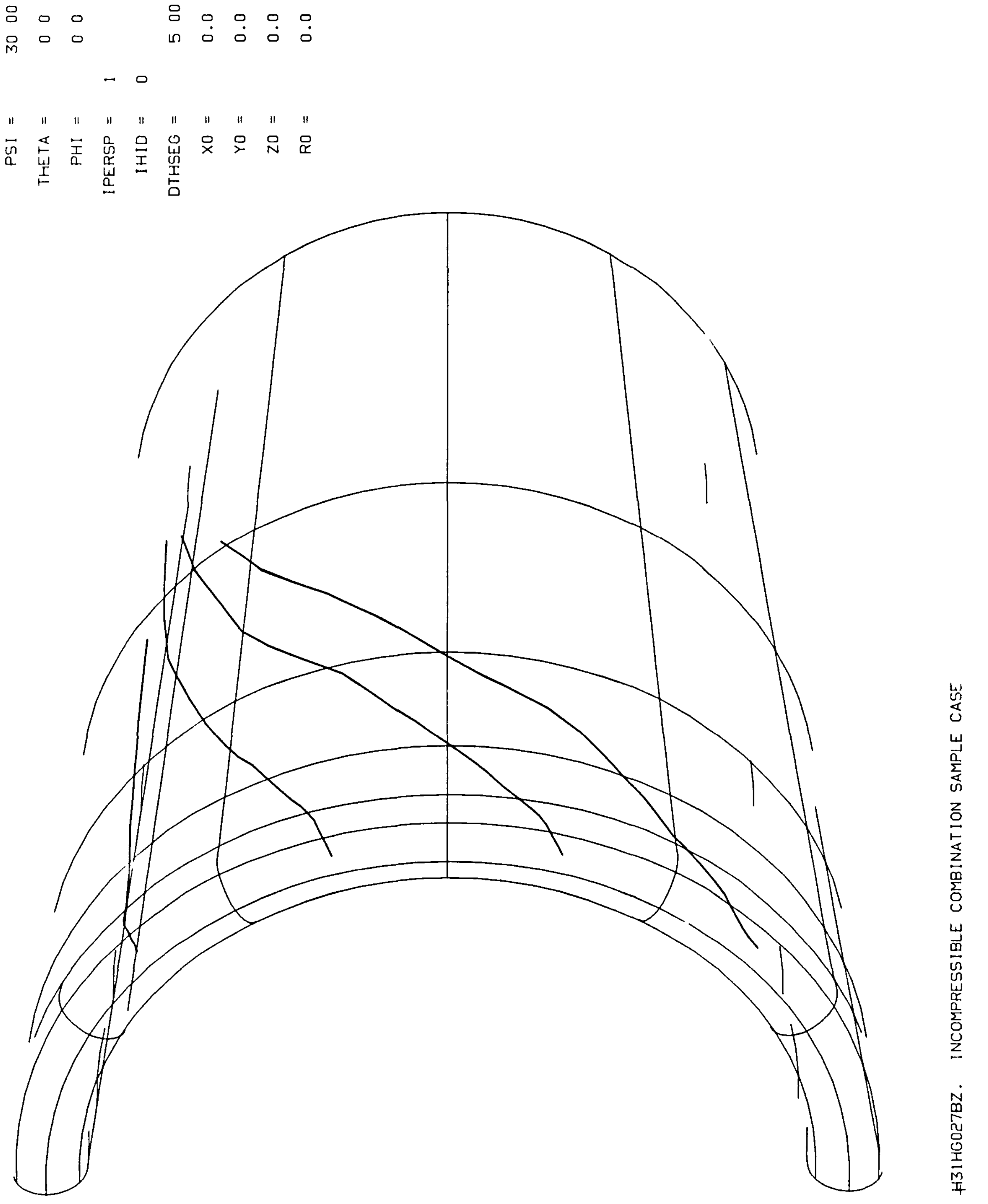


Fig. 23. A sample of the individual plots of Cp vs x for one of the streamlines from the round inlet sample case.

