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TITLE: *A502I User's Manual–PAN AIR Technology Program for Solving Problems of Potential Flow about Arbitrary Configurations*

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ABSTRACT

The PAN AIR Technology Code (A502) is a program that calculates flow properties about arbitrary three-dimensional configurations. The program uses a higher-order panel method to solve the linearized potential flow boundary-value problem at subsonic and supersonic Mach numbers.

The aerodynamic solution provides surface flow properties (flow directions, pressures, Mach number), configuration forces and moments, sectional forces and moments, and pressures. In addition, A502 calculates flow properties in the flow-field points and flow-field streamlines. Results are limited to subsonic and supersonic cases (transonic cases excluded) with attached flow.

This user's manual includes user input data necessary for running A502 on the CRAY computer, printout descriptions, and details for processing output files. Also included are sample cases with computer printout.

KEYWORDS

Subsonic Flow
Supersonic Flow
Panel Method
Linearized
User Documentation
Computer Program
Three-Dimensional Flow
Potential Flow

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1. SUMMARY AND INTRODUCTION

The primary aim of this user's manual is to describe how to use the PAN AIR Technology Code (A502H) to solve for subsonic or supersonic flow properties about an arbitrary configuration. The document includes program updates made since the release of A502F documentation (reference 1), and includes all the A502 program options.

1.1 BACKGROUND

The PAN AIR Technology Code was developed to test a variety of approaches and boundary value problem formulations for solving subsonic and supersonic flow about arbitrary configurations. The original user's manual (reference 2) required inputs to be defined from setting parameters in a FORTRAN subroutine. The next A502 document (reference 3) contained both a user's manual and a theory/applications manual. Formatted inputs, generation of paneling for simple geometric configurations, numerous boundary conditions, and support programs for post-processing results were available for use. Following this, additional support programs and numerous program updates were developed (references 4 and 5).

With increased production usage, the boundary-value problem formulation settled in on the most economical approach. Also, almost all of the geometry analyzed represented complex configurations that had to be lofted and then paneled (reference 6). To simplify the user's document, the A502F User's Manual (reference 1) focused on the most commonly used options and omitted all the boundary conditions and geometry-generating capabilities.

The present manual is described immediately below in the next section.

1.2 OVERVIEW OF MANUAL

In response to a few experienced users who occasionally use some of the uncommon features, all the program options have been included in the current documentation. To maintain the focus for the average user, the least used options appear in the appendices (similar to the A502F User's Manual).

Other additions to the manual include:

- The most recent program updates.
- Some of recent ideas checked out for analyzing flows with different total flow properties have been included in the appendix.

Numerous references are given to help with additional understanding of the theory, application, and evaluation of this method. Some references are for the PAN AIR program, since the basic problem formulation is the same as A502.

To help you locate needed information, a description of each section is provided below:

Section	Description
2. Capability	Briefly describes program capability. After reading this section, you should know whether or not A502 can solve your problem.
3. Terminology	Reviews fundamental terminology used in the program.
4. Overview of an Analysis	Outlines the complete performance of a subsonic flow analysis.
5. Program Inputs	Describes inputs required to run the program. These are presented in block form, indicating that they are either required or optional, with implied defaults. Each text subsection describes one or more input blocks. Inputs are also defined in appendixes C, D, and E.
6. Program Printout	Describes program output, defining significant output symbols.
7. Submitting a Run	Gives control card decks for executing A502H.
8. Processing Output Files	Describes processing of program output files.
9. Example: Wing-Body Configuration	Treats a simple wing-body case, with all output .
10. Example: Power-On Nacelle	Treats a simple nacelle and illustrates the results.

Appendix	Description
A. A502 Support Programs	Lists and describes various support programs and files for your reference.
B. Detailed Printout for Locating Program Errors	Details A502 printout for your reference. (Extension of section 6.)
C List of All Input Boundary Conditions	Summarizes all the boundary conditions for A502. This includes the primary boundary conditions given in section 5.9.
D. Geometry-Generating and -Modifying Tools	Describes inputs to generate simple geometry and modify existing networks.
E. Some New A502H Capabilities.	Describes wake vortex filaments, second-order wake, and representing regions with different total pressure and/or temperature.

1.3 HELPFUL HINTS FOR USING THIS MANUAL

While the ideal aim of the user's manual is to provide easy-to-find answers to any user's particular questions, the manual must contain a large amount of information to cover the wide range of user experience. This makes locating particular information difficult and is contrary to the original purpose of the manual.

Some helpful hints for using this manual are:

- The primary focus of this manual is on how to work through the numerous details for setting up, running, and post-processing a linear three-dimensional subsonic or supersonic flow analysis.
- Examine section 1.2, "Overview of Manual," to see what is presented.
- The key A502 terminology is given in Section 3.
- Many sections start off with key information for the entire section. Spending a little time with the front of a section may help in understanding some of the specific details.
- Most significant input program options and explanations are placed first in a description.
- The manual teaches how to run a case by giving examples (computer input and output) for a simple wing-body and power-on nacelle.
- The appendices contain many of the complete details for input options of the program and are provided to document all the options. Some of the boundary condition inputs overlap with the primary options given in the input in section 5.9.

2. CAPABILITY

Program A502 solves the general three-dimensional aerodynamic/hydrodynamic problem for arbitrary configurations. The program uses a higher-order panel method, based on the solution of the linearized potential flow boundary-value problem at subsonic and supersonic Mach numbers. Results are generally valid for cases with either subsonic or supersonic flow (transonic regime excluded) within the framework of the linearized potential equation. The results are not usually applicable to cases where viscous effects and separation are dominant. The following subsections outline what A502 can and cannot do for you.

2.1 WHAT A502 CAN DO

A502 predicts linear subsonic and supersonic irrotational flow properties in regions of constant total pressure and temperature[1] about arbitrary 3D lifting configurations.

2.1.1 Flow Properties

- Surface flow properties (on upper and lower surfaces)
  - Second–order pressure coefficient (also isentropic, linear, and slender body pressure coefficients)
  - Mass flux components, nondimensional
  - Velocity components, nondimensional (option to correct values for velocities less than freestream)
  - Local Mach number (second-order)
  - Potential
- 3D surface pressure forces and moments (FX, FY, FZ, MX, MY, MZ)
  - Per panel column
  - Per network (an array of panels)
  - Accumulation of all previous networks
- Configuration forces and moments (CL, CDI, CY, FX, FY, FZ, MX, MY, MZ)
  - Input configuration
  - Full configuration
- Sectional pressure forces and moments along a user-specified plane (CFX, CFY, CFZ, CMX, CMY, CMZ, CLC, CDC, CNC, CMC, CLC*CHORD/CREF, CUT–LEN)
  - Per network
  - Total
  - Pressures (CP2ND) along cut sections

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[1] A partial implementation has been made for solving flows with different total pressure and temperature than freestream. See appendix E for additional details.

- Flow-field properties for all solutions; may be calculated for subset of surface networks
  - Mass flux or velocity components, nondimensional
  - Second-order pressure coefficient
  - Perturbation potential
  - Local Mach number
- Streamlines in the flow field for requested solutions; may be calculated for subset of surface networks
  - Mass flux or velocity components, nondimensional
  - Second-order pressure coefficient
  - Perturbation potential
  - Local Mach number

2.1.2 Program Operational Features

- Solves up to four solutions (different angles of attack, etc.) in one computer run
- Reduces geometric input and computer cost for configurations with one or two planes of flow symmetry or antisymmetry
- Restarts subsequent solutions from saved data
  - Produces additional solutions, etc., from previously saved aerodynamic influence coefficients
  - Solves for flow-field properties, etc., from previously saved aerodynamic influence coefficients and singularity strengths

2.1.3 Output Files

- Printout
- Surface flow properties at panel center control points; used for plotting
- Pressures at panel corner points, calculated by extrapolation and interpolation from neighboring control points (GGP)
- Sectional cut pressures versus X, Y, Z, X/C (GGP)
- Sectional forces and moments (GGP)
- Configuration forces and moments summary (GGP)
- Configuration paneling and flow-field streamline paths (A230–style)
- Off-body point flow properties (GGP without runids)
- Flow-field streamline properties (GGP)
- Input for A598 boundary layer analysis (binary)
- Aerodynamic influence coefficients (binary)
- Factored aerodynamic matrix (binary)
- Singularity strengths (binary)

2.2 WHAT A502 CANNOT DO

- Predict flow dominated by viscous effects
- Predict flow dominated by transonic flow effects
- Predict flow with different total pressures; for example:
  - Flow properties for a configuration inside a jet plume with supersonic flow
  - Flow properties for a configuration inside a propeller slipstream swirl
- Will not automatically determine wake shapes

3. TERMINOLOGY

It is of primary importance to understand A502 terminology before you begin any configuration analysis. The special terminology used for A502 comes from the developers and the users. It clarifies program processes, configuration representation to the program, and interpretation of the resulting analysis. A502 terminology contains nomenclature that has special meaning in this program; it also reviews some definitions familiar to the aeronautical engineer.

A summary of the terminology is provided below. The list is not complete, i.e., an integrated top-down layout of terms; but it represents basic and frequently used terminology, an understanding of which can make the remaining documentation much simpler to follow. Because of the relationships among some of the terms, the list is organized under major topics.

SUMMARY OF TERMINOLOGY

3.1 ABUTMENTS OF DOUBLET NETWORK EDGES

Abutment. Two or more (full or partial) network edges *connected* along a common interface to maintain continuity of doublet singularity strength. Singularity parameters are defined along the network edges, and determined from edge-matching conditions and aerodynamic boundary conditions along the edge, as assigned by the program.

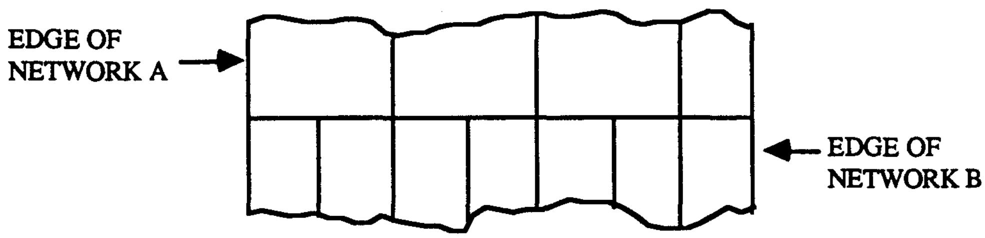
Abutment Summary. A printout from the liberalized abutment processor of A502, listing the relationships of the doublet network edges. The first edge of the first network and all the other network edges coincident with it are grouped together as abutment 1. The list continues through all the remaining network edges not previously listed. Unabutted network edges and network edges along the planes of symmetry (or antisymmetry) are also assigned abutment numbers.

Forced Abutment. The movement by the program of one or more network panel edges to eliminate gaps between adjacent networks. Such abutments are user-specified.

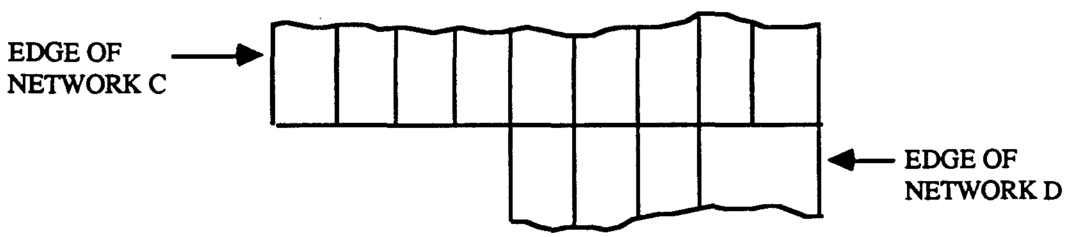
Liberalized Abutment. The program process for establishing the doublet network edge relationships (abutments, etc.) and for making *small* adjustments in the edge points to make them identical. The program finds all points within a tolerance (set by A502 or input directly) and equates them to the average value of the common points. Thus, the input network edge points do not have to be correct to the last significant figure.

3.2 ABUTMENT TYPES

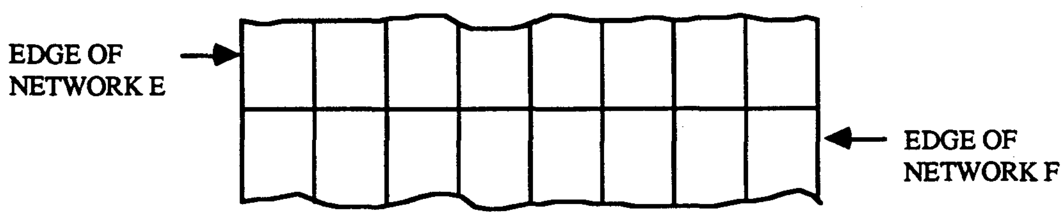
Full Network Edge Abutment. Edge match for which entire edge of one network abuts entire edge of an adjacent network. The network corner points used to form the first point of an abutment must be identical. The same is required for the last point of the abutment.



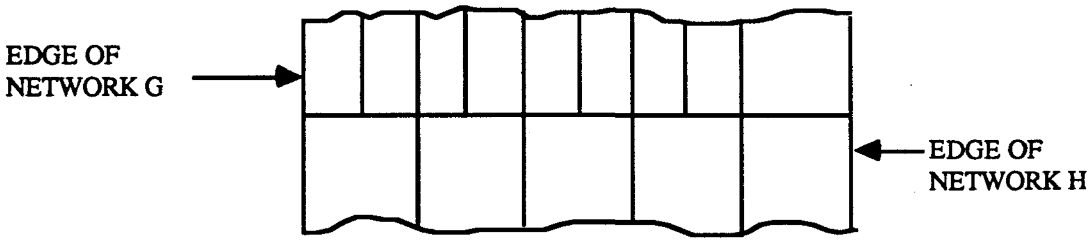
Partial Network Edge Abutment. Edge match for which a portion of a network edge abuts a portion or an entire edge of an adjacent network. The panel edge points used to form the first common point of an abutment must be identical. The same is required for the last common point of the abutment.



Identical Abutment. A full or partial network edge abutment for which all panel edges of abutting networks are identical (to the last significant figure).



Subset Abutment. A full or partial network edge abutment for which some (a subset) of the panel edges are identical to the abutting panel edges.



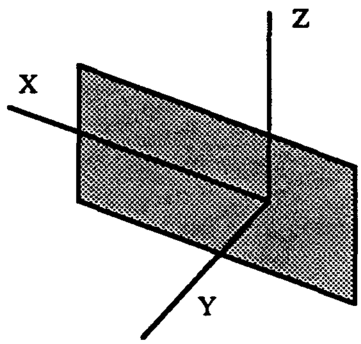
Unabutted Network Edge. A doublet network edge that is not connected to another doublet network edge. Except for the downstream trailing edge of wake networks and abutments in the plane of symmetry, the doublet strength along these edges is assumed to be zero.

Abutments in a Plane of Symmetry. Doublet network edges in a plane of symmetry (or antisymmetry). Since configurations for most problems are defined with one or more planes of symmetry, network edges in the plane of symmetry form an imaginary abutment with their image network edges.

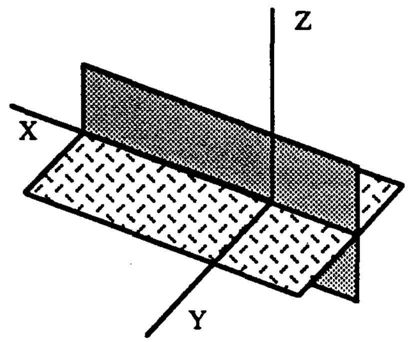
3.3 COORDINATE SYSTEM

Reference Coordinate System. Right-hand orthogonal coordinate system used to define configuration and related data.

XZ and XY Planes of Symmetry (Antisymmetry). Reference coordinate system planes used in defining configuration, flow symmetry, and antisymmetry (free-surface).



PLANE OF SYMMETRY



TWO PLANES OF SYMMETRY

3.4 FLOW PROPERTIES

Velocity Vector (VX, VY, VZ).

$$\bar{V} = \bar{V}_\infty + (u, v, w)$$

where:

$\bar{V}_\infty$ = onset velocity of unit magnitude (sometimes referred to as freestream velocity or undisturbed velocity)

(u, v, w) = reference coordinate system components of perturbation velocity vector; components defined from the derivative of the perturbation potential ($u = \phi_x$, $v = \phi_y$, $w = \phi_z$)

Mass Flux Vector (WX, WY, WZ). Flow direction (velocity x density).

$$\bar{W} = \bar{V}_\infty + [(1 - M_\infty^2)\, u_c, v_c, w_c] = \bar{V}_\infty + \bar{w}$$

where:

M_∞ = freestream Mach number (input name = amach)

(u_c, v_c, w_c) = compressible coordinate system components of perturbation velocity vector; components defined from derivative of the perturbation potential ($u_c = \phi_{xc}$, $v_c = \phi_{yc}$, $w_c = \phi_{zc}$)

Second-Order Pressure Coefficient (CP2ND). Preferred pressure coefficient.

$$\text{CP2ND} = -2u_c - [(1 - M_\infty^2)u_c^2 + v_c^2 + w_c^2]$$

Isentropic Pressure Coefficient (CPISN).

$$\text{CPISN} = \frac{2}{\gamma M_\infty^2}\left\{\left[1 + \frac{\gamma - 1}{2} M_\infty^2 \left(1 - \frac{V^2}{V_\infty^2}\right)\right]^{\frac{\gamma}{\gamma - 1}} - 1\right\}$$

where:

γ = ratio of specific heats for air (1.4)

Linearized Pressure Coefficient (CPLIN).

$$CPLIN = -2u_C$$

Slender Body Pressure Coefficient (CPSLN).

$$CPSLN = -2u_C - (v_C{}^2 + w_C{}^2)$$

Mach Number or Local Mach Number (M, LMACH, or MACH)

$$M = M_\infty \sqrt{\frac{\bar{W} \cdot \bar{V}}{\rho_\infty V_\infty^2 \left(1 + \frac{\gamma M_\infty^2}{2} C_{pisn}\right)}}$$

Density (ρ) - Linearized about the Freestream

$$\rho = \rho_\infty [1 - M_\infty^2 \phi_{XC}]$$

The density evaluation is good near freestream but poor near stagnation. Density is not computed by the program.

McLean-Rubbert Velocity Correction (Used for Boundary Layer Analysis)

$$\bar{V} = \frac{\rho_\infty \bar{W}}{\rho} \quad \text{for } u_C < 0$$

$$= \frac{|\bar{V}|\ \bar{W}}{|\bar{W}|} \quad \text{for } u_C > 0$$

Boctor Velocity Correction ($\bar{V}_B$) (Used for Inlet Flows, Etc.)

The velocity correction is applied along the direction of compressibility effects. When requested, only velocities with a component along the direction of compressibility (V_{XC}) less than one (i.e., $u_C < 0.0$) are corrected. The corrected velocity component (V'_{XC}) is determined from

$$W_{XC} = V'_{XC} \left[1 + \frac{\gamma - 1}{2} M_\infty^2 \left(1 - \frac{V'^2_{XC}}{V_\infty^2}\right)\right]^{1/1-\gamma}$$

where mass flux component (W_{XC}) is known from the potential flow solution.

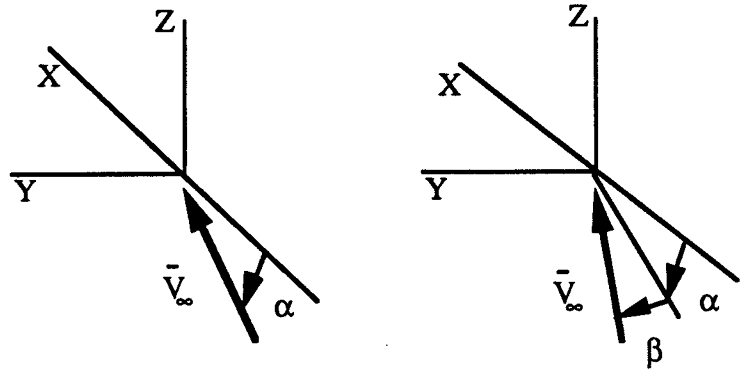
The corrected velocity is

$$\bar{V}_B = (V'_{XC}, v_C, w_C)$$

3.5 FREESTREAM FLOW

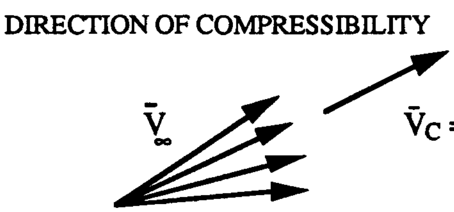
Onset Flow. Uniform flow field of unit magnitude; specified by an angle of attack (α) and an angle of sideslip (β) defining flow environment for solving a potential flow boundary-value problem. The components of the onset flow are:

$$\bar{V}_\infty = (\cos\alpha\cos\beta, -\cos\alpha\sin\beta, \sin\alpha)$$



Direction of Compressibility Effects. Direction specified by angle of attack (α_C) and angle of sideslip (β_C), along which Prandtl-Glauert Rule (sometimes called Gothert's Rule) compressibility effects are implemented. (Invisible to the user, the geometry is scaled by $\sqrt{1 - M_\infty^2}$ along the direction of compressibility effects.) In general, the direction of compressibility effects is set equal to the primary direction of the onset flow. Small changes in onset flow ($\pm$ 5 degrees for subsonic flow and $\pm$ 2 degrees for supersonic flow) can be analyzed without significant error.

CONFIGURATION



$$\bar{V}_C = (\cos\alpha_C\cos\beta_C, -\cos\alpha_C\sin\beta_C, \sin\alpha_C)$$

Freestream Mach Number (M_∞)

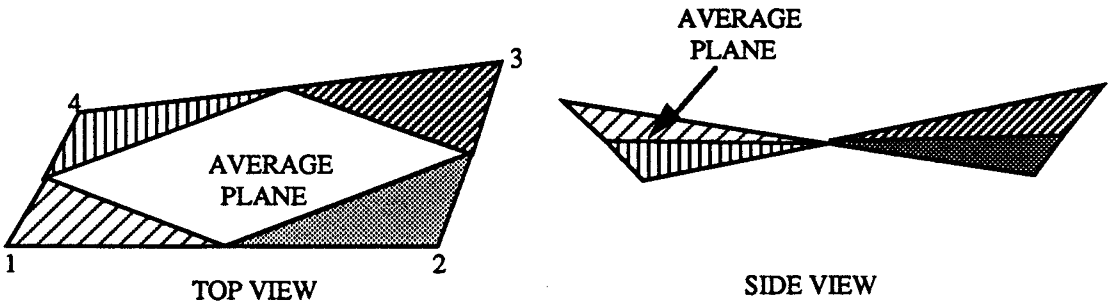
Subsonic range = 0.0-.9999

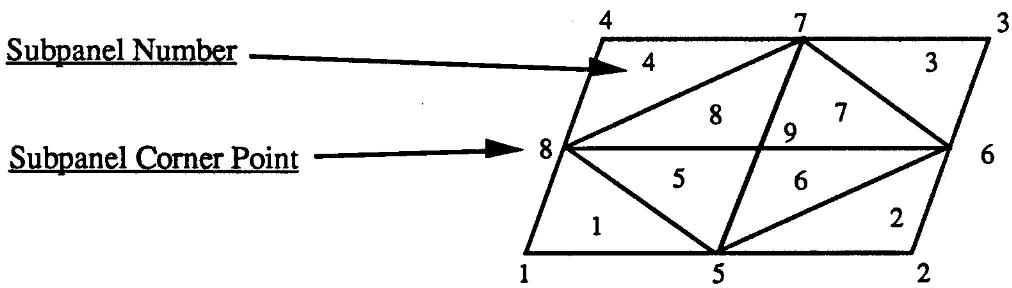
Supersonic range = 1.0001-4.0

While the Mach number can be specified in the above range, not all values will represent acceptable flow. When significant regions of transonic flow appears, the flow simulation using a linear theory has been exceeded. Your assessment of the flow properties is required to qualify the solution.

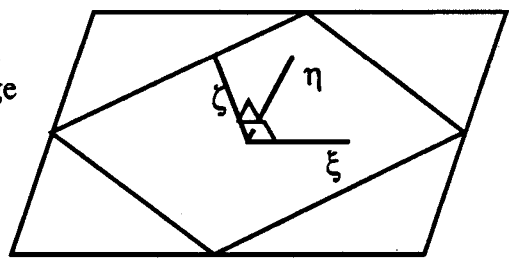
3.6 PANEL

Subpanel. One of eight parts into which each network panel is divided. A panel edge is a straight line connecting two corner points. Thus, a panel is completely connected with neighboring panels, and the continuity (value and derivatives) of the singularity strength is maintained. The diagram below shows top and side views for a subpanel.



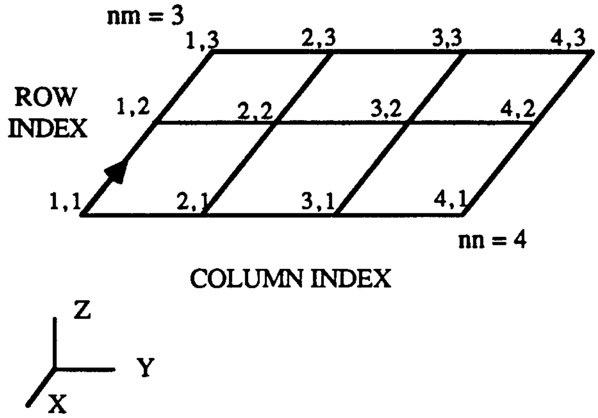


Panel Coordinate System
η and ξ are in the average plane
ζ is perpendicular to the average plane



3.7 SURFACE

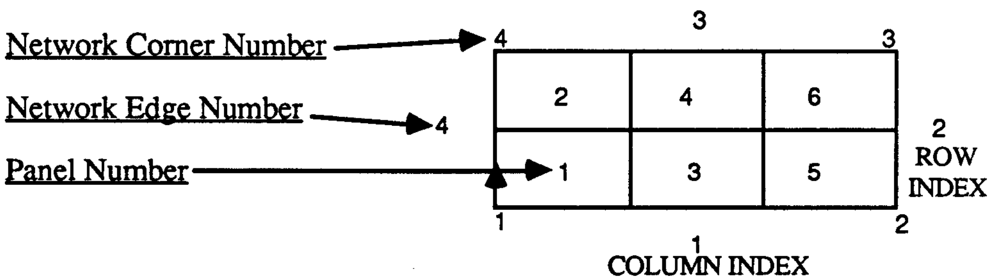
Network of Surface Points (Network). Ordered array of points used to define a portion of a surface or a surface as an array of panels. Also shown is the point coordinate layout for the network, as specified in computer input.

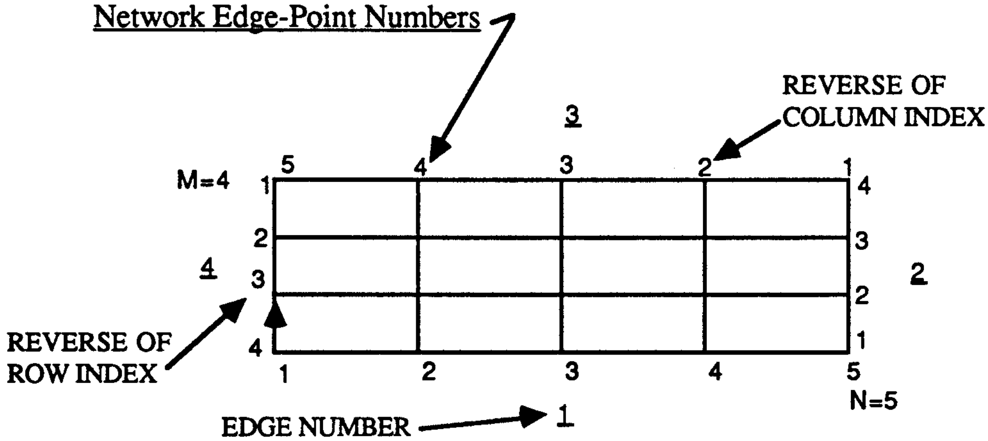


COMPUTER INPUT FOR NETWORK FROM:

```
nm nn                              netname
x11 y11 z11 x12 y12 z12
x13 y13 z13
x21 y21 z21 x22 y22 z22
x23 y23 z23
x31 y31 z31 ...
```

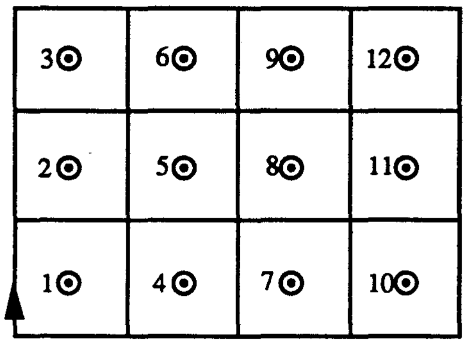
Network Origin. First point in a network; sometimes flagged by a small arrow pointing toward the second point in the network, which identifies the first network point column.



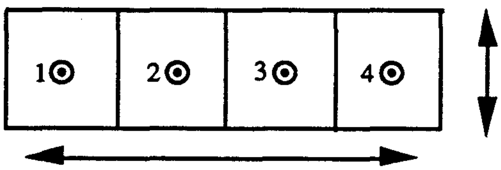


Singularity Parameters (.) and Boundary Condition Locations (o) for Source Panel Network.

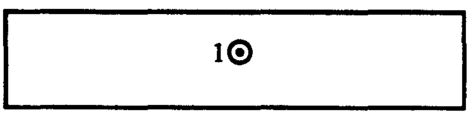
General - Linear variation of source strength (σ).



Single Row or Column of a Source Panel in a Network - Linearly varying source strength in the direction of the panels and constant-strength source panel across a single panel.

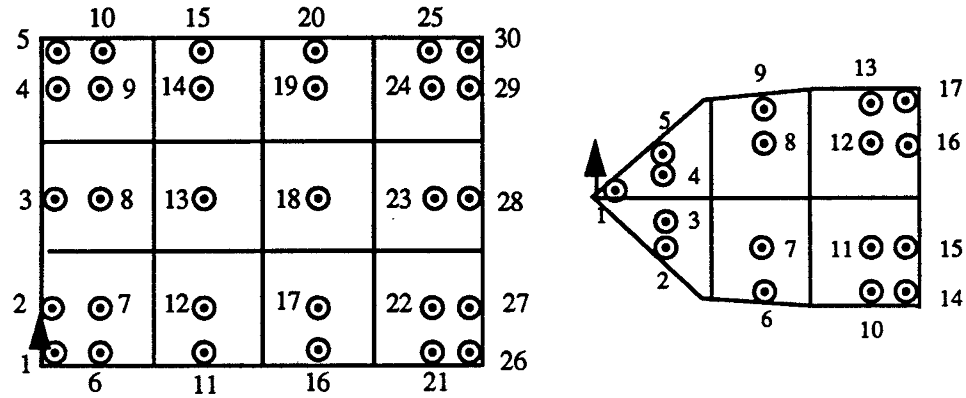


Single Source Panel in a Network - Constant-strength source panel.

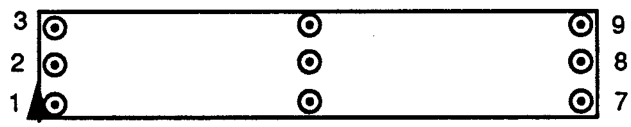


Singularity Parameters (.) and Boundary Condition Locations (o) for Doublet Panel Network.

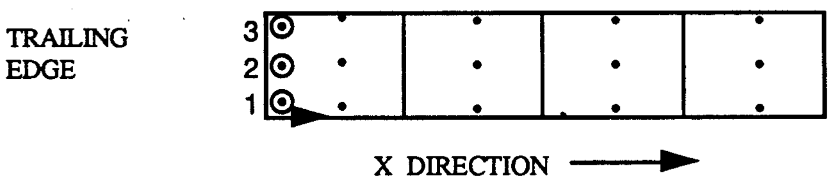
General - Quadratic variation of doublet strength (μ) in both directions.



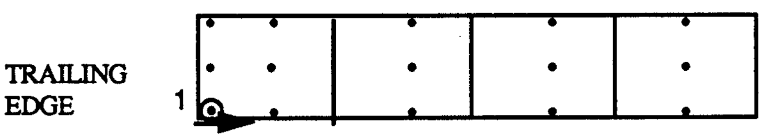
Single Doublet Panel in a Network - Quadratic variation of doublet strength in both directions.



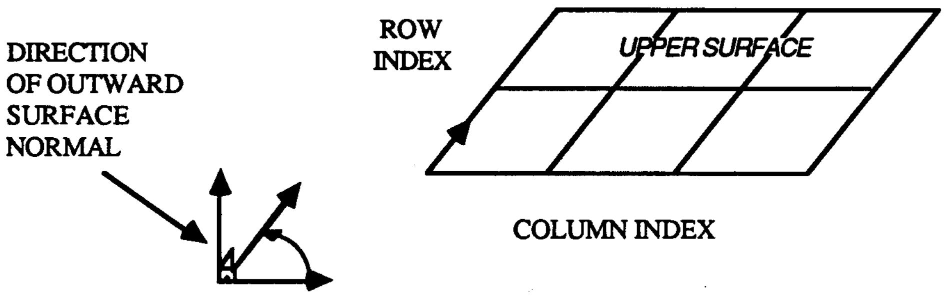
Doublet Wake (kt = 18) or Trailing Wake - Quadratic variation of doublet strength in the direction of the trailing edge and constant strength in X direction.



Doublet Wake (kt = 20) - Constant doublet strength over entire network.



Upper Surface. Use the right-hand rule convention between the column index and the row index to determine the unit normal vector from the upper surface. The rule requires that you point the fingers of the right hand in the direction of the column index and turn them to the row index direction, forcing the thumb to point in the direction of the upper surface unit normal vector. The subscript "u" denotes upper surface.



Lower Surface. Surface opposite to upper surface; denoted by the subscript "l".

> **Note:** Be sure to define a network with the upper surface exposed to the flow field. It is very easy to become confused since (1) boundary conditions can be defined on both the upper and lower sides of an input surface and (2) flow properties can be output on both the upper and lower surfaces.

Upper Surface Unit Normal Vector ($\hat{n}$) - Unit normal vector from the upper surface; used in defining boundary conditions.

4. OVERVIEW OF AN ANALYSIS

A subsonic or supersonic flow analysis is a complex procedure involving many decisions. To see the complete picture of an analysis requires a road map. This section provides such a road map in outline form. The outline gives an overview of considerations and questions involved in a flow analysis.

I. AERODYNAMIC OBJECTIVES

A. What are the aerodynamic objectives of the problem?

B. What results do you expect?

C. Does program capability match anticipated objectives?

1. If A502 cannot solve the problem, look for another approach (if necessary, check program capability in section 2).

2. If A502 can solve the problem, continue.

II. PLANNING SUBSONIC FLOW ANALYSIS

A. What kinds of theoretical models are necessary to achieve aerodynamic objectives and to best represent physical flow? Make a list of all necessary models.

1. Most models are based on proven theoretical models.

2. If a new theoretical model is developed, it requires validation.

B. What configuration components are significant in the flow representation? Omit components that do not have a primary influence on the analysis.

C. Do you have access to other compatible models for comparison? For comparing results, compatibility with previous and subsequent models is important.

D. What computer run cost do you expect? Estimate the total number of panels for each configuration and refer to section 7 to find the estimated solution run cost. You can analyze a maximum of four flight conditions for a given Mach number in one solution run. You can run additional flight conditions as a restart at less than half the cost.

E. How much personnel time is required for the analysis? Estimate the hours required for personnel to define surfaces, panel the configuration, complete the datacheck, and analyze results for one analysis. It is not possible to predict the exact amount of time required for the analysis. However, please note that a large part of the cost comes from defining surfaces, developing paneling, and examining results. Thus, you should develop a sound overall plan at this point. Remember that, once the program is started, a significant number of personnel hours must be committed to the project.

III. DEFINING CONFIGURATION SURFACES

A. To develop panels on most complex surfaces, you need a quality surface definition in a form convenient for easy extraction of panel coordinates.

B. Several surface definition sources are:

1. Previously defined AGPS surfaces
2. Previously defined GCS surfaces
3. Master dimension data, containing information to develop a surface definition
4. Special FORTRAN program containing surface definition
5. A set of panels (for small surface)

C. To represent surfaces with the indirect mass flux boundary condition of composite panels, you require surfaces with no holes or gaps. A wing trailing edge must have zero thickness.

IV. IDENTIFYING SURFACE BOUNDARY CONDITIONS (See section 5.9)

Select from the following:

A. Composite panel (source and doublet) representation of:

1. Thick wing
2. Body
3. Nacelle

B. Wakes (doublet)

1. Wing
2. Wing-body, etc.
3. Body and nacelle

C. Bases (source and doublet)

1. Body
2. Nacelle

D. Flow-through surface (source and doublet) -- inlet

E. Source representation of a surface (used only to avoid complex panel matching)

1. Vertical tail (unloaded surface)
2. Strut (used with a doublet distribution on the cambered surface, to account for the loading)

F. Doublets on a cambered surface

1. Thin wing or wing-type surface
2. Strut-cambered surface

V. LAYING OUT PANEL NETWORKS (RECTANGULAR ARRAY OF PANELS)

A. Use one or more networks to represent each configuration component.

B. Use at least one network for each type of surface boundary condition.

C. Define networks consistently (right-hand networks) to produce an outward surface unit normal vector which points into the flow field of interest.

D. Start a new network along large surface slope discontinuity and along small discontinuities in the streamwise direction. This allows the doublet singularity to have a slope discontinuity along the network edge.

E. To assist in processing the output files, order the input networks with the most important surface networks first and the wake surface networks last.

F. If possible, reduce the number of networks. This has some impact on reducing computer run cost and increasing run accuracy.

G. To keep track of input data for complex configurations, name each network and make a list of networks. Using a network name of less than ten characters allows the network input to be labeled and used in the program.

H. To check abutment data for complex configurations, make a drawing of network edges (with edge numbers) and their interrelationships (see section 9).

VI. DEVELOPING PANELS

A. The major cost and flow time involved in an analysis come from development of network paneling for a configuration.

B. The ideal paneling program uses an automated paneling procedure that allows for changes in panel distribution and then reproduces all proper configuration panel networks in a minimum amount of time.

C. To finalize panel spacing:

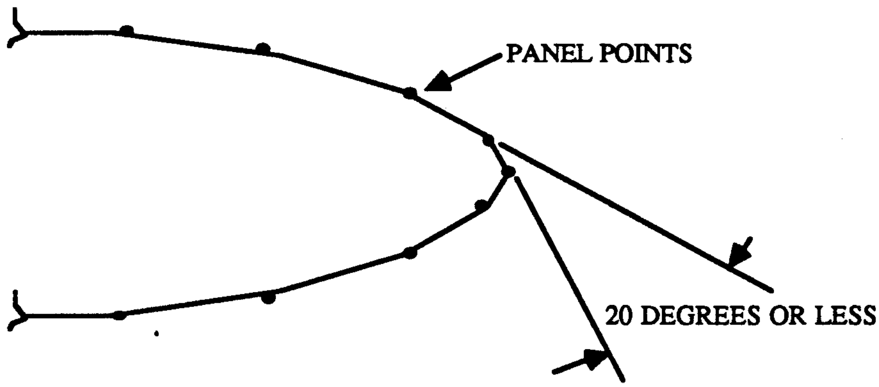
1. For detailed pressure distribution analysis, panel the surface being analyzed by anticipating pressure distribution (smaller panels in region of large pressure variation) and placing necessary panels to record the distribution details.

   Note: Recall that the resulting flow properties are given only at the panel center.

2. When you must account for the influence of one surface on another, you can reduce the paneling distribution over the previously described detailed pressure distribution.

3. Make a reasonable variation in panel size to avoid having small panels next to large panels.

4. Make a change of less than or equal to a 20-degree angle between panels within a network, as shown below for a column of wing leading edge points.



D. Where feasible, make sure that abutting composite or doublet panel networks have the same spacing; otherwise, you must force abutments. In general, all panels should match for the best doublet strength matching for abutting networks. If this is not possible, match as many panel edges as possible.

E. Use a terminal display to check all panel spacing across adjacent networks.

VII. ASSEMBLING A502 INPUTS

Start by using the A502IN/UN=D22CMTG input deck. See section 5 for details.

VIII. CHECKING A502 INPUTS–RUNNING DATACHECK

A. Assemble the job control card deck (see section 7).

B. Ensure that all inputs have been read in without errors.

C. See if all upper surface unit normal vectors point into the flow field. This is not important if the networks are laid out as right-hand networks. If they are not, you need additional printout to obtain surface normal vectors and determine if they are acceptable.

Note: One of the most common irregular surface flow property errors arises when the upper surface unit normal vector ($\bar{n}$) points into a configuration.

D. See if all abutments have been properly made. Make sure that the program has moved your specified abutments and found all relationships for matching with appropriate network panel edges (see subsection 6.7.4 for abutment summary printout).

E. Display the panels modified by the program to check for panel edge distortion caused by abutments. If distortion is excessive, it can alter pressures.

IX. MAKING THE A502 SOLUTION COMPUTER RUN

A. When the datacheck process is complete, prepare for a solution run as follows:

1. Change the A502 input mode from datacheck to solution.
2. Estimate computer central processor time, based on the number of panels (see section 7).
3. Adjust job priority to the lowest level, to keep the run cost down.

B. Observe that the basic job card deck is used for multiple datacheck runs and for one solution run (up to four angles of attack, etc.). For multiple solution runs and for restart runs, you may have to rename some of the output files (see section 7).

X. EXAMINING OUTPUT TO VALIDATE ANALYSIS

A. Check error messages in the printout dayfile.

B. Examine error messages in the printout.

C. Make sure that the solution run has executed as you expected. Examine the printout for:

1. Configuration forces
2. Sectional lift
3. Pressures on the entire configuration

D. If required, qualify aspects of the solution which may have exceeded the limitation of linear theory (i.e., large regions of transonic flow or portions of the configuration which are crudely represented).

XI. PROCESSING RESULTS OF ANALYSIS

A. To process surface pressures from panel center data, run the EFP program, using the PF output file (see section 8). Output is a compact GGP file which contains chord fraction parameters. This process is used for making plots of:

1. Isobars
2. Pressure versus chord fraction
3. Pressure versus X, Y, or Z

B. To plot sectional pressures from sectional cuts, use the SPG output file (see section 8). This is a GGP file containing a run ID (runid) for each network of the cut, sectional pressure, and chord fraction.

C. To plot panel center surface flow properties, use the EXTRACT program to extract requested data from the PF file. You can then transfer the output file to another computer site to generate a GGP file via the GGPL program. This procedure is commonly used to generate:

  1. Surface flow direction displays

  2. Surface streamline displays

  3. Mach number plots

D. To plot flow-field properties for off-body points, use the OFF file. Data is laid out in table format, easily converted to GGP format with the addition of format, parameter list, runid's, etc. An alternate approach is to use printout data directly.

E. Use the STR file to plot flow-field streamline properties. The data is laid out in a table which is easily convertible to a GGP format by adding format, parameter list, runid's, etc. Alternately, you can use printout data directly.

F. To plot the configuration panel and flow-field streamlines, use the MPX file. Data is formatted as A230-style data and can be read into the AGPS program for viewing.

G. To plot sectional forces and moments from sectional cuts, use the SFG file, a GGP file containing sectional force and moment properties.

H. To process configuration forces and moments, use the FMG output file, a small GGP file containing the forces and moments summary.

I. Use the BL output file to do a subsequent boundary layer analysis of a configuration component via A598. You need to run the data in the A598 program with a preprocessing program to generate a streamline grid on the surface.

XII. MANAGING OUTPUT FILES

A. Data output file suffix names and complete filenames:

AIC	Aerodynamic influence coefficient	Restarting new solutions
FAM	factored aerodynamic matrix	Restarting new solutions
SIN	Singularity strengths	Restarting same solutions
PF	Surface flow properties	Plotting surface flow properties

PC	Pressure at grid points	Optional plotting of surface flow properties
SPG	Sectional pressures	Plotting pressures along sectional cuts
SFG	Sectional forces	Plotting sectional forces and moments
FMG	Forces and moments summary	Plotting configuration results
OFF	Off-body flow properties	Plotting
STR	Sreamline flow properties	Plotting
MPX	Configuration panel and streamline paths	Displaying configuration panel as used in analysis and, if requested, flow-field streamlines
BL	Boundary layer data	Subsequent analysis in A598
OUT	Printout	Making a microfiche copy and/or a laser printer copy

B. What should you do about the large number of files on your account and about using up your computer resources?

1. Store needed files via TAPEUM or File Management System (FMS) until you are ready to use them.

2. Purge unneeded files.

3. Process plotting files and transfer them to other systems.

4. To run additional solutions and/or results from existing solutions, store the aerodynamic influence coefficient and singularity parameters on tape.

C. Is the work complete? If it is, purge the saved files.

5. PROGRAM INPUTS

The A502 program input data file contains all inputs necessary to solve a flow boundary-value problem, calculate flow-field properties, and control program output. This data file is stored on your account and is called by the job control deck used to execute the computer run (see section 7).

Program input features are:

- All coordinate numbers and related data are defined in the units of the configuration. Thus, if a configuration is defined in inches, the input reference area must be in square inches.
- All numbers are assumed to be decimal numbers, represented in (6E10.0) format. This format includes the format (6F10.0) and is used to specify most data. It uses a maximum of six numbers per line, with ten spaces for each number. Any exceptions to this format are noted when they apply.
- All input data is defined in data blocks, some of which are optional. A data block represents a complete set of data. Because of the amount of data to be defined, the data blocks for the summary of configuration forces and moments and the sectional property inputs contain sub-blocks. If a sub-block is input, all its internal data must be defined.
- Input data blocks between the first ($TITLE) and the end ($END) of the data file may be defined in any order, except for options that depend on networks; i.e., partial network edge abutment ($PEA). The latter block of data must be placed after network surfaces. The recommended order for the data blocks is the order in which they are documented. If this order is retained, the blocks can be easily checked against the documentation.
- Five symbols are used in *column 1* to identify particular input data features:

$	Marks the beginning of a data block.
*	Identifies the start of a data sub-block (block of data within a data block) in the configuration forces and moments summary and in the sectional properties input section.
=	Introduces a comment line; generally used for defining symbols above a line of input, or for any comment that is useful to the program user.
!	Introduces a comment line; same as "="; since "!" is also a universal CMEDIT symbol, enter F %! to find a line starting with !.
# D L	Used to duplicate "D" times the following "L" lines; D and L are input as free-field data separated by a space.

Comments are useful in defining input parameters and qualifying input data.

To enter inputs for the program, start with an input deck (A502IN/UN=D22CMTG) containing all necessary labeled parameters. You are responsible only for inserting the correct value below each symbol. By entering the proper qualifying comments concerning the input data, you can modify the input list to contain all important notes of interest for the case. Figure 5-1 illustrates typical program input. Refer to subsequent paragraphs for descriptions of available A502 data blocks.

Input Blocks and Parameters	Section
$TITLE =TITLE =TITLE	5.1
$SOLUTION OR $DATACHECK OR =NDTCHK $RESTART =NCKUSP NCKAIC NCKFAM	5.2
$SYMMETRIC FLOW =XZPLN XYPLN	5.3
$MACH NUMBER =AMACH	5.4
$CASES - NO. OF SOLUTIONS =NACASE	5.4
$ANGLES OF ATTACK =ALPC =ALPHA(1) ALPHA(2) ALPHA(3) ALPHA(4)	5.4
$YAW ANGLE =BETC =BETA(1) BETA(2) BETA(3) BETA(4)	5.4
$REFERENCE DATA FOR 3-D FORCES AND MOMENTS =XREF YREF ZREF =SREF BREF CREF DREF	5.5
$FORCES AND MOMENTS SUMMARY FOR NONWAKE NETWORKS *NETWORK SELECTION =NUMNET IDFLT =NETDAT(*) *PRESSURE SURFACE =NUMSCD =NETDAT(*) SURFCD(*)	5.6
$PRINTOUT CONTROL =ISINGS IGEOMP ISINGP ICONTP IBCONP IEDGEP =IPRAIC NEXDGN IOUTPR IFMCPR ICOSTP	5.7
$BOUNDARY LAYER PROGRAM (A598) INPUT DATA GENERATED =IVCORR	5.8
$VELOCITY CORRECTION =IVCORR	5.8

Figure 5-1 Typical A502 Input (Sheet 1 of 3)

Input Blocks and Parameters							Section
$POINTS - DEFINES NETWORK GEOMETRY AND BOUNDARY CONDITIONS							5.9
=KN							
=KT							
=NM	NN					NETNAME	
=X(1,1)	Y(1,1)	Z(1,1)	X(*,*)	Y(*,*)	Z(*,*)		
$POINTS - FLOW-THROUGH SURFACES, FAN FACES, ETC. (KT = 5.)							5.9
=KN							
=KT							
=NM	NN					NETNAME	
=X(1,1)	Y(1,1)	Z(1,1)	X(*,*)	Y(*,*)	Z(*,*)		
=BET1(1)	BET1(2)	BET1(3)	BET1(4)				
$TRAILING WAKE NETWORKS							5.9
=KN							
=KT	MATCHW						
=INAT	INSD	XWAKE	TWAKE			NETNAME	
$PEA - PARTIAL OR FULL NETWORK EDGE ABUTMENTS							5.10.1
=NFPA	IOPFOR						
=NNE	PEATOL						
=NN(*)	EN(*)	EPINIT(*)	EPLAST(*)				
$ABUT - FOR FULL NETWORK EDGE ABUTMENT (IF POSSIBLE, USE $PEA)							5.10.2
=ABNET1(*)	ABSIDE1(*)	ABNET2(*)	ABSIDE2(*)				
$EAT - LIBERALIZED ABUTMENTS							5.10.3
=EPSGEO	IGEOIS	IGEOUT	NWXREF	TRIINT	IABSUM		
$SECTIONAL PROPERTIES							5.11
=NUMGRP							
*NETWORK SELECTION FOR SECTIONAL PROPERTIES							
=NUMNET							
=NETDAT(*)							
*CUT AND REFERENCE PRINTOUT FOR SECTIONAL PROPERTIES							
=OPTCRD	OPTMRP	IPRTNF	IPRTPP	ISECPR	IXYZOP	REFLEN	
=NUMCUT							
=XC(*)	YC(*)	ZC(*)	XCN(*)	YCN(*)	ZXN(*)	LEN(*)	
=CHRD(*)	REFRAC(*)						

Figure 5-1 Typical A502 Input (Sheet 2 of 3)

Input Blocks and Parameters							Section
$FLOW-FIELD PROPERTIES (REQUIRED FOR OFF-BODY POINTS & STREAMLINES)							5.12
=NFLOWV	TPOFF						
$XYZ COORDINATES OF OFF-BODY POINTS							5.12
=ISK1							
=XOF(1)	YOF(1)	ZOF(1)	XOF(*)	YOF(*)	ZOF(*)		
$GRIDS - OFF-BODY POINT DATA ENTERED AS A GRID OF POINTS							
=NGT							
=OX(*)	OY(*)	OZ(*)	X3(*)	Y3(*)	Z3(*)		
=X2(*)	Y2(*)	Z2(*)	X1(*)	Y1(*)	Z1(*)		
=D3(*)	D2(*)	D1(*)	I3(*)	I2(*)	I1(*)		
$STREAMLINES IN THE FLOW FIELD							5.12
=NSTMLN							
=NUMPTS	HMIN	HMAX	MAXSTM	MAXORDR	ABSERR		
=MAXARR1	ISPRNT	TPSL	SLNO1	SLNO2	SLNO3	SLNO4	
=X(*)	Y(*)	Z(*)	DX(*)	DY(*)	DZ(*)		
=FWDBK(*)							
$END OF A502 INPUTS							

Figure 5-1 Typical A502 Input (Sheet 3 of 3)

5.1 BEGINNING AND END

Input Data for Beginning and End

```
$TITLE
Case title
User information
.
.
Other data blocks
.
.
$END
```

For convenience of case identification, input a title block ($TITLE) first. An end block ($END) indicates the end of the input. All other data blocks are placed between these two blocks.

5.2 PROGRAM CONTROL–DATACHECK, SOLUTION, OR RESTART

The program control data block is used to control different modes of program execution: datacheck, solution, and restart. A datacheck run executes the first part of the program and is terminated before the aerodynamic influence coefficients are generated. After completion of the datacheck, the program control data block is changed and the complete program is executed for a solution. If additional solutions and/or other flow properties are required, you can execute a restart using the previously generated aerodynamic influence coefficients and/or the singularity strengths. To control the mode of program execution, enter one of the blocks of data described below.

Input Data for Datacheck, Solution, or Restart

```
$DATACHECK OF ABUTMENTS
=ndtchk
2.0
```
! Short form of datacheck; used to validate doublet network abutments; preferred datacheck

```
$DATACHECK, COMPLETE
=ndtchk
1.0
```
! Full datacheck; gives detailed examination of input data

```
$SOLUTION
```
! Solves boundary-value problem and computes flow properties

```
$RESTART FOR NEW SOLUTIONS WITH ... AIC AND ...FAM TAPES*
=nckusp    nckaic     nckfam
0.         1.         1.

$RESTART SAME SOLUTIONS WITH ...AIC, ...FAM, AND ...SIN TAPES*
=nckusp    nckaic     nckfam
1.         1.         1.

$RESTART SAME SOLUTIONS WITH ...SIN TAPE
! VELOCITY FROM GRADIENT OF POTENTIAL
=nckusp    nckaic     nckfam
1.         2.
```

* Restarts made with ...FAM tape will be less expensive than runs made without it. The program will still make restart runs without ...FAM (set nckfam=0).

Datacheck

The datacheck mode of execution validates inputs for a solution run. The checking procedure uses the first portion of program execution to check the readability of the inputs and the abutment summary for doublet networks. A complete datacheck continues examining the execution of the program and defines the control point locations and the unit normal vector outward from a surface. It can also determine if any panels pierce other panels after doublet panel edges have been moved for abutment (see section 5.10.3, $EAT). This complete datacheck is costly and should only be run for complex configurations.

The abutment datacheck sees if all data is present and readable. You need to examine the printout for validation of:

- Erroneous abutments
- Incomplete abutments
- Excessive movement of network panel edges from matching panels for abutments

Both complete and abutment datachecks produce an MPIX file containing all network panel geometry after abutments, for plotting purposes. Inputs and outputs of the datacheck process are summarized in figure 5-2.

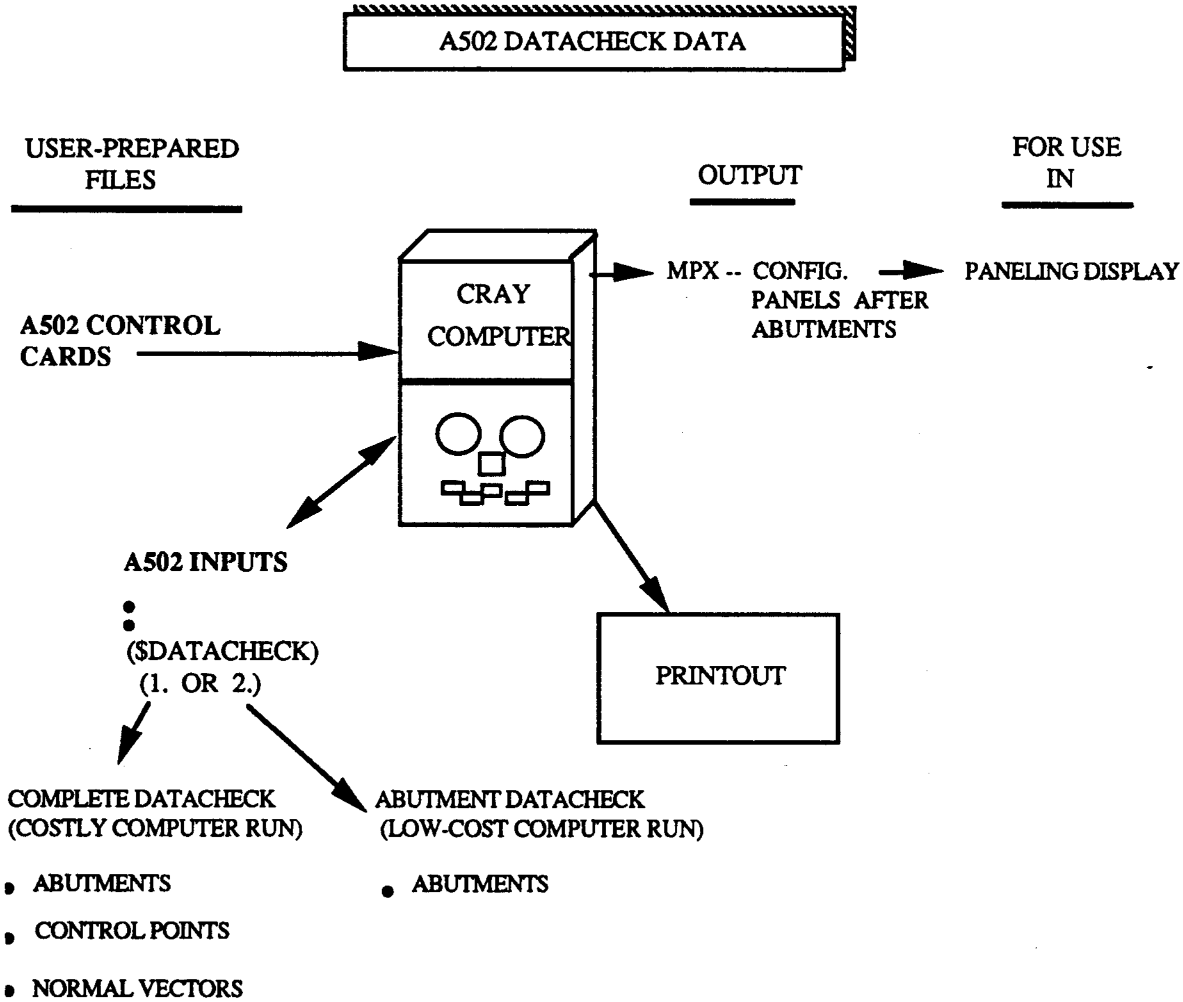
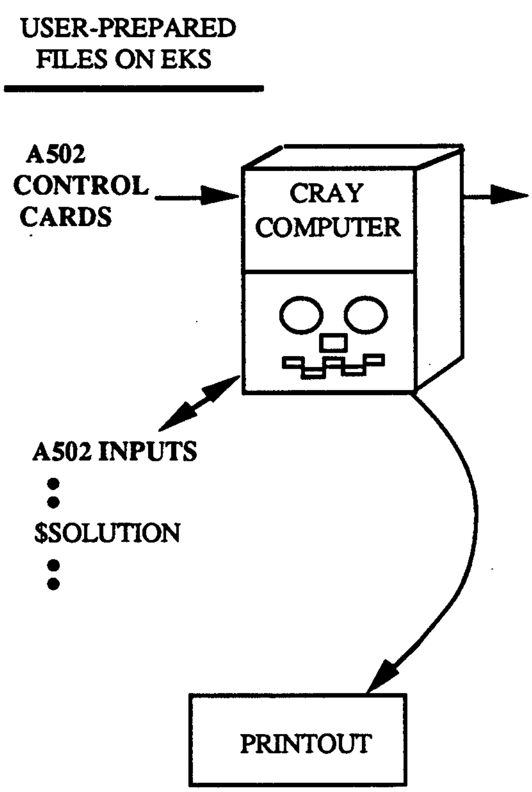


Figure 5-2 Datacheck Mode Inputs and Outputs

Solution

In the solution mode of execution, A502 calculates all surface flow properties, configuration forces and moments, and additional flow properties. In addition to printed output, the program generates a number of output files containing analysis results. Some output files are generated only if you have requested optional input. A summary of solution mode inputs and outputs is given in figure 5-3.

A502 SOLUTION



OPTIONAL DATA FILES OUTPUT	FOR USE IN	HOW TO REQUEST
AIC - AERODYNAMICS INFLUENCE COEFF.	RESTART A502	AUTO
SIN - SINGULARITY STRENGTHS	RESTART A502	AUTO
PF - SURFACE FLOW PROPERTIES	AS A PLOTTING DATA BASE	AUTO
PC - PRESSURE AT GRID POINTS	PLOTTING, ETC.	AUTO
SPG - SECTIONAL PRESSURES	PLOTTING, ETC.	$SEC
SFG - SECTIONAL FORCES	PLOTTING, ETC.	$SEC
FMG - FORCES AND MOMENTS SUMMARY	PLOTTING, ETC.	AUTO
OFF - OFF-BODY FLOW PROPERTIES	PLOTTING, ETC.	$FLO
STR - STREAMLINE FLOW PROPERTIES	PLOTTING, ETC.	$FLO
MPX - CONFIG. PANEL & STREAMLINE PATHS	PANELING DISPLAY	AUTO
BL - BOUNDARY LAYER DATA	DATA FOR A598, A411, OR A567	$BOU
OUT - PRINTOUT	LASER, MICROFICHE, EDITING	

Figure 5-3 Solution Mode Inputs and Outputs

Restart

The restart mode of execution is used to run additional solutions (angle-of-attack, inlet flow, etc.) or to make additional flow property evaluations. It takes advantage of aerodynamic influence coefficients (AICs), factored aerodynamic influence coefficent (FAM), and/or singularity (SIN) strengths from an existing solution to produce additional aerodynamic results. Compared with results of a new solution run, these results can be computed at a lower cost because some of the existing data is reused. To make a restart run, you need the AIC, FAM, and/or SIN data files from the solution run. Runs made with FAM tape will cost less than runs made without it. This is especially important when doing a subsequent boundary layer analysis. Figure 5-4 gives a summary of the restart mode inputs and outputs.

The type of restart run used depends on the additional data that you desire and on the velocity evaluation. Table 5-1 summarizes the restart mode of execution and which data can and cannot be changed.

Note: A restart *cannot* be made for the following "basic data" changes:

- Mach number
- Direction of compressibility effects
- Symmetric flow options
- Network geometry
- Abutment specifications

Table 5-1 Restart Summary

Solution Requiring Restart	Data That Can Change	Data That Cannot Change	Data Restored
New solution	Solution data*	Basic data	AIC, FAM
	Remaining data not previously mentioned		
Existing solution	Remaining data not previously mentioned	Solution data* Basic data	AIC, FAM, and SIN
Existing solution having indirect composite boundary conditions for complete configuration	Remaining data not previously mentioned	Solution data* Basic data	SIN

*Solution data: angle of attack, angle of sideslip, specified flow normal or tangential to a surface

A502 RESTART - FOR NEW SOLUTIONS
(AIC DATA AVAILABLE FROM PREVIOUS SOLUTION)

USED FOR:

- NEW ANGLES OF ATTACK
- NEW INLET FLOWS
- NEW SIDE-SLIP ANGLES
- SOME ABORTED RUNS

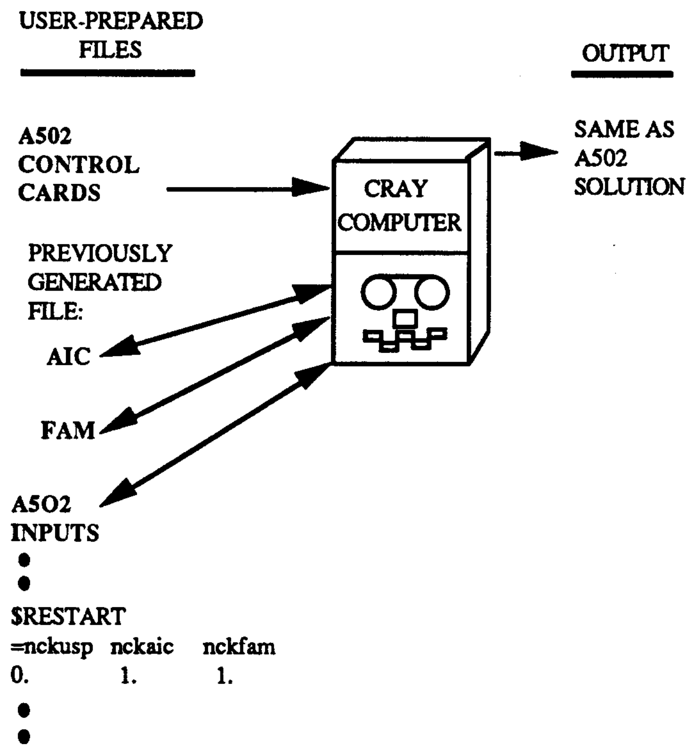


Figure 5-4 Restart Mode Inputs and Outputs (Sheet 1 of 2)

A502 RESTART - WITH SAME SOLUTION (AIC DATA & SIN STRENGTH AVAILABLE FROM PREVIOUS SOLUTION)

USED FOR:

- OFF-BODY POINT FLOW PROPERTIES
- STREAMLINES
- SECTIONAL PROPERTIES
- FORCES AND MOMENTS
- SOME ABORTED RUNS

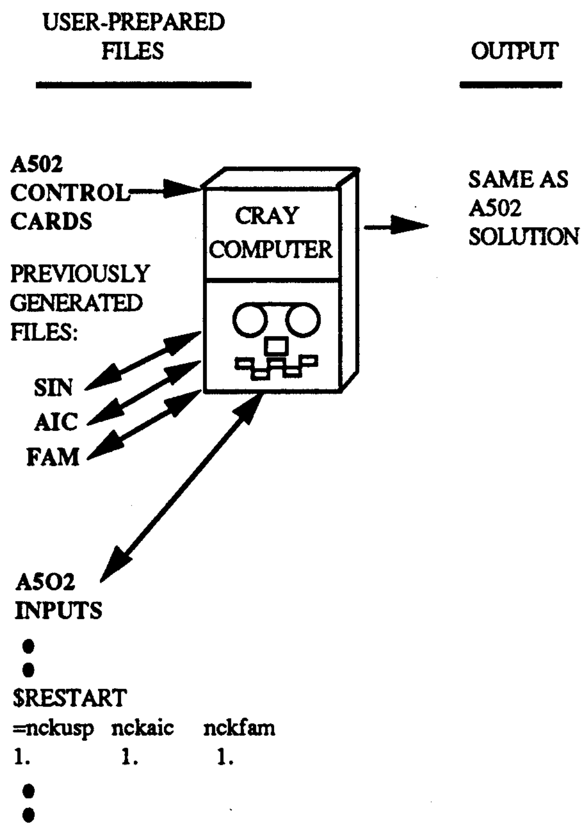


Figure 5-4 Restart Mode Inputs and Outputs (Sheet 2 of 2)

5.3 FLOW SYMMETRY

To define the planes of flow symmetry or antisymmetry, enter one of the blocks of data defined below.

Input Data for Flow Symmetry

```
$SYMMETRIC FLOW ABOUT XZ PLANE
=XZPLN     XYPLN
1.0        0.0
! Inputs half configuration
```

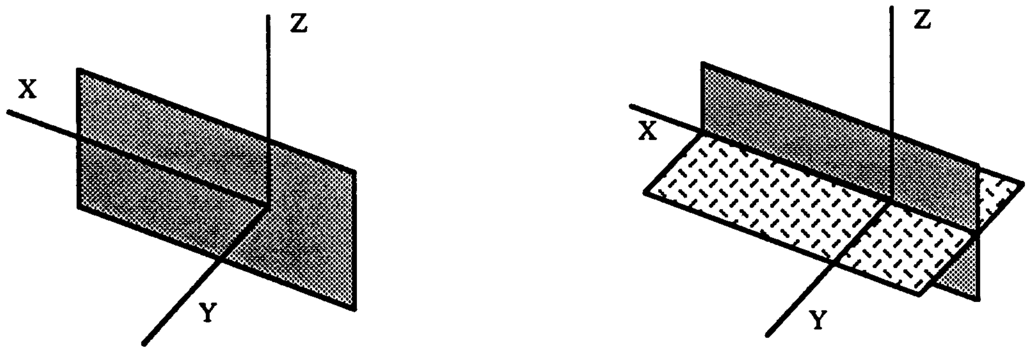
```
$SYMMETRIC FLOW ABOUT XZ AND XY PLANES
1.0        1.0
! Inputs quarter configuration
```

```
$SYM - UNSYMMETRIC FLOW (DEFAULT VALUE)
0.0        0.0
! Inputs full configuration
```

```
$SYM - ANTISYMMETRIC FLOW ABOUT XZ PLANE AND SYMMETRIC FLOW ABOUT XY PLANE
1.0        -1.0
! Inputs half configuration
```

```
$SYM - ANTISYMMETRIC FLOW ABOUT XZ PLANE
-1.0       0.0
! Inputs full configuration above or below XZ plane
```

Most configuration and flow analyses have one plane of symmetry. For this type of problem, you only need to define half the configuration. Onset flow is defined with a zero angle of yaw. This approach represents a considerable savings over an analysis of the complete configuration. A summary of the planes of symmetry and the recommended placement of the configuration are given in figure 5-5.



PLANE OF SYMMETRY

TWO PLANES OF SYMMETRY

Figure 5-5 Summary of Planes of Symmetry

5.4 ONSET FLOW CONDITIONS

Input Data for Onset Flow Conditions

```
$MACH NO.   (DEFAULT VALUE IS 0.0)
amach
```
! Mach number (0 to .99 and 1.01 to 4.0)

```
$CASE, NO. OF SOLUTIONS   (DEFAULT VALUE IS 1.0)
nacase
```
! Number of solutions (1. to 4.)

```
$ANGLE OF ATTACK IN DEGREES   (DEFAULT VALUE IS 0.0)
alpc
```
! Direction of compressibility effects (-90. to 90.)
```
alpha(1) alpha(2)   alpha(3)   alpha(4)
```
! Angle of attack for each solution

```
$SIDESLIP ANGLE IN DEGREES   (DEFAULT VALUE IS 0.0)
betc
```
! Direction of compressibility effects (-90. to 90.)
```
beta(1)  beta(2)    beta(3)    beta(4)
```
! Sideslip angle for each solution

Mach Number and Direction of Compressibility Effects

To solve the subsonic and supersonic flow boundary-value problem, A502 uses a three-dimensional (3D) Prandtl-Glauert compressibility rule to scale geometry and flow results. Mach number and direction of compressibility effects define the data necessary to implement this rule. This information is used to develop aerodynamic influence coefficients and is defined only once for a solution and subsequent restart. Different compressibility conditions require a new solution run.

The direction of compressibility effects is defined in the same manner as the angles of attack and sideslip. In general, the compressibility direction used is the primary onset flow direction of interest, or a mean onset flow direction. A solution is exact only when the onset flow and the direction of compressibility effects are the same. However, in practice, a small range of onset flow variations about the compressibility direction (± 5 degrees at Mach no. 0.8) can be applied for a good solution. In supersonic flow, the error is greater when angles of attack and compressibility are not the same (±2 degrees may be acceptable).

The range of Mach numbers given in the input is from 0.0 to 4.0, excluding 1.0. While the acceptable range of input Mach numbers appears to be large, there is a real limitation that only you can be aware of: is the configuration and Mach number combination within the range of linear potential flow theory? You may be able to answer this question before attempting a solution, or you may have to wait until after the solution has been run. Results that exceed the range of the theory should be identified.

Angles of Attack and Sideslip

The angles of attack and sideslip are used to define the unit onset flow (flow solution for nondimensionalized onset flow). These angles are defined in degrees and in the reference coordinate system, as shown in figure 5-6.

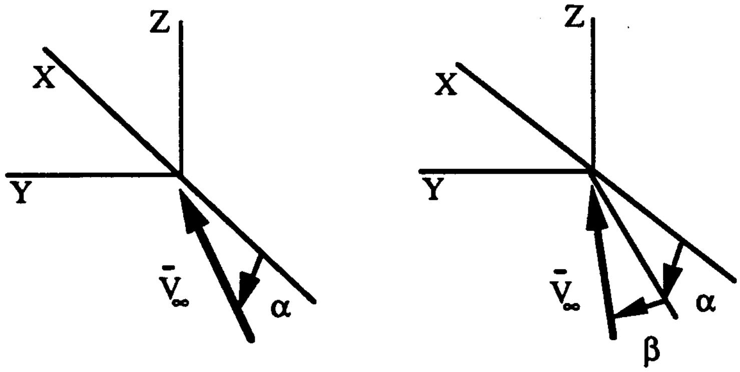


Figure 5-6 Definition of Angles of Attack and Sideslip

Number of Solutions (Cases)

You can include one to four solutions in one computer run. Additional solutions are processed by a restart run. The most common variation between solutions is in the direction of onset flow (for example, angle-of-attack changes). Other conditions that may vary between solutions are:

- Flow normal to a surface (for example, flow into an inlet)
- Flow tangential to a surface

5.5 REFERENCE DATA FOR 3D FORCES AND MOMENTS

Reference area and lengths used to nondimensionalize the network surface and the configuration forces and moments are specified in the data block below.

Input Data for Referencing Forces and Moments

```
$REFERENCE DATA FOR 3-D AND CONFIGURATION FORCES AND MOMENTS
xref        yref        zref
! Moment reference coordinates
sref        bref        cref        dref
! Reference area and reference lengths for rolling, pitching, and yawing moments
! xref        The X component of the moment reference location (R̄o)
! yref        The Y component of the moment reference location
! zref        The Z component of the moment reference location
! sref        Full airplane reference area (see details below)
! bref        Reference length for MX (span)
! cref        Reference length for MY (chord)
! dref        Reference length for MZ (span)
```

Use the full wing reference area for the *reference area* defined for an airplane with one plane of symmetry, along with inputs defining half an airplane. With this reference area, the output forces and moments represent the input network surfaces and the accumulated totals for these surfaces.

The 3D forces (FX, FY, FZ) and moments (MX, MY, MZ) are calculated by integration of the *second-order pressure coefficient* over the *input nonwake network surfaces*. Pressure distribution varies linearly over each panel. Forces and moments are given for:

- Upper surface (surface of predominant interest)
- Lower surface
- Upper surface plus lower surface (thin surface representation)

The forces and moments are calculated for the following:

- Each panel column (optional; see section 5.7, ifmcpr)
- Each network
- All previous networks (accumulated values used to form totals)

The force per panel column is represented by the following equation:

$$\bar{F}_{\substack{panel\\column}} = -1/sref \int_{\substack{panel\\column}} Cp2nd \; \bar{n} \; dA$$

where:

$\bar{F}$ = 3-D forces (FX, FY, FZ)
sref = full airplane reference area
$\bar{n}$ = unit normal vector to surface
dA = small increment of panel area
C_{p2nd} = second-order pressure coefficient

The moment per panel column is:

$$\bar{M}_{column} = -1/sref \, L_T \int_{\substack{panel\\column}} Cp2nd \; (\bar{P} - \bar{R}_O) \times \bar{n} \; dA$$

where:

$\bar{M}$ = 3-D moments (MX, MY, MZ)
L_T = reference length defined for each component:
bref = reference length for MX (span)
cref = reference length for MY (chord)
dref = reference length for MZ (span)
$\bar{P}$= point of integration on panel
$\bar{R}_O$ = moment reference location (xref, yref, zref)

The force and moment for each network are found by summing the results for all columns of the network. The accumulated forces and moments are summed over all the previous networks. These results are printed out for each network, following the surface flow properties.

5.6 CONFIGURATION FORCES AND MOMENTS SUMMARY

The configuration forces and moments summary gives the lift (CL), induced drag (CD), side force (CY), and forces and moments about the reference coordinate system (FX, FY, FZ, MX, MY, MZ) for both the inputs and the complete configuration. Results are based on the appropriate summation of the previously mentioned 3D network surface forces and moments.

To assemble a configuration forces and moments summary, the program assumes a configuration defined from all upper surfaces of the composite network surfaces (kt = 1). In general, body bases, fan faces, wakes, etc. are not included in the total configuration forces, because they are fictitious surfaces to the real flow. The associated data block is used to specify network surfaces and pressure surface (upper, lower, or difference) used to define the configurations that are *different* from the assumed surfaces.

If you do not supply inputs to the configuration forces and moments summary, the program outputs a forces-and-moments summary using the upper surface pressure coefficient integrated over a configuration defined by all networks for which kt = 1. See below for input data for the forces-and-moments summary.

Input Data for Forces and Moments Summary

```
$FORCES AND MOMENTS SUMMARY FOR NONWAKE NETWORKS                    FM1
```

Note: If all indirect mass flux networks (kt = 1) are desired for this summary, omit lines FM2-FM4.

```
*NETWORK SELECTION FOR SUMMARY                                      FM2
numnet     idflt                                                    FM3
netdat(1)                                                           FM4
netdat(2)                                                           FM4
.
.
netdat(numnet)                                                      FM4
```

! numnet — Number of networks input in the FM4 lines, preceded by a plus sign or a minus sign; negative number used to delete networks from base of networks

! idflt — Value defining default base of assumed networks:

=0.0 or blank	All kt=1 networks; input networks can be added to and/or removed from base
=1.0	All nonwake networks; input networks can be removed from base
=2.0	No networks in base; all networks used used in summary must be input

! netdat — Numbers defining networks used to modify or define network summary base

---

Note: If all upper surface pressure coefficients are used in the summary, omit lines FM5-FM7.

```
*PRESSURE SURFACE FOR SUMMARY
numscd                                                    FM6
netdat(1)   surfcd                                        FM7
netdat(2)   surfcd                                        FM7
.
.
netdat(numscd) surfcd                                     FM7
```

! numscd	Number of networks to have pressure surface specified as being different from the upper surface
! netdat	Identification number of network having pressure surface different from default
! surfcd	Pressure surface code: =1.0 Upper surface =2.0 Lower surface =3.0 Difference surface (upper minus lower pressure)

Outputs of Configuration Forces and Moments Summary

Forces and moments on the full configuration are figured on the input configuration plus the reflected images (planes of symmetry). The planes of antisymmetry do not change the definition of the full configuration.