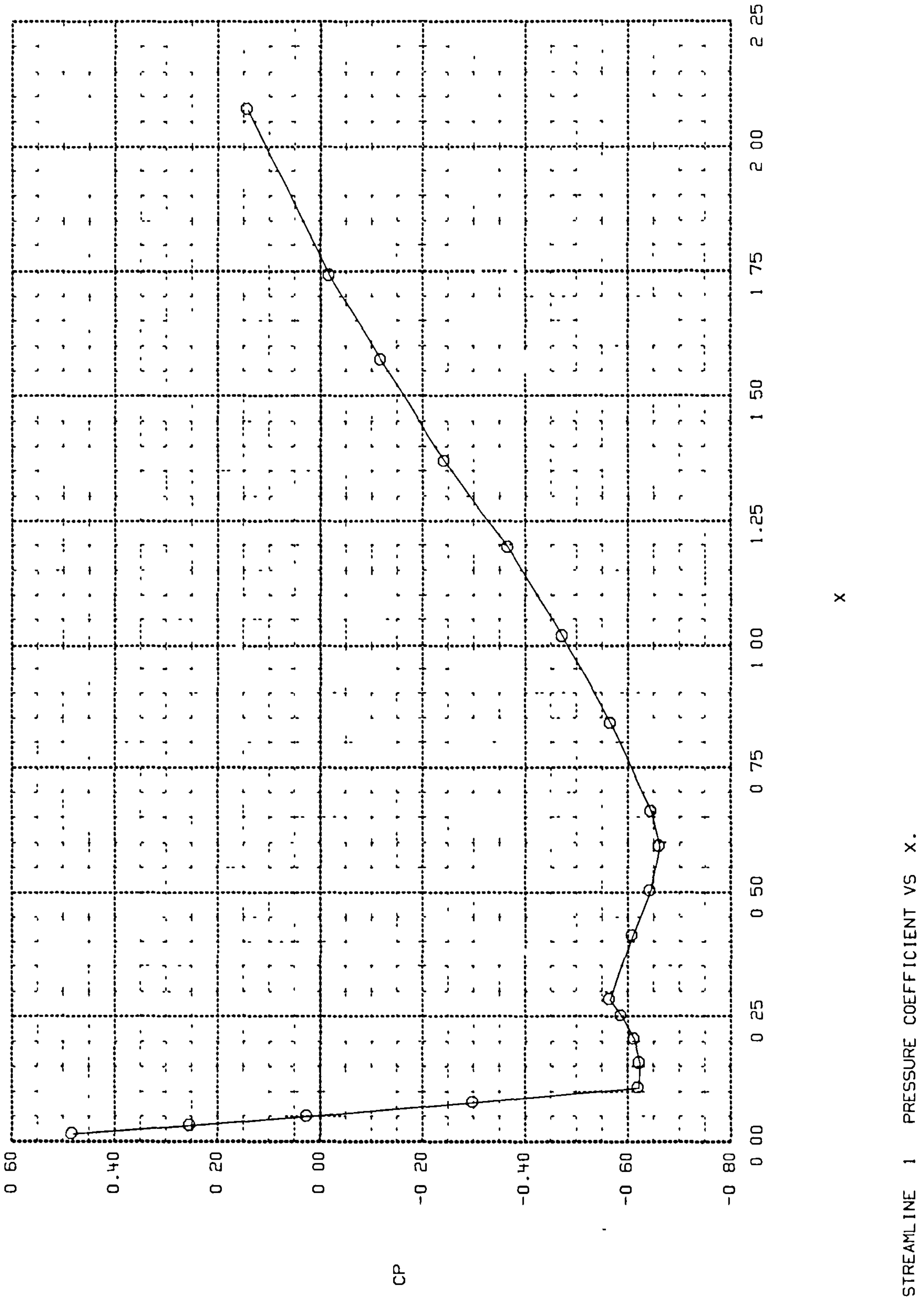
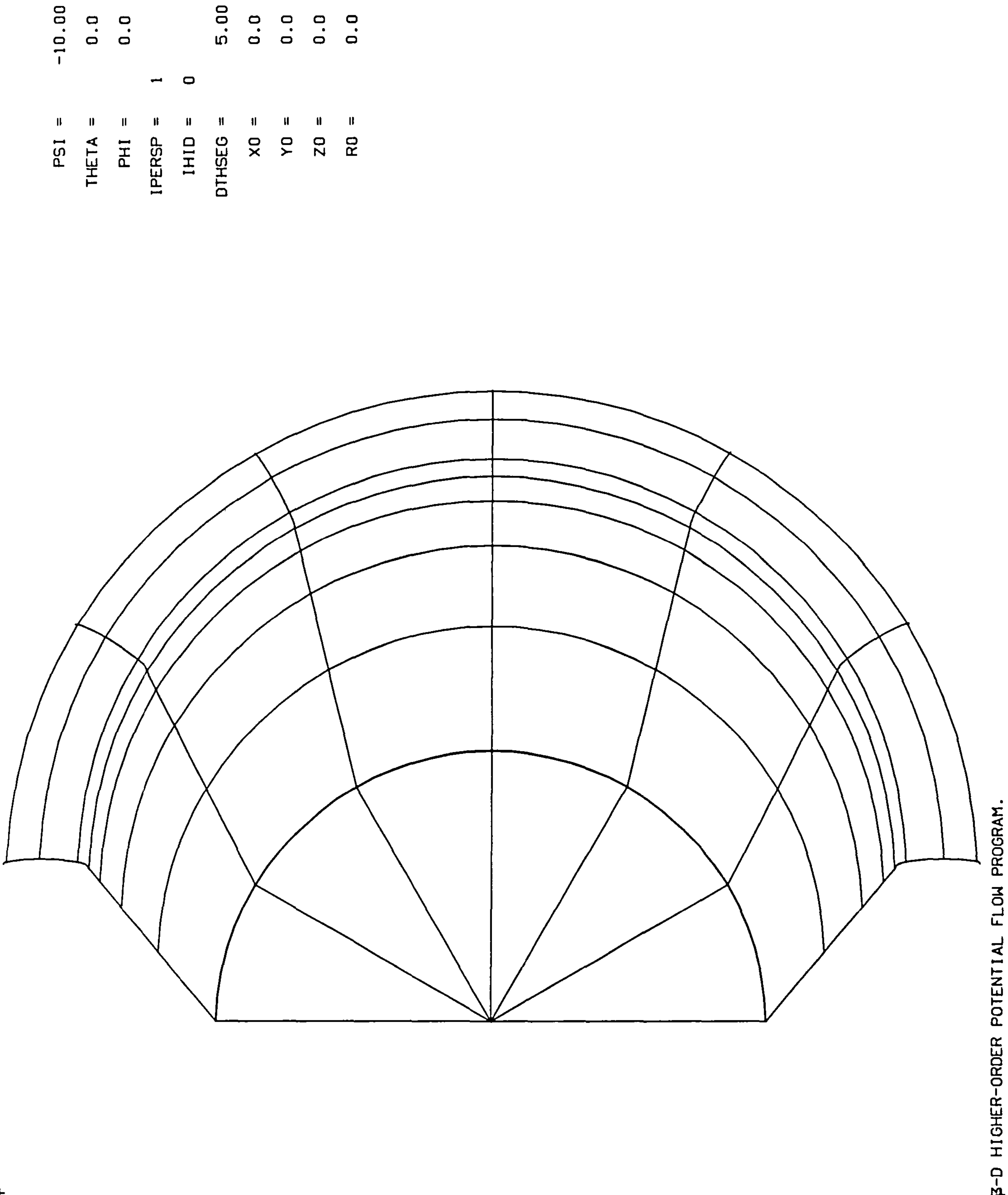