Lift, induced drag, and side force are defined from:

CL = –FX sin(ALPHA) cos(BETA) + FY sin(ALPHA) sin(BETA) + FZ cos(ALPHA)
CD = FX cos(ALPHA) cos(BETA) – FY cos(ALPHA) sin(BETA) + FZ sin(ALPHA)
CY = +FX sin(BETA) + FY cos(BETA)

where:

FX, FY, FZ = force coefficients along reference coordinate axes
ALPHA, BETA = angles of attack and sideslip, respectively

5.7 PRINTOUT CONTROL

The printout control data block contains print parameters that determine program outputs concerned with formulation of the boundary-value problem, the resulting surface flow properties, and the resulting surface forces and moments. The first two blocks below produce standard printouts used for most of the computer runs. The third block gives the complete description of all printout control parameters.

Input Data for Printout Control

```
$PRINT - STANDARD SOLUTION OR RESTART PRINTOUT
0.        0.        0.        0.        0.        0.
0.        0.        1.        0.        0.
```
! Outputs 12 flow properties for each control point
! Network force and moment output includes results for each column

```
$PRINT - STANDARD PRINTOUT FOR A DATACHECK 1.0
0.        0.        0.        2.        0.        0.
0.        0.        1.        0.        0.
```
! Outputs control point location and upper surface normal
! Outputs boundary conditions at each control point

```
$PRINT - GENERAL DESCRIPTION OF PRINTOUT OPTIONS
isings    igeomp    isingp    icontp    ibconp    iedgep
ipraic    nexdgn    ioutpr    ifmcpr    icostp
```

! isings	=2.0	Outputs wake singularity grid - singularity strength and gradients at nine points per panel (section B.7.1)
	=3.0	isings=2.0 plus single table of singularity parameter values (section B.7.2)
	=4.0	isings=3.0 plus network array of singularity values (section B.7.3)
	=5.0	isings=4.0 plus singularity grid for all network (section B.7.4)
! igeomp	=1.0	Outputs panel data - geometry diagnostic data (section B.1)
! isingp	=1.0	Outputs singularity spline data (section B.2)
! icontp	=1.0	Outputs control point location, upper-surface unit normal vector, control point diagnostic data, control point maps, and singularity parameter maps (section B.4).
	=2.0	icontp = 1.0 plus an additional control point map after each network (section B.4)
! ibconp	=1.0	Outputs boundary condition coefficients, diagnostic data, boundary condition maps, control point maps, and singularity parameter maps (section B.5)

(continued)

! iedgep	=1.0	Outputs edge-matching diagnostic data (section B.6)
! ipraic		Inputs control point sequence number for which AIC values are to be printed (rarely used)
! nexdgn	=1.0	Outputs edge and extra control point data (PF file cannot be used to generate GGP file in EFP program, see section B.2)
! ioutpr	=-1.0	Omits flow parameter output
	=0.0	Outputs 49 flow parameters (section 6.10)
	=1.0	Outputs 13 flow parameters (section 6.10)
! ifmcpr	=-1.0	Omits network force and moment output
	=0.0	Outputs network forces and moments summary per column, per network, and accumulation over all previous networks (section 6.11)
	=1.0	Outputs network forces and moments summary per network and accumulation over all previous networks
! icostp	=1.0	Outputs detailed job cost for different segments of the program (rarely used)

Flow property output defaults (ioutpr = 0.0) to 49 flow properties printed for each panel center control point. For most analyses, an output of 12 flow properties (ioutpr = 1.0) is sufficient. The parameters output are JC, IP, X, Y, Z, WX, WY, WZ, S0, D0, MACHU, CP2NDU, and CPISNU.

For a complete datacheck (1.0), defaults are automatically changed to include control point (icontp = 2.0) data output. This data includes the control point upper surface unit normal vector, used to determine if a network is properly oriented.

5.8 BOUNDARY LAYER AND VELOCITY CORRECTION CONTROL

The boundary layer and velocity correction control input data blocks initiate velocity corrections for generating boundary layer input data and for internal flow (for example, an inlet). These corrections primarily improve the flow properties for flow slower than the onset flow. The biggest corrections are made near the stagnation region. The correction changes the surface velocity components, mass flux components, pressures, and Mach numbers. These results replace the surface flow properties in the printout. Also, these results are on a save tape (suffix BL) available for performing a subsequent boundary layer analysis (A598, reference 34). The velocity corrections may also be used in computing the flow field properties, when the velocity method of calculation is exercised (off-body properties - $FLO, troff=1.0, or streamlines - $STR, trsl=1.0).

To maintain consistency with the approximations used in developing linear compressible flow theory, the program uses uncorrected velocity with the second-order pressure coefficient to calculate all forces and moments.

In general, the two data blocks are not input in the same computer run, since boundary layer analysis is primarily for body and wing-type surfaces, and velocity correction is mainly for internal flows like inlets. If both data blocks are used and velocity corrections (ivcorr) are different, the last velocity correction input, controls the output.

Input Data for Boundary Layer and Velocity Correction Control

Note: The optional $BOU data block generates an input data file for Boundary Layer Program in A598. The mass storage file BL must be saved after execution. There are certain restrictions on configuration paneling if this option is used (see reference 34). Currently, body networks above and below a wing need to have the same number of control points in the X direction. Their distributions should be similar, but they do not have to be exactly the same.

CAUTION: Currently the boundary layer output will provide correct results only for ipot ≠ 0.0 networks. For ipot = 0.0 networks, it will output zero velocities. (See section C.2)

$BOUNDARY LAYER PROGRAM (A598) DATA GENERATED
ivcorr

! ivcorr	=1.0	Corrects velocity vector to be colinear with mass flux vector (McLean-Rubbert Correction)
	=0.0	Does not correct velocity vector calculated by the program
	=-1.0	Saves uncorrected velocity components use when velocity impermeability KT=11 boundary conditions are specified

---

Note: The $VEL data block is the same as the $BOU data block, with an additional velocity correction (Boctor). It does not produce a boundary layer output file.

$VELOCITY CORRECTION
ivcorr

! ivcorr	=0.0	Does not correct velocity vector calculated by the program
	=1.0	Uses McLean-Rubbert Correction to correct velocity vector calculated by the program
	=2.0	Corrects the velocity component along the direction of compressibility and results in an improved pressure coefficient (Boctor Correction)

5.9 FUNDAMENTAL NETWORK GEOMETRY AND BOUNDARY CONDITIONS

To analyze the flow about a configuration, you must describe geometrically the surface boundaries and specify boundary conditions that best represent physical flow. While A502 is capable of executing many different boundary conditions and generating specific geometric shapes from simplified inputs, most program usage falls into a narrow range of options. Since most configurations have complex surfaces that require lofting, this section does not cover A502 geometry generation and modification capability. Additionally, because the most economical boundary conditions are those most often used, this section does not treat the complete list of boundary conditions. (See appendix C for all of A502 input boundary conditions and appendix D for generation of simple geometric shapes, etc.)

Specific boundary conditions are specified on the upper and lower surfaces, as interpreted by the program. The upper-surface unit normal vector is used in defining the boundary conditions and is assumed to be outward and into the flow field being analyzed. Thus, the input order of network points representing a solid body configuration must follow the right-hand rule (that is, using the fingers of the right hand to represent the intersection of column and row indices, the thumb points in the direction of the upper surface normal vector). See section 3 (upper surface) for details.

An important limitation to consider in representing a surface by network points is that, *except for collapsed network edges, all panel sides have a finite length.* A collapsed network edge is a common point used for all network points. Acceptable combinations of collapsed edges for a network are: one per network and collapsed opposite edges of the network (figure 5-7).

Figure 5-7 Simple Networks with Acceptable Collapsed Edges

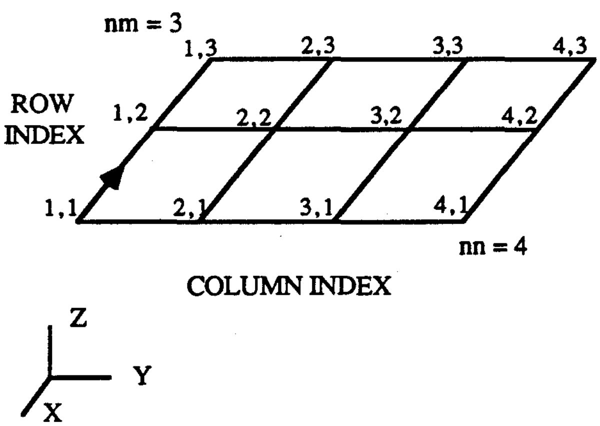
The program is dimensioned to handle models up to the maximum numbers listed below. The actual problem size which can be run is limited by the file sizes generated on the computer (see section 7.1 - Processing Jobs with More Than 10,000 Panels).

Item	Printout Parameter	Maximum Number
Networks	NNETT	150
Panels	NPANT	18,000
All network (mesh) points	NZMPT	20,000
Panels per network		8,000
Control points	NCTRT	24,000
Known singularities	NSNGK	18,000
Unknown singularities	NSNGU	24,000
Singularities per network		17,500
Doublet network edge points		8,000
Equivalent points in an equivalence class		6,000
Total number of points in an abutment		200
Control points with non-linear equations		1,000

The input order of the surfaces is arbitrary and repeatable. When assembling the inputs, you will find it convenient to group networks defined by the same boundary conditions. Input all data with format (6F10.0), unless otherwise specified. Common parameters used in the inputs are defined in the following data block.

Input Data for Network Geometry and Boundary Conditions

$POINTS	Introductory line for defining a boundary condition and one or more networks by inputting X, Y, Z network points
$TRAILING	Introductory line for defining a wake boundary condition and one or more wake networks by inputting network edge and X coordinate of the wake downstream edge
netname	Network name; placed in columns 71-80
kn	Number of networks input for this group
nm	Number of points in a network point column (rows)
nn	Number of point columns in a network
x,y,z	Orthogonal coordinates of a network point; first point of each column starts on a new line; see figure 5-8 for order of points
kt	Parameter defining a boundary condition



COMPUTER INPUT FOR NETWORK FROM:

```
nm nn                              netname
x11 y11 z11 x12 y12 z12
x13 y13 z13
x21 y21 z21 x22 y22 z22
x23 y23 z23
x31 y31 z31 ...
```

Figure 5-8 Ordering Network Points

Composite Panels with Indirect Mass Flux Boundary Conditions (kt = 1) ($\sigma = -\bar{V}_\infty \cdot \bar{n}$, $\phi_L = 0$)

Inputs in this category represent solid surfaces. A solid surface is preferred because of the low computer-run cost as compared with run costs for other representations.

The exterior surface (A502's upper surface) is exposed to the onset flow. The interior region has a uniform onset flow with an interior surface boundary condition of $\phi_L = 0$. (To have this condition almost all cases require that the configuration be completely covered with panel networks and have no holes or gaps. The upper surface velocity is simply computed as the difference of the surface velocity between the upper and lower surfaces. Since the velocity is only a function of the local singularity strengths, it is inexpensive to compute. This is a good method of velocity computation as long as the lower surface boundary condition ($\phi_L = 0$) is satisfied. (If required, the velocity can be computed from the influence of all the singularities by defining the boundary condition using kt=30.0 and setting ipot = 0.0, see appendix C). Other boundary conditions with $\phi_L = 0$ (Kt = 5.0 and 9.0) compute the velocity from the local singularity strength.

Figure 5-9 summarizes boundary conditions and gives an application for a simple wing. A502 inputs used to define this type of surface are:

```
$POINTS - COMPOSITE PANELS WITH INDIRECT MASS FLUX CONDITIONS        P1
kn                                                                   .P2
=kt
1.                                                                    P3
nm         nn                                              netname    P4
x11        y11        z11       x12        y12        z12             P5
x13        y13        z13...                                          P5
x21        y21        z21...                                          P5
.
.
```

! To define remaining networks, repeat P4 and P5 inputs.

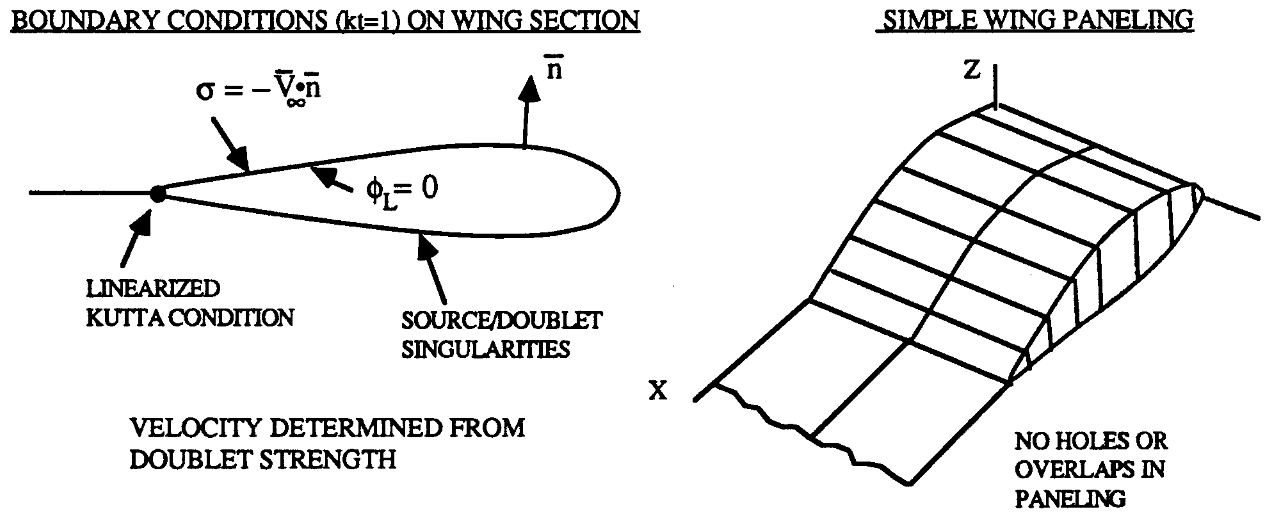


Figure 5-9 Indirect Mass Flux Boundary Condition with Composite Source/Doublet Singularities

Sources of the Exterior (kt = 7) ($\bar{w}_u \cdot \bar{n} = -\bar{V}_\infty \cdot \bar{n}$)

Inputs in this category are used to represent nonlifting or lifting solid surfaces, along with doublet-cambered surfaces (figure 5-10). The following inputs define such a surface.

```
$POINTS - SOURCE ON THE EXTERIOR                                             P1
kn                                                                           P2
=kt
7.                                                                           P3
nm        nn                                                   netname       P4
x11       y11       z11       x12       y12       z12
X13       y13       Z13
x21       y21       z21...                                                   P5.
.
.
```

! To define remaining networks, repeat P4 and P5.

Doublets of the Cambered Surface (kt = 2) ($1/2(\bar{w}_u + \bar{w}_L) \cdot \bar{n} = -\bar{V}_\infty \cdot \bar{n}$)

Inputs of this type represent thin lifting wings and lifting effects with sources on the exterior surface (figure 5-10).

```
$POINTS - DOUBLETS ON THE CAMBERED SURFACE                                   P1
kn                                                                           P2
=kt
2.                                                                           P3
nm        nn                                                   netname       P4
x11       y11       z11       x12       y12       z12                        P5
x13       y13       z13...                                                   P5
x21       y21       z21...                                                   P5.
.
.
```

! To define remaining networks, repeat P4 and P5.

$\Rightarrow \Phi_u = 0$

Bases - Body and Nacelles, Etc. (Source and Doublet; kt = 5) ($\phi_u = \bar{V}_\infty \cdot (\bar{R}-\bar{R}_{ctr})$, $\phi_L = 0$)

Inputs are used to represent separated flow regions on a bodybase and the exit plane of a nacelle or jet plume (figure 5-11). You must input the network so that the panel normals point outward from the surface (that is, downstream). The upper surface velocity is computed from the velocity difference across the surface (see kt=1 boundary condition).

```
$POINTS - BODY, NACELLE, AND JET PLUME BASES                                 P1
kn                                                                           P2
=kt
5.                                                                           P3
nm        nn                                                   netname       P4
x11       y11       z11       x12       y12       z12...                     P5
x13       y13       z13...                                                   P5
x21       y21       z21...                                                   P5
.
.
```

! To define remaining networks, repeat P4 and P5.

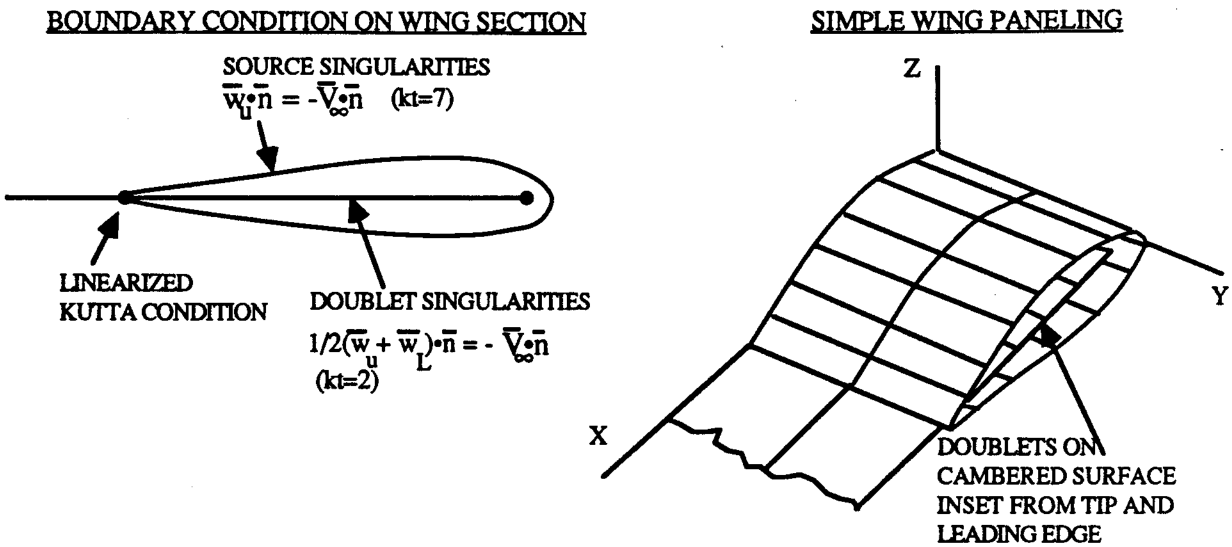


Figure 5-10 Source Exterior and Doublet Interior Boundary Conditions

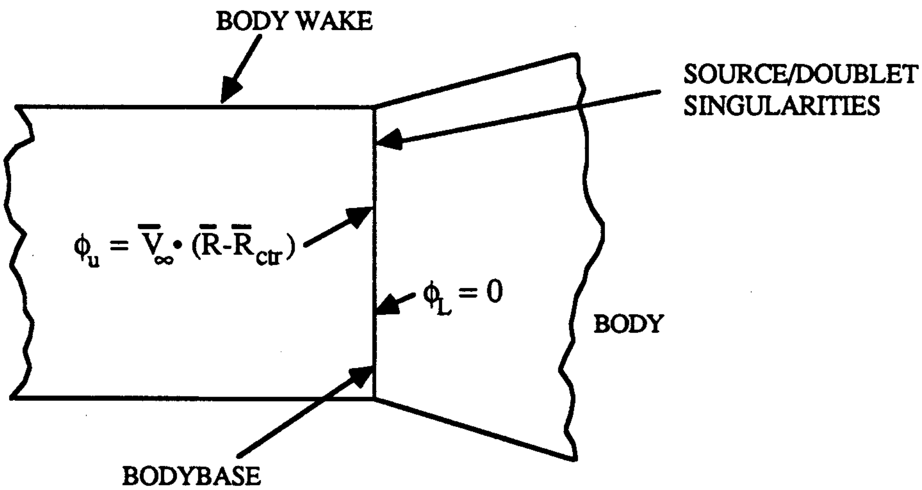


Figure 5-11 Side View of Boundary Condition (kt = 5) on Bodybase Section

Flow-Through Surface, Fan Face, Etc. (Source and Doublet; kt = 9) ($\bar{w}_u \cdot \bar{n} = -\bar{V}_\infty \cdot \bar{n}$ + bet1, $\phi_L = 0$)

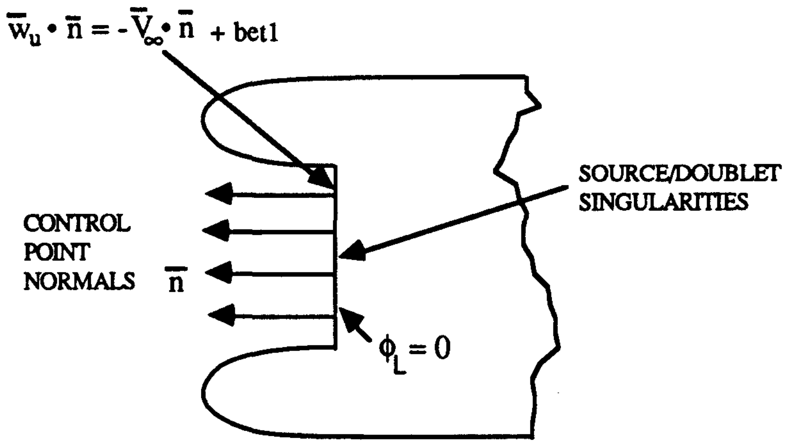
Inputs represent surfaces with flow normal to the surface (figure 5-12). Each solution requires an additional input of the flow normal to the surface (bet1) at the panel center control points. Input the network so that the panel normals point outward from the surface (for example, upstream for a fan face). The upper surface velocity is computed from the velocity differences across the surface (see kt = 1 boundary condition).

```
$POINTS - FLOW-THROUGH SURFACES, FAN FACES                              P1
kn                                                                      P2
9.                                                                      P3
nm        nn                                              netname       P4
x11       y11        z11       x12       y12       z12                  P5
x13       y13        z13...                                             P5
x21       y21        z21...                                             P5..
.
.
bet1(1)   bet1(2)    bet1(3)   bet1(4)   First control point            BC4
bet1(1)   bet1(2)    bet1(3)   bet1(4)   Second control point           BC4
bet1(1)...
.
.
```

1 → 4 means the 4 solutions

! To define remaining networks, repeat P4, P5, and BC4.

! bet1(k) Nondimensional mass flux magnitude along the upper surface normal for the kth solution. One value per case (k) is specified for each panel center control point, in the order of the control points. The value of bet1 is negative for flow into a fan face.



Notes:

1. bet1 = $\bar{w}_u \cdot \bar{n} + \bar{V}_\infty \cdot \bar{n}$ = total mass flux vector
2. For flow into fan face, bet1 is negative.

bet1 = 3

Figure 5-12 Boundary Condition (kt = 9) on Fan Face Section

Wakes (Doublet Panels with Constant Strength in Downstream Direction)

Inputs in this group are used to represent wakes shed from a configuration. The $TRAILING block of input is a convenient means of obtaining a program-generated simple wake. These wakes are attached to a network edge and go straight downstream (y = constant and z = constant) to the specified xwake coordinate. Figures 5-13 through 5-15 illustrate some of the wake networks.

All input wakes should be terminated at some common, convenient location aft of the configuration. The distance selected can be a short distance aft of the configuration. A semi-infinite wake (wake filament) is added in the direction of the compressibility axis (defined from alpc and betc) to the downstream edge (edge number three) of the input wake network, when it is not attached to another network. The wake filament has the same doublet strength along the edge as the matching wake upstream wake and maintains that constant value in the downstream direction. The addition of wake filaments to a wake network is noted in the "Abutment Summary" printout.

If, for some reason, the addition of wake filaments is not required in the formulation of the boundary value problem, they can be turned off. This optional turn-off will apply to all wake networks. Then all the input wake networks will have to be extended downstream (approximately 50 times a reference length) by their input definition.

Use the following input data to turn off the addition of wake filaments.

```
$NOF - NO WAKE FILAMENT - APPLIED GLOBALLY
```

Wakes defined by the $TRAILING block can be input with the $POINTS block. You need to input the wake coordinates, starting at the trailing edge and going downstream for each column of the network. The third line in the $TRAILING block will be the third line in the $POINTS block.

The following gives the input for four commonly used wakes:

```
$TRAILING WAKES FROM WINGS, ETC. (SHARP TRAILING EDGES)              T1
kn                                                                   T2
=kt          matchw
18.                                                                  T3
inat         insd         xwake      twake                netname    T4
```

! To define remaining networks, repeat T4.

! matchw	=0.	Wake vorticity matching Kutta condition (see page C-17)
	=1.	Wake doublet matching Kutta condition
! inat	User-assigned network name from network inputs or network number assumed from input order of networks to which wake is attached.	
! insd	Edge number of network inat to which side 1 of wake is attached	
! xwake	X coordinate for the downstream edge of the wake	
! twake	=0.	Wake parallel to reference X axis
	=1.	Wake parallel to direction of compressibility effects

CAUTION: In using the twake option, recall that all neighboring wake side edges must be abutted.

```
$TRAILING WAKES FROM WINGS, ETC., 2ND-ORDER KUTTA CONDITION   T1
kn                                                                   T2
=kt          matchw
18.          2.                                                      T3
inat        insd         xwake      twake                 netname    T4
```

! To define remaining networks, repeat T4.

Note: Use only for large angular flow differences between merging trailing edge flows. The solution cost increases because, after the normal system of linear equations is solved, an iteration technique is used to satisfy the second-order Kutta condition. This capability is still under evaluation.

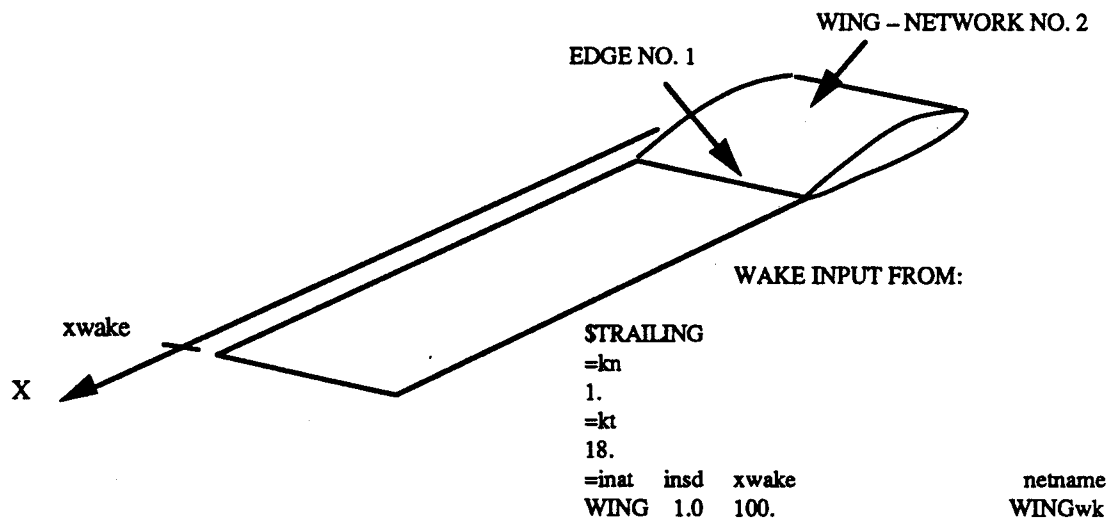
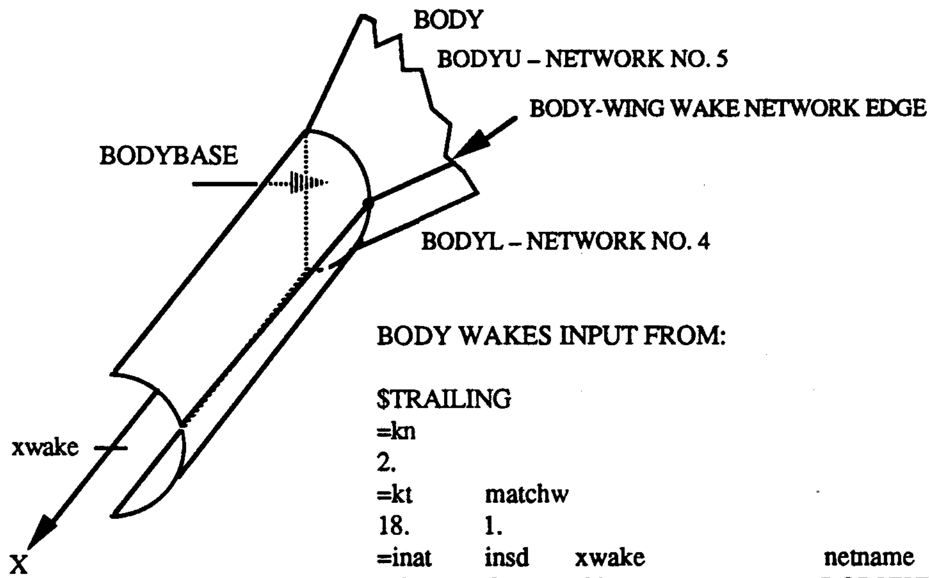


Figure 5-13 Input for Generation of Simple Wing Wake

```
$TRAILING WAKES FROM BODIES, NACELLES, ETC. (SURFACE WITH BASE)          T1
! ALSO USED TO CONNECT TO AN UPSTREAM WAKE
kn                                                                       T2
=kt         matchw
18.         1.                                                           T3
inat        insd        xwake     twake                      netname     T4
```

! To define remaining networks, repeat T4.



BODY WAKES INPUT FROM:

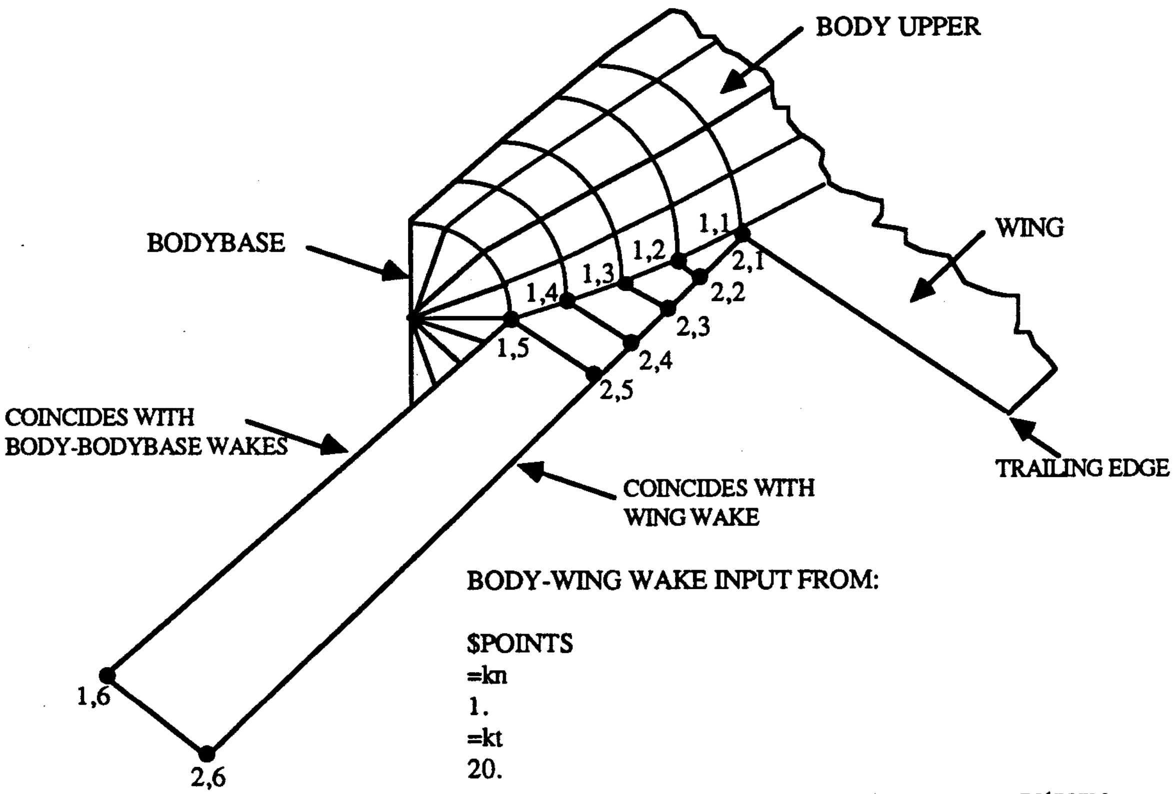
```
$TRAILING
=kn
2.
=kt      matchw
18.      1.
=inat    insd    xwake          netname
BODYL    3.      100.           BODYWL
BODYU    3.      100.           BODYWU
```

Figure 5-14 Input for Generation of Body-Bodybase Wake

CAUTION: This wake (kt = 18.0, matchw = 1.0) must always be used when trailing a wake from another wake or single surface doublet sheet.

```
.   $POINTS - BODY-WING WAKES, ETC. (ATTACH WING WAKE TO BODY)                    P1
    kn                                                                            P2
    =kt
    20.                                                                           P3
    nm          nn                                                   netname      P4
    x11         y11         z11         x12         y12         z12               P5
    x13         y13         z13...                                                P5
    x21         y21         z21...                                                P5
    .
    .
```

! To define remaining networks, repeat P4 and P5.



BODY-WING WAKE INPUT FROM:

```
$POINTS
=kn
1.
=kt
20.
=nm    nn                                     netname
6.     2.                                     BWWAKE
x11    y11    z11    x12    y12    z12
x13    y13    z13    ...
x21    y21    z21    x22    y22    z22
x23    y23    z23    ...
```

Figure 5-15 Input for Simple Body-Wing Wake

5.10 OVERVIEW OF DOUBLET NETWORK EDGE ABUTMENTS

After configuration geometry has been described and the proper boundary conditions have been defined, the next important task is to check the doublet network edge abutments. The abutments provide the means for A502 to maintain the continuity of doublet strength across network edges. You are responsible for reviewing and accepting the abutments as determined by the program. Thus, you must determine that all the necessary abutments (relationships between adjacent network edges) have been made, and that no extraneous abutments have been formed. Part of this check determines exposed network edges; i.e., edges with no ties to adjacant network edges. Along these edges, the doublet strength is assumed to be zero. The resulting doublet distribution over a simple wing-body configuration is given in section 9.

As the heart of the program requires, the abutting network edges must have exact panel edge points which match along the network edge, or panel edge points which are on the straight line between the exact points. Thus, the interfaces of two or more doublet network surfaces must match, i.e., have no gaps between adjacent networks. You can meet this requirement by ensuring any one or a combination of the following:

1. Input geometry has exact matching of every panel edge point along abutting network edges.
2. Input geometry nearly matches for every panel edge point along abutting network edges, and the liberalized abutment capability ($EAT) makes the abutment identical for points within a single tolerance. Small adjustments are made to the network edge points to make them abut without any gaps and to help eliminate the small round-off error in the input network geometry.
3. Input geometry contains some mismatched points along abutting network edges. You must identify these edges for special treatment. Use the partial (or full) network edge abutment capability ($PEA) to form a new common edge from matching points along a network. All nonmatching points are projected onto the new network edge.

Note that the latter two situations modify the original input geometry along abutting network edges. This modified geometry is used in solving the boundary-value problem and can result in small errors in the resulting surface flow properties. To reduce network edge distortion:

1. Keep nonmatching points to a minimum with only small mismatches, and
2. Use the network option to retain the original unit normal vector (cpnorm = 2.0, section C.3) in solving the boundary-value problem. This option uses the control point on the distorted geometry, along with the unit normal vector from the input geometry, thus locally linearizing the flow boundary condition. This option is now assumed for all non-wake networks and requires no user input. (See section C.3.)

Basic assumptions concerning abutments are listed below. Refer to subsequent paragraphs for details of inputs in each of these categories.

1. All doublet network edge abutments are assumed to start and end at identical (within a small tolerance, for example, epsgeo in $EAT) network edge points.
2. To maintain the quality of the original input geometry along an abutment, match as many points as possible.
3. Abutments are processed in the following order:

   a. Partial or full network edge abutments ($PEA preferred over $ABU) forced for user-specified network edges

   b. Finer full-doublet network edge forced to coarser network edge ($ABU) for user-specified network edges (only useful for processing an equal number of panel edge points along an abutment)

   c. Liberalized abutments ($EAT) for all network edges
4. You are responsible for reviewing and validating abutments (abutment summary printout, section 6.7.4) before making a solution run. The important questions to answer are:

   a. Have all abutments been made?

   b. Are appropriate networks abutted?

   c. Are there extraneous abutments?

To assist you in verifying abutments, several printouts are of interest:

- The abutment summary printout lists all doublet network edge abutments determined by the program. This list includes the doublet network edges that are unabutted, but do abut the plane of symmetry.
- The abutment intersection summary (section 6.7.2) lists all abutment end points determined by A502.
- The partial network edge printout (section 6.6) lists all details of points moved, along with the amount they have been moved. Also, this printout identifies the network edge equivalent and nonequivalent points along an abutment.
- Also printed is a list of the network edge-point coordinates (section 6.7.5) for any edge which has a point moved by $EAT. This list is useful for reviewing the moved points. If no points have been moved by $EAT, a message to this effect is printed.

5.10.1 Forced Partial or Full Network Edge Abutments ($PEA)

The $PEA data block moves (abuts) network edge points for full or partial network edges that you specify. These edge points are abutted to a common edge. You may specify two to ten network edges in a single abutment. After you use $PEA, no gaps are left in the abutting network edges. The $PEA process is described below (refer to figure 5-16).

- Determines full groups of equivalent points, i.e., network edge points found to be identical within a specified tolerance. It contains one point from every network in an abutment.
- Determines all other (nonequivalent) points, network edge points in an abutment which are not identified as equivalent to any other point.
- Defines a common network edge by forming a straight line between adjacent full groups of equivalent points.
- Projects nonequivalent points onto the new common network edge.

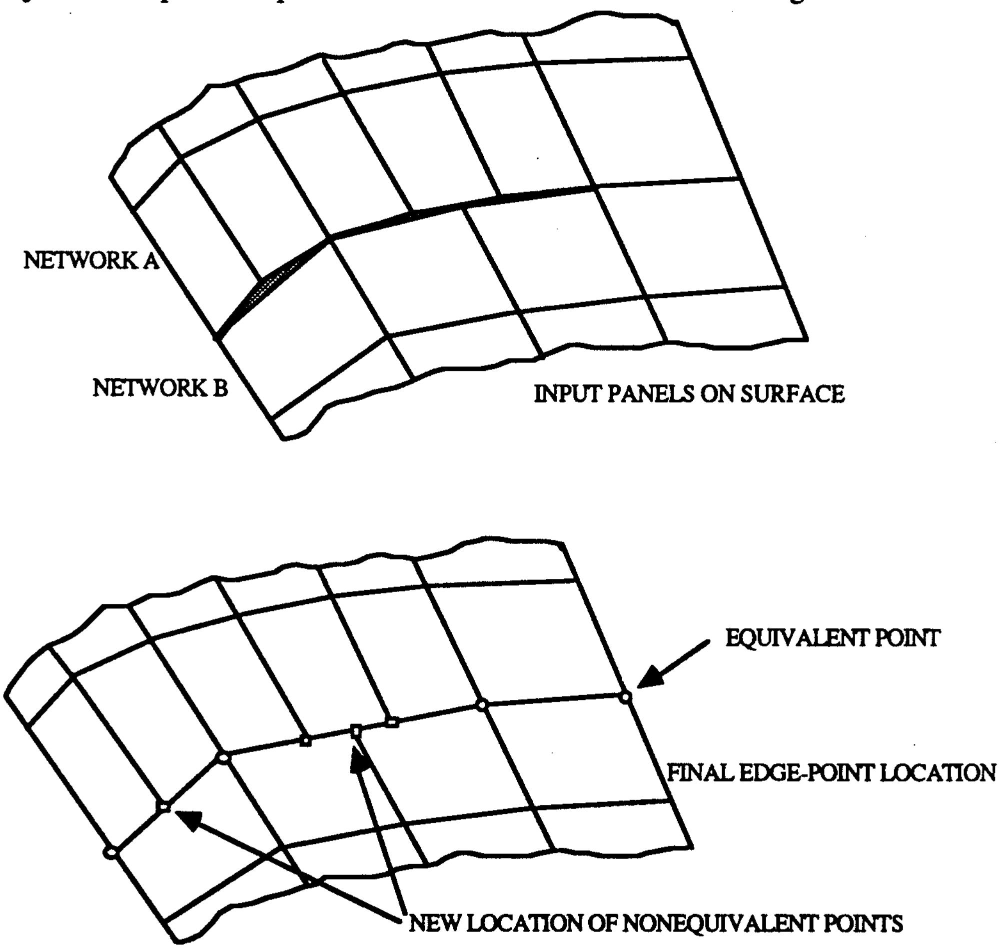


Figure 5-16 $PEA Processing for Simple Abutment of Two Network Edges

A502 uses the following items as criteria for selecting the final location of a full group of equivalent points:

- Point from the first specified network in the abutment (recommended)
- Average of all points in the group

When you use the recommended criterion, you know which edge will remain fixed. Thus, the number of moved network edges is minimized.

If required, a tolerance is available to establish equivalent points for each abutment. The default tolerance is .0001. You may specify a tolerance for each abutment, thus overriding the default. This user-defined tolerance is used for all subsequent abutments until it is overridden by a new specification. By selecting a tolerance value slightly larger than the accuracy of the network geometry (epsgeo, section 5.10.3), you can identify equivalent points and use them to form the new abutted network edge.

In defining a partial network edge abutment, you must specify network name or number, network edge number, and first and last edge-point numbers for each abutment edge. The network number corresponds to the input order of the network. The convention used to define network edge-point numbers is shown in figure 5-17. Please observe that, for edges 1 and 2, the edge-point numbers correspond to column and row number conventions used to define a network input. For edges 3 and 4, the edge-point numbers correspond to the reverse order of the column and row conventions.

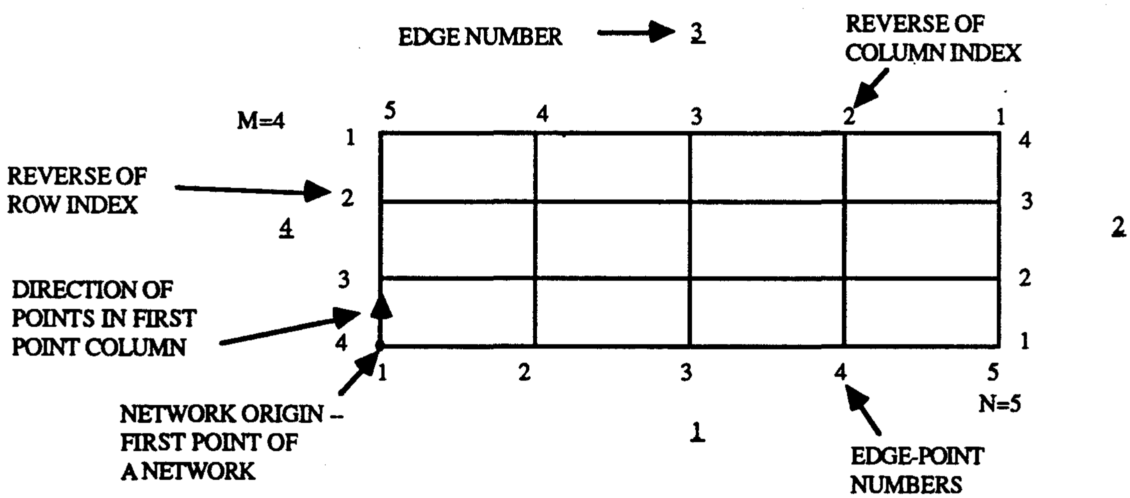


Figure 5-17 Edge and Edge-Point Number Convention

Note: To accommodate changes in the options on the second card (PE2), you may specify the $PEA input section more than once. The maximum number of panel edge points in an abutment is 200. The maximum number of equivalent panel edge-point locations in an abutment is 50.

Input Data for Partial or Full Network Edge Abutments

```
$PEA - PARTIAL OR FULL NETWORK EDGE ABUTMENT                          PE1
nfpa          iopfor         ipeapt                                   PE2
nne(1)        peatol(1)                                               PE3
nn(a)         en(a)          epinit(a)         eplast(a)              PE4
nn(b)         en(b)          epinit(b)         eplast(b)              PE4
.
.
nn(nne(1))    en(nne(1))     epinit(nne(1))    eplast(nne(1))         PE4
```

! To define remaining abutments, repeat PE3 and PE4.

! nfpa — Number of forced partial network edge abutments specified; $1.0 \leq$ nfpa ≤ 100.0

! iopfor — Forms abutment edge from straight lines:

=0.0 or blank	First specified network edge equivalent points (preferred)
=1.0	Average location of equivalent points

! ipeapt — Controls forced partial network edge printout:

=0.0 or blank	Abutment matching edge point numbers and distance moved by each point
=1.0	ipeapt=0.0 plus original edge coordinate points
= −1.0	No partial network edge printout

! nne — Number of network edges specified in current abutment; $2.0 \leq$ nne ≤ 10.0

! peatol — Tolerance (distance) used to establish equivalent points of current abutment:

=blank	Program default value used (.0001)
=user-specified tolerance value	Tolerance specified only once; same value is used for all subsequent abutments, if "peatol" is left blank

! nn	User-assigned network name from network inputs or network number assumed from input order of networks
! en	Edge number

Note: To specify a full network edge, omit the next two parameters.

! epinit	First network edge-point number in abutment; first and last edge-point numbers are interchangeable (see figure 5-17)
! eplast	Last network edge-point number in abutment

5.10.2 Forced Full-Doublet Network Edge Abutments ($ABU)

$ABU inputs geometrically move finer network edge points to a coarser network edge to establish an abutment. These inputs apply only to a full network edge abutting another full network edge. There are two types of forced full-doublet network edge abutments:

- When there is an equal number of edge points for both networks in the abutment, the first network edge points specified in $ABU are moved to the edge points of the second network.
- In the case of coarse network edge points (formed from a subset of edge points of a finer network), the edge points of the finer network which are not common are projected onto the coarse network edge (same capability as in $PEA).

Input Data for Full-Doublet Network Edge Abutments

Note: To accommodate changes in the options on the second card (ABT2), you can specify the $ABU input section more than once. The maximum number of panel edge points in an abutment is 200. The maximum number of equivalent panel edge-point locations in an abutment is 50.

```
$ABU - FOR FULL NETWORK EDGE ABUTMENT                                     ABT1
nabut                                                                     ABT2
abnet1(1)      absidel(1)      abnet2(1)      abside2(1)                  ABT3
abnet1(2)      absidel(2)      abnet2(2)      abside2(2)                  ABT3
abnet1(3)      absidel(3)      abnet2(3)      abside2(3)                  ABT3
.
.
abnet1(nabut) absidel(nabut)  abnet2(nabut) abside2(nabut)                ABT3
```

! nabut — Number of abutments

! abnet1 — Name or number of first network in abutment (finer paneling); this network edge is moved

! abside1 — Edge number for first network

! abnet2 — Name or number of second network in abutment (coarser paneling); this network edge is fixed

! abside2 — Edge number for second network

5.10.3 Liberalized Abutments ($EAT)

The liberalized abutment program function ($EAT) establishes doublet network edge relationships used by A502, and is applied to all doublet network edges. It determines full or partial abutment within a specified tolerance. The procedure used is similar to that for $PEA. However, $PEA is applied only to specified network edges and, in general, has a larger tolerance for determining equivalent points. $EAT geometrically averages full equivalence groups of points and projects other points onto the common abutment edge. It moves doublet network edge points to eliminate mismatches between network edges. While comparing network edge points, $EAT also establishes the matching information on doublet network edge points required to solve the potential flow problem.

$EAT examines doublet network edge points to find groups of equivalent edge points (identical points within a tolerance). Points which are equivalent but different are all changed to the average value of the equivalent points. With the liberalized abutment capability, A502 does not require doublet network edge abutments to be exact to the last significant figure input. $EAT allows calculation by program or user input of the tolerance used to establish equivalent points. Program-selected default tolerance is .001 times the minimum panel diagonal of all panels. The maximum user-specified tolerance is .03 times the minimum panel diagonal of all panels.

If the tolerance is too large, it is reduced to the maximum allowable value. Too large a tolerance can cause inappropriate points to be equal and bring together unwanted doublet network edge points. It is your responsibility to check points moved by $EAT for unwanted equivalent points. You cannot turn off the liberalized abutment capability for moving doublet network edge points.

To eliminate small mismatches in equivalent network edge points, specify a tolerance equal to the accuracy of your network geometry. If the network geometry is accurate to two significant figures to the right of the decimal point, set the tolerance equal to .01. This allows abutments to be met even when the network geometry contains a small error.

> **CAUTION:** If the tolerance is large, unwanted abutments may occur. Always check the summary of moved points.

To prevent $EAT from moving points if network edge geometry is identical, specify a tolerance smaller than the number of significant figures of the input geometry. For example, if geometry is defined using four significant figures to the right of the decimal point, set the tolerance to .00009.

In addition to the input tolerance, $EAT contains other options. Normally used options are defaulted. The following are $EAT options, and details are provided in the input section:

- Network geometry printed before $EAT (on)
- Network geometry printed after $EAT (off)
- Network-by-network cross-reference printed for abutment and abutment intersections
- Final network geometry checked for intersecting panels (off)
- Control of abutment printout

Input Data for Liberalized Abutments

Input of a block of data for liberalized abutments is optional and primarily specifies the tolerance used by the liberalized abutment processor. If this block is omitted, the program picks a tolerance based on a fraction of the minimum panel diagonal. The remaining options are defaulted. These rarely used options include: printout of network geometry before (turned on) and after (turned off) liberalized abutment processor, troubleshooting printout for abutments, and checkout to see if the final abutted configuration intersects any other portion of the configuration.

```
$EAT - LIBERALIZED ABUTMENTS                                          EA1
epsgeo   igeoin      igeout   nwxref    triint    iabsum              EA2
```

! epsgeo — Absolute value of tolerance used to establish equivalent network edge points; minimum panel diagonal times 0.001 ≤ epsgeo ≤ minimum panel diagonal times 0.03

To not be restricted by the limits, input a negative value of tolerance. The absolute value of the input will be used as the tolerance.

Note: For most cases, the remaining options are defaulted, and do not have to be input.

! igeoin — Prints network geometry before $EAT:

=0.0 or blank	Prints geometry
=-1.0	Omits printout

! igeout — Prints network geometry after $EAT:

=0.0 or blank	Omits printout
=1.0	Prints geometry

! nwxref — Prints abutment cross-reference; for each network, all abutments and abutment intersections are described in a format similar to that used in the abutment summary and abutment intersection summary output sections:

=0.0 or blank	Omits printout
=1.0	Prints reference

! triint — Optionally checks for intersection of network edges through other panels for final geometry; used only if needed on complex configurations; can increase the cost of a computer run by one or two times that of a datacheck (2.) run

=0.0 or blank	Omits intersection checking
=1.0	Checks intersection

! iabsum — Prints abutment data

=0.0	Abutment summary
=1.0	iabsum=0.0 plus intersection summary
=2.0	iabsum=1.0 plus complete list of each network and the associated abutments (*currently not available*)
=3.0	iabsum=2.0 plus diagnostic data for program developer
=-1.0	No abutment printout

5.11 SECTIONAL PROPERTIES

Sectional forces, moments, and pressures are calculated along a specified plane (point and unit vector normal to the plane). Usually, A502 calculates wing sectional lift and induced drag properties. However, the plane can be defined arbitrarily to cut through specified networks or all networks. You need to define meaningful sectional properties by selecting appropriate networks and cuts.

Forces and moments are calculated by integrating the second-order pressure coefficient on the upper surface (CP2NU). Alternate pressure surfaces (lower or difference) can be requested. The pressure is assumed to have a linear variation over a panel. This integration method gives the most accurate answers consistent with A502 theory.

Input Data for Sectional Properties

```
$SECTIONAL PROPERTIES option                                    SP1
numgrp                                                          SP2
```

! Number of sectional cut groups (1. to 5.)

Notes:
- Repeat cards SP3-SP13 "numgrp" times.
- If all nonwake* networks are used in this cut group, omit cards SP3-SP5.

```
*NETWORK SELECTION for cuts                                     SP3
numnet                                                          SP4
netdat(1)                                                       SP5
netdat(2)                                                       SP5
.
.
netdat(numnet)                                                  SP5
```

! numnet	Number of networks input in card set SP5, preceded by a plus or minus sign; a negative number indicates that input network numbers are deleted from the assumed base of all nonwake networks
! netdat	Network numbers used to form a cut group

---

* Because kt = 19 wake networks have panel center control point properties, they have been included into the group of networks assumed for sectional properties. To exclude them from a standard computation of wing sectional properties, the kt = 19 wake networks should be removed via input (*NET).

Note: If only upper surface pressure coefficients are used in the cut group, omit cards SP6-SP8.

```
*PRESSURE SURFACE FOR CUTS                                SP6
numscd                                                    SP7
netdat(1)         surfcd(1)                               SP8
netdat(2)         surfcd(2)                               SP8
.
.
netdat(numscd)    surfcd(numscd)                          SP8
```

! numscd — Number of networks for which pressure surface is specified as being different from default

! netdat — Network number with pressure surface different from default

! surfcd — Pressure surface code:
=1.0 Upper surface
=2.0 Lower surface
=3.0 Difference surface (upper minus lower)

```
*CUT, REFERENCE, AND PRINT OUT (Figure 5-18)                                    SP9
optcrd     optmrp     iprtnf     iprtpp     isecpr     ixyzop     reflen       SP10 **
ncut                                                                            SP11
xc(1)      yc(1)      zc(1)      xcn(1)     ycn(1)     zcn(1)     len(1)       SP12 **
xc(2)      yc(2)      zc(2)      xcn(2)     ycn(2)     zcn(2)     len(2)       SP12 **
.
.
xc(ncut)   yc(ncut)   zc(ncut)   xcn(ncut)  ycn(ncut)  zcn(ncut)  len(ncut)    SP12 **
```

Note: If optcrd = 2.0, or optcrd = 1.0 and optmrp = 1.0, replace SP12 with the following inputs:

```
xc(1)      yc(1)      zc(1)      xcn(1)     ycn(1)     zcn(1)     len(1)       SP12 **
chrd(1)    refrac(1)                                                           SP13 **
.
.
```

! To define remaining cuts, repeat SP12, or SP12 and SP13.

** Format (7F10.0)

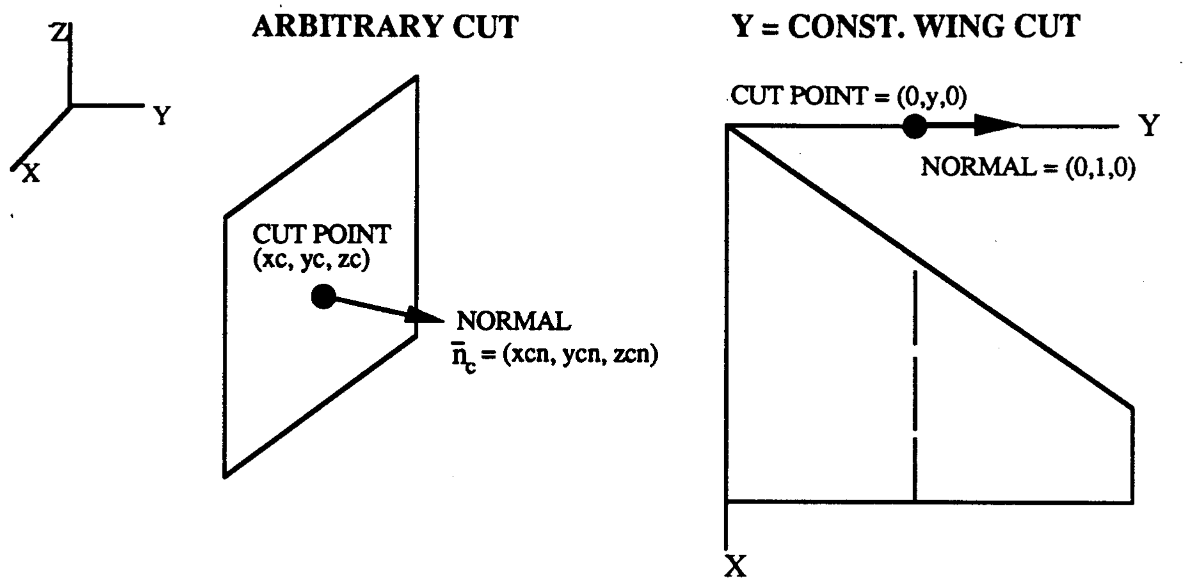


Figure 5-18 Example of Data Used to Specify Sectional Cuts

! optcrd — Chord definition (see figure 5-19):

=0.0	Maximum minus minimum X, Y, or Z of a cut (see definition of "ixyzop" below)
=1.0	Maximum distance between two points of a cut
=2.0	Input chord value for each cut on card SP13

! optmrp — Moment reference definition (see figure 5-20):

=0.0	3D moment reference point (xref, yref, zref)
=1.0	Chord fraction (SP13) specified for each cut along chord defined by optcrd = 1.0
=2.0	Point defining cut plane (xc, yc, zc) on card SP12

! iprtnf — Option to print sectional properties for each network:

=0.0	Does not print
=1.0	Prints

! iprtpp — Option to print panel pressures along a cut:

=0.0	Does not print
=1.0	Prints

! isecpr — Uses diagnostic printout to check cut traces, integration across a surface, and coefficients of pressure distribution on each panel:

=0.0	Does not print (recommended)
=1.0	Prints

! ixyzop — Option to select preferred direction for defining chord:

=0.0 or 1.0	The X direction
=2.0	The Y direction
=3.0	The Z direction

! reflen — Reference length for nondimensionalizing the sectional cut location; (default value of 1.; see "len" below)

Note: For a wing, enter semi-span

! ncut — Number of cuts (1.0 to 25.0)

! xc, yc, zc — Coordinates of point in cut plane

! xcn, ycn, zcn — Components of normal vector ($\tilde{n}_c$) perpendicular to cut plane

! chrd — Reference chord for each cut

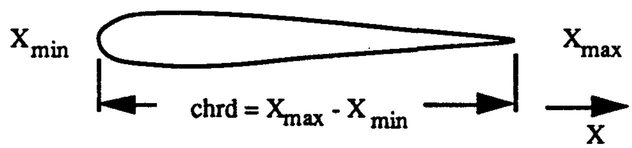
! refrac — Chord fraction for each cut used to define moment reference location

! len — Length used to form fraction (len/reflen) for a section

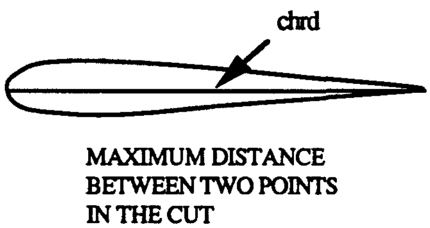
The *order of pressure locations* for a cut is based on the order of the input networks. Within a network, order is based on an examination of each panel as the panels are numbered. Pressures in the printout and the GGP file can be out of order (as you think appropriate). For example, if a cut is taken through a horizontal stabilizer (y = constant), with panel column edge conforming to the side of an aft fuselage with closure, the results on the first panel column near the leading edge can appear before the results on the second panel column near the trailing edge. When you are using a LINE or CURVE option in GGP, the abscissa is not continuous. Currently, the solution for this problem is to plot the points using GGP, then connect the data points by hand.

Sectional chord and moment reference location can be determined by the program or input directly for each section. The chord options calculated by the program are based on the minimum and maximum X, Y, or Z coordinates or on the distance between points of a cut. If the last chord option is selected, specify a program-calculated moment reference option as a fraction of chord length. You can also use the 3D moment reference for the sectional moment reference. These options are summarized in figures 5-19 and 5-20.

<u>optcrd = 0.</u>



<u>optcrd = 1.</u>



<u>optcrd = 2.</u>

Input chord value (chrd) for each cut.

Figure 5-19 Sectional Property Input Options for Chord Definition

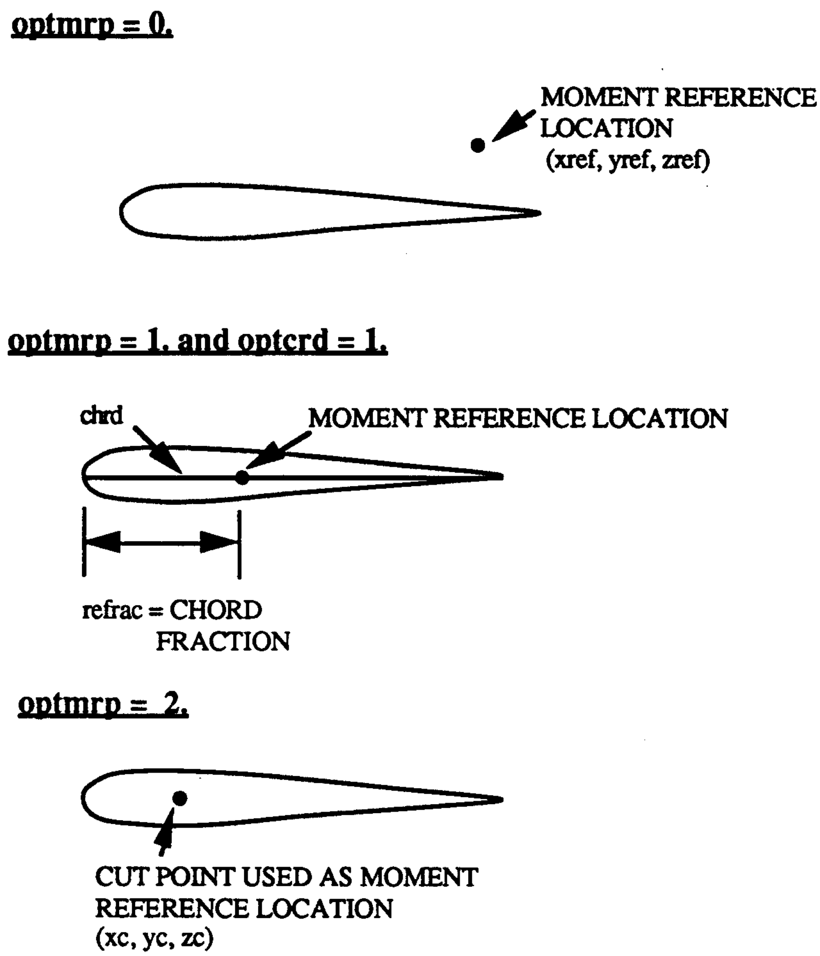


Figure 5-20 Sectional Property Input Options for Moment Reference Definition

5.12 FLOW-FIELD PROPERTIES–OFF-BODY POINTS AND STREAMLINES

A502 can compute mass flux or velocity components, second-order pressure coefficient, and perturbation potential (flow-field properties) for:

- Points in flow field (off-body points) input as:
  - Points
  - Grid of points
- Streamlines traced in flow field

The program calculates these flow-field properties from all surfaces or from a selected group of surface networks. It processes flow-field point properties for all solutions, and streamlines for one or more selected solutions.

Note: The total number of flow-field points (points plus grid of points) must be less than 1666 for one solution; 1000 for two solutions; 666 for three solutions; 500 for four solutions; the total number of streamlines must be less than 500.

CAUTION: The $FLO data block is *required* to compute flow-field properties.

```
$FLOW-FIELD PROPERTIES (INTRODUCTION)                              OF1
nflowv      tpoff                                                  OF2
```

! nflowv	=0.0	No off-body points provided (default)
	=1.0	Information calculated at off-body points
! tpoff	=0.0	Mass flux components
	=1.0	Velocity components

Note: If flow-field properties are computed from all networks, omit the $NWL data block. Use the $NWL data block only to compute flow-field properties from a subset of the total number of surface networks.

```
$NWL - NETWORK SELECTION FOR FLOW-FIELD PROPERTIES                          NWL1
nnofb                                                                       NWL2
nwofb(1)   nwofb(2)   nwofb(3)   nwofb(4)   nwofb(5)   nwofb(6)             NWL3
nwofb(7)   nwofb(8)   nwofb(nnofb)                                          NWL3
```

!nnofb	Number of networks to be included in flow-field property calculations (off-body points *and* streamlines)
! nwofb(i)	Network numbers to be included in flow-field property calculations

---

Note: Use the $XYZ data block to enter point locations for computing flow-field properties. This block may be repeated.

```
$XYZ - OFF-BODY POINT DATA ENTERED AS POINTS                                    XYZ1
iskl                                                                            XYZ2
xof(1)     yof(1)      zof(1)     xof(2)     yof(2)     zof(2)                  XYZ3
xof(3)     yof(3)      zof(3)     xof(4)     yof(4)     zof(4)                  XYZ3
.
.
xof(iskl) yof(iskl)   zof(iskl)                                                 XYZ3
```

! iskl — Number of subsequent off-body points input

! xof, yof, zof — The X,Y,Z coordinates of the off-body points; should be two points per line

Note: Use the $GRI data block to enter the point location as a grid (3D, 2D, 1D) of points for computing flow-field properties. The three points selected to define the directions are also used to order the grid points. The first point (x1, y1, z1) defines the first variation of grid points, the second point defines the second variation, etc. The resulting order of generated points is shown in figure 5-21. (So as not to change the input parameters, the current inputs list the points in reverse order.)

```
$GRIDS - OFF-BODY POINT DATA ENTERED AS GRID OF POINTS                          GR1
ngt                                                                             GR2
0x(1)      0y(1)       0z(1)      x3(1)       y3(1)       z3(1)                 GR3
x2(1)      y2(1)       z2(1)      x1(1)       y1(1)       z1(1)                 GR4
d3(1)      d2(1)       d1(1)      i3(1)       i2(1)       i1(1)                 GR5
.
.
```

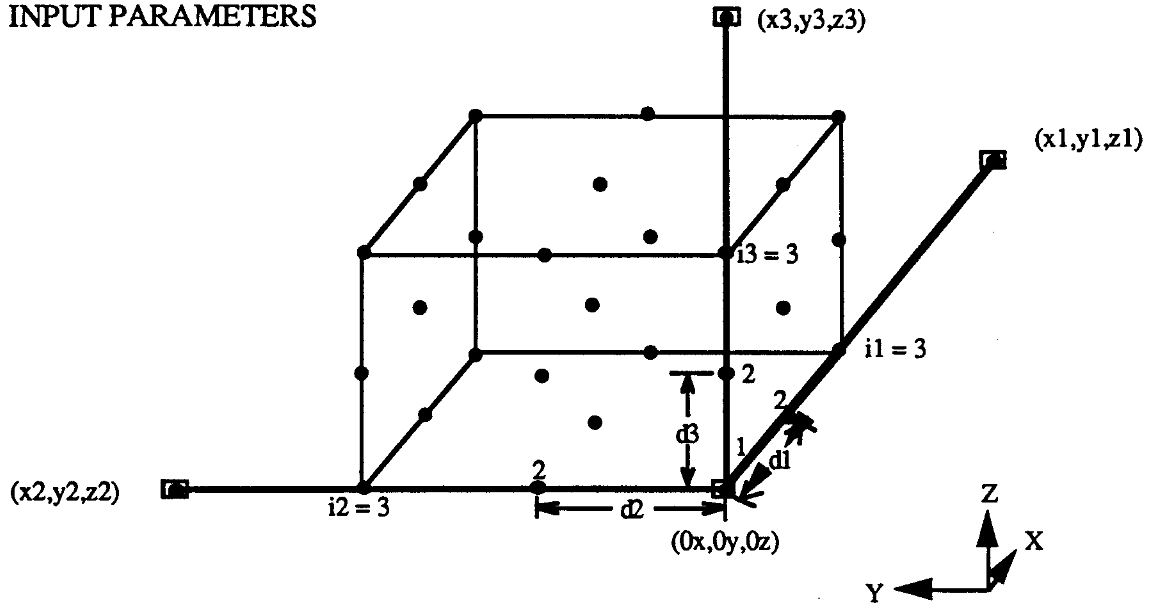
! To define remaining grids, repeat GR3-GR5.

! ngt — Number of grids for program to calculate; be aware of restriction on number of off-body points, noted in $FLO

! 0x, 0y, 0z — The X,Y,Z coordinates of grid origin

! x1,y1,z1 — The X,Y,Z coordinates of point determining first direction of variation

INPUT PARAMETERS



Assume that the X axis is the initial selected direction of variation, with the Y axis as the second direction and the Z axis as the final direction.

ORDER OF GRID POINTS

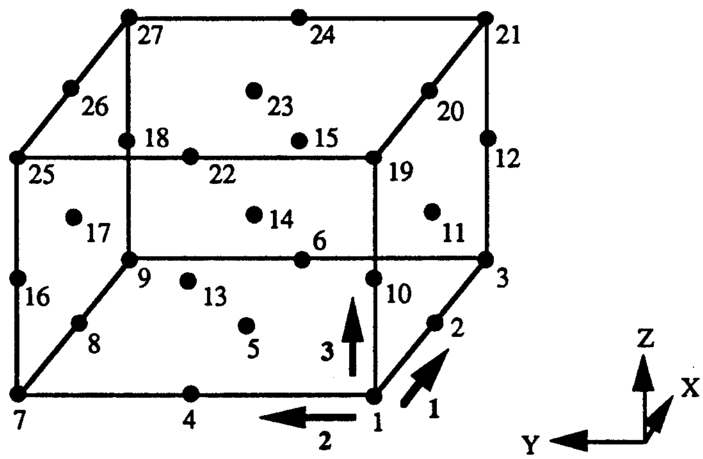


Figure 5-21 Order of Generated Points for $GRI Data Block

! x2,y2,z2	The X,Y, Z coordinates of point determining second direction of variation
! x3,y3,z3	The X,Y, Z coordinates of point determining third direction of variation
! d1, d2, d3	Distances between points in directions 1, 2, 3
! i1, i2, i3	Number of points in grid in directions 1, 2, 3

Note: The $STR data block is used to define information for computing flow-field streamlines.

CAUTION: Many long streamlines can cost a large amount of computer central processor time, thus causing an expensive computer run. Calculate streamlines with caution, until you become aware of the run cost.

```
$STREAMLINES                                                                   STR1
nstmln                                                                         STR2
numpts    hmin      hmax      maxstr    maxordr   abserr                       STR3
maxarr1   isprnt    tpsl      slno1     slno2     slno3     slno4              STR4*
x(1)      y(1)      z(1)      dx(1)     dy(1)     dz(1)                        STR5
fwdbk(1)                                                                       STR6
.
.
```

! To define remaining streamlines, repeat STR5 and STR6.

! nstmln	=0.0	Does not calculate streamlines
	=1.0	Calculates streamlines

Note: Nominal values of the following parameters are relative to a reference length of 1.0. For most geometries, upscale these values to a length scale relevant to the streamline calculation; for example, mean aerodynamic chord.

! numpts	Number of streamlines to be calculated; must not be greater than 500
! hmin	Minimum step size to be used in spatial integration
! hmax	Maximum step size to be used in spatial integration of streamlines

* Format (7F10.0)

! maxstr	Maximum number of integrations to be performed per streamline; less than 1000 (nominal value 100)	
! maxordr	Maximum order of finite difference formulas to which integration limits itself (use 6)	
! abserr	Absolute error to be allowed in integrations (nominal value 0.01)	
! maxarr1	Maximum size of scratch array (use 10000)	
! isprnt	=1.0 =0.0	Prints intermediate output Does not print intermediate output
! tpsl	=0.0 =1.0	Uses mass flux vector to calculate streamlines (recommended) Uses velocity vector to calculate streamlines
! slno1-slno4	=blank	Calculates streamlines only for first solution
	=solution numbers	One to four solution numbers specified; slno1-slno4 equals ascending order of solution number for calculating streamlines
! x, y, z	The X,Y,Z coordinates of starting point	
! dx, dy, dz	Maximum travel in X,Y,Z directions (stopping criterion) **Note:** Integration automatically stops when the X, Y, or Z coordinate of any point on the streamline reaches (x ± dx), (y ± dy), or (z ± dz), respectively.	
! fwdbk	=1.0 =-1.0	Integration proceeds downstream (increasing X) Integration proceeds upstream (decreasing X)

6. PROGRAM PRINTOUT

A502 printout reflects the sequential processing of the program. A large portion of the initial printout provides information on how the program interprets and processes a particular case. The latter portion of the printout gives analysis results. Of prime interest to you, the user, are the resultant forces and moments and the detailed pressures at each control point. Be sure to check these carefully to verify initial processing results.

Note that you are responsible for validating and accepting the aerodynamic results. The simple fact that A502 has given you answers does not mean that the results are acceptable.

- Sometimes the program traps the obvious errors for you (e.g., input errors with unreadable data and inappropriate number of cards) and discontinues processing.
- In other situations, the program gives you diagnostic information regarding the geometry of the boundary-value problem (e.g., warning messages for unabutted network edges, twisted panels, and low aspect-ratio panels).
- Sometimes there is only the normal printout to help you locate a problem (e.g., inappropriate supporting data–force and moment reference area).
- For a few problems, the printout provides no help (e.g., network defined with the upper-surface unit normal vector pointing into the interior of a configuration).

A502 originally used very detailed printed output for checkout of program algorithms. During development of this program, efforts have been made to make printed output as user-friendly as possible. The more detailed print options are now turned off to eliminate unnecessary exposure to processing details. For the rare occasions when detailed printouts may be of assistance in debugging a problem run, refer to appendix B.

This section describes only the portions of the A502 printout that you are likely to use as a directory to detailed comments for a particular output. An overview of significant printout is given in table 6-1.

- This table provides titles of the printout sections and index labels found in the program printout. Index labels are used to tag different printout sections. Thus, it is easy to find a particular section of the A502 printout when scanning the output in an editor on EKS.
- The table also lists input parameters, values used to control portions of the printout, and default values for print options. Some printout is directly related to selected options, e.g., sectional properties. Defaults are set to print only commonly used data.

The remainder of this section explains the content of the printout and provides examples for each printout section. Index labels have been included with the titles to each output section. Also included are comments on the importance of each section of printout and on interpretation of results.

Table 6-1 Printout Overview

Index Label	Data Block Title	Input Controls	Section
O*B*INPUT-DA			
	-- LIST OF A502 INPUT DATA CARDS --		6.3
	RECORD OF INPUT PROCESSING		6.4
	***** QUICK SUMMARY OF A502 INPUT *****		6.5
	RECORD OF FORCED PARTIAL EDGE ABUTMENT PROCESSING (ONLY CHANGED POINTS ARE REPORTED)	$PEA	6.6
O*E*INPUT-DA			
O*B*LIBGEOAB			
	*****LIBERALIZED GEOMETRY ABUTMENT ANALYSIS***** EDGE ABUTMENT TOLERANCE=____		6.7
O*B*GEOBFADJ			
	***** GEOMETRY BEFORE LIBERALIZED GEOMETRY ADJUSTMENT (CONTROLLED BY $EAT)*****	$EAT igeoin=0.0 *	6.7.1
O*E*GEOBFADJ			
O*B*ABUT INT			
	ABUTMENT INTERSECTION SUMMARY	$EAT iabsum≥1.0	6.7.2
O*B*EXTRA-CP	*****SUMMARY OF EXTRA CONTROL POINTS*****		
O*E*EXTRA-CP			
O*E*ABUT INT			
O*B*ABUTMENT	ABUTMENT SUMMARY	$EAT iabsum≥0.0 *	6.7.3
O*E*ABUTMENT			
O*B*NWEDGMOV	LIST OF NETWORK EDGE POINTS MOVED BY $EAT		6.7.5
O*E*NWEDGMOV			
O*B*ABNWXREF			
	NETWORK-BY-NETWORK ABUTMENT CROSS-REFERENCE • Print off • Print abutments and abutment intersections	$EAT nwxref=0.0 * nwxref=1.0	
O*E*ABNWXREF			
O*E*LIBGEOAB	(End of liberalized geometry abutments)		
	PANEL DATA	igeomp=1.0	B.1
	CHECKING INTERSECTIONS OF TRIANGULAR SUBPANELS • Print off • Print panel intersections	$EAT triint=0.0 * triint=1.0	

Index Label	Data Block Title	Input Controls	Section
O*B*NETNORML			
	=== PANEL NORMALS FOR NETWORK 1, ETC.	$PRINT	B.3
	• Print off	icontp=0.0 *	
	• Print panel normals	icontp=2.0 **	
O*E*NETNORML			
	CONTROL POINTS FOR NETWORK 1,ETC.	$PRINT	B.4
	• Print off	icontp=0.0 *	
	• Print control points	icontp=1.0 ***	B.4
	BOUNDARY CONDITION INFORMATION FOR NET. , ETC.	$PRINT	B.5
	• Print off	ibconp=0.0 *	
	• Print boundary condition information	ibconp=1.0	
	(End of datacheck run)		
O*B*PROBLEM			
	PROBLEM AND NETWORK INDICES (Program generates AIC tape, TAPE4)		6.8
O*B*SOLUTION			
	SIMULTANEOUS SOLUTION NUMBER 1 Summary of flow conditions		6.9
	Singularity strengths & Singularity grid	$PRINT	B.7
	• Print off	isings=0.0 *	
	• Print singularity grid for wake networks	isings≥2.0	
	• Print singularity value in a table	isings≥3.0	
	• Print network array of singularity values	isings≥4.0	
	• Print singularity grid for all networks	isings=5.0	
	Flow properties at control points	$PRINT	6.10
	• Print 12 flow properties/control point (recommended)	ioutpr=1.0 *	
	• Print 48 flow properties/control point	ioutpr=0.0	
	• Print off	ioutpr=-1.0	
O*B*FOR-MOM-NET#-1			
	FORCE/MOMENT DATA FOR NETWORK 1	$PRINT	6.11
	• Print accumulated results per column, per net.	ifmcpr=0.0 *	
	• Print accumulated results per network	ifmcpr=1.0	
	• Print off	ifmcpr=-1.0	
O*E*FOR-MOM			
. . .	(Repeated for each network)		
O*B*SECTION			
	$SECTIONAL		6.12
	SECTIONAL PROPERTIES -- CUT DEFINITIONS AND REFERENCE DATA, SOLUTION 1, GROUP 1		6.12.1
	SECTIONAL PROPERTIES -- CUT FORCE AND MOMENT DATA, SOLUTION 1, GROUP 1		6.12.2
	SECTIONAL PROPERTIES -- NETWORK FORCE AND MOMENT DATA, SOLUTION 1, GROUP 1	$SECTIONAL	6.12.3
	• Print off	iprtnf=0.0 *	
	• Print on	iprtnf=1.0	

Index Label	Data Block Title	Input Controls	Section
	SECTIONAL PROPERTIES -- PANEL FORCE AND MOMENT DATA (AND PRESSURES), SOLUTION 1, GROUP 1	$SECTIONAL	6.12.4
	• Print off	iprtpp=0.0 *	
	• Print on	iprtpp=1.0	
	CUT NUMBER 1 . . .		
	(Repeated for each group of cuts) . . .		
O*E*SECTION			
	(End of first solution)		
O*B*SOLUTION			
	(Repeated for each solution)		
	INPUT CONFIGURATION FORCES AND MOMENTS SUMMARY	$FORCE	6.13
	FULL CONFIGURATION FORCES AND MOMENTS SUMMARY	$FORCE	6.13
O*B*OFF-BODY			
	OFF-BODY FLOW CHARACTERISTICS	$FLOW-FIELD $XYZ $GRID	6.14
O*E*OFF-BODY			
O*B*STREAML			
O*B*STREAML	(Streamline output)	$FLOW-FIELD	6.15
O*E*STREAML	$STREAMLINE		
	JOB COST SUMMARY BY FUNCTION		6.16
	LOCAL DATASETS		6.17
	DAYFILE		6.18

* **Default.**
** **Default datacheck**
*** **Default datacheck 1.0**

6.1 CASE AND A502 TITLE PAGE

The first printout section is a header page containing case title, user's name, date, and names of consultants.