Fig. 24. A sample of the geometry checkout drawing option of Step 4, as applied to the round inlet sample case.



(a)

```
ENTRY MAIN
OVERLAY ALPHA
  INSERT CKCALC
  INSERT CORPTS
  INSERT INITO
  INSERT INPUT
  INSERT MBMT
  INSERT MOMENT
  INSERT PANELP
  INSERT PCPAN
  INSERT PD
  INSERT PNLPRT
  INSERT PQRO
  INSERT QPLACE
  INSERT SAVEPU
  INSERT TRAPEZ
  INSERT XIETZE
OVERLAY ALPHA
  INSERT COMDAT
  INSERT DVFIND
  INSERT FAR
  INSERT INTER
  INSERT NEAR
  INSERT SIGMAK
  INSERT VFORM
OVERLAY ALPHA
  INSERT AFORM
OVERLAY ALPHA
  INSERT ITSOLV
  INSERT MAXRES
  INSERT REBLOC
  INSERT QUASI2
OVERLAY ALPHA
  INSERT FUND
OVERLAY ALPHA
  INSERT DIRECT
  INSERT COLSOL
  INSERT READ1
  INSERT WRITE1
```

(b)

```
//*
//*  STEP 1.  PC-PATCH FITTING.
//*
//PCPATCH   EXEC PGM=H31K,PARM='1,0,0',REGION=300K,COND=(4,LT)
//STEPLIB   DD DSN=TSOT3DF.DMF.LOAD,DISP=SHR
//FT01F001  DD DSN=TSOT3DF.H31H.G027B.DATA,DISP=SHR
//FT06F001  DD SYSOUT=A,DCB=(RECFM=VA,BLKSIZE=141)
//FT11F001  DD DSN=&FT11,UNIT=SYSDA,SPACE=(TRK,(30,10)),
//             DCB=(RECFM=VBS,BLKSIZE=6447,BUFNO=1)
//FT12F001  DD UNIT=SYSDA,DISP=(NEW,PASS),
//             SPACE=(TRK,(30,10),RLSE),
//             DCB=(RECFM=VBS,BLKSIZE=6447,BUFNO=1)
//*
//*
//*  STEP 2.  FUNDAMENTAL SOLUTIONS.
//*
//H12D      EXEC PGM=MAIN,REGION=1200K,COND=(4,LT)
//STEPLIB   DD DSN=TSOT3DF.H12D.LOAD,DISP=SHR
//FT01F001  DD DSN=*.PCPATCH.FT12F001,
//             DISP=SHR
//FT02F001  DD DSN=TSOT3DF.INLET.FUNDSOLN.G027B.CASE2,
//             DISP=(NEW,CATLG),UNIT=TSODA,SPACE=(TRK,(41,5),RLSE)
//FT03F001  DD UNIT=SYSDA,SPACE=(TRK,(29,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT04F001  DD UNIT=SYSDA,SPACE=(TRK,(5,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT05F001  DD DSN=TSOT3DF.H12D.CONFLAGS.D27.T142458,
//             DISP=(OLD,DELETE)
//FT06F001  DD SYSOUT=A,DCB=(RECFM=VA,BLKSIZE=141)
//FT08F001  DD UNIT=SYSDA,SPACE=(CYL,(85,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT09F001  DD UNIT=SYSDA,SPACE=(CYL,(85,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT10F001  DD UNIT=SYSDA,SPACE=(CYL,(85,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT11F001  DD UNIT=SYSDA,SPACE=(CYL,(85,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT12F001  DD UNIT=SYSDA,SPACE=(CYL,(85,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT13F001  DD UNIT=SYSDA,SPACE=(CYL,(28,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT14F001  DD UNIT=SYSDA,SPACE=(CYL,(28,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT15F001  DD UNIT=SYSDA,SPACE=(TRK,(2,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT16F001  DD UNIT=SYSDA,SPACE=(TRK,(2,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
//FT17F001  DD UNIT=SYSDA,SPACE=(CYL,(28,1)),
//             DCB=(RECFM=VBS,BLKSIZE=6356)
```