6.2 PROGRAM UPDATES AND OUTPUT INDEX LABELS

The next output section describes latest program changes that have not been formally documented, maximum sizes of key parameters, and output index labels used for online editing of the printout.

6.3 A502 INPUT DATA CARDS (0*B*INPUT-DA)

The data card output section lists all inputs, with each line numbered. Certain diagnostic information may appear if errors have been found by the program. In most cases, the error messages are self-explanatory.

```
                    - LIST OF A502 INPUT DATA CARDS -

 1      $TITLE
 2      SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
 3      SAARIS  865-6209  M/S 7C-36
 4      $SOLUTION
 5      $SYMMETRY - XZ PLANE OF SYMMETRY
 6      =MISYMM   MJSYMM
 7      1.        0.
 8      $MACH NUMBER
 9      =AMACH
10      .6
11      $CASES - NO. OF SOLUTIONS
12      =NACASE
13      3.
14      $ANGLES-OF-ATTACK
15      =ALPC
16      4.
17      =ALPHA(1) ALPHA(2)  ALPHA(3)
18      4.        10.       0.
19      $PRINTOUT OPTIONS
20      =ISINGS   IGEOMP    ISINGP    ICONTP    IBCONP    IEDGEP
21      0.        0.        0.        0.        0.        0.
22      =IPRAIC   NEXDGN    IOUTPR    IFMCPR
23      .0        .0        1.        0.
24      $REFERENCES FOR ACCUMULATED FORCES AND MOMENTS
25      =XREF     YREF      ZREF
26      46.       0.        0.
27      =SREF     BREF      CREF      DREF
28      2400.     60.       40.       90.
29      $POINTS - WING-BODY  WITH COMPOSITE PANELS
30      =KN
31      4.
32      =KT
33      1.
34      =NM       NN                                                        NETNAME
35      11.       3.                                                        WINGA
36      =X(1,1)   Y(1,1)    Z(1,1)    X(*,*)    Y(*,*)    Z(*,*)
37         69.4737    9.2105    0.0000   63.7818    9.5807    0.7831
38         53.7705    9.7741    1.9747   37.2370    9.4677    1.9614
39         30.2755    9.1527    0.8173   29.4086    9.1127   -0.0025
40         30.2800    9.1529   -0.8192   37.2409    9.4679   -1.9617
.
.
.
```

6.4 RECORD OF INPUT PROCESSING

The input processing record section of the printout lists keywords from input data processing. If an obvious input error is detected, the program aborts. The last keyword line read in helps to locate the input problem. A sample of this printout is shown below.

```
                              RECORD OF INPUT PROCESSING

$TITLE
$SOLUTION
$SYMMETRY - XZ PLANE OF SYMMETRY
$MACH NUMBER
$CASES - NO. OF SOLUTIONS
$ANGLES-OF-ATTACK
$PRINTOUT OPTIONS
$REFERENCES FOR ACCUMULATED FORCES AND MOMENTS
$POINTS - WING-BODY  WITH COMPOSITE PANELS
    KN,KT           4          1
   NETWORK # BEING PROCESSED   1   11.0000   3.0000   0.0000   0.0000   0.0000   0.0000   WINGA

   NETWORK # BEING PROCESSED   2    6.0000   2.0000   0.0000   0.0000   0.0000   0.0000   WINGTA

   NETWORK # BEING PROCESSED   3   11.0000   3.0000   0.0000   0.0000   0.0000   0.0000   BODYL

   NETWORK # BEING PROCESSED   4   11.0000   3.0000   0.0000   0.0000   0.0000   0.0000   BODYU

$POINTS - BODYBASE WITH COMPOSITE PANELS
    KN,KT           1          5
   NETWORK # BEING PROCESSED   5    5.0000   2.0000   0.0000   0.0000   0.0000   0.0000   BODYB

$POINTS - BODY TO WING WAKES
    KN,KT           1         20
   NETWORK # BEING PROCESSED   6    4.0000   2.0000   0.0000   0.0000   0.0000   0.0000   AWBW

$TRAILING WAKES FROM WINGS
    KN,KT           1         18
   NETWORK # BEING PROCESSED   7                                                          WINGWK

$TRAILING WAKES FROM BODY
    KN,KT           2         18
   NETWORK # BEING PROCESSED   8                                                          BODYLWK

   NETWORK # BEING PROCESSED   9                                                          BODYUWK

$PEA - PARTIAL OR FULL NETWORK EDGE ABUTMENTS
$EAT - LIBERALIZED ABUTMENTS
$SECTIONAL PROPERTIES
*NETWORK SELECTION FOR SECTIONAL PROPERTIES
*CUT AND REFERENCE PRINTOUT FOR SECTIONAL PROPERTIES
$FLOWFIELD PROPERTIES
$XYZ COORDINATES OF OFF-BODY POINTS
$GRID - OFFBODY POINTS ENTERED AS A GRID OF POINTS
$STREAMLINES IN THE FLOW FIELD
 --INDVSL         4
     1.          1          0          0          0
 --NCASSL         1
$END OF A502 INPUTS


TPCRIT, M    0.784004    0.600000
```

6.5 QUICK SUMMARY OF A502 INPUT

The quick summary of A502 input gives a case summary of all input data and options. Additionally, the summary provides a good list of all network names, with associated network numbers. This printout section lists all input options, along with their user-assigned values. It also summarizes the aerodynamic data. A sample of the printout follows:

```
1                *** QUICK SUMMARY OF A502 INPUT ***
 TITLE1: SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
 TITLE2: SAARIS  865-6150  M/S 7K-04

0                PROCESSING OPTIONS
          0 = DATACHECK.    (0=REGULAR RUN,1=FULL DATACHECK,2=SHORT DATACHECK)
          0 = S.P. FLAG.    (0 ==> NO S.P. FILE (FT09) PROVIDED, 1 ==> LOCAL FILE FT09 WITH SINGULARITY VALUES IS PROVIDED)
          0 = AIC FLAG.     (0 ==>  NO AIC FILE (FT04) PROVIDED, 1 ==> LOCAL FILE FT04 WITH AIC-S IS PROVIDED BY THE USER)
          0 = B.L. FLAG     (0 ==> NO BOUNDARY LAYER FILE REQUESTED, 1 ==> BOUNDARY LAYER DATA WILL BE WRITTEN TO FILE FT17)
          0 = VELOCITY CORRECTION INDEX.  (0 ==> NO CORRECTION, 1 ==> MCLEAN CORRECTION, 2 ==>  BOCTOR CORRECTION)
          1 = FLOW VISUALIZATION FLAG.  (NONZERO ==> OFF-BODY AND STREAMLINE PROCESSING WILL BE PERFORMED)
          0 = OFF-BODY CALCULATION TYPE.  (0 ==> MASS FLUX, NONZERO ==> VELOCITY)
          0 = STREAMLINE CALCULATION TYPE.  (0 ==> MASS FLUX, NONZERO ==> VELOCITY)
         19 = NUMBER OF OFF-BODY POINTS.
          2 = NUMBER OF STREAMLINES TO BE TRACED.

0                CASE SUMMARY
          3 = NUMBER OF CASES
   0.600000 = MACH NUMBER
   4.000000 = COMPRESSIBILITY AXIS ANGLE OF ATTACK (ALPC)
   0.000000 = COMPRESSIBLIITY AXIS ANGLE OF SIDESLIP (BETC)
```

0 CASE	ALPHA	BETA	MAG(F-S-V)
1	4.000000	0.000000	1.000000
2	10.000000	0.000000	1.000000
3	0.000000	0.000000	1.000000

```
0                SYMMETRY OPTIONS
          1 = NUMBER OF PLANES OF SYMMETRY
          1 = X-Z PLANE OF SYMMETRY FLAG (0 ==> NO SYMMETRY, 1==> FLOW SYMMETRY, -1 ==> FLOW ANTISYMMETRY)
          0 = X-Y PLANE OF SYMMETRY FLAG (0 ==> NO SYMMETRY, 1==> FLOW SYMMETRY, -1 ==> FLOW ANTISYMMETRY)

0                CONFIGURATION SUMMARY
          9 = TOTAL NUMBER OF NETWORKS READ IN
        147 = TOTAL NUMBER OF MESH POINTS
         78 = TOTAL NUMBER OF PANELS
```

0NETWORK ID&INDEX		#ROWS	#COLS	SOURCE	DOUBLT	NLOPT1	NROPT1	NLOPT2	NROPT2	IPOT	# PTS	# PANS	CPNORM	CUM PT	CUM PN
WINGA	1	11	3	1	12	5	3	7	-2	2	33	20	2	0	0
WINGTA	2	6	2	1	12	5	3	7	-2	2	12	5	2	33	20
BODYL	3	11	3	1	12	5	3	7	-2	2	33	20	2	45	25
BODYU	4	11	3	1	12	5	3	7	-2	2	33	20	2	78	45
BODYB	5	5	2	1	12	6	9	7	-2	2	10	4	2	111	65
AWBW	6	4	2	0	20	0	9	6	2	2	8	3	0	121	69
WINGWK	7	2	3	0	18	0	9	15	2	2	6	2	0	129	72
BODYLWK	8	2	3	0	18	0	9	6	2	2	6	2	0	135	74
BODYUWK	9	2	3	0	18	0	9	6	2	2	6	2	0	141	76

NETWORK-ID&INDEX		UPPER SURF, INDEX		LOWER SURF, INDEX	
WINGA	1	AIR	0	AIR	0
WINGTA	2	AIR	0	AIR	0
BODYL	3	AIR	0	AIR	0
BODYU	4	AIR	0	AIR	0
BODYB	5	AIR	0	AIR	0
AWBW	6	AIR	0	AIR	0
WINGWK	7	AIR	0	AIR	0
BODYLWK	8	AIR	0	AIR	0
BODYUWK	9	AIR	0	AIR	0

```
          MATERIAL PROPERTIES FOR THE VARIOUS VALUES OF SURFACE INDEX

   MATERIAL INDEX  TEMPERATURE RATIO  PRESSURE RATIO      G          P          R      K/V RATIO  K/W RATIO  K/P RATIO
   --------------  -----------------  --------------  ---------  ---------  ---------  ---------  ---------  ---------
 AIR           0             1.00000          1.0000    1.00000    1.00000    1.00000    1.00000    1.00000    1.00000
                   FREE STREAM VECTORS FOR EACH MATERIAL
 MATERIAL & INDEXCASE 1 VX     VY      VZ  CASE 2 VX     VY      VZ  CASE 3 VX     VY      VZ  CASE 4 VX     VY      VZ
 ----------  -----  ------  ------  ------      ------  ------  ------      ------  ------  ------      ------  ------  ------
 AIR           0    0.9976  0.0000  0.0698      0.9848  0.0000  0.1736      1.0000  0.0000  0.0000

0                PRINT OPTIONS
              0 = SINGULARITY GRID PRINT FLAG
              0 = PANEL GEOMETRY PRINT FLAG
              0 = SPLINE DATA FLAG   ( 0 ==> OFF, NONZERO ==> ON )
              0 = CONTROL POINT INFORMATION PRINT FLAG
              0 = BOUNDARY CONDITION DATA PRINT FLAG
              0 = EDGE MATCHING INFORMATION PRINT FLAG
              0 = INDEX OF CONTROL POINT FOR WHICH AIC-S ARE PRINTED
              0 = EDGE CONTROL POINT FLOW PROPERTIES PRINT FLAG
              1 = OUTPUT CONTROL FLAG (-1 ==> NO SURFACE FLOW PROPERTIES, 0 ==> STANDARD OUTPUT, 1 ==> SHORT FORM OUTPUT )
              0 = FORCE/MOMENT CONTROL FLAG (-1 ==> NO FORCE AND MOMENT DATA, 0 ==> STANDARD OUTPUT, 1 ==> NW TOTALS ONLY )
              0 = PRINT FLAG FOR DETAILED COST INFORMATION DURING EXECUTION OF JOB
              0 = PRINT FLAG FOR SINGULARITY PARAMETER MAPS

0                ABUTMENT PROCESSING OPTIONS
     0.0000E+00 = GLOBAL EDGE ABUTMENT TOLERANCE SPECIFIED BY USER.  IF THIS VALUE IS ZERO, A DEFAULT VALUE WILL BE CALCULATED
                  LATER.   THIS DEFAULT VALUE IS TAKEN AS:  .001  *  (MINIMUM PANEL DIAMETER)
              1 = PRINT FLAG CONTROLLING GEOMETRY PRINTOUT  B E F O R E  THE ABUTMENT PROCESSING.  ( NONZERO ==> DO PRINT )
              0 = PRINT FLAG CONTROLLING GEOMETRY PRINTOUT  A F T E R    THE ABUTMENT PROCESSING.  ( NONZERO ==> DO PRINT )
              0 = NETWORK/ABUTMENT/ABUTMENT-INTERSECTION PRINT FLAG.  ( NONZERO ==> GENERATE THE CROSS REFERENCED ABUTMENT LISTING
              0 = CONTROL INDEX FOR PANEL INTERSECTION CHECKING.  ( NONZERO ==> DO PERFORM THE CHECK. )
              1 = ABUTMENT/ABUTMENT-INTERSECTION (SHORT LISTING) PRINT FLAG ( 0 ==> SUPPRESS, NONZERO ==> GENERATE USUAL PRINT )

                 FORCE AND MOMENT REFERENCE PARAMETERS
     2.4000E+03 = REFERENCE AREA FOR FORCE AND MOMENT CALCULATIONS.     (SREF)
     6.0000E+01 = ROLLING MOMENT REFERENCE LENGTH  (BREF)
     4.0000E+01 = PITCHING MOMENT REFERENCE LENGTH (CREF)
     9.0000E+01 = YAWING MOMENT REFERENCE LENGTH   (DREF)
     4.6000E+01 = X - COORDINATE FOR THE POINT ABOUT WHICH MOMENTS WILL BE CALCULATED  (XREF)
     0.0000E+00 = Y - COORDINATE FOR THE POINT ABOUT WHICH MOMENTS WILL BE CALCULATED  (YREF)
     0.0000E+00 = Z - COORDINATE FOR THE POINT ABOUT WHICH MOMENTS WILL BE CALCULATED  (ZREF)
              3 = PRESSURE COEFFICIENT INDEX (NPRCOF) (1=LINEAR, 2=SLENDERBODY, 3=2ND, 4=ISENTROPIC)

0                COORDINATES OF  19 OFF-BODY POINTS
                 1 X   19  (   1),     COLUMNS    1 THROUGH  10
   1   1 X  -50.000000  -20.000000   -5.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000
         Y    0.000000    0.000000    0.000000   22.500000   22.500000   22.500000   22.500000   27.500000   27.500000   27.500000
         Z    0.000000    0.000000    0.000000   -7.500000   -2.500000    2.500000    7.500000   -7.500000   -2.500000    2.500000
                 1 X   19  (   1),     COLUMNS   11 THROUGH  19
   1  11 X   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000
         Y   27.500000   32.500000   32.500000   32.500000   32.500000   37.500000   37.500000   37.500000   37.500000
         Z    7.500000   -7.500000   -2.500000    2.500000    7.500000   -7.500000   -2.500000    2.500000    7.500000

0                INPUT DATA FOR STREAMLINES.  NUMBER OF STREAMLINES =      2

     X(START)      Y(START)      Z(START)      DELX(MAX)     DELY(MAX)     DELZ(MAX)    UP/DOWN FLAG (0==> DOWNSTREAM, #0==> UPSTREAM)
    ----------    ----------    ----------    ----------    ----------    ----------    ------------
    4.0000E+01    3.0000E+01   -2.0000E+00    5.0000E+01    1.0000E+01    1.0000E+01    1.0000E+00
    4.0000E+01    3.0000E+01    0.0000E+00    5.0000E+01    1.0000E+01    1.0000E+01    1.0000E+00
1
```

6.6 RECORD OF FORCED PARTIAL EDGE ABUTMENT PROCESSING

This section of printout lists results obtained from processing partial edge abutments. Each abutment is numbered and treated separately. Listed for each abutment are:

- Network names and network numbers
- Network edge numbers
- Edge point numbers along the edge (a zero indicates that no point was matched)
- Maximum distance change for an adjusted point

A zero used for an edge point number indicates that no point was matched for this edge.

Be sure to review the data in this section to ensure that abutments you have specified are properly processed. The following is an example of printout for the record of forced partial edge abutment processing:

```
                         RECORD OF FORCED PARTIAL EDGE ABUTMENT PROCESSING
                              (ONLY CHANGED POINTS ARE REPORTED)

NW NAME      NW.EDGE MAX CHG  CORRESPONDING EDGE POINTS.  MINUS (-) --> POINT MOVED BY SPEA,  (*) --> EXCEEDS .2 OF A PANEL DIAMETER
WINGA           1.4  5.81E-01   1    2    3    4   -5    6
                                :    :    :    : 5E-1    :
BODYL           3.2  0.00E+00   9    8    7    6    0    5
                                :    :    :    :    :    :

NW NAME      NW.EDGE MAX CHG  CORRESPONDING EDGE POINTS.  MINUS (-) --> POINT MOVED BY SPEA,  (*) --> EXCEEDS .2 OF A PANEL DIAMETER
WINGA           1.4  5.84E-01   6   -7    8    9   10   11
                                : 5E-1    :    :    :    :
BODYU           4.4  0.00E+00   7    0    6    5    4    3
                                :    :    :    :    :    :


 FORCED PARTIAL EDGE ABUTMENTS PROCESSING COMPLETE


 OFF-BODY-POINTS NETWORK LIST,     9 NETWORKS
   1    2    3    4    5    6    7    8    9

 GEOMETRY INPUT COMPLETE

0*E*INPUT-DA

          LEADING EDGE CONDITIONS ON WAKE NETWORKS

          NW-ID    NW-NAME          CONDITION
          -----    -------    ----------------------
            7      WINGWK       VORTICITY MATCHING
            8      BODYLWK      DOUBLET MATCHING ONLY
            9      BODYUWK      DOUBLET MATCHING ONLY
```

Following the record of partial edge abutment processing, information is echoed concerning the networks which will be used to calculate the off-body and streamline flow properties and the type of wake leading-edge condition requested.

6.7 LIBERALIZED GEOMETRY ABUTMENT ANALYSIS (0*B*LIBGEOAB)

The liberalized geometry abutment analysis part of the program establishes abutment relationships (i.e., given a network panel edge, examines all other panel edges to determine which other edges are adjacent to it). Exposed doublet panel edges not abutting other edges are assumed to have doublet strength of zero. Warning messages are printed for such panel edges. Details of these messages are provided in the abutment summary data discussed in section 6.7.4. For the liberalized geometry abutment analysis to yield the correct results, *you are responsible for determining if all abutments are correct.*

During abutment processing (partial, full, or liberalized), configuration geometry may be modified to make abutments along the edges of a doublet panel network. For details, refer to network edge movement information in section 6.7.5. Remember, *you must ensure that all geometrical modifications are reasonable.*

> **Note:** Check and validate abutment processing results before making a solution run. Some types of abutment errors have no program stops; therefore, you are responsible for reviewing and accepting abutment processing based on a datacheck run.

The liberalized geometry abutment analysis printout consists of an introduction and five labeled output areas. The introduction is described below, while subsequent paragraphs contain details of the five output sections.

The introduction to the printout follows the liberalized geometry abutment analysis printout title. It gives the edge abutment tolerance used by the liberalized abutment processor to determine identical abutting network edge points. This tolerance is determined by the program as a fraction (.001) of the minimum panel diagonal (diameter); alternatively, you can specify the tolerance via the liberalized abutment input ($EAT). A sample of the introductory printout is shown below:

```
O*B*LIBGEOAB

1         *****  LIBERALIZED GEOMETRY ABUTMENT ANALYSIS  *****

0 EDGE ABUTMENT TOLERANCE   =   1.1749E-03
  MINIMUM PANEL DIAMETER    =   1.1749E+00
  SYMMETRY CONDITION INDEX  =            1
        1 --> PHI(S-S)
        2 --> PHI(A-S)
        3 --> PHI(A-A)
        4 --> PHI(S-A)
```

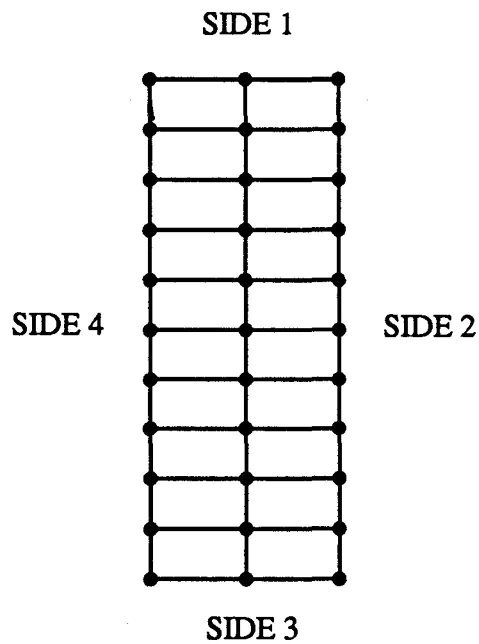
6.7.1 Geometry Before Liberalized Geometry Adjustment (0*B*GEOBFADJ)

The first main portion of the liberalized geometry abutment analysis outputs rectangular arrays of the points (X,Y,Z coordinates) used to define the networks. At this processing stage, points have been adjusted by the partial-network edge-abutment input ($PEA) and the old full-network edge-abutment input ($ABU). Some of the network edge points may have been altered to satisfy the abutments, according to specifications that you have made.

Each column of data output represents a column of network points. The X,Y,Z coordinates are stacked, and each set is considered to form one network point. The first column represents the fourth edge of a network, while the last column gives the points for the second network edge. The first row in the printout represents the first edge of the network, and the last row describes the points for the third network edge. Typical printout for this section follows (accompanied by an explanatory illustration):

```
0*B*GEOBFADJ

1           *****  GEOMETRY BEFORE LIBERALIZED GEOMETRY ADJUSTMENT (CONTROLLED BY $EAT)  *****
  NETWORK INDEX =    1  IDENTIFIER = WINGA
  ROW COL                NROW  NCOL    -------  COLUMNS  ------->              BEFORE ADJUSTMENT OF
EDGE POINTS BY $EAT
                 11 X    3  (  11),    COLUMNS   1 THROUGH   3
   1   1 X   69.473700  76.666000  83.333000
         Y    9.210500  20.000000  30.000000
         Z    0.000000   0.000000   0.000000
   2   1 X   63.781800  70.846000  77.394300
         Y    9.580700  20.178100  30.000000
         Z    0.783100   0.783100   0.783100
   3   1 X   53.770500  60.767900  67.254100
         Y    9.774100  20.271100  30.000000
         Z    1.974700   1.974700   1.974700
   4   1 X   37.237000  44.340300  50.924800
         Y    9.467700  20.123800  30.000000
         Z    1.961400   1.961400   1.961400
   5   1 X   30.417412  37.487800  44.173300
         Y    9.158447  19.972200  30.000000
         Z    0.250579   0.817300   0.817300
   6   1 X   29.408600  36.634700  43.333000
         Y    9.112700  19.953000  30.000000
         Z   -0.002500  -0.002500  -0.002500
   7   1 X   30.420705  37.492200  44.177600
         Y    9.158600  19.972300  30.000000
         Z   -0.255672  -0.819200  -0.819200
   8   1 X   37.240900  44.344100  50.928600
         Y    9.467900  20.123800  30.000000
         Z   -1.961700  -1.961700  -1.961700
   9   1 X   53.772200  60.769500  67.255700
         Y    9.774100  20.271100  30.000000
         Z   -1.974600  -1.974600  -1.974600
  10   1 X   63.782300  70.846500  77.394800
         Y    9.580700  20.178100  30.000000
         Z   -0.783000  -0.783000  -0.783000
  11   1 X   69.473700  76.666000  83.333000
         Y    9.210500  20.000000  30.000000
         Z    0.000000   0.000000   0.000000
```



6.7.2 Abutment Intersection Summary–iabsum≥1.0 (O*B*ABUT INT)

The abutment intersection summary printout provides a complete list of all doublet corner abutments found by A502. This output should be of secondary interest to you, since the abutment summary output (section 6.7.4) gives a full summary of abutments along the entire edge of a network. Thus, if all edges are properly abutted, all abutment intersections are met. This will be output only if iabsum≥1.0 in $EAT input.

This printout section outputs no warning messages. Abutment intersections are numbered in the order of the corner point numbers, as they have been input for each network. Each intersection is listed only once. An example of abutment intersection summary printout follows:

```
                              ABUTMENT INTERSECTION SUMMARY

AI #  1               POINT DBLT     PREVIOUS SEGMENT       BOUNDARY    NEXT SEGMENT
        NW CORNER     TYPE TYPE      NW EDGE PT ABMT POS    CONDITION   NW EDGE PT ABMT POS

         1     4       4    12        1    3    3   -1      -->          1   4   1   -4          WINGA
         1     1       4    12        1    4   11    5      -->          1   1   1   -1          WINGA
EXTRA    3    -2       4    12        3    2    9   -4      AERO         3   2   9   -7          BODYL
EXTRA    4    -4       4    12        4    4    3   -7      AERO         4   4   3    5          BODYU
         6     2       5    20        6    4    4   -7      -->          6   2   1  -14          AWBW
         7     1       5    18        7    4    2  -14      -->          7   1   1   -1          WINGWK

AI #  2               POINT DBLT     PREVIOUS SEGMENT       BOUNDARY    NEXT SEGMENT
        NW CORNER     TYPE TYPE      NW EDGE PT ABMT POS    CONDITION   NW EDGE PT ABMT POS

         1     2       4    12        1    1    3    1      <--          1   2   1   -2          WINGA
         1     3       4    12        1    2   11    3      <--          1   3   1    1          WINGA
         2     2       4    12        2    4    6   -2      AERO         2   2   1    3          WINGTA
         7     2       5    18        7    1    3    1      -->          7   2   1  -17          WINGWK
```

6.7.3 Summary of Extra Control Points (O*B*EXTRA-CP)

Extra control points introduced to accommodate partial network edge abutments are summarized and printed in a table. These control points are used to match the doublet panel strength of adjacent network singularity parameters. They are placed along the network edge, close to a panel corner point. Extra control points are commonly introduced when a network corner occurs in the middle of another network edge, at the leading edge of the wing, or on the body when the body network splits to go around the wing. A sample of this printout is shown below:

```
O*B*EXTRA-CP


0 *****  SUMMARY OF EXTRA CONTROL POINTS  *****

      NW   EDGE   POINT  ROW  COL     FINE GRID LOCATION
  1.   1     2      6     6    3       11   5
  2.   1     4      6     6    1       11   1
  3.   3     2      5     5    3        9   5
  4.   3     2      9     9    3       17   5
  5.   4     4      3     9    1       17   1
  6.   4     4      7     5    1        9   1
  7.   5     4      3     3    1        5   1

O*E*EXTRA-CP
```

6.7.4 Abutment Summary (0*B*ABUTMENT)

The abutment summary printout provides a complete list of all doublet edge abutments found by A502 and is *of primary interest for checking abutments*. Summary features are:

- Printout of abutment number, network number, edge number, corresponding network edge-point numbers, etc., associated with each abutment
- Minus sign (-) on network edge-point numbers identifying points moved within tolerance by the liberalized abutment processor ($EAT)
- Emphasis on particular abutment messages output for any network edge not abutting another edge, or a plane of symmetry or antisymmetry; messages are of the following types:

  *** WARNING *** Identifies edges that do not abut another network edge or a plane of symmetry; edge doublet strength assumed to be zero.

  *** GENTLE REMINDER *** Identifies downstream wake edges, to which filaments (semi-infinite doublet sheets) are added.

- Numbering of abutments in order of network edge numbers for each network as input; each abutment has only one listing.

```
0*B*ABUTMENT
1                                 ABUTMENT SUMMARY

0ABUTMENT #   1
                     DBLT EDGE                        STARTS AT AI #   1      ENDS AT AI #   2
  NW.EDGE  NW/ID     TYPE TYPE  MATCHING  KUTTA-FL    CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   1.1  WINGA         12    4   VOR-MTCH                1   2   3
   1.3  WINGA         12    4                           3   2   1
   7.1  WINGWK        18    5   MU-MATCH  VOR-MTCH      1   2   3
0ABUTMENT #   2
                     DBLT EDGE                        STARTS AT AI #   3      ENDS AT AI #   2
  NW.EDGE  NW/ID     TYPE TYPE  MATCHING  KUTTA-FL    CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   1.2  WINGA         12    4                           1   2   3   4   5   6
   2.4  WINGTA        12    4   MU-MATCH                6   5   4   3   2   1
o
o
o
0ABUTMENT #  14
                     DBLT EDGE                        STARTS AT AI #  10      ENDS AT AI #   1
  NW.EDGE  NW/ID     TYPE TYPE  MATCHING  KUTTA-FL    CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   6.2  AWBW          20    2                           1   2   3   4
   7.4  WINGWK        18    2                           2   0   0   1
0ABUTMENT #  15      WAKE TRAILING EDGE UNABUTTED.   WAKE FILAMENTS WILL BE ADDED                        *** GENTLE REMINDER ***
                     DBLT EDGE                        STARTS AT AI #  10      ENDS AT AI #  11
  NW.EDGE  NW/ID     TYPE TYPE  MATCHING  KUTTA-FL    CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   6.3  AWBW          20    2                           1   2
0ABUTMENT #  16
                     DBLT EDGE                        STARTS AT AI #  11      ENDS AT AI #   6
  NW.EDGE  NW/ID     TYPE TYPE  MATCHING  KUTTA-FL    CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   6.4  AWBW          20    2                           1   2
   8.2  BODYLWK       18    2                           2   1
   9.4  BODYUWK       18    2                           1   2
0ABUTMENT #  17      WAKE SIDE EDGE LEFT UNABUTTED                                                           ***  WARNING  ***
                     DBLT EDGE                        STARTS AT AI #   2      ENDS AT AI #  12
  NW.EDGE  NW/ID     TYPE TYPE  MATCHING  KUTTA-FL    CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   7.2  WINGWK        18    2                           1   2
```

6.7.5 Network Edge Movement (0*B*NWEDGMOV)

The A502 network edge movement printout provides a summary of edge points of all network panels that have been moved. This summary shows you how the doublet panel network edges have been altered by the liberalized abutment processor. The printout includes the original and final coordinates for each abutment and the incremental difference. If no points have been moved, this printout section and index label are replaced by the following statement:

```
O*E*ABUTMENT

  *****  NO POINTS WERE MOVED BY THE LIBERALIZED GEOMETRY PROCESSOR (CONTROLLED BY SEAT)  *****


    ----      SUMMARY OF FREE WAKE TRAILING EDGES      ----
             (SEMI-INFINITE FILAMENTS TO BE ATTACHED)

    NW   NETWORK-ID   ABMT
    --   ----------   ----
     6   AWBW           15
     7   WINGWK         18
     8   BODYLWK        19
     9   BODYUWK        22
   T/ABTIDN    0.241143
  ABTCAL/ANL   0.000002

O*E*LIBGEOAB

0    SINGULARITY PARAMETER COUNTS
  NAIVE S.P. COUNT (BASED ON NETWORKING)          272
  BASIC S.P. COUNT (DUPLICATES SQUEEZED OUT)      257
       NO. OF UNKNOWN BASIC S.P.-S                164
       NO. OF  KNOWN  BASIC S.P.-S                 65
       NO. OF EQUIVALENCED BASIC S.P.-S            27
       NO. OF ZEROED  BASIC S.P.-S                  1
  FINAL S.P. COUNT ( KNOWN + UNKNOWN )            229
                                                          AFTER NW   1 HAVING   40 AIC ROWS,   40 CUM
                                                          AFTER NW   2 HAVING    6 AIC ROWS,   46 CUM
                                                          AFTER NW   3 HAVING   47 AIC ROWS,   93 CUM
                                                          AFTER NW   4 HAVING   41 AIC ROWS,  134 CUM
                                                          AFTER NW   5 HAVING   18 AIC ROWS,  152 CUM
                                                          AFTER NW   6 HAVING    1 AIC ROWS,  153 CUM
                                                          AFTER NW   7 HAVING    3 AIC ROWS,  156 CUM
                                                          AFTER NW   8 HAVING    4 AIC ROWS,  160 CUM
                                                          AFTER NW   9 HAVING    4 AIC ROWS,  164 CUM

1
O*B*PROBLEM
```

6.8 PROBLEM AND NETWORK INDICES (0*B*PROBLEM)

The printout of problem and network indices furnishes statistics regarding overall problems and details for each network. For very large cases, it shows some of the parameters that may have to be monitored so as not to exceed program limits. For most trouble-free boundary-value problems, this section is of little interest. A sample of the printout is shown below, followed by definitions of some of the printout symbols:

```
O*B*PROBLEM

                                                    PROBLEM AND NETWORK INDICES

  NNETT =    9  NZMPT = 147   NPANT =   78  NSNGT = 229   NSNGU = 164  NSNGK =   65  NCTRT = 188  NBCOT = 229

 SYMMETRY DATA,  NSYMM =    1  NISYM =    2  NJSYM =    1  MISYM =     1  MJSYM =    0

0    NW  =    1    2    3    4    5    6    7    8    9
     NTS =    1    1    1    1    1    0    0    0    0
     NTD =   12   12   12   12   12   20   18   18   18
     NM  =   11    6   11   11    5    4    2    2    2
     NN  =    3    2    3    3    2    2    3    3    3
     NZ  =   33   12   33   33   10    8    6    6    6
     NP  =   20    5   20   20    4    3    2    2    2
     NSS =   20    5   20   20    4    0    0    0    0
     NSD =   50   21   50   50   19    1    4    4    4
     NC  =   50   17   47   47   14    1    4    4    4
     NABC=   60   11   67   61   18    1    3    4    4
     IPOT=    2    2    2    2    2    2    2    2    2
     NWOFB    1    2    3    4    5    6    7    8    9
     NCA =    0   50   67  114  161  175  176  180  184  188
     NBCA=    0   48   69  117  165  183  184  188  192  196
     MAPCA    0   50   71  121  171  190  191  195  199  203
     NXSP=    2    0    2    2    1    0    0    0    0
  I/O CALLS          4          4          138
  I/O WORDS      77568      77568        20672
       MXRWS     MXCLS     MXBLKS      NRPB     NCPBKC     NCPBKW     NCPGP     NPABK     NPAGP
        100        192        192       100          0          0         2         0         2
  STRNS CALLS  TYPE 5/6 =    0   TYPE 6 =    1


   PIC COUNTS                                      PANEL/SOURCE  PANEL/DOUBLET  BLOCK/SOURCE  BLOCK/DOUBLET

   NO INFLUENCE                                           0             0             0             0
   MONOPOLE FAR FIELD                                  1056          1056             0             0
   DIPOLE FAR FIELD                                    5166          6010             0             0
   QUADRUPOLE FAR FIELD                                4247          4732             0             0
   ONE SUB-PANEL INTERMEDIATE FIELD                    5783          6349             0             0
   TWO SUB-PANEL INTERMEDIATE FIELD                    2257          2778             0             0
   EIGHT SUB-PANEL NEAR FIELD                           535           603             0             0


                    INFLUENCE COEFFICIENT GENERATION I/O COUNT
  NCALG-       0  NWRDG-          0  NCALT-        0  NWRDT-          0

OLOGICAL FLAGS FOR CP/2 ITERATION:
       F = BKPRNT, PRINT FLAG FOR SOLVER STATISTICS
0
              ***********************************
              *                                 *
              *       CONDITION INDICATORS      *
              *                                 *
              *  UNIFORM SOLUTION 0.365930E-11  *
              *                                 *
              ***********************************
```

Symbols used in the first output block of the problem and network indices printout are defined below:

NNETT	Total number of networks
NZMPT	Total number of network points
NPANT	Total number of panels
NSNGT	Total number of singularity parameters (see note below)
NSNGU	Total number of unknown singularity parameters in the problem
NSNGK	Total number of known singularity parameters
NCTRT	Total number of control points
NBCOT	Total number of boundary conditions **Note:** A properly processed boundary value has the same number of singularities (NSNGT) and boundary conditions (NBCOT). If NSNGT does not equal NBCOT, the system of linear equations cannot be solved.
NSYMM	=0 No symmetry =1 ZX is plane of symmetry =2 ZX and XY are planes of symmetry
NISYM	=1 ZX is not a plane of symmetry =2 ZX is a plane of symmetry
NJSYM	=1 XY is not a plane of symmetry =2 XY is a plane of symmetry
MISYM	ZX plane flow symmetry indicator: =0 No plane of symmetry =1 Symmetric flow =-1 Antisymmetric flow
MJSYM	XY plane flow symmetry indicator: =0 No plane of symmetry =1 Symmetric flow =-1 Antisymmetric flow

The next output block contains a column of data for each network. The rows of the block are designated by the symbols defined below:

NW	Network number
NTS	Source type
NTD	Doublet type
NM	Number of points in a network column
NN	Number of network columns
NZ	Number of network points
NP	Number of network panels
NSS	Number of source singularity network parameters
NSD	Number of doublet singularity network parameters
NC	Number of network control points
NABC	Number of boundary conditions in network
IPOT	Parameter for velocity vector computation after the solution
NWOFB	List of networks to be used in off-body and streamline calculations
NCA	Cumulative number of control points for each network (final numbering)
NBCA	Cumulative counts of boundary condition control points for input configuration (helpful for setting NECPT1, NECPT2 values for wind tunnel models)
MAPCA	Cumulative counts of boundary condition control points, including extra control points
NXSP	Number of extra singularity parameters added to accommodate partial network abutments

Data output next summarizes the different types of influence coefficients used in solving the boundary-value problem. This printout is self-explanatory. The final section of the problem and network indices printout contains the set of condition indicators for satisfaction of the system of linear equations. The largest acceptable value of a condition indicator for a good solution is approximately 10^{-7}. Values greater than this indicate a problem with the solution of the system of linear equations.

6.9 SIMULTANEOUS SOLUTION NUMBER (0*B*SOLUTION)

The simultaneous solution number printout introduces you to the results of each solution. The program outputs onset flow conditions for the solution.

A sample of the printout is given below:

```
0*B*SOLUTION
                                         SIMULTANEOUS SOLUTION NUMBER    1

 MACH NUMBER =   0.60000    ANGLE OF ATTACK =   4.00000    SIDESLIP ANGLE =   0.00000    FREESTREAM SPEED =   1.00000
 COMPRESSIBILITY FACTOR =   0.80000   COMPRESSIBILITY ANGLE OF ATTACK =   4.00000   COMPRESSIBILITY ANGLE OF SIDESLIP =   0.00000
 FREESTREAM VELOCITY = (   0.99756,   0.00000,   0.06976)   COMPRESSIBILITY DIRECTION = (   0.99756,   0.00000,   0.06976)
```

6.10 FLOW PROPERTIES AT CONTROL POINTS

A502 outputs detailed flow properties at control points, ordered by the panels for each network. Following the flow properties for each network, the program prints force and moment data for that network (see section 6.11). These two printout portions are repeated for each network in the configuration.

The output of flow properties is controlled by the input parameters ioutpr and nexdgn (see section 5.7). The output options are:

ioutpr	nexdgn	Description of Output
1.0	0.0	12 flow properties at panel center control points (standard)
0.0	0.0	48 flow properties at panel center control points
0.0	1.0	48 flow properties at all control points
-1.0	0.0	Deletion of printout for flow properties

Since wake networks do not have panel center control points, the results for wake network edge control points are only available with the third option. For almost all cases, the flow properties on the wakes are not of interest.

The first option (ioutpr = 1) gives the most commonly used output. It produces upper surface flow results at panel center control points. Printout includes control point location, mass flux components (indicate flow direction for subsonic flow), second-order pressure coefficient (recommended), isentropic pressure coefficient, Mach number, source strength, and doublet strength. A sample of the printout follows (refer to table 6-2):

```
1    NETWORK ID:WINGA       INDEX:  1   SOURCE TYPE =  1   DOUBLET TYPE = 12     NUMBER ROWS =  10    NUMBER COLUMNS =   2
```

JC	IP	X	Y	Z	WX	WY	WZ	CP2NDU	CPISNU	LMACHU	SOURCE	DOUBLET
15	1	70.2006	14.7247	0.3889	0.9806	-0.0280	-0.1318	0.0545	0.0539	0.5848	-0.1989	3.8196
16	2	62.3039	14.9272	1.3756	1.0601	-0.0562	-0.1292	-0.1996	-0.1981	0.6666	-0.1854	3.3459
17	3	49.0449	14.8798	1.9681	1.1241	-0.0619	0.0005	-0.4122	-0.4091	0.7348	-0.0694	1.0861
18	4	37.3803	14.6624	1.2518	1.1376	-0.0857	0.2083	-0.5256	-0.5190	0.7734	0.0963	-1.4239
19	5	33.4887	14.5451	0.2681	0.9794	-0.0004	0.7712	-0.5891	-0.5592	0.8152	0.5856	-2.4898
20	6	33.4820	14.5448	-0.2674	0.6618	0.3309	-0.4338	0.6037	0.5047	0.4346	0.6752	-2.9033
21	7	37.3399	14.6610	-1.2445	0.9945	0.0324	-0.1667	0.0040	0.0036	0.6018	0.2341	-3.0163
22	8	48.9759	14.8789	-1.9681	1.0745	-0.0056	-0.0012	-0.2382	-0.2375	0.6773	0.0709	-1.8185
23	9	62.2491	14.9280	-1.3821	1.0511	-0.0244	0.1253	-0.1873	-0.1869	0.6606	-0.0469	-0.0884
24	10	70.1612	14.7266	-0.3942	0.9771	-0.0062	0.1293	0.0467	0.0467	0.5852	-0.0610	0.2368
27	11	77.0685	25.0278	0.3889	0.9580	-0.1724	-0.1415	0.0918	0.0899	0.5747	-0.1989	2.8104
28	12	69.0775	25.0895	1.3757	1.0220	-0.1895	-0.1351	-0.1102	-0.1092	0.6395	-0.1853	2.7350
29	13	55.8370	25.0704	1.9681	1.0930	-0.1481	0.0007	-0.3229	-0.3204	0.7060	-0.0693	1.2905
30	14	44.2410	25.0060	1.3930	1.1468	-0.0821	0.2033	-0.5553	-0.5479	0.7834	0.0970	-0.8366
31	15	40.4081	24.9769	0.4111	0.9022	0.1925	0.7538	-0.3671	-0.3570	0.7436	0.5855	-2.0843
32	16	40.4025	24.9768	-0.4071	0.6563	0.5068	-0.3088	0.5540	0.4531	0.4540	0.6752	-2.4886
33	17	44.2019	25.0056	-1.3868	1.0366	0.1443	-0.1601	-0.1470	-0.1455	0.6511	0.2347	-2.2978
34	18	55.7712	25.0701	-1.9681	1.0660	0.0602	-0.0013	-0.2136	-0.2130	0.6695	0.0710	-0.9298
35	19	69.0244	25.0897	-1.3820	1.0228	0.0288	0.1177	-0.0934	-0.0933	0.6302	-0.0468	0.2706
36	20	77.0295	25.0283	-0.3941	0.9561	0.0990	0.1173	0.1043	0.1040	0.5672	-0.0610	0.2563

The second option (ioutpr = 0) controls printout of all flow properties at panel center control points. This output is lengthy, needed mostly for uncommon formulations of the boundary-value problem. The same data in an "E" format is placed in the A502 PF output file and can be accessed via the EFP program (see section 8.2). Following is a printout example (reference also table 6-2):

1 NETWORK ID:WINGA INDEX: 1 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 10 NUMBER COLUMNS = 2

JC IP	X	Y	Z	DO	DX	DY	DZ	SO	ANX	ANY	ANZ
IMACHU	WXU	WYU	WZU	PHEU	VXU	VYU	VZU	CPLINU	CPSINU	CP2NDU	CPISNU
IMACHL	WXL	WYL	WZL	PHEL	VXL	VYL	VZL	CPLINL	CPSINL	CP2NDL	CPISNL
WNU	WNL	PWNU	PWNL	VTU	VTL	PVTU	PVTL	CPLIND	CPSIND	CP2NDD	CPISND
15 1	70.2006	14.7247	0.3889	3.8118	-0.0084	-0.0457	-0.0035	-0.1989	0.0035	-0.0023	0.0265
0.5845	0.9804	-0.0282	-0.1318	3.8118	0.9629	-0.0282	-0.1330	0.0975	0.0568	0.0553	0.0547
0.6000	0.9976	0.0000	0.0698	0.0000	0.9976	0.0000	0.0698	0.0000	0.0000	0.0000	0.0000
0.0000	0.1988	-0.1989	0.0000	0.9724	0.9800	0.0466	0.0000	0.0975	0.0568	0.0553	0.0547
16 2	62.3039	14.9272	1.3756	3.3406	0.1115	-0.0708	-0.0112	-0.1854	0.0052	-0.0035	0.0446
0.6665	1.0600	-0.0562	-0.1292	3.3406	1.0872	-0.0562	-0.1273	-0.1513	-0.1957	-0.1993	-0.1978
0.6000	0.9976	0.0000	0.0698	0.0000	0.9976	0.0000	0.0698	0.0000	0.0000	0.0000	0.0000
-0.0002	0.1851	-0.1854	0.0000	1.0961	0.9827	0.1323	0.0000	-0.1513	-0.1957	-0.1993	-0.1978
17 3	49.0449	14.8798	1.9681	1.0808	0.1945	-0.0619	0.0050	-0.0694	-0.0001	0.0000	0.0720
0.7348	1.1241	-0.0619	0.0005	1.0808	1.1922	-0.0619	0.0052	-0.3792	-0.3891	-0.4121	-0.4091
0.6000	0.9976	0.0000	0.0698	0.0000	0.9976	0.0000	0.0698	0.0000	0.0000	0.0000	0.0000
-0.0005	0.0689	-0.0694	0.0000	1.1938	0.9976	0.2041	0.0000	-0.3792	-0.3891	-0.4121	-0.4091
18 4	37.3803	14.6624	1.2518	-1.4287	0.2439	-0.0962	0.0502	0.0963	-0.0064	0.0034	0.0299
0.7733	1.1376	-0.0855	0.2083	-1.4287	1.2214	-0.0855	0.2142	-0.4667	-0.4905	-0.5254	-0.5188
0.6000	0.9976	0.0000	0.0698	0.0000	0.9976	0.0000	0.0698	0.0000	0.0000	0.0000	0.0000
-0.0421	-0.1384	0.0963	0.0000	1.2418	0.9904	0.2666	0.0000	-0.4667	-0.4905	-0.5254	-0.5188
19 5	33.4887	14.5451	0.2681	-2.4940	0.3022	-0.1871	0.1872	0.5856	-0.0024	0.0015	0.0041
0.8148	0.9792	-0.0003	0.7711	-2.4940	0.9963	-0.0003	0.7723	-0.0955	-0.5867	-0.5882	-0.5584
0.6000	0.9976	0.0000	0.0698	0.0000	0.9976	0.0000	0.0698	0.0000	0.0000	0.0000	0.0000
0.1599	-0.4258	0.5856	0.0000	1.2513	0.9048	0.3988	0.0000	-0.0955	-0.5867	-0.5882	-0.5584

Table 6-2 Control Point Flow Property Output Symbols

Symbol	Definition
ANX, ANY, ANZ	Components of upper surface unit normal vector ($\bar{n}$) scaled by ratio of panel area to reference area (sref): $\bar{n}$ * (panel area/sref)
CP2NDU, CP2NDL	Second-order pressure coefficients on upper and lower surfaces
CPISNU, CPISNL	Isentropic pressure coefficients on upper and lower surfaces
CPLINU, CPLINL	Linear pressure coefficients on upper and lower surfaces
CPSLNU, CPSLNL	Slender body pressure coefficients on upper and lower surfaces
D0 or DOUBLET	Doublet strength
DX, DY, DZ	Gradient of doublet strength in X, Y, and Z directions
IP	Panel number
JC	Control point number
LMACHU, LMACHL	Local Mach numbers on upper and lower surfaces
PHEU, PHEL	Perturbation potentials on upper and lower surfaces
PVTU, PVTL	Tangential component of perturbation velocity vector on upper and lower surfaces
PWNU, PWNL	Perturbation mass flux normal to upper and lower surfaces
S0 or SOURCE	Source strength
VXU, VYU, VZU VXL, VYL, VZL	Total velocity vectors on upper and lower surfaces in X, Y, and Z directions
VTU, VTL	Tangential component of velocity on upper and lower surfaces
WNU, WNL	Normal components of total mass flux vectors on upper and lower surfaces
WXU, WYU, WZU WXL, WYL, WZL	Components of total mass flux vectors on upper and lower surfaces
X, Y, Z	Coordinates of control point in reference coordinate system

The third option (ioutpr = 0, nexdgn = 1) is the same as the previous option and includes all the edge control point flow properties. While this data is interesting and sometimes useful, it is not consistently accurate. In addition, this data is difficult to work with, since all the extra control points generated by the program to satisfy the partial network edge abutments are included. Thus the arrays of control points no longer have the same number of points in a network column of control points. Collapsed network edges also contribute to this problem, since only one control point is used along a collapsed network edge.

> **CAUTION:** Using this option will result in a PF file, which cannot be used to generate GGP files via EFP program (see section 8.2). This is because no information is available on how to account for the extra control points.

Subsonic flow used in A502 is formulated using small perturbation theory. The analysis problem is linearized about the freestream Mach number. The flow results about the freestream are the most consistent with this approach. The results in the region of stagnation are not consistent with the small perturbation about the freestream. Since this region of stagnation, or near-stagnation, flow is so small as compared with the total problem area, little attention is paid to the poor results from this region. The computed mass flux and pressure coefficients are not realistic in the regions near stagnation. For some studies that require improved results in the stagnation region, two corrections are available (see section 5.8 for boundary layer and velocity correction control information). When these corrections are used, they are printed as the surface flow properties. The corrected pressures are never used in calculating forces and moments.

The second-order pressure coefficient is the recommended pressure coefficient because it is consistent with theory approximations. Even considering the poor result for the stagnation region, the integration of this coefficient gives the best results for forces and moments. Mass flux components are used to indicate flow direction in subsonic flow.

After obtaining a solution run, you must validate the results. Small regions of the configuration may exceed the basic assumptions of the analysis and have to be excluded or appropriately labeled. Some of these local errors do not invalidate remaining results. An extreme local error or error over a large region of the configuration may indicate a geometry error or an error in the formulation of the boundary-value problem. Some areas to look for are:

- Upper surface Mach numbers much larger than one
- Isentropic pressure coefficients lower than vacuum pressure, $-2/M_\infty^2$
- Upper surface unit normal vector mass flux values differing significantly from zero; impermeability not being achieved
- Second-order pressure coefficient deviating noticeably from isentropic pressure coefficient; indicates a violation of linear theory assumptions

6.11 FORCE-MOMENT DATA FOR NETWORK (0*B*FOR-MOM-NET#-1)

A502 prints force and moment data following the output of control point flow properties for each network (see section 6.10). The 3D forces (FX, FY, FZ) and moments (MX,MY,MZ) are calculated by integration of the *second-order pressure coefficient* over the *input nonwake network surfaces*. Pressure distribution is assumed to vary linearly over each panel. The surface area of the network is also included in the force-moment printout. This printout is controlled by the ifmcpr input parameter (see section 5.7). The output options are:

ifmcpr	Description of the Output
1.0	Prints force and moment per network and accumulated results for all previous networks
0.0	Same as above, with the addition of forces and moments for each column of network
-1.0	Deletes printout for network forces and moments

Printouts for the first and second options have the same form. However, the second option gives a more detailed breakdown of the results over the network panel columns. An example of the first option printout is given below. The three unlabeled rows of data are the results on the *upper, lower, and upper plus lower surfaces.*

```
0*B*FOR-MOM-NET#- 1
                                    FORCE / MOMENT DATA FOR NETWORK     1


 TOTALS FOR COLUMN        1      AREA          FX          FY          FZ          MX          MY          MZ

                              861.57317    -0.00165     0.00067     0.03366     0.00823     0.00466    -0.00006
                              861.57317     0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
                              861.57317    -0.00165     0.00067     0.03366     0.00823     0.00466    -0.00006

 TOTALS FOR COLUMN        2      AREA          FX          FY          FZ          MX          MY          MZ

                              802.62916    -0.00238     0.00159     0.02303     0.00935    -0.00052     0.00066
                              802.62916     0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
                              802.62916    -0.00238     0.00159     0.02303     0.00935    -0.00052     0.00066

 TOTALS FOR NETWORK              AREA          FX          FY          FZ          MX          MY          MZ

                             1664.20232    -0.00403     0.00226     0.05669     0.01758     0.00413     0.00060
                             1664.20232     0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
                             1664.20232    -0.00403     0.00226     0.05669     0.01758     0.00413     0.00060

 TOTALS FOR ALL NETWORKS SO FAR    AREA          FX          FY          FZ          MX          MY          MZ

                             1664.20232    -0.00403     0.00226     0.05669     0.01758     0.00413     0.00060
                             1664.20232     0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
                             1664.20232    -0.00403     0.00226     0.05669     0.01758     0.00413     0.00060
0*E*FOR-MOM
```

Force per panel column is represented by the following equation:

$$\bar{F}_{\substack{\text{panel}\\ \text{column}}} = -1/\text{sref} \int_{\substack{\text{panel}\\ \text{column}}} C_{p2nd}\ \bar{n}\ dA$$

where:

$\bar{F}$	=	3D forces (FX, FY, FZ)
sref	=	full airplane reference area; see details below
$\bar{n}$	=	unit normal vector to surface
dA	=	small increment of panel area
C_{p2nd}	=	second-order pressure coefficient

Moment per panel is:

$$\bar{M}_{\substack{\text{panel}\\ \text{column}}} = -1/\text{sref}\ L_T \int_{\substack{\text{panel}\\ \text{column}}} C_{p2nd}\ (\bar{P} - \bar{R}_o) \times \bar{n}\ dA$$

where:

$\bar{M}$ = 3D moments (MX,MY,MZ)

L_T = reference lengths for moment components as given below:

bref	=	reference length for MX (span)
cref	=	reference length for MY (chord)
dref	=	reference length for MZ (span)

$\bar{P}$ = point of integration on panel

$\bar{R}_o$ = moment reference location (XREF, YREF, ZREF)

Forces and moments for a panel column are found by summing the results over a panel column, and forces and moments for each network are found by summing the results for all columns of a network. Accumulated forces and moments are summed over all the previous networks. These results are printed out following the surface flow properties for each network.

6.12 SECTIONAL PROPERTIES (O*B*SECTIONAL)

The printout of sectional properties is divided into four main parts. A502 always outputs the first two parts, which give cut reference data used for developing cuts and integrated properties along each cut. The remaining output parts are optional. The third part gives integrated properties for each network, while the fourth part contains pressure along a cut. You will not usually need this output. See subsequent paragraphs for descriptions of outputs for each group of sectional properties input. The following symbols are commonly used in the printout:

Symbol	Description
MXP, MYP, MZP	Reference coordinate moment components along a panel cut $\{(-s/chord^2) * [(\bar{R}_{exit} - \bar{R}_{entry}) * (C_{p\ exit} - C_{p\ entry})/12 + (\bar{R}_{exit} + \bar{R}_{entry}) * 0.5 * C_{p\ avg.} - \bar{R}_R] \cdot \bar{n}\}$
$\bar{n}$ = (NX,NY,NZ)	Panel unit normal vector
$\bar{n}_c$	Normal vector perpendicular to cut plane
$\bar{u}$	Unit normal vector parallel to onset flow [cos(ALPHA) * cos(BETA), -cos(ALPHA) *sin(BETA), sin(ALPHA)]
$\bar{l}$	Unit lift vector in cut plane $[\bar{u} \times \bar{n}_c/\text{norm}(\bar{u} \times \bar{n}_c)]$
$\bar{d}$	Unit drag vector in cut plane $(\bar{n}_c \times \bar{l})$
$\bar{R}_R$	Reference coordinate position vector of moment reference point
$\bar{R}_{exit}$	Reference coordinate position vector of exit point from a panel and a cut plane
$\bar{R}_{entry}$	Reference coordinate position vector of entry point into a panel and a cut plane
C_p	Second-order pressure coefficient on a panel
s	Cut distance along a panel

6.12.1 Cut Definition and Reference Data

For each cut, A502 outputs the following data:

```
O*B*SECTION

0           SECTIONAL PROPERTIES - CUT DEFINITIONS AND REFERENCE DATA, SOLUTION NUMBER    1, GROUP NO.    1

OREFERENCE LENGTH FOR ETA =            30.00000
OCUT NO.      ETA        XC         YC         ZC         XCN        YCN        ZCN        XR         YR         ZR        CHORD

      1  5.000E-01  0.000E+00  1.500E+01  0.000E+00  0.000E+00  1.000E+00  0.000E+00  4.333E+01  1.500E+01 -1.875E-03  4.000E+01
      2  8.333E-01  0.000E+00  2.500E+01  0.000E+00  0.000E+00  1.000E+00  0.000E+00  5.000E+01  2.500E+01 -1.875E-03  4.000E+01
0


 GROUP NO.   1  USES THE FOLLOWING NETWORKS (BY NUMBER) AND SURFACE (SURF) PRESSURE DISTRIBUTION FOR COMPUTATIONS -


   1 UPPER


 NOTE - THE SAME PRESSURE DISTRIBUTION USED IN CALCULATING THE 3-D FORCES AND
        MOMENTS IS USED TO CALCULATE THE SECTIONAL PROPERTIES.  CURRENTLY, THE SECOND
        ORDER PRESSURE COEFFICIENT IS USED WITHOUT VELOCITY CORRECTIONS.
```

Header	Output Description
CUT NO.	Cut number
ETA	Coordinate for cut data, e.g., semi-span fraction or span coordinate for a wing (len/reflen)
XC,YC,ZC	Reference coordinates defining cut plane (input)
XCN,YCN,ZCN	Components of unit normal vector defining cut plane ($\bar{n}_C$) (input)
XR,YR,ZR	Reference coordinates defining moment reference point ($\bar{R}_R$)
CHORD	Chord used to nondimensionalize sectional forces and moments
CREF	Reference chord for 3D configuration (input under $REF)

6.12.2 Cut Force and Moment Data–Totals for Each Cut

A502 outputs force-moment data for each cut, including totals. This data is also output in a GGP-type file (see section 8). An example of the output follows:

```
1                 SECTIONAL PROPERTIES - CUT FORCE AND MOMENT DATA, SOLUTION NUMBER    1, GROUP NO.    1

0FORCE (X,Y,Z) AND MOMENT (X,Y,Z) IN GLOBAL COORDINATES.
 FORCE (L,D) IN CUT PLANE. FORCE (N) NORMAL TO CUT PLANE.
   DIRECTION OF POSITIVE CL IS: FREE STREAM VECTOR CROSSED INTO THE CUT PLANE NORMAL
   DIRECTION OF POSITIVE CN IS: SAME AS CUT PLANE NORMAL
   DIRECTION OF POSITIVE CD IS: CUT PLANE NORMAL CROSSED INTO THE LIFT (CL) VECTOR
 SECTIONAL MOMENT NORMAL TO CUT.

0       CUT NO.         CFX         CFY         CFZ         CMX          CMY          CMZ
            ETA         CDC         CNC         CLC  CLC*CHORD/CREF      CMC    CUT-LENGTH
       ________    ________    ________    ________    ________     ________    __________

              1   -0.008944    0.003597    0.185128   -0.000381     0.001584   -0.004017
       0.500000    0.003991    0.003597    0.185301    0.185300     0.001584   80.481757

              2   -0.014936    0.009958    0.136095   -0.000374    -0.001797   -0.001584
       0.833333   -0.005406    0.009958    0.136806    0.136806    -0.001797   80.659352
```

Header	Output Description
CUT NO.	Cut number
ETA	Coordinate for cut data, e.g., semi-span fraction or span coordinate for a wing (len/reflen)
CFX,CFY,CFZ	Reference coordinate force components
CMX,CMY,CMZ	Reference coordinate moment components
CDC,CNC,CLC	Induced drag in cut plane, force normal to cut, lift in the cut plane ($\bar{CF} \cdot \bar{u}$, $\bar{CF} \cdot \bar{n}$, $\bar{CF} \cdot \bar{l}$); represents true drag and lift only if y = constant for the cut and the flow has one plane of symmetry
CLC*CHORD/CREF	Load in cut plane
CMC	Moment normal to cut plane ($\bar{CM} \cdot \bar{n}_C$)
CUT-LENGTH	Length of cut

6.12.3 Network Force and Moment Data–Totals for Each Network (iprtnf = 1)

This section of the sectional properties printout provides force-moment data for each section of a network. It is identical to the printout for the cut force-moment data except that it is broken down into network totals.

6.13 CONFIGURATION FORCES AND MOMENTS SUMMARY

Forces and moments are figured on the input configuration defined from selected input networks, and on the full configuration with images reflected about the planes of symmetry. Planes of antisymmetry do not change the definition of the full configuration. The configuration is defined by the networks and pressure surfaces (upper, lower, or difference) specified in the forces and moments summary inputs for nonwake networks (section 5.6).

The forces (FX, FY, FZ) and moments (MX, MY, MZ) are summed from the previously generated network forces and moments (see section 6.11). Lift, induced drag, and side force are defined by:

$$\begin{aligned} CL &= -FX \sin(ALPHA)\cos(BETA) + FY \sin(ALPHA)\sin(BETA) + FZ \cos(ALPHA) \\ CD &= FX \cos(ALPHA)\cos(BETA) - FY \cos(ALPHA)\sin(BETA) + FZ \sin(ALPHA) \\ CY &= FX \sin(BETA) + FY \cos(BETA) \end{aligned}$$

where ALPHA and BETA are the angles of attack and yaw, respectively.

A sample of the force-moment printout is shown below. This data is also saved in a GGP forces and moments summary file for plotting (section 8).

****

INPUT CONFIGURATION FORCES AND MOMENTS SUMMARY

SOL-NO	ALPHA	BETA	CL	CDI	CY	FX MX	FY MY	FZ MZ	AREA
1	4.0000	0.0000	0.08140	0.00341	0.07005	-0.00228 0.01761	0.07005 0.01365	0.08144 0.00303	3953.75087
2	10.0000	0.0000	0.19981	0.02400	0.10904	-0.01106 0.04341	0.10904 0.03349	0.20094 0.00734	3953.75087
3	0.0000	0.0000	-0.00001	-0.00062	0.06218	-0.00062 0.00000	0.06218 0.00017	-0.00001 0.00215	3953.75087

****

0

FULL CONFIGURATION FORCES AND MOMENTS SUMMARY

SYMMETRY CONDITIONS: MISYMM = 1 MJSYMM = 0

SOL-NO	ALPHA	BETA	CL	CDI	CY	FX MX	FY MY	FZ MZ	AREA
1	4.0000	0.0000	0.16279	0.00682	0.00000	-0.00455 0.00000	0.00000 0.02731	0.16287 0.00000	7907.50174
2	10.0000	0.0000	0.39962	0.04801	0.00000	-0.02211 0.00000	0.00000 0.06699	0.40189 0.00000	7907.50174
3	0.0000	0.0000	-0.00001	-0.00123	0.00000	-0.00123 0.00000	0.00000 0.00033	-0.00001 0.00000	7907.50174

```
*****************************************************************************************************************************

1

CONFIGURATION IS COMPOSED OF THE FOLLOWING SELECTED NETWORKS
     1 WINGA              2 WINGTA              3 BODYL              4 BODYU

NOTE: THESE NETWORKS ARE ALL   KT=1   TYPES


REFERENCE CONDITIONS ARE:
SREF =          2400.00000 XREF =             46.00000 YREF =              0.00000 ZREF =             0.00000
                           CREF =             40.00000 BREF =             60.00000 DREF =            90.00000

*****************************************************************************************************************************
```

6.14 FLOW-FIELD PROPERTIES–OFF-BODY POINTS (0*B*OFF-BODY)

If the off-body point option has been requested, A502 prints off-body point locations, flow components, second-order pressure coefficient, perturbation potential, and other flow-field data. This data is output in the order of input of the off-body points. Output is continued for all solutions. A sample of the printout follows:

0*B*OFF-BODY

OFF BODY FLOW CHARACTERISTICS

SOLN	PT	X	Y	Z	WX	WY	WZ	PPOT	CP/2ND	MACH
1	1	-50.0000	0.0000	0.0000	0.9942	0.0000	0.0707	-0.2569	0.0103	0.5967
1	2	-20.0000	0.0000	0.0000	0.9833	0.0000	0.0722	-0.5808	0.0435	0.5860
1	3	-5.0000	0.0000	0.0000	0.9228	0.0000	0.0777	-1.3201	0.2225	0.5284
1	4	85.0000	22.5000	-7.5000	0.9815	0.0268	0.0570	-0.1401	0.0516	0.5834
1	5	85.0000	22.5000	-2.5000	0.9759	0.0530	-0.0009	-0.4010	0.0744	0.5765
1	6	85.0000	22.5000	2.5000	0.9759	-0.1103	-0.0193	2.2655	0.0659	0.5799
1	7	85.0000	22.5000	7.5000	0.9820	-0.0817	0.0175	1.8451	0.0500	0.5844
1	8	85.0000	27.5000	-7.5000	0.9835	0.0398	0.0856	0.0366	0.0382	0.5878
1	9	85.0000	27.5000	-2.5000	0.9742	0.1185	0.0888	0.0616	0.0535	0.5836
1	10	85.0000	27.5000	2.5000	0.9724	-0.1750	0.0684	1.5192	0.0473	0.5865
1	11	85.0000	27.5000	7.5000	0.9831	-0.0915	0.0523	1.3970	0.0400	0.5876
1	12	85.0000	32.5000	-7.5000	0.9875	0.0204	0.1067	0.1928	0.0214	0.5932
1	13	85.0000	32.5000	-2.5000	0.9815	0.0152	0.1530	0.4247	0.0245	0.5925
1	14	85.0000	32.5000	2.5000	0.9802	-0.0763	0.1402	0.8474	0.0277	0.5917
1	15	85.0000	32.5000	7.5000	0.9870	-0.0700	0.0830	0.9797	0.0248	0.5923
1	16	85.0000	37.5000	-7.5000	0.9916	0.0019	0.1027	0.2411	0.0101	0.5968
1	17	85.0000	37.5000	-2.5000	0.9897	-0.0122	0.1147	0.4042	0.0125	0.5961
1	18	85.0000	37.5000	2.5000	0.9895	-0.0362	0.1086	0.5885	0.0137	0.5958
1	19	85.0000	37.5000	7.5000	0.9917	-0.0443	0.0880	0.6960	0.0121	0.5962
2	1	-50.0000	0.0000	0.0000	0.9814	0.0000	0.1761	-0.2544	0.0094	0.5970
2	2	-20.0000	0.0000	0.0000	0.9706	0.0000	0.1798	-0.5750	0.0407	0.5870
2	3	-5.0000	0.0000	0.0000	0.9106	0.0000	0.1930	-1.3067	0.2117	0.5322
2	4	85.0000	22.5000	-7.5000	0.9706	0.1080	0.1119	-1.6337	0.0543	0.5827
2	5	85.0000	22.5000	-2.5000	0.9668	0.1748	-0.0153	-2.3941	0.0696	0.5793
2	6	85.0000	22.5000	2.5000	0.9659	-0.2315	-0.0336	4.2385	0.0500	0.5871
2	7	85.0000	22.5000	7.5000	0.9702	-0.1623	0.0730	3.3165	0.0514	0.5844
2	8	85.0000	27.5000	-7.5000	0.9721	0.1379	0.1876	-0.9898	0.0137	0.5968
2	9	85.0000	27.5000	-2.5000	0.9635	0.3367	0.2057	-1.0324	-0.0632	0.6267
2	10	85.0000	27.5000	2.5000	0.9575	-0.3926	0.1855	2.5958	-0.0763	0.6328
2	11	85.0000	27.5000	7.5000	0.9694	-0.1890	0.1548	2.4044	0.0191	0.5956
2	12	85.0000	32.5000	-7.5000	0.9748	0.0885	0.2474	-0.4039	-0.0140	0.6060
2	13	85.0000	32.5000	-2.5000	0.9674	0.0838	0.3709	0.1017	-0.0763	0.6291
2	14	85.0000	32.5000	2.5000	0.9634	-0.1441	0.3582	1.1564	-0.0678	0.6268
2	15	85.0000	32.5000	7.5000	0.9726	-0.1373	0.2240	1.5611	-0.0054	0.6035
2	16	85.0000	37.5000	-7.5000	0.9782	0.0369	0.2445	-0.1054	-0.0162	0.6063
2	17	85.0000	37.5000	-2.5000	0.9757	0.0060	0.2808	0.2608	-0.0290	0.6111
2	18	85.0000	37.5000	2.5000	0.9751	-0.0539	0.2747	0.7210	-0.0261	0.6102
2	19	85.0000	37.5000	7.5000	0.9778	-0.0786	0.2298	1.0306	-0.0117	0.6049
3	1	-50.0000	0.0000	0.0000	0.9966	0.0000	0.0000	-0.2570	0.0105	0.5966
3	2	-20.0000	0.0000	0.0000	0.9858	0.0000	0.0000	-0.5811	0.0439	0.5859
3	3	-5.0000	0.0000	0.0000	0.9254	0.0000	0.0002	-1.3210	0.2240	0.5279
3	4	85.0000	22.5000	-7.5000	0.9827	-0.0276	0.0200	0.8575	0.0507	0.5836
3	5	85.0000	22.5000	-2.5000	0.9759	-0.0286	0.0088	0.9315	0.0726	0.5766
3	6	85.0000	22.5000	2.5000	0.9767	-0.0288	-0.0097	0.9349	0.0717	0.5771
3	7	85.0000	22.5000	7.5000	0.9839	-0.0275	-0.0197	0.8520	0.0501	0.5841
3	8	85.0000	27.5000	-7.5000	0.9851	-0.0260	0.0171	0.7213	0.0438	0.5858
3	9	85.0000	27.5000	-2.5000	0.9754	-0.0278	0.0102	0.7912	0.0742	0.5761
3	10	85.0000	27.5000	2.5000	0.9764	-0.0287	-0.0102	0.7915	0.0727	0.5767
3	11	85.0000	27.5000	7.5000	0.9862	-0.0258	-0.0165	0.7161	0.0431	0.5863
3	12	85.0000	32.5000	-7.5000	0.9900	-0.0251	0.0121	0.5898	0.0294	0.5905
3	13	85.0000	32.5000	-2.5000	0.9849	-0.0307	0.0066	0.6377	0.0452	0.5855
3	14	85.0000	32.5000	2.5000	0.9854	-0.0306	-0.0061	0.6360	0.0448	0.5857
3	15	85.0000	32.5000	7.5000	0.9906	-0.0247	-0.0116	0.5858	0.0293	0.5907
3	16	85.0000	37.5000	-7.5000	0.9946	-0.0214	0.0075	0.4708	0.0158	0.5949
3	17	85.0000	37.5000	-2.5000	0.9930	-0.0243	0.0031	0.4974	0.0209	0.5933
3	18	85.0000	37.5000	2.5000	0.9931	-0.0242	-0.0029	0.4965	0.0209	0.5933
3	19	85.0000	37.5000	7.5000	0.9949	-0.0211	-0.0072	0.4685	0.0161	0.5949

0*E*OFF-BODY

Output parameters are defined below:

Parameter	Definition
SOLN	Solution number
PT	Off-body point number
X, Y, Z	Coordinates of off-body point
PPOT	Perturbation potential at off-body point
WX or VX, WY or VY, WZ or VZ	Components of mass flux vector (tpoff = 0.0, recommended) or velocity vector (tpoff = 1.0), where tpoff is specified in input section $FLO (see section 5.12)
CP/2ND	Second-order pressure coefficient at off-body point
MACH	Local Mach number

6.15 FLOW-FIELD PROPERTIES–STREAMLINES (0*B*STREAML)

If the flow-field streamline option has been requested, A502 prints streamline point locations, flow components, second-order pressure coefficient, perturbation potential, and other flow-field streamline data. The data is output in the order of input of the streamline starting points. An example of streamline data printout is given below:

```
O*B*STREAML
1

      NO. OF STREAMLINES IN CORE        (ICORE ) =    92
      STORAGE REQD. PER STREAMLINE      (IPTSEQ) =   108
      GLOBAL STORAGE REQUIRED.          (IABSPS) =    21
      STORAGE REQUIRED FOR ARRAY ARR1   (ITOTAL) =  9957     (+ 100 FOR ARRAY IWRK)


      NSTMIN, NUMPTS, HMIN, HMAX                   =     1        2     0.10000E+00     0.20000E+01
      MAXSTM, MXORDR, ABSERR, MXARR1, ISPRNT       =   100        6     0.10000E-01     10000    0


                               *** MAP OF ARRAY ARR1 IN OCTAL ***

         ISTMLN      ITINP      ITOUT     IRELER     IABSER     IPHIMX      IIPOS     IRELPS     IABSPS         IY
     0000000001 0000000017 0000001076 0000000020 0000000021 0000000022 0000000023 0000000024 0000000025 0000000026

             IT     IIFLAG        IYY         IP        IYP       IPHI     IALPHA      IBETA       ISIG         IV
     0000000452 0000002012 0000002302 0000002726 0000003352 0000003776 0000010236 0000011306 0000012356 0000013562

             IW         IG     IAPHSE       IPSI         IX         IH      IHOLD     IASTRT     ITOLD     IDELSN
     0000014632 0000015702 0000017106 0000017242 0000020312 0000020446 0000020602 0000020736 0000021072 0000021226

            INS     IIFAIL         IK      IKOLD     IICOMP     IIPTS1     IIPTS2      IKNEW       IEPS     IICRSH
     0000021362 0000021516 0000021652 0000022006 0000022142 0000022276 0000022432 0000022566 0000022722 0000023056

         IACRSH     ITOTAL     IHMNST     IHMXST     IMORDR     IDUMST     IPOTEN
     0000023212 0000023345 0000000606 0000000742 0000001232 0000001366 0000002146


                               *** MAP OF ARRAY ARR1 IN DECIMAL NUMBERS ***

         ISTMLN      ITINP      ITOUT     IRELER     IABSER     IPHIMX      IIPOS     IRELPS     IABSPS         IY
              1         15        574         16         17         18         19         20         21         22

             IT     IIFLAG        IYY         IP        IYP       IPHI     IALPHA      IBETA       ISIG         IV
            298       1034       1218       1494       1770       2046       4254       4806       5358       6002

             IW         IG     IAPHSE       IPSI         IX         IH      IHOLD     IASTRT      ITOLD     IDELSN
           6554       7106       7750       7842       8394       8486       8578       8670       8762       8854

            INS     IIFAIL         IK      IKOLD     IICOMP     IIPTS1     IIPTS2      IKNEW       IEPS     IICRSH
           8946       9038       9130       9222       9314       9406       9498       9590       9682       9774

         IACRSH     ITOTAL     IHMNST     IHMXST     IMORDR     IDUMST     IPOTEN
           9866       9957        390        482        666        758       1126
1
0     STREAMLINE NO. =    1     INTEGRATION POINTS =     34    STARTING POSITION =  0.400000E+02  0.300000E+02 -0.200000E+01
     ENDING POSITION =  0.910454E+02  0.256082E+02  0.309611E+01     MIN. MAX. STEP SIZE =  0.252497E-01  0.200000E+01
     MAX. ORDER =  5    FORWARD BACKWARD FLAG = 1.00  (NON ZERO VALUE INDICATES BACKWARD)

0     STREAMLINE NO. =    2     INTEGRATION POINTS =     36    STARTING POSITION =  0.400000E+02  0.300000E+02  0.000000E+00
     ENDING POSITION =  0.909429E+02  0.241617E+02  0.271506E+01     MIN. MAX. STEP SIZE =  0.252014E-01  0.200000E+01
     MAX. ORDER =  6    FORWARD BACKWARD FLAG = 1.00  (NON ZERO VALUE INDICATES BACKWARD)
```