Fig. 25. JCL (Job Control Language) for IBM system: (a) overlay directions for step 2 (the Fundamental Solutions program), (b) JCL for Steps 1 and 2.

```
//*
//*  STEP 3.  PC-PATCH FITTING.
//*
//PCPAT2   EXEC PGM=H31K,PARM='1,0,0',REGION=300K,COND=(4,LT)
//STEPLIB  DD DSN=TSOT3DF.DMF.LOAD,DISP=SHR
//FT01F001 DD DSN=TSOT3DF.H31H.G027BX.DATA,
//            DISP=SHR
//FT06F001 DD SYSOUT=A,DCB=(RECFM=VA,BLKSIZE=141)
//FT11F001 DD DSN=&FT11,UNIT=SYSDA,SPACE=(TRK,(30,10)),
//         DCB=(RECFM=VBS,BLKSIZE=6447,BUFNO=1)
//FT12F001 DD UNIT=SYSDA,DISP=(NEW,PASS),
//         SPACE=(TRK,(30,10),RLSE),
//         DCB=(RECFM=VBS,BLKSIZE=6447,BUFNO=1)
//*
//*
//*  STEP 4.  COMBINATION OF SOLUTIONS.
//*
//H12I     EXEC PGM=MAIN,REGION=1100K,COND=(4,LT)
//STEPLIB  DD DSN=TSOT3DF.H12I.LOAD,DISP=SHR
//FT01F001 DD DSN=*.PCPAT2.FT12F001,
//         DISP=(OLD,DELETE)
//FT02F001 DD DSN=TSOT3DF.INLET.FUNDSOLN.G027B.CASE2,
//         DISP=SHR
//FT05F001 DD DSN=TSOT3DF.H12H.CONFLAGS.D27.T142705,
//         DISP=(OLD,DELETE)
//FT06F001 DD SYSOUT=A,DCB=(RECFM=VA,BLKSIZE=141)
//FT08F001 DD UNIT=SYSDA,SPACE=(CYL,(43,1)),
//         DCB=(RECFM=VBS,BLKSIZE=6356)
//FT09F001 DD UNIT=SYSDA,SPACE=(CYL,(43,1)),
//         DCB=(RECFM=VBS,BLKSIZE=6356)
//FT10F001 DD UNIT=SYSDA,SPACE=(CYL,(43,1)),
//         DCB=(RECFM=VBS,BLKSIZE=6356)
//FT11F001 DD UNIT=SYSDA,SPACE=(CYL,(43,1)),
//         DCB=(RECFM=VBS,BLKSIZE=6356)
//FT12F001 DD UNIT=SYSDA,SPACE=(CYL,(43,1)),
//         DCB=(RECFM=VBS,BLKSIZE=6356)
//FT13F001 DD UNIT=SYSDA,SPACE=(TRK,(10,10)),
//         DCB=(RECFM=VBS,BLKSIZE=6356)
//FT14F001 DD UNIT=SYSDA,SPACE=(TRK,(10,10)),
//         DCB=(RECFM=VBS,BLKSIZE=6356)
//FT15F001 DD DUMMY
//FT16F001 DD DUMMY
//SD4060   DD DSN=ROUTE.DAC.GCMIF.BON.FL0100.H12I.T142705,
//         UNIT=TAPE16,LABEL=RETPD=25,DISP=(NEW,KEEP),
//         DCB=(RECFM=FB,LRECL=240,BLKSIZE=960,DEN=3)
//*
//
```

Fig. 26. JCL (for IBM) for execution of Steps 3 and 4.

APPENDIX

The input to this program consists of the coordinates of a number of points. These points define the surface of the three-dimensional inlet around which the flow is to be computed. For the purpose of organizing these points for computation, each point is assigned a pair of integers, m and n. These integers need not be input, but their use must be understood to insure the correctness of the input and to facilitate the interpretation of the output.

For each point, n identifies the "column" of points to which it belongs, while m identifies its position in the "column," i.e., the "row." The first point of a "column" always has m = 1. To insure that the program will compute outward normal vectors, the following condition must be satisfied by the input points. If an observer is located in the flow and is oriented so that locally he sees points on the surface with m values increasing upward, he must also see n values increasing toward the right. Examples of correct and incorrect input are shown in figure A-1. In this figure the flow field lies about the paper, while the interior of the body lies below the paper. Occasionally, it happens that despite all care abody is input incorrectly. If the entire body is input incorrectly - not some sections correctly and some incorrectly - the difficulty can be remedied by changing the sign of one coordinate of all the input points. This trick will give a correctly input body of the proper shape at perhaps a peculiar location. Otherwise, the input will have to be done over. If the inlet is input correctly (Step 2), but a cross-section (Step 4) is input so that its normal vector points upstream, the combined flow will be correct, but the flux at the cross section will be negative. Clearly a control station with the wrong normal vector invalidates the calculation (Step 4).