O*B*STREAML

MASS FLUX STREAMLINE NUMBER 1 FOR CASE 1 FORWARD/BACK = 1.00

INT. PT.	INDEP. VARIABLE S	STREAMLINE LOCATION X	Y	Z	DIRECTION(-V/-W, BACKWARD INT) WX	WY	WZ	POTEN. PPOT	2ND ORDER CP CP/2ND	LOCAL MACH MACH	ORDER K
1	0.0000	40.0000	30.0000	-2.0000	0.9698	0.1203	0.0775	-1.1971	0.0691	0.5786	0
2	0.0252	40.0245	30.0030	-1.9980	0.9698	0.1207	0.0774	-1.1978	0.0691	0.5786	1
3	0.1252	40.1215	30.0152	-1.9903	0.9696	0.1226	0.0769	-1.2004	0.0693	0.5786	2
4	0.3252	40.3154	30.0401	-1.9751	0.9694	0.1264	0.0757	-1.2057	0.0694	0.5786	3
5	0.7252	40.7031	30.0922	-1.9453	0.9692	0.1344	0.0730	-1.2155	0.0683	0.5791	4
6	1.5252	41.4790	30.2067	-1.8899	0.9709	0.1527	0.0646	-1.2284	0.0598	0.5821	5
7	2.3252	42.2582	30.3372	-1.8427	0.9784	0.1739	0.0532	-1.2366	0.0321	0.5914	4
8	3.9252	43.8555	30.6418	-1.7632	1.0281	0.1995	0.0594	-1.1732	-0.1341	0.6452	4
9	5.3652	45.3623	30.9155	-1.6378	1.0492	0.1694	0.1234	-1.0118	-0.2087	0.6689	4
10	6.8052	46.8746	31.1250	-1.4160	1.0520	0.1261	0.1662	-0.8312	-0.2210	0.6726	4
11	8.2452	48.3874	31.2748	-1.1598	1.0491	0.0828	0.1852	-0.6545	-0.2106	0.6690	3
12	9.6852	49.8938	31.3697	-0.8886	1.0427	0.0520	0.1896	-0.4949	-0.1876	0.6614	3
13	11.1252	51.3917	31.4313	-0.6152	1.0390	0.0353	0.1908	-0.3523	-0.1746	0.6571	4
14	12.5652	52.8877	31.4723	-0.3387	1.0391	0.0203	0.1938	-0.2136	-0.1754	0.6573	4
15	14.0052	54.3844	31.4893	-0.0566	1.0391	0.0044	0.1976	-0.0734	-0.1767	0.6578	5
16	15.4452	55.8802	31.4837	0.2309	1.0386	-0.0122	0.2017	0.0678	-0.1773	0.6580	4
17	17.4452	57.9561	31.4346	0.6404	1.0372	-0.0373	0.2080	0.2657	-0.1771	0.6581	3
18	19.4452	60.0285	31.3315	1.0624	1.0351	-0.0666	0.2140	0.4663	-0.1764	0.6581	3
19	21.4452	62.0963	31.1626	1.4952	1.0326	-0.1040	0.2186	0.6725	-0.1769	0.6587	3
20	23.4452	64.1584	30.9062	1.9309	1.0295	-0.1554	0.2159	0.8889	-0.1789	0.6599	3
•											
•											
•											
33	48.6452	89.0793	25.8974	3.0289	0.9822	-0.1481	0.0354	1.6211	0.0319	0.5910	3
34	50.6452	91.0454	25.6082	3.0961	0.9838	-0.1411	0.0319	1.5971	0.0296	0.5917	3

MASS FLUX STREAMLINE NUMBER 2 FOR CASE 1 FORWARD/BACK = 1.00

INT. PT.	INDEP. VARIABLE S	STREAMLINE LOCATION X	Y	Z	DIRECTION(-V/-W, BACKWARD INT) WX	WY	WZ	POTEN. PPOT	2ND ORDER CP CP/2ND	LOCAL MACH MACH	ORDER K
1	0.0000	40.0000	30.0000	0.0000	0.9684	0.1206	0.1271	-1.1408	0.0595	0.5819	0
2	0.0252	40.0244	30.0030	0.0032	0.9683	0.1211	0.1274	-1.1413	0.0595	0.5819	1
•											
•											
•											
35	48.2452	88.9777	24.4286	2.7035	0.9818	-0.1369	0.0067	1.8599	0.0397	0.5885	4
36	50.2452	90.9429	24.1617	2.7151	0.9833	-0.1300	0.0051	1.8296	0.0372	0.5892	3

O*E*STREAML

Output parameters are defined below:

Parameter	Definition
INT. PT.	Integration point number
S	Independent variable of integration, arc length along streamline
X, Y, Z	Coordinates of point on streamline
WX or VX, WY or VY, WZ or VZ	Components of mass flux vector (recommended; default) or velocity vector, depending on value of tpsl in $STR data block (section 5.12)
POTEN.	Perturbation potential of point on streamline
2ND ORDER CP	Second-order pressure coefficient
LOCAL MACH	Local Mach number
ORDER	Number of previous streamline points used in integration to calculate the current streamline point

6.16 BOUNDARY LAYER INPUT DATA OR VELOCITY CORRECTION

If the $BOUNDARY LAYER option with McLean-Rubbert velocity correction (ivcorr=1.0), or the $VELOCITY CORRECTION option has been requested with McLean-Rubbert (ivcorr= 1.0) or Boctor (ivcorr=2.0) velocity corrections, the surface flow properties will be changed. The surface flow property output displays the corrected surface velocity components, mass flux components, pressures, and Mach numbers for both options. If the appropriate input options are selected (section 5.8), the flow field properties can be computed with this velocity correction. These printouts have the same form as the properties without the correction (section 6.10, 6.14, and 6.15).

The $BOUNDARY LAYER option produces a binary file (...BL, section 8.9). Within this option, if the McLean-Rubbert velocity correction is exercised, some additional output is generated for the corrected velocities. The printout comes after the Configuration Force and Moment Summary and has no title block. The data is provided for each solution and is ordered as in the same manner as the input networks. An example of boundary layer data printout is given below:

1CHORD	I	XP	YP	ZP	UP	VP	WP
1	1	2.00000	0.23241	-0.56579	0.60027	0.00012	0.00000
	2	2.00000	0.56440	-1.36727	0.59983	0.00067	-0.00025
	3	2.00000	0.73653	-1.78222	0.59944	0.00141	-0.00063
2	1	2.00000	0.56441	-0.23573	0.60027	0.00040	-0.00001
	2	2.00000	1.36590	-0.56772	0.59989	0.00146	-0.00015
	3	2.00000	1.78103	-0.73942	0.59930	0.00255	-0.00049
3	1	2.00000	0.56579	0.23241	0.60027	0.00040	0.00000
	2	2.00000	1.36727	0.56440	0.59989	0.00146	0.00015
	3	2.00000	1.78222	0.73653	0.59929	0.00253	0.00050
4	1	2.00000	0.23573	0.56441	0.60027	0.00012	0.00000
	2	2.00000	0.56772	1.36590	0.59984	0.00068	0.00026
	3	2.00000	0.73942	1.78103	0.59949	0.00149	0.00078

1CHORD	I	XP	YP	ZP	UP	VP	WP
1	1	6.23627	0.96845	-2.34305	1.35643	-0.00232	-0.00096
	2	5.67708	0.96793	-2.34327	1.35995	-0.00412	-0.00171
2	1	6.23627	2.34159	-0.97199	1.35450	-0.00027	-0.00065
	2	5.67708	2.34137	-0.97252	1.35687	-0.00016	-0.00038
3	1	6.23627	2.34305	0.96845	1.35444	-0.00028	0.00068
	2	5.67708	2.34327	0.96793	1.35685	-0.00016	0.00038
4	1	6.23627	0.97199	2.34159	1.35605	-0.00261	0.00108
	2	5.67708	0.97252	2.34137	1.36148	-0.00422	0.00175

Output parameters are defined below:

Parameter	Definition
CHORD	Panel center column number
I	Panel center number in a column
XP, YP, ZP	Reference coordinate location of panel center
UP, VP,WP	Upper surface velocity components at the panel center

6.17 JOB COST SUMMARY BY FUNCTION

The next printout region gives costs of major A502 functions (see table 6-3). This printout itemizes computer resources used to perform each function. Program names are associated with major program overlays. While this data is of statistical interest, it contains little information of use for a typical application. The data of greatest interest is the cost for running off-body points (PPPDQ function) and streamlines (S-L COMP and S-L SORT functions). After a run is completed, central processor time and cost in dollars are output. This information allows you to make better central processor estimates for future runs and gives you a better idea of the cost for these functions.

Table 6-3 Major A502 Functions

A502 Processing Step	Function	Program
Reads input	INITIALZ	
	INPUT	SINPUT
	INIT	
Computes defining quantities associated with panel and network geometry	GEOMETRY	SGEOMC
Computes defining quantities associated with network singularity splines	SINGULAR	SSING
Computes control-defining quantities	CNTRL PT	SCNTRL
Analyzes boundary conditions	BNDY CND	SBCOND
Calculates far-field influence singularities	FFGEN	FFGEN
Computes potential and velocity influence coefficients	PIC COST	SVINFC
Computes left-hand influence coefficient and right-hand matrices of boundary-value problem	AIC COST	SAICAL
Solves problem matrix equation	MTRXSOLN	SINVER
Calculates and prints output	OUTPUT	SUTPUT
Calculates potential at off-body points	PPPDQ	PPPDQ OFFBDX
Calculates streamline	S-L COMP	STMLNE
Organizes streamline data for efficiency, to compute more than one streamline at a time	S-L SORT	STMLNE2

6.18 LOCAL DATA SETS

The program outputs two tables listing all tapes used during program execution, and associated data. It uses the command DNLIST in the job control deck. This data notes for you the size of large files for the large configuration runs, to let you know if a large data file needs to be transferred to tape (see section 7). Main files of interest are listed by program tape (FT) number. The program lists the length of each file in the first table, in units of words; it uses the second table to list each file length in units of disk sectors.

6.19 DAYFILE

The final A502 printout is the dayfile, the record of computer operation for program processing. You should check this output for messages of errors that may have occurred during the program run. If a run breaks in the middle of a job, the dayfile identifies the last program function used. It also contains a record of output files that have been saved. Of particular interest is the output of computer central processor time and computer run cost.

8. PROCESSING OUTPUT FILES

A502 output files are useful for displaying detailed results of the program solution. Some data files can be used directly as input for display programs. Other output files require additional processing and input data to generate files that can be used by display programs.

This section instructs you in the processing of A502 output data: the identification and reformatting of the data in workable form for subsequent display or processing. Current display systems are on the VAX, IRIS, APOLLO, etc. It is assumed that you know the following:

- How to use the display programs: AGPS, RPD, PEGASUS, PLOPP, GGP, or GCP.
- How to transfer data to other computer systems.

Table 8-1 summarizes the A502 output files used for examining analysis results and shows the primary use of each output file or processed file. For most files, the use is clear. However, surface pressure outputs may be used in several overlapping ways. As summarized in the table, the primary purpose emphasizes the best single use of the data. No recommendations are made for combinations of displays; for example, one processed GGP file may be input for several display approaches.

The standard A502 job control card deck is set up to automatically save all output files generated during program execution. Four of the output files are not controlled by program inputs:

- CASE.pf
- CASE.pc
- CASE.fmg
- CASE.mpx

Generation of the remaining files is based on program options: sectional properties, off-body points, and boundary layer.

After initial validation and acceptance of a solution run, you can use A502 output files to display the results. Because of the additional time required for this, it is good practice to check the solution for obvious errors before you start your display work. A detailed display of pressures may uncover some additional small errors.

Table 8-1 Summary of A502 Output Files and Primary Processing for Display

File Suffix	and Description	Primary Purpose	Processing	Sect.
MPX	A502 networks after abutment processing in A230-style format. Plus optional flow-field streamline paths as two-column network data.	Display configuration panel networks after a datacheck run. or Display configuration and optional flow-field streamlines.	On workstation, use AGPS	8.1
PF	48 flow properties per panel center control point, identical with the full flow property printout.	Provide gridded plots of pressure (CP) versus X/C, X, Y, Z or	Run EFP program to generate a compact GGP file. On workstations, run ggp_to_ran program to produce a .RAN file. Run GGP program.	8.2
		Generate surface streamlines and selected properties along a streamline. or	Run EFP program to generate a compact GGP file. With GGP and A502 MPX files, run AGPS to make streamlines.	8.2
		Assemble a file of any surface flow properties (maximum of 12 flow properties and up to 4 solutions).	Same as above, but select different flow properties.	8.2
PC	Network corner points and second-order pressure in GGP-style format.	Provide raster display of surface pressures.	Read file directly into AGPS via the GGP command.	8.3
SPG	Sectional cut pressures in GGP-style format.	Provide gridded plots of pressure (CP) versus X/C, X, Y, Z.	On workstations, run ggp_to_ran program to produce a .RAN file. Run 2-D plotting program.	8.4
SFG	Sectional cut forces and moments in GGP-style format.	Gridded plots of sectional properties versus semi-span, etc.	On workstations, run ggp_to_ran program to produce a .RAN file. Run 2-D plotting program..	8.5
FMG	Configuration forces and moments in GGP-style format.	Gridded plots of configuration forces and moments versus angle of attack.	On workstations, run ggp_to_ran program to produce a .RAN file. Run 2-D plotting program.	8.6
OFF	Table of off-body locations, flow directions, and pressures.	Gridded plots of flow-field properties.	Edit file to add runid's etc., to transform it into a GGP file.	8.7
STR	Table of streamline locations, flow directions, and pressures.	Gridded plots of streamline properties.	On workstations, run ggp_to_ran program to produce a .RAN file.	8.8
BL	Input for boundary layer flow analysis (A598).	Perform A598 boundary layer analysis.	Run RDBLT program to produce an input file for A598.	8.9

8.1 CONFIGURATION DATA (AND OPTIONAL FLOW-FIELD STREAMLINE PATHS)

The A502 MPX output file contains configuration panel networks and, if computed, flow-field streamline paths in A230-style format. Configuration panel networks consist of all the geometry, as modified by the program for abutments, and the generated wake networks in coordinate form. A streamline path is defined in the same form as the panel network (rectangular data array) by being output as a two-point column network. Both columns of the network contain the same streamline path.

The first part of an A502 MPX file is shown below:

```
CASE
SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
SAARIS  865-6209  M/S 7C-36
GEOM
  1.0000
SOUR
 11.0000
 11.00000   3.00000                                                    WINGA
  69.4737    9.2105    0.0000   63.7818    9.5807    0.7831
  53.7705    9.7741    1.9747   37.2370    9.4677    1.9614
  30.4174    9.1584    0.2506   29.4086    9.1127   -0.0025
  30.4207    9.1586   -0.2557   37.2409    9.4679   -1.9617
  53.7722    9.7741   -1.9746   63.7823    9.5807   -0.7830
  69.4737    9.2105    0.0000
  76.6660   20.0000    0.0000   70.8460   20.1781    0.7831
  60.7679   20.2711    1.9747   44.3403   20.1238    1.9614
  37.4878   19.9722    0.8173   36.6347   19.9530   -0.0025
  37.4922   19.9723   -0.8192   44.3441   20.1238   -1.9617
  60.7695   20.2711   -1.9746   70.8465   20.1781   -0.7830
  76.6660   20.0000    0.0000
  83.3330   30.0000    0.0000   77.3943   30.0000    0.7831
  67.2541   30.0000    1.9747   50.9248   30.0000    1.9614
  44.1733   30.0000    0.8173   43.3330   30.0000   -0.0025
  44.1776   30.0000   -0.8192   50.9286   30.0000   -1.9617
  67.2557   30.0000   -1.9746   77.3948   30.0000   -0.7830
  83.3330   30.0000    0.0000
  6.00000   2.00000                                                    WINGTA
  83.3330   30.0000    0.0000   77.3943   30.0000    0.7831
  67.2541   30.0000    1.9747   50.9248   30.0000    1.9614
  44.1733   30.0000    0.8173   43.3330   30.0000   -0.0025
  83.3330   30.0000    0.0000   77.3948   30.0000   -0.7830
  67.2557   30.0000   -1.9746   50.9286   30.0000   -1.9617
  44.1776   30.0000   -0.8192   43.3330   30.0000   -0.0025
 11.00000   3.00000                                                    BODYL
   0.0000    0.0000    0.0000    3.0000    0.0000   -3.4147
  10.0000    0.0000   -6.0000   20.0000    0.0000   -8.0000
  29.4086    0.0000   -9.1127   37.2409    0.0000   -9.6690
  53.7722    0.0000   -9.9715   63.7823    0.0000   -9.6126
  69.4737    0.0000   -9.2105   80.0000    0.0000   -8.0000
  90.0000    0.0000   -6.0000
   0.0000    0.0000    0.0000    3.0000    2.4142   -2.4149
  10.0000    4.2421   -4.2432   20.0000    5.6561   -5.6576
  29.4086    6.4428   -6.4445   37.2409    6.8363   -6.8377
  53.7722    7.0506   -7.0513   63.7823    6.7970   -6.7973
  69.4737    6.5128   -6.5128   80.0000    5.6569   -5.6569
  90.0000    4.2427   -4.2427
   0.0000    0.0000    0.0000    3.0000    3.4147   -0.0009
  10.0000    6.0000   -0.0016   20.0000    8.0000   -0.0022
  29.4086    9.1127   -0.0025   37.2409    9.4679   -1.9617
  53.7722    9.7741   -1.9746   63.7823    9.5807   -0.7830
  69.4737    9.2105    0.0000   80.0000    8.0000    0.0000
  90.0000    6.0000    0.0000
```

For VAX display of configuration and optional streamlines, transfer the MPX file to a VAX computer. Then use the AGPS R23 command to read it directly into AGPS for display (see reference 6).

8.2 PANEL CENTER SURFACE FLOW PROPERTIES

The A502 CASE.pf output file contains panel center flow properties and panel center location for each nonwake network. This database is identical in content but different in format (E) to the complete flow properties printout (ioutpr = 0.0).

To access this database for postprocessing the results of an A502 solution, the Extract Flow Properties program (EFP or A594) on CRAY can be used to develop a GGP file of user-selected flow properties. The generated GGP file will automatically contain the panel index within a panel column, panel center coordinates, and wing chord fraction (requires input planform specification). You can select up to 12 flow properties and particular solutions (one to all). All the selected flow properties will appear as one string of data along with the associated control point location, etc. For large cases, this can be a large file and may require careful selection of properties to keep it manageable.

The CASE.pf output file contains the 49 parameters of panel center data. This file is formatted as printout, with headers, etc. Data follows the order of the panels in a network and the order of the networks throughout the configuration. The data is repeated for each solution. Examples of the CASE.pf output data file are shown in sections 9 and 6.10.

An overview of the process is given below.

1. Generate the program input CASE.efpi (see section 8.2.1).
2. Check on the status of CASE.pf file to see that it is in the present directory and not migrated.
3. Run the interactive A594 program to generate the CASE.efpg file.
4. Transfer the CASE.efpg file to other systems for processing (i.e., AGPS, PEGASUS, ETAGS etc.)

The following paragraphs explain the steps to go through in GGP file generation. They give special network inputs, details of execution of the EFP program as an interactive CRAY job, and an example of EFP input (section 8.3).

8.2.1 EFP Program Inputs

EFP inputs control the extraction of the data from the A502 PF file. The inputs contain three major blocks of information:

- Specification of the parameters and solutions to be extracted.
- Identification of networks for special processing.
- Planform definitions for defining chord fractions.

Unless specified, all these inputs are in (6F10.0) format. Refer to figure 8-1 for a description of EFP inputs.

Specification of the first major block of EFP inputs (EFP1 - EFP6) places the extracted data (IP, X, Y, Z, and specified flow data for specified solutions) into a GGP file for plotting. The specified data for extraction can be specified by using the output parameter name or a number associated with the parameter (6 to 49). This data can be input in free field format. A run ID (runid) is associated with each network panel column. It consists of:

- Case letter identifier.
- Network number.
- Panel column number.

For example, the runid A11C2 refers to case A, network 11, and panel column 2.

In the selection of pressures, the second-order pressure coefficient is recommended, because it is most consistent with program theory. An input option is available for placing in the GGP file all the nonwake networks or only the special networks.

Some networks require special treatment to develop the appropriate data for plotting. Network data can be modified for:

- Adding a chord fraction parameter (section 8.2.1.1) based on horizontal or vertical wing leading and trailing edge coordinates.
- Making runid's from panel rows (section 8.2.1.2).
- Subdividing a network panel column into two runid's (section 8.1.2.3).

Enter one line of input (EFP7; see figure 8-1) for each special network. Use the nonwake network input order to identify special networks.

> **Note:** To maintain the same network numbers as in the A502 run, place all nonwake networks before wake networks in the A502 input.

The chord fraction definition requires specification of a particular planform (inputs EFP9 - EFP10). A particular network is associated with this planform definition. The planform number is assumed from the input order of the planforms.

8.2.1.1 Calculating Chord Fraction

To calculate the chord fraction, you must define the planform by specifying the leading and trailing edge points between which linear interpolation is used. You can define a maximum of five planforms, with 20 points per edge. A planform number (npl) is assigned through input to each network in which a control point chord fraction (X/C) is to be calculated. The npl is assumed from the order in which planforms are input. Thus, several networks can be associated with the same planform definition.

```
TITLE FOR A502 RUN (COLUMNS 1-60)                                      EFP1
nofp                                            Flow Properties        EFP2
fpn(1)      fpn(2)      fpn(3)      ...         (free field format)    EFP3
nos                                             Solutions              EFP4
sn1         sn2         sn3         sn4                                EFP5
ridlet      optids      nsn                                            EFP6

! nofp     number of flow properties to be extracted (1. to 12.)
! fpi(j)   flow property name (nofp inputs).
              DO      DX      DY      DZ      SO      ANX     ANY     ANZ
              LMACHU  WXU     WYU     WZU     PHEU    VXU     VYU     VZU
              CPLINU  CPSLNU  CP2NDU  CPISNU  LMACHL  WXL     WYL     WZL
              PHEL    VXL     VYL     VZL     CPLINL  CPSLNL  CP2NDL  CPISNL
              WNU     WNL     PWNU    PWNL    VTU     VTL     PVTU    PVTL
              CPLIND  CPSLND  CP2NDD  CPISND
           (for definition of these parameters see section 6.10)

! nos      Number of solutions to be extracted (1 to nacase, see pages 5-13,-14)
! sn(i)    Solution number corresponding to the input order of solutions.
           Place in ascending order.  (values 1. to 4.)

! ridlet   First runid letter (input left-adjusted)

! optids   Option to control networks output.
           =0.0       All nonwake networks, including networks with special
                      treatment (default)
           =1.0       Only networks requiring special treatment

! nsn      Number of networks requiring special treatment


INPUT ONE LINE FOR EACH NETWORK REQUIRING SPECIAL TREATMENT; NSN LINES
ORDERED BY NST VALUE, LOWEST VALUE FIRST; MAXIMUM 100 SPECIAL NETWORKS.
IF NO NETWORKS NEED SPECIAL TREATMENT, OMIT ALL OF THE FOLLOWING DATA.

nst         npl     optpli   optrid    optsp         Special Treatment     EFP7

! nst      Nonwake network number from A502 input order

! npl      Associated planform number used to define chord fraction
           = 0.0      No planforms input
           = 1.0      First input planform used to define chord fraction
           = 2.0      Second input planform used to define chord fraction
           Etc.

! optpli   Planform option:
           =0.0       Horizontal (X,Y) (default)
           =1.0       Vertical (X,Z)

! optrid   The runid option
           =0.0       Columns (default)
           =1.0       Rows

! optsp    Option or value for Network column split into two runid's
           =last panel row of first runid
           =0.0       No split of network column (default)
```

(Continued on next page)

```
INPUT ONE SET OF THE FOLLOWING CARDS (EFP8-EFP10) FOR EACH PLANFORM
(MAXIMUM OF FIVE PLANFORMS).
nle      nte                                Planforms          EFP8
xL1      YL1     xL2     YL2      xL3       YL3                EFP9
xL4      YL4...                                                EFP9
xT1      YT1     xT2     YT2      xT3       YT3                EFP10
xT4      YT4...                                                EFP10
.
.
! nle      Number of leading edge points; maximum 20 points/edge
! nte      Number of trailing edge points; maximum 20 points/edge
! xLi,YLi  Planform leading edge, starting with lowest Y; i = 1-20
! xTi,YTi  Planform trailing edge, starting with lowest Y; i = 1-20
! For a vertical planform (optpli = 1.0), replace Y by Z in the above data.
```

Figure 8-1. Inputs for EFP Program

The default planform type (optpli = 0.0) assumes a horizontal wing-type surface with a planform defined by xL, yL values for leading edges and xT, yT values for trailing edges. An alternate planform type (optpli = 1.0) is chosen for processing vertical wing-type surfaces. Use of the second option defines the planform by x,z coordinates for leading and trailing edges.

The control point chord fraction is calculated by projecting control points onto a panel column chord. The panel column chord is assumed from the first and last control points in a panel column (y = constant or z = constant) projected onto the planform leading and trailing edges.

Figure 8-2 illustrates different types of panel columns for the wing upper surface and the determination of leading and trailing edge points. The program uses linear interpolation for leading and trailing edge points. The result is an approximate chord that is reasonable for most wing-type surfaces. This method of calculating the chord is expedient and takes advantage of the splitting of the A502 network at the wing leading edge. The program will linearly extrapolate from the first and last planform definition points to define chords located outside of the planform distribtution.

Reasonable values for the chord fraction can be obtained for multiple chordwise networks on the upper surface, as long as the panel column control points are nearly parallel to the X axis. If they are not nearly parallel, some error may result in the chord fraction values and in the program.

8.2.1.2 Making Runid's from Network Panel Rows

In assembling configurations for A502 analysis, we pay little attention to the panel column direction within a panel network. By default, the EFP program makes a network control point column into a runid for plotting (optrid = 0.0). After completing an A502 solution and planning some of the plots, you may find it helpful to make network panel rows into plot runid's. This option is exercised by inputting the network number and the runid option (optrid = 1.0).

8.2.1.3 Subdividing Network Panel Columns

You can also split a network panel column runid into two runid's. A single-option parameter (optsp) serves two purposes:

- The default value of zero indicates no splitting of a network panel column.
- A positive value indicates that the network is to be split, with the last row of the first split network panel column to be equal to optsp. The next runid contains the optsp+1 panel through the last panel in the column.

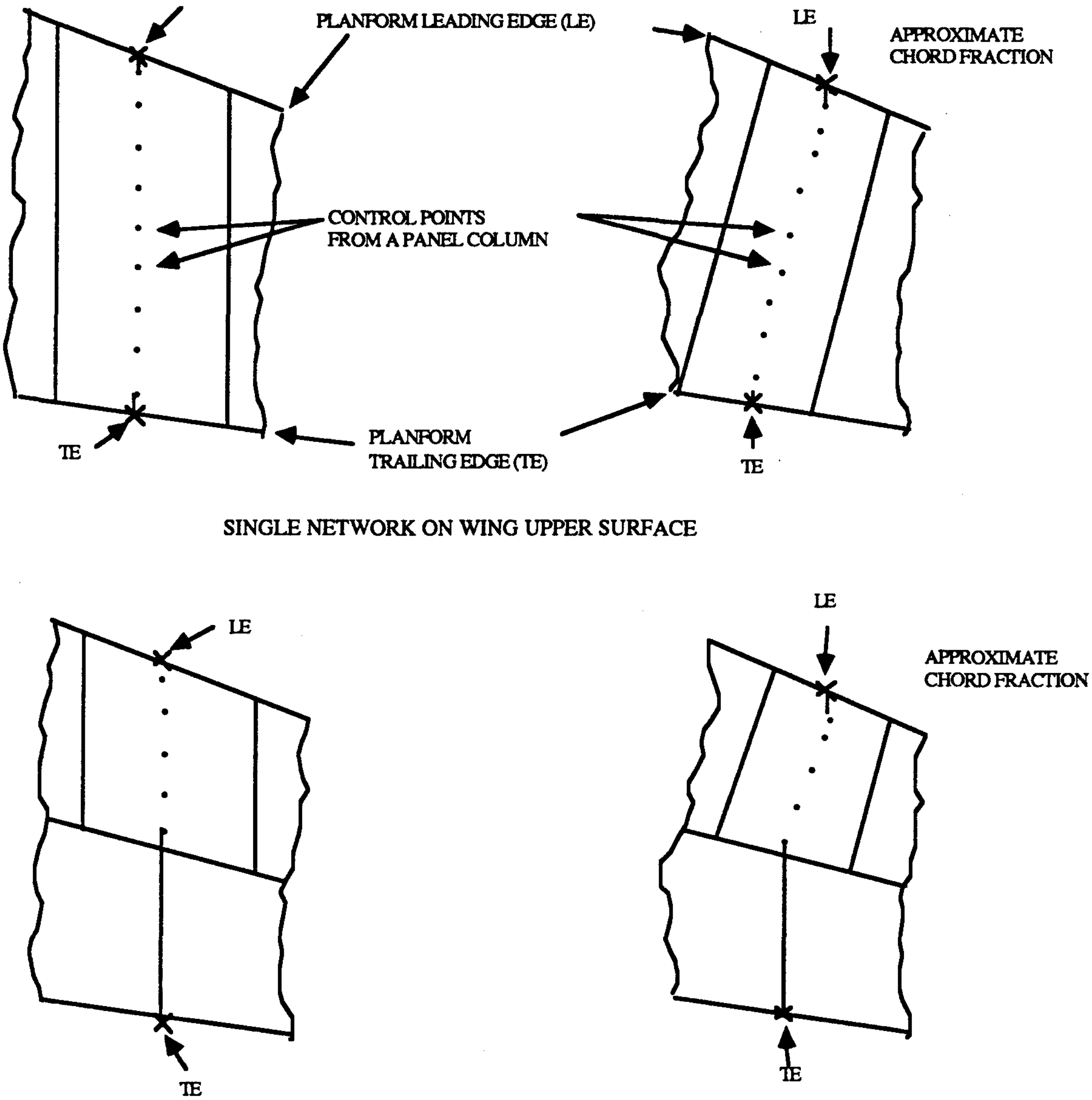


Figure 8-2 Determining Leading and Trailing Edge Points

8.2.2 Executing EFP Program

The EFP program is run interactivly on the CRAY computer. All the files associated with the program have assumed file extensions. A listing of the files is given below.

- CASE.efpi - Input data for EFP program as given in section 8.2.1.
- CASE.pf - A502 output file containing the panel center flow properties. This is the input database used by EFP program to extract the data used in the GGP file.
- CASE.efpg - User requested flow properties in GGP format; output from EFP program.
- CASE.efpo - A printout of intermediate steps used to generate the GGP file. The printout is only of use for runs that may have an error. CASE.efpo is used to debug a problem run or to check on a chord fraction value. This printout monitors the assembling of the flow properties and calculation of first network column chord fraction values for each network. A print option (optxcp = 1.0) is available to give the full results for each network column chord fraction.

It is assumed that both the CASE.efpi and the CASE.pf files are in the current directory. Then the EFP program can be executed by entering:

```
/u/ba/bectl/aero/a594
```

Several interactive questions will be asked and then the program will produce the CASE.efpg and the CASE.efpo output files.

8.2.3 Sample Case

To help you understand the generation of the GGP file of the panel center locations, chord fractions, and pressures, consider the simple wing-body configuration treated in section 9. The interactive session, inputs (EFPI), and a diagram of the resulting runid's are given in figures 8-3a, 8-3b, and 8-3c.

- The requested data are the second-order pressure coefficient and the Mach number for the first two solutions.
- The wing is paneled as two networks: wing (1) and wing tip (2).
- The planform of the wing leading and trailing edges has been specified to support the calculation of the chord fraction for the two wing networks.
- The wing runid's have been split at the wing leading edge into upper and lower surface runid's. The runid's follow in the same order as the points for a network.

The complete GGP file is given in figure 8-4.

```
sn1028 ls -lt *.pf *.efpi
-rwx------    1 grs2756   cfdapp      100000 Feb 1  12:00 swb.pf
-rwx------    1 grs2756   cfdapp         100 Feb 1  12:00 swb.efpi

sn1028 /u/ba/bectl/aero/a594
EFP program used to assemble up to 12 panel center surface properties
into a GGP file from A502 panel center file.

Assumed input files:
CASE.pf - A502 output file of panel center properties.
CASE.efpi - EFP program input

Output files:
CASE.efpg - GGP file of flow properties
CASE.efpo - Output file of intermediate data.

Enter case-id used to define files.
swb
Enter A502 directory for files (<CR> => current directory).

EFP program working.

   STOP
 CP: 4.00s,  Wallclock: 30.000s,  0.1% of 4-CPU Machine

sn1028 ls -lt *.efpg *.efpo
-rwx------    1 grs2756   cfdapp      100000 Feb 1  12:00 swb.efpg
-rwx------    1 grs2756   cfdapp         100 Feb 1  12:00 swb.efpo
```

Figure 8-3a EFP Interative Session

```
SIMPLE WING-BODY CONFIGURATION WITH COMPOSITE PANELS                  EFP1
2.                                                                    EFP2
CP2NDU     LMACHU                                                     EFP3
2.                                                                    EFP4
1.         2.                                                         EFP5
S          0.         2.                                              EFP6
1.         1.         0.                    5.                        EFP7
2.         1.         0.         0.                                   EFP7
2.         2.                                                         EFP8
29.4086    9.1127     43.3330    30.0000                              EFP9
69.4737    9.2105     83.3330    30.0000                              EFP10
```