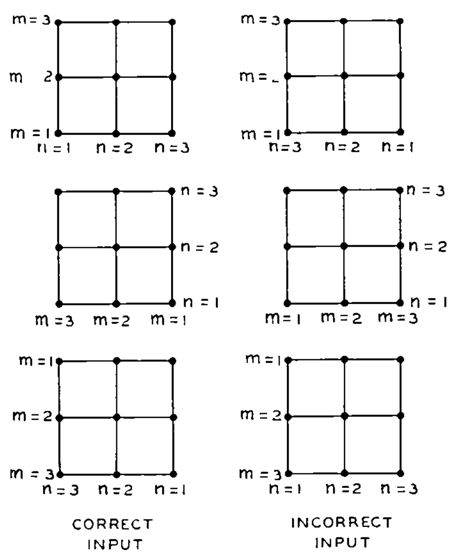


Figure A-1. Examples of correct and incorrect input.

The body surface is imagined divided into sections, which may be actual physical divisions or may be selected for convenience. A section is defined as consisting of a certain number of n-lines, say N_T, and this number, which must be at least two, must be specified on the input at the beginning of the section. Within each section the n-lines are input in order of increasing n. On each n-line the points are input in order of increasing m. All n-lines in a section must have the same number of points, but this may vary from section to section. The first n-line of the first section is n = 1. From then on the n-lines are numbered consecutively through all sections, i.e., the numbering is not begun over at the beginning of each section. Elements will be formed that are associated with points on every n-line except those that are last in their respective sections. Points on these latter n-lines are used only to form elements associated with points on the next lowest n-lines.

To illustrate this procedure, consider the plan view of a body shown in figure A-2.

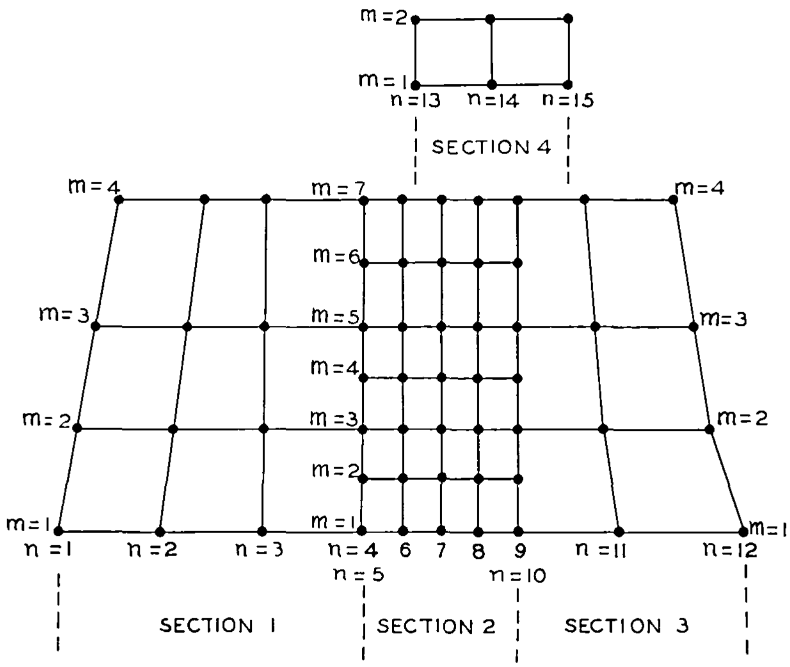


Figure A-2. Plan view of the input points on a body divided into sections.

This body has been divided into four sections as shown in figure A-2. The first section contains four n-lines, n = 1, 2, 3, 4; the second, five n-lines, n = 5, 6, 7, 8, 9; the third three n-lines, n = 10, 11, 12; and the fourth, three n-lines, n = 13, 14, 15. The number of points on each n-line are:

Section = 1 2 3 4

M = 4 7 4 2

Notice that the line n = 4 has only four points, the points m = 1, 2, 3, 4 in the m-grid of section 1, which is listed in the figure along the n = 1 line. The lines n = 4 and n = 5 are physically identical. Some of the points on the two lines are physically identical but correspond to different values of m. This is of no consequence. In this scheme sections are completely independent. No elements are computed corresponding to points on lines n = 4, 9, 12, 15.

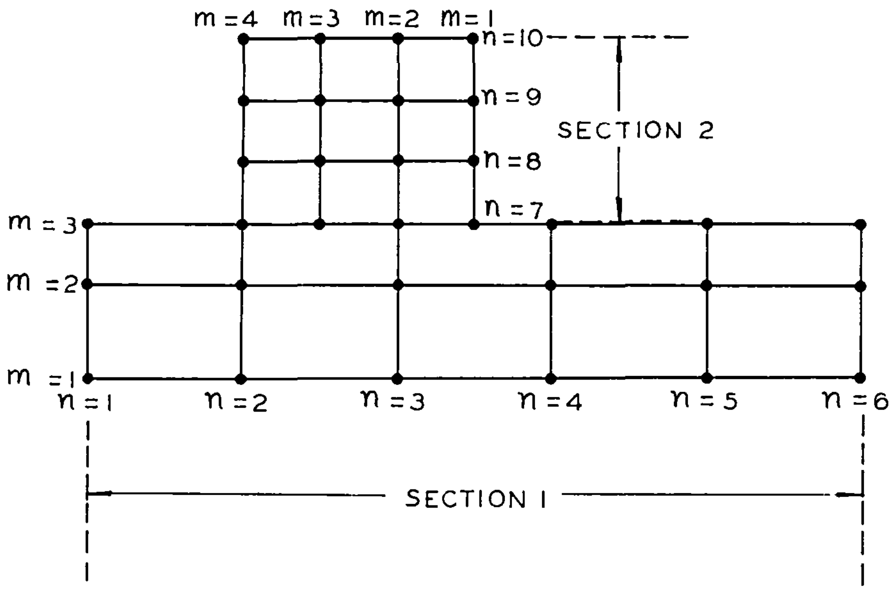


Figure A-3. Another possible division into sections.

There is no restriction that the m and n lines of different sections have to be roughly parallel. The arrangement shown in figure A-3 is permissible.

1. Report No. NASA CR-168009	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Calculation of Compressible Flow In and About Three-Dimensional Inlets With and Without Auxiliary Inlets by a Higher-Order Panel Method		5. Report Date October 1982 6. Performing Organization Code
7. Author(s) John L. Hess Douglas M. Friedman		8. Performing Organization Report No. MDC J2548 10. Work Unit No.
9. Performing Organization Name and Address Douglas Aircraft Company McDonnell Douglas Corporation 3855 Lakewood Boulevard Long Beach, A 90846		11. Contract or Grant No. NAS3-22147 13. Type of Report and Period Covered Contractor Report Oct 1980-Oct 1982
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio 44135		14. Sponsoring Agency Code

15. Supplementary Notes
Final Report. Project Manager: Danny P. Hwang
Propulsion Aerodynamics Division
NASA Lewis Research Center
Cleveland, Ohio 44135

16. Abstract

A three-dimensional higher-order panel method has been specialized to the case of inlets with auxiliary inlets. The resulting program has a number of graphical input-output features to make it highly useful to the designer. This report describes the various aspects of the program and presents instructions for its use. Additionally, some calculated results are included.

17. Key Words (Suggested by Author(s))		18. Distribution Statement
Aerodynamics Auxiliary Inlets Compressible Flow Computer Program Flow Field Graphical Display	Inlets Panel Method Potential Flow	Unclassified - Distribution Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	86	

*For sale by the National Technical Information Service, Springfield, Virginia 22151

NASA-C-168 (Rev. 6-71)

End of Document