Figure 8-3b EFP Inputs

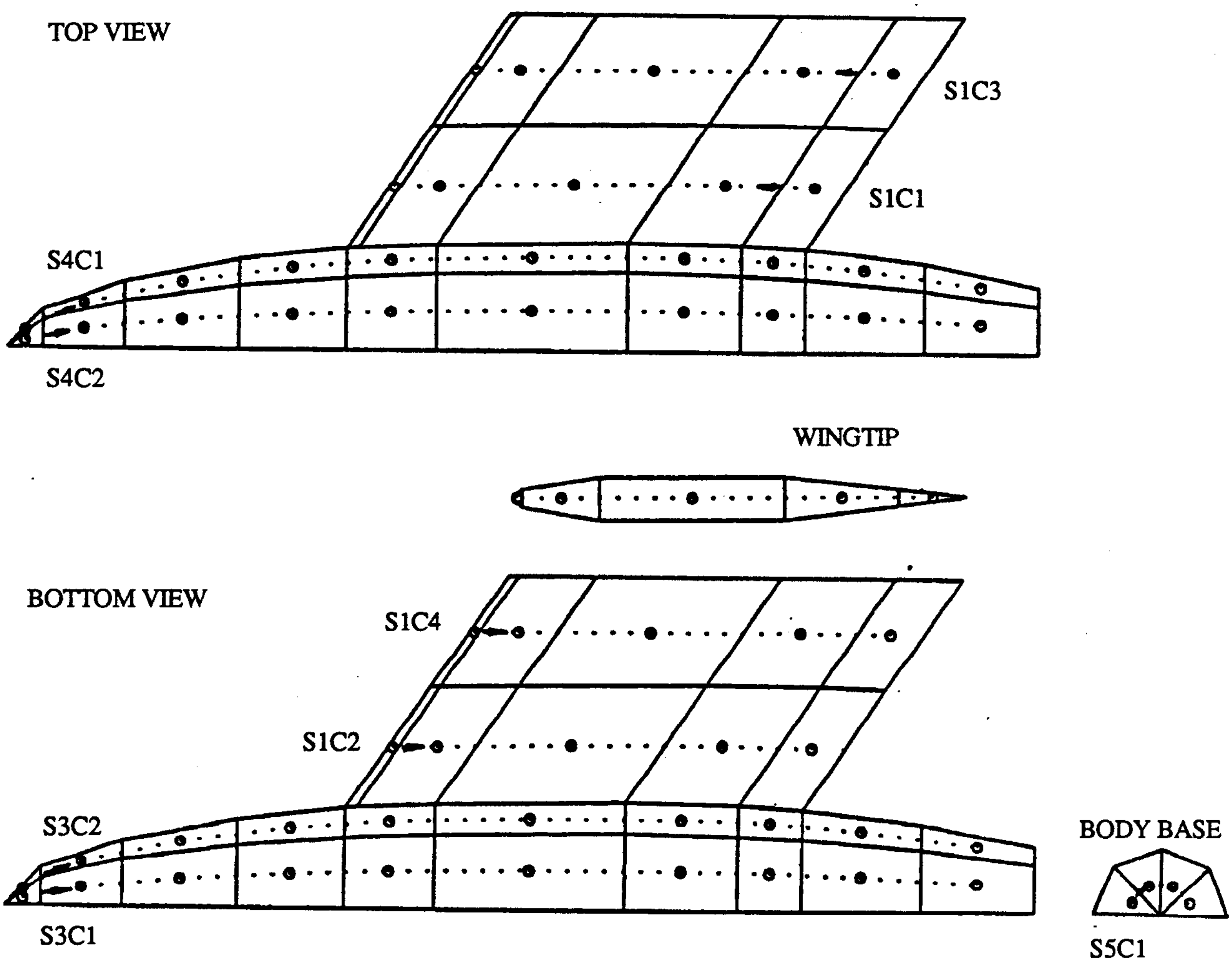


Figure 8-3c EFP Runid's for Simple Wing-Body Configuration

```
(F5.0, 8F10.4)
*DUPT
$SIMPLE WING-BODY CONFIGURATION (RUN WITH A502H)
*DUP
S1C1
    I    X         Y         Z         X/C       CP2NDU1   LMACHU1   CP2NDU2   LMACHU2
    1   70.2006   14.7247    0.3889    0.9263    0.0545    0.5848    0.0834    0.5754
    2   62.3039   14.9272    1.3756    0.7288   -0.1996    0.6666   -0.1830    0.6606
    3   49.0449   14.8798    1.9681    0.3974   -0.4122    0.7348   -0.5194    0.7698
    4   37.3803   14.6624    1.2518    0.1057   -0.5256    0.7734   -0.9450    0.9227
    5   33.4887   14.5451    0.2681    0.0084   -0.5891    0.8152   -1.9038    1.3850
*EOF
S1C2
    6   33.4820   14.5448   -0.2674    0.0083    0.6037    0.4346    0.9849    0.3301
    7   37.3399   14.6610   -1.2445    0.1047    0.0040    0.6018    0.3625    0.4871
    8   48.9759   14.8789   -1.9681    0.3956   -0.2382    0.6773   -0.0881    0.6280
    9   62.2491   14.9280   -1.3821    0.7275   -0.1873    0.6606   -0.1505    0.6480
   10   70.1612   14.7266   -0.3942    0.9253    0.0467    0.5852    0.0656    0.5785
*EOF
S1C3
    1   77.0685   25.0278    0.3889    0.9263    0.0918    0.5747    0.0096    0.6076
    2   69.0775   25.0895    1.3757    0.7265   -0.1102    0.6395   -0.1586    0.6593
    3   55.8370   25.0704    1.9681    0.3955   -0.3229    0.7060   -0.4331    0.7447
    4   44.2410   25.0060    1.3930    0.1056   -0.5553    0.7834   -0.9166    0.9134
    5   40.4081   24.9769    0.4111    0.0097   -0.3671    0.7436   -1.4875    1.1803
*EOF
S1C4
    6   40.4025   24.9768   -0.4071    0.0096    0.5540    0.4540    0.7168    0.4253
    7   44.2019   25.0056   -1.3868    0.1046   -0.1470    0.6511    0.0926    0.5780
    8   55.7712   25.0701   -1.9681    0.3938   -0.2136    0.6695   -0.1612    0.6539
    9   69.0244   25.0897   -1.3820    0.7252   -0.0934    0.6302   -0.1163    0.6388
   10   77.0295   25.0283   -0.3941    0.9253    0.1043    0.5672    0.0402    0.5917
*EOF
S2C1
    1   80.3672   30.0000    0.0035    0.9259   -0.7071    0.8618   -4.4966 1000.0000
    2   72.3356   30.0000    0.0109    0.7251   -0.2186    0.6765   -1.0853    1.0112
    3   59.1066   30.0000    0.0158    0.3943   -0.2273    0.6764   -0.7130    0.8589
    4   47.5609   30.0000    0.0093    0.1057   -0.3357    0.7113   -0.7799    0.8807
    5   43.7563   30.0000    0.0004    0.0106   -1.1800    1.0133   -1.7144    1.2705
*EOF
S3C1
    1    1.4965    0.5975   -1.4560    0.0000    0.9349    0.3285    1.1459    0.2531
    2    6.4885    1.6514   -4.0192    0.0000    0.0777    0.5835    0.2391    0.5328
    3   14.9827    2.4571   -5.9790    0.0000    0.0011    0.6030    0.1062    0.5695
    4   24.6851    3.0060   -7.3092    0.0000   -0.0111    0.6052    0.0893    0.5731
    5   33.3060    3.3020   -8.0220    0.0000   -0.0451    0.6155    0.0804    0.5748
    6   45.4807    3.4477   -8.3919    0.0000   -0.1298    0.6422   -0.0242    0.6076
    7   58.7558    3.4424   -8.3670    0.0000   -0.1644    0.6531   -0.1110    0.6354
    8   66.6121    3.3131   -8.0403    0.0000   -0.1227    0.6396   -0.0931    0.6296
    9   74.7167    3.0245   -7.3548    0.0000   -0.0751    0.6243   -0.0589    0.6186
   10   84.9827    2.4599   -5.9846    0.0000    0.0364    0.5890    0.0342    0.5893
*EOF
S3C2
    1    1.4965    1.4519   -0.6072    0.0000    0.7944    0.3781    0.7522    0.3976
    2    6.4885    4.0095   -1.6748    0.0000   -0.0095    0.6105   -0.0299    0.6204
    3   14.9827    5.9649   -2.4911    0.0000   -0.0493    0.6186   -0.0887    0.6345
    4   24.6851    7.2936   -3.0438    0.0000    0.0394    0.5886    0.0358    0.5933
    5   33.3075    7.9567   -3.8248    0.0000    0.0372    0.5893    0.1970    0.5375
    6   45.4855    8.2719   -4.4747    0.0000   -0.1818    0.6590   -0.0386    0.6120
    7   58.7582    8.2925   -4.1701    0.0000   -0.2336    0.6757   -0.1852    0.6598
    8   66.6125    8.0199   -3.5390    0.0000   -0.0927    0.6303   -0.0788    0.6258
    9   74.7167    7.3393   -3.0620    0.0000   -0.0095    0.6034    0.0020    0.5993
   10   84.9827    5.9711   -2.4923    0.0000    0.0623    0.5813    0.0699    0.5783
*EOF
S4C1
    1    1.4965    1.4560    0.5973    0.0000    0.6952    0.4065    0.5087    0.4670
    2    6.4885    4.0192    1.6508    0.0000   -0.0709    0.6278   -0.1840    0.6664
    3   14.9827    5.9790    2.4562    0.0000   -0.0881    0.6298   -0.1896    0.6655
    4   24.6851    7.3092    3.0049    0.0000   -0.0731    0.6243   -0.2451    0.6840
    5   33.3055    7.9722    3.7910    0.0000   -0.2293    0.6753   -0.4536    0.7519
    6   45.4827    8.2923    4.4370    0.0000   -0.3554    0.7155   -0.4656    0.7516
    7   58.7571    8.3098    4.1356    0.0000   -0.2660    0.6872   -0.2672    0.6862
    8   66.6123    8.0325    3.5104    0.0000   -0.0826    0.6282   -0.0569    0.6187
    9   74.7167    7.3548    3.0245    0.0000   -0.0044    0.6024    0.0125    0.5964
   10   84.9827    5.9846    2.4599    0.0000    0.0694    0.5801    0.0828    0.5755
*EOF
```

Figure 8-4 GGP Output File –Simple Wing-Body Configuration (continued on next page)

```
S4C2
    1   1.4965   0.6070   1.4519   0.0000   0.5853   0.4414   0.2956   0.5323
    2   6.4885   1.6742   4.0095   0.0000  -0.1302   0.6460  -0.2763   0.6942
    3  14.9827   2.4902   5.9649   0.0000  -0.1285   0.6423  -0.2154   0.6707
    4  24.6851   3.0426   7.2936   0.0000  -0.1387   0.6450  -0.2262   0.6736
    5  33.3041   3.3374   8.0068   0.0000  -0.2031   0.6658  -0.3068   0.6998
    6  45.4779   3.4959   8.3715   0.0000  -0.2440   0.6791  -0.3050   0.6983
    7  58.7547   3.4822   8.3504   0.0000  -0.2006   0.6654  -0.2030   0.6652
    8  66.6119   3.3426   8.0281   0.0000  -0.1269   0.6419  -0.1073   0.6348
    9  74.7167   3.0620   7.3393   0.0000  -0.0645   0.6224  -0.0346   0.6121
   10  84.9827   2.4923   5.9711   0.0000   0.0656   0.5823   0.1078   0.5686
*EOF
S5C1
    1  90.0000   1.0563   2.5713   0.0000   0.5776   0.4124   0.5991   0.4056
    2  90.0000   2.5651   1.0713   0.0000   0.5674   0.4155   0.5835   0.4103
    3  90.0000   2.5713  -1.0563   0.0000   0.5610   0.4173   0.5735   0.4129
    4  90.0000   1.0713  -2.5651   0.0000   0.5533   0.4196   0.5643   0.4156
*EOF
```

Figure 8-4 GGP Output File for Simple Wing-Body Configuration

8.3 PANEL CORNER PRESSURES

Program A502 interpolates second-order upper surface pressure coefficients at the panel corner points (network points). These coefficients are output as a GGP file (suffix PC). This output file can be used to make a raster graphics display of the surface pressures.

The extrapolation to the network edge points is based on pressure data within a network and, thus, may not result in smooth transition across network boundaries. This problem is further emphasized by coarsely paneled configurations and for regions of rapidly varying pressures.

> **Note:** Possible A502 program developments might eliminate the pressure discontinuity across network boundaries by interpolating across these boundaries. However, it is currently best to make a small panel along the boundary of a network, especially in a region of large pressure variation.

The PC output file contains panel corner point coordinates and second-order pressure coefficients for all solutions. Each runid contains the results for a network column of points, and the pressures for all solutions. The runid is composed of the network number and the column number. The compact PC file contains no duplicate data.

The following is a sample printout for the first few networks for a simple case:

```
(F5.0,6F13.4)
$TITLE SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
$TITLE SAARIS  865-6209  M/S 7C-36
$      SECOND ORDER PRESSURES AT GRID POINTS
*DUPT
*DUP
N01C001
 IROW         X            Y            Z          CP1          CP2          CP3
    1  6.94737E+01  9.21050E+00  0.00000E+00  1.12497E-01  1.91294E-01  9.08163E-02
    2  6.37818E+01  9.58070E+00  7.83100E-01 -1.11756E-01 -2.92496E-02 -1.34203E-01
    3  5.37705E+01  9.77410E+00  1.97470E+00 -3.41826E-01 -2.97661E-01 -3.38320E-01
    4  3.72370E+01  9.46770E+00  1.96140E+00 -5.60232E-01 -7.14089E-01 -4.15733E-01
    5  3.04174E+01  9.15845E+00  2.50579E-01 -7.66920E-01 -1.84647E+00 -1.19240E-01
    6  2.94086E+01  9.11270E+00 -2.50000E-03  3.83891E-02 -4.92714E-01  1.38747E-01
    7  3.04207E+01  9.15860E+00 -2.55672E-01  4.44836E-01  1.11080E+00 -1.24606E-01
    8  3.72409E+01  9.46790E+00 -1.96170E+00 -2.34962E-01  1.02172E-01 -4.13462E-01
    9  5.37722E+01  9.77410E+00 -1.97460E+00 -3.11205E-01 -2.20641E-01 -3.38999E-01
   10  6.37823E+01  9.58070E+00 -7.83000E-01 -1.33444E-01 -8.20574E-02 -1.35613E-01
   11  6.94737E+01  9.21050E+00  0.00000E+00  9.22743E-02  1.41647E-01  9.00106E-02
*EOF
N01C002
    1  7.66660E+01  2.00000E+01  0.00000E+00  1.57902E-01  1.25702E-01  1.64066E-01
    2  7.08460E+01  2.01781E+01  7.83100E-01 -2.19445E-02 -3.83918E-02 -1.80263E-02
    3  6.07679E+01  2.02711E+01  1.97470E+00 -2.36005E-01 -2.75326E-01 -2.10273E-01
  . 4  4.43403E+01  2.01238E+01  1.96140E+00 -4.84824E-01 -8.00645E-01 -2.92838E-01
    5  3.74878E+01  1.99722E+01  8.17300E-01 -4.39802E-01 -1.21359E+00 -4.83752E-02
    6  3.66347E+01  1.99530E+01 -2.50000E-03  9.14456E-02 -4.28493E-01  1.89253E-01
    7  3.74922E+01  1.99723E+01 -8.19200E-01  2.31093E-01  4.18671E-01 -5.02322E-02
    8  4.43441E+01  2.01238E+01 -1.96170E+00 -1.18687E-01  1.02558E-01 -2.92301E-01
    9  6.07695E+01  2.02711E+01 -1.97460E+00 -1.87317E-01 -1.54387E-01 -2.10646E-01
   10  7.08465E+01  2.01781E+01 -7.83000E-01 -2.17691E-02 -3.86011E-02 -1.83291E-02
   11  7.66660E+01  2.00000E+01  0.00000E+00  1.56964E-01  1.22116E-01  1.64449E-01
*EOF
N01C003
    1  8.33330E+01  3.00000E+01  0.00000E+00  1.99140E-01  6.33213E-02  2.31344E-01
    2  7.73943E+01  3.00000E+01  7.83100E-01  2.35360E-02 -5.85274E-02  3.83280E-02
    3  6.72541E+01  3.00000E+01  1.97470E+00 -1.79265E-01 -2.02164E-01 -1.85382E-01
    4  5.09248E+01  3.00000E+01  1.96140E+00 -4.69902E-01 -5.68646E-01 -4.03734E-01
    5  4.41733E+01  3.00000E+01  8.17300E-01 -5.97315E-01 -1.45727E+00 -1.18793E-01
    6  4.33330E+01  3.00000E+01 -2.50000E-03  2.00834E-01 -3.78948E-01  3.09419E-01
    7  4.41776E+01  3.00000E+01 -8.19200E-01  2.67238E-01  6.34474E-01 -1.19557E-01
    8  5.09286E+01  3.00000E+01 -1.96170E+00 -3.33970E-01 -2.20497E-01 -4.02219E-01
    9  6.72557E+01  3.00000E+01 -1.97460E+00 -2.11407E-01 -2.80742E-01 -1.86141E-01
   10  7.73948E+01  3.00000E+01 -7.83000E-01  1.91896E-02 -7.10278E-02  3.84622E-02
   11  8.33330E+01  3.00000E+01  0.00000E+00  2.16331E-01  1.03053E-01  2.32841E-01
*EOF
N02C001
    1  8.33330E+01  3.00000E+01  0.00000E+00 -8.87436E-01 -5.75623E+00  7.81839E-02
    2  7.73943E+01  3.00000E+01  7.83100E-01 -4.12513E-01 -2.49999E+00  1.10014E-03
    3  6.72541E+01  3.00000E+01  1.97470E+00 -1.64029E-01 -6.08247E-01 -7.62644E-02
    4  5.09248E+01  3.00000E+01  1.96140E+00 -2.47469E-01 -6.40313E-01 -1.72855E-01
    5  4.41733E+01  3.00000E+01  8.17300E-01 -7.61983E-01 -1.24467E+00 -6.51412E-01
    6  4.33330E+01  3.00000E+01 -2.50000E-03 -1.27394E+00 -1.81840E+00 -1.12825E+00
*EOF
```

The PC output file can be read into AGPS via the GGP command for raster graphics display of surface pressures. This file requires no additional processing in AGPS, since the pressure results are given at panel corner points.

8.4 SECTIONAL PRESSURES

You can output second-order pressure coefficients (upper surface) along sectional cuts as a GGP file (suffix SPG). The data is primarily used for developing grid plots of pressure along sectional cuts (chord fraction versus pressure). The output order of pressure data primarily follows network order. For cuts that cross two or more networks, data order may not transition continuously from network to network.

For example, consider a wing composed of numerous upper and lower surface networks. The order of output file data may jump from the upper to the lower surface. This can create a problem when the results are being plotted as a single line connecting all data points. To minimize this problem, several approaches can be used:

- Order the wing networks in a logical fashion, that is upper to lower surface, then progressing from inboard to outboard. This approach does not eliminate the problem, but it does minimize it.
- You can edit the data before or during plotting.
- You can plot your data with points.

The A502 SPG output file contains coordinate points along a sectional cut, chord fraction, and second-order pressure coefficient data. Each runid contains the results for a sectional cut, and has the pressures for a solution. The runid is composed of three sets of data separated by periods:

- Solution number
- Network number.
- Cut number

This is not a compact file since coordinate locations and chord fraction values are repeated for each solution. Thus, for a significant configuration with many sectional cuts, this output file can be large.

An example of this data file for two cuts and two solutions is shown below:

```
(5E13.5)
$TITLE SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
$TITLE SAARIS  865-6209  M/S 7C-36
$       SECTIONAL PRESSURES
*DUPT
*DUP
C1.1.01
            X            Y            Z          X/C           CP
  7.03636E+01  1.50000E+01  3.91550E-01  9.25766E-01  5.53491E-02
  6.23242E+01  1.50000E+01  1.37890E+00  7.24780E-01 -1.99336E-01
  4.90895E+01  1.50000E+01  1.96805E+00  3.93911E-01 -4.11865E-01
  3.75808E+01  1.50000E+01  1.25906E+00  1.06194E-01 -5.22938E-01
  3.37849E+01  1.50000E+01  2.77110E-01  1.12970E-02 -5.63644E-01
  3.37868E+01  1.50000E+01 -2.81291E-01  1.13447E-02  5.80365E-01
  3.75846E+01  1.50000E+01 -1.26089E+00  1.06289E-01  8.18203E-03
  4.90922E+01  1.50000E+01 -1.96815E+00  3.93979E-01 -2.37255E-01
  6.23253E+01  1.50000E+01 -1.37880E+00  7.24807E-01 -1.85947E-01
  7.03639E+01  1.50000E+01 -3.91500E-01  9.25772E-01  4.91508E-02
*EOF
C1.1.02
  7.70301E+01  2.50000E+01  3.91550E-01  9.25766E-01  9.10898E-02
  6.89907E+01  2.50000E+01  1.37890E+00  7.24780E-01 -1.11074E-01
  5.57560E+01  2.50000E+01  1.96805E+00  3.93911E-01 -3.23874E-01
  4.42155E+01  2.50000E+01  1.38935E+00  1.05401E-01 -5.55532E-01
  4.04197E+01  2.50000E+01  4.07400E-01  1.05038E-02 -3.67031E-01
  4.04218E+01  2.50000E+01 -4.10850E-01  1.05577E-02  5.54643E-01
  4.42196E+01  2.50000E+01 -1.39045E+00  1.05502E-01 -1.47542E-01
  5.57587E+01  2.50000E+01 -1.96815E+00  3.93979E-01 -2.13203E-01
  6.89918E+01  2.50000E+01 -1.37880E+00  7.24806E-01 -9.31214E-02
  7.70304E+01  2.50000E+01 -3.91500E-01  9.25772E-01  1.04604E-01
*EOF
C2.1.01
  7.03636E+01  1.50000E+01  3.91550E-01  9.25766E-01  8.17002E-02
  6.23242E+01  1.50000E+01  1.37890E+00  7.24780E-01 -1.83492E-01
  4.90895E+01  1.50000E+01  1.96805E+00  3.93911E-01 -5.20448E-01
  3.75808E+01  1.50000E+01  1.25906E+00  1.06194E-01 -9.51345E-01
  3.37849E+01  1.50000E+01  2.77110E-01  1.12970E-02 -1.84391E+00
  3.37868E+01  1.50000E+01 -2.81291E-01  1.13447E-02  9.29098E-01
  3.75846E+01  1.50000E+01 -1.26089E+00  1.06289E-01  3.60735E-01
  4.90922E+01  1.50000E+01 -1.96815E+00  3.93979E-01 -8.81603E-02
  6.23253E+01  1.50000E+01 -1.37880E+00  7.24807E-01 -1.49759E-01
  7.03639E+01  1.50000E+01 -3.91500E-01  9.25772E-01  6.59453E-02
*EOF
C2.1.02
  7.70301E+01  2.50000E+01  3.91550E-01  9.25766E-01  9.18142E-03
  6.89907E+01  2.50000E+01  1.37890E+00  7.24780E-01 -1.59278E-01
  5.57560E+01  2.50000E+01  1.96805E+00  3.93911E-01 -4.35098E-01
  4.42155E+01  2.50000E+01  1.38935E+00  1.05401E-01 -9.18228E-01
  4.04197E+01  2.50000E+01  4.07400E-01  1.05038E-02 -1.48913E+00
  4.04218E+01  2.50000E+01 -4.10850E-01  1.05577E-02  7.19361E-01
  4.42196E+01  2.50000E+01 -1.39045E+00  1.05502E-01  9.17866E-02
  5.57587E+01  2.50000E+01 -1.96815E+00  3.93979E-01 -1.60191E-01
  6.89918E+01  2.50000E+01 -1.37880E+00  7.24806E-01 -1.15455E-01
  7.70304E+01  2.50000E+01 -3.91500E-01  9.25772E-01  4.06428E-02
*EOF
```

You can transfer the SPG output file to the VAX or the PDP computer and process it into a .RAN file via the RANGER program. The .RAN file is read into the GGP program to display and make hard copies of the pressure results.

8.5 SECTIONAL FORCES AND MOMENTS

The sectional force and moment properties for each cut are computed from the optional $SECTION PROPERTIES input section. These properties are output into a GGP file (suffix SFG) for plotting. The abscissa for plotting is the semi-span fraction (ETA). This data is commonly used to make plots of wing loading, lift distribution, pitching moment distribution, and drag distribution.

> **Note:** Please recall that all force and moment results do not include viscous effects.

The SFG output file contains sectional properties, as given in the printout. Each runid covers the results for a solution and for a group of sectional cuts defined in the inputs. The runid is composed of two sets of data separated by a period:

- Solution number
- Cut group number

An example of this data file for two cuts and three solutions follows:

```
(F14.0,6F16.6,/,F14.6,6F16.6)
$TITLE SIMPLE WING-BODY WITH COMPOSITE PANEL.  (RUN WITH A502H)
$TITLE SAARIS  865-6150  M/S 7k-04
$      SECTIONAL FORCES
*DUPT
*DUP
C1.1
      CUT-NO.             CFX             CFY             CFZ             CMX             CMY             CMZ  MORE
          ETA             CDC             CNC             CLC CLC*CHORD/CREF             CMC      CUT-LENGTH
            1       -0.008944        0.003597        0.185128       -0.000381        0.001584       -0.004017
     0.500000        0.003991        0.003597        0.185301        0.185300        0.001584       80.481757
            2       -0.014936        0.009958        0.136095       -0.000374       -0.001797       -0.001584
     0.833333       -0.005406        0.009958        0.136806        0.136806       -0.001797       80.659352
*EOF
C2.1
            1       -0.025757        0.013840        0.456700       -0.000934        0.009310       -0.005006
     0.500000        0.053939        0.013840        0.454235        0.454234        0.009310       80.481757
            2       -0.030089        0.020060        0.335120       -0.000916        0.001666       -0.006420
     0.833333        0.028561        0.020060        0.335254        0.335254        0.001666       80.659352
*EOF
C3.1
            1       -0.005583        0.001561        0.000142       -0.000011       -0.004430       -0.003827
     0.500000       -0.005583        0.001561        0.000142        0.000142       -0.004430       80.481757
            2       -0.011933        0.007956        0.000414       -0.000011       -0.004767       -0.000658
     0.833333       -0.011933        0.007956        0.000414        0.000414       -0.004767       80.659352
*EOF
```

You can transfer the SFG output file to the VAX or the PDP computer and process it into a .RAN file via RANGER. The .RAN file is then read into the GGP program to display and make hard copies of sectional properties.

The ETA parameter used for plotting is controlled by the sectional property inputs.

- If no input has been specified for this parameter, the ETA value is the cut value (yc) input.
- If a global reference length (reflen) has been input, the ETA value is yc divided by reflen.

See sectional property inputs (section 5.11) for an additional way of defining the ETA parameter.

8.6 CONFIGURATION FORCES AND MOMENTS

Data for a full configuration forces and moments summary is placed into a GGP file (suffix FMG) for plotting or spreadsheet analysis. The resultant small data file is useful for making force and moment comparisons with other configurations. Abscissas available for plotting are the onset flow angles ALPHA and BETA for any of the forces or moments. This data is commonly used to make plots of lift versus angle of attack and lift versus pitching moment.

The A502 FMG output file contains full configuration forces and moments as given in the printout. One runid covers all results for all solutions.

A sample of the FMG data file follows:

```
(F7.0,2F10.4,2F14.5,/,4F14.5,/,4F14.5)
$TITLE SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
$TITLE SAARIS  865-6150  M/S 7k-04
$      FORCE AND MOMENT SUMMARY
FORMOMS
 SOL-NO     ALPHA       BETA          CL            CDI  MORE
             CY          FX           FY             FZ  MORE
             MX          MY           MZ            AREA
      1   4.0000    0.0000     0.16279       0.00682
     0.00000    -0.00455     0.00000        0.16287
     0.00000     0.02731     0.00000     7907.50174
      2  10.0000    0.0000     0.39962       0.04801
     0.00000    -0.02211     0.00000        0.40189
     0.00000     0.06699     0.00000     7907.50174
      3   0.0000    0.0000    -0.00001      -0.00123
     0.00000    -0.00123     0.00000       -0.00001
     0.00000     0.00033     0.00000     7907.50174
*EOF
```

The FMG output file can be transferred to the VAX or the PDP computer, where it is processed into a .RAN file. The .RAN file is then read into the GGP program to display and make hard copies of the configuration force and moment information.

8.7 OFF-BODY FLOW-FIELD PROPERTIES

Flow-field properties computed from the optional $FLOWFIELD PROPERTIES, $XYZ COORDINATE, and/or $GRID input sections can be output into a file (suffix OFF) for plotting. This data is commonly used to plot flow-field pressures, Mach numbers, and directions.

The A502 OFF output file contains the flow-field properties given in the printout. As shown in Figure 8-5, the data is formatted as a GGP file with all the off-body points for a solution given a single runid. Depending on the layout of the off-body points, additional runids's may have to be added. Within a runid, the data are ordered as input with one line for each off-body point.

If additional runid's are required for processing the output, they can be hand-edited into the file. If the number of off-body points is large, some automated approach may be worthwhile, such as a set of edited commands or writing a reformatting program)

You can transfer the assembled GGP file to the VAX or the PDP computer and process it into a .RAN file via the RANGER program. The .RAN file is read into the GGP program to display and make hard copies of the flow properties. Alternately, you can display the assembled GGP file in AGPS. It is read into AGPS via the GGP command, as long as it is in the special GGP format that AGPS requires. Finally, it is possible to produce flow direction displays (upwash and sidewash) by processing the mass flux vectors in either the GGP or the AGPS program.

```
(F5.0,9E12.5)
$TITLE SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
$TITLE SAARIS  865-6209  M/S 7C-36
$      OFF-BODY FLOW-FIELD PROPERTIES
$      CAUTION:  THE DATA WITHIN A SOLUTION HAVE NOT BEEN GIVEN A RUNID.
*DUPT
*DUP
S1
   PT           X           Y           Z          WX          WY          WZ        PPOT      CP/2ND        MACH
    1-5.00000E+01 0.00000E+00 0.00000E+00 9.94183E-01 0.00000E+00 7.07383E-02-2.56875E-01 1.03074E-02 5.96686E-01
    2-2.00000E+01 0.00000E+00 0.00000E+00 9.83344E-01 0.00000E+00 7.22465E-02-5.80791E-01 4.34664E-02 5.86027E-01
    3-5.00000E+00 0.00000E+00 0.00000E+00 9.22835E-01 0.00000E+00 7.76771E-02-1.32011E+00 2.22505E-01 5.28418E-01
    4 8.50000E+01 2.25000E+01-7.50000E+00 9.81475E-01 2.67769E-02 5.70100E-02-1.40108E-01 5.16342E-02 5.83449E-01
    5 8.50000E+01 2.25000E+01-2.50000E+00 9.75860E-01 5.29782E-02-8.68759E-04-4.00997E-01 7.43931E-02 5.76515E-01
    6 8.50000E+01 2.25000E+01 2.50000E+00 9.75917E-01-1.10311E-01-1.93259E-02 2.26546E+00 6.58945E-02 5.79935E-01
    7 8.50000E+01 2.25000E+01 7.50000E+00 9.82001E-01-8.17495E-02 1.74867E-02 1.84513E+00 5.00458E-02 5.84430E-01
    8 8.50000E+01 2.75000E+01-7.50000E+00 9.83524E-01 3.97724E-02 8.56471E-02 3.65958E-02 3.81790E-02 5.87829E-01
    9 8.50000E+01 2.75000E+01-2.50000E+00 9.74200E-01 1.18541E-01 8.87997E-02 6.15634E-02 5.34522E-02 5.83626E-01
   10 8.50000E+01 2.75000E+01 2.50000E+00 9.72360E-01-1.74976E-01 6.83901E-02 1.51923E+00 4.72578E-02 5.86516E-01
   11 8.50000E+01 2.75000E+01 7.50000E+00 9.83063E-01-9.14702E-02 5.22656E-02 1.39696E+00 3.99975E-02 5.87620E-01
   12 8.50000E+01 3.25000E+01-7.50000E+00 9.87511E-01 2.04428E-02 1.06686E-01 1.92777E-01 2.13744E-02 5.93227E-01
   13 8.50000E+01 3.25000E+01-2.50000E+00 9.81477E-01 1.51927E-02 1.52978E-01 4.24698E-01 2.45340E-02 5.92513E-01
   14 8.50000E+01 3.25000E+01 2.50000E+00 9.80150E-01-7.63037E-02 1.40221E-01 8.47377E-01 2.77473E-02 5.91680E-01
   15 8.50000E+01 3.25000E+01 7.50000E+00 9.87003E-01-7.00475E-02 8.29632E-02 9.79744E-01 2.47985E-02 5.92306E-01
   16 8.50000E+01 3.75000E+01-7.50000E+00 9.91647E-01 1.92975E-03 1.02701E-01 2.41082E-01 1.01337E-02 5.96802E-01
   17 8.50000E+01 3.75000E+01-2.50000E+00 9.89684E-01-1.22287E-02 1.14687E-01 4.04197E-01 1.25275E-02 5.96092E-01
   18 8.50000E+01 3.75000E+01 2.50000E+00 9.89524E-01-3.62232E-02 1.08604E-01 5.88494E-01 1.36949E-02 5.95752E-01
   19 8.50000E+01 3.75000E+01 7.50000E+00 9.91661E-01-4.42886E-02 8.79944E-02 6.96033E-01 1.20843E-02 5.96240E-01
*EOF
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    2-2.00000E+01 0.00000E+00 0.00000E+00 9.70639E-01 0.00000E+00 1.79840E-01-5.74997E-01 4.07283E-02 5.86989E-01
    3-5.00000E+00 0.00000E+00 0.00000E+00 9.10580E-01 0.00000E+00 1.93003E-01-1.30665E+00 2.11700E-01 5.32190E-01
    4 8.50000E+01 2.25000E+01-7.50000E+00 9.70621E-01 1.08006E-01 1.11894E-01-1.63367E+00 5.43128E-02 5.82725E-01
    5 8.50000E+01 2.25000E+01-2.50000E+00 9.66826E-01 1.74760E-01-1.53314E-02-2.39410E+00 6.95569E-02 5.79341E-01
    6 8.50000E+01 2.25000E+01 2.50000E+00 9.65863E-01-2.31500E-01-3.35698E-02 4.23855E+00 5.00363E-02 5.87113E-01
    7 8.50000E+01 2.25000E+01 7.50000E+00 9.70157E-01-1.62314E-01 7.29826E-02 3.31651E+00 5.13550E-02 5.84425E-01
    8 8.50000E+01 2.75000E+01-7.50000E+00 9.72141E-01 1.37935E-01 1.87619E-01-9.89807E-01 1.36651E-02 5.96821E-01
    9 8.50000E+01 2.75000E+01-2.50000E+00 9.63539E-01 3.36717E-01 2.05736E-01-1.03240E+00-6.31568E-02 6.26724E-01
   10 8.50000E+01 2.75000E+01 2.50000E+00 9.57502E-01-3.92634E-01 1.85513E-01 2.59584E+00-7.62786E-02 6.32819E-01
   11 8.50000E+01 2.75000E+01 7.50000E+00 9.69424E-01-1.88972E-01 1.54765E-01 2.40441E+00 1.90747E-02 5.95647E-01
   12 8.50000E+01 3.25000E+01-7.50000E+00 9.74822E-01 8.84549E-02 2.47399E-01-4.03934E-01-1.39544E-02 6.06034E-01
   13 8.50000E+01 3.25000E+01-2.50000E+00 9.67382E-01 8.37705E-02 3.70876E-01 1.01667E-01-7.62746E-02 6.29144E-01
   14 8.50000E+01 3.25000E+01 2.50000E+00 9.63405E-01-1.44150E-01 3.58185E-01 1.15643E+00-6.78290E-02 6.26756E-01
   15 8.50000E+01 3.25000E+01 7.50000E+00 9.72610E-01-1.37316E-01 2.23960E-01 1.56109E+00-5.38104E-03 6.03456E-01
   16 8.50000E+01 3.75000E+01-7.50000E+00 9.78208E-01 3.68880E-02 2.44474E-01-1.05400E-01-1.61753E-02 6.06346E-01
   17 8.50000E+01 3.75000E+01-2.50000E+00 9.75668E-01 6.01465E-03 2.80820E-01 2.60802E-01-2.89634E-02 6.11140E-01
   18 8.50000E+01 3.75000E+01 2.50000E+00 9.75062E-01-5.39209E-02 2.74738E-01 7.21048E-01-2.61408E-02 6.10250E-01
   19 8.50000E+01 3.75000E+01 7.50000E+00 9.77818E-01-7.86279E-02 2.29824E-01 1.03062E+00-1.17256E-02 6.04909E-01
*EOF
S3
    1-5.00000E+01 0.00000E+00 0.00000E+00 9.96642E-01 0.00000E+00-8.44388E-07-2.56988E-01 1.04588E-02 5.96635E-01
    2-2.00000E+01 0.00000E+00 0.00000E+00 9.85833E-01 0.00000E+00 4.27577E-06-5.81121E-01 4.38817E-02 5.85885E-01
    3-5.00000E+00 0.00000E+00 0.00000E+00 9.25392E-01 0.00000E+00 2.42046E-04-1.32104E+00 2.24050E-01 5.27867E-01
    4 8.50000E+01 2.25000E+01-7.50000E+00 9.82740E-01-2.75938E-02 2.00362E-02 8.57467E-01 5.07001E-02 5.83611E-01
    5 8.50000E+01 2.25000E+01-2.50000E+00 9.75944E-01-2.86149E-02 8.78810E-03 9.31533E-01 7.25898E-02 5.76641E-01
    6 8.50000E+01 2.25000E+01 2.50000E+00 9.76681E-01-2.87649E-02-9.70267E-03 9.34930E-01 7.16998E-02 5.77062E-01
    7 8.50000E+01 2.25000E+01 7.50000E+00 9.83923E-01-2.74869E-02-1.96547E-02 8.51981E-01 5.00934E-02 5.84095E-01
    8 8.50000E+01 2.75000E+01-7.50000E+00 9.85129E-01-2.59781E-02 1.70746E-02 7.21337E-01 4.37799E-02 5.85846E-01
    9 8.50000E+01 2.75000E+01-2.50000E+00 9.75379E-01-2.77794E-02 1.02221E-02 7.91237E-01 7.42228E-02 5.76105E-01
   10 8.50000E+01 2.75000E+01 2.50000E+00 9.76351E-01-2.86569E-02-1.01877E-02 7.91509E-01 7.27357E-02 5.76733E-01
   11 8.50000E+01 2.75000E+01 7.50000E+00 9.86176E-01-2.58458E-02-1.64551E-02 7.16139E-01 4.31389E-02 5.86297E-01
   12 8.50000E+01 3.25000E+01-7.50000E+00 9.89963E-01-2.50692E-02 1.21320E-02 5.89814E-01 2.94456E-02 5.90481E-01
   13 8.50000E+01 3.25000E+01-2.50000E+00 9.84904E-01-3.06647E-02 6.63367E-03 6.37684E-01 4.52479E-02 5.85452E-01
   14 8.50000E+01 3.25000E+01 2.50000E+00 9.85354E-01-3.05623E-02-6.08912E-03 6.35972E-01 4.48456E-02 5.85674E-01
   15 8.50000E+01 3.25000E+01 7.50000E+00 9.90596E-01-2.47296E-02-1.16357E-02 5.85816E-01 2.93442E-02 5.90688E-01
   16 8.50000E+01 3.75000E+01-7.50000E+00 9.94574E-01-2.14112E-02 7.46402E-03 4.70835E-01 1.57874E-02 5.94893E-01
   17 8.50000E+01 3.75000E+01-2.50000E+00 9.93009E-01-2.43289E-02 3.12067E-03 4.97429E-01 2.08899E-02 5.93289E-01
   18 8.50000E+01 3.75000E+01 2.50000E+00 9.93147E-01-2.41921E-02-2.92656E-03 4.96450E-01 2.09372E-02 5.93319E-01
   19 8.50000E+01 3.75000E+01 7.50000E+00 9.94859E-01-2.11026E-02-7.19059E-03 4.68509E-01 1.60571E-02 5.94915E-01
*EOF
```

Figure 8-5 Example of OFF Output File

8.8 FLOW-FIELD STREAMLINE PROPERTIES

You can output the streamline properties computed from the optional $FLOWFIELD PROPERTIES and $STREAMLINES IN THE FLOW-FIELD input sections. These properties are placed in an output file (suffix STR) for plotting. The data are commonly used to display streamline paths, flow-field pressures, and Mach numbers along the streamlines. The flow-field streamline data is described and processed similarly to the off-body point flow properties.

The STR output file contains flow-field properties as given in the printout. As shown in Figure 8-6, the data is formated as a GGP file with each line given a runid. The location and flow properties for each point on the streamline are output with one point per line. Each streamline is output in the order of the input streamlines.

As with the other files described in this section, you can transfer the assembled GGP file to the VAX or the PDP, where it is processed into a .RAN file. The .RAN file is then read into the GGP program to display and make hard copies of the streamlines and associated flow properties. This data can also be displayed in AGPS by placing the file in the special GGP format required by AGPS and then using the GGP command.

```
(F6.0,10E12.5,F3.1)
$TITLE SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
$TITLE SAARIS  865-6150  M/S 7K-04
$      FLOW-FIELD STREAMLINE PROPERTIES
*DUPT
*DUP
S01C1
    PT          S           X           Y           Z          WX          WY          WZ        PPOT     CP/2ND        MACH C
     1 0.00000E+00 4.00000E+01 3.00000E+01-2.00000E+00 9.69822E-01 1.20286E-01 7.75300E-02-1.19710E+00 6.90767E-02 5.78618E-01  1
     2 2.52497E-02 4.00245E+01 3.00030E+01-1.99804E+00 9.69780E-01 1.20741E-01 7.74025E-02-1.19777E+00 6.91210E-02 5.78610E-01  1
     3 1.25250E-01 4.01215E+01 3.00152E+01-1.99033E+00 9.69626E-01 1.22574E-01 7.68753E-02-1.20043E+00 6.92633E-02 5.78589E-01  1
     4 3.25250E-01 4.03154E+01 3.00401E+01-1.97507E+00 9.69368E-01 1.26378E-01 7.57086E-02-1.20570E+00 6.93664E-02 5.78608E-01  1
     5 7.25250E-01 4.07031E+01 3.00922E+01-1.94532E+00 9.69225E-01 1.34412E-01 7.29566E-02-1.21547E+00 6.83229E-02 5.79060E-01  1
     6 1.52525E+00 4.14790E+01 3.02067E+01-1.88986E+00 9.70894E-01 1.52719E-01 6.45732E-02-1.22839E+00 5.97998E-02 5.82088E-01  1
     7 2.32525E+00 4.22582E+01 3.03372E+01-1.84269E+00 9.78450E-01 1.73875E-01 5.31561E-02-1.23655E+00 3.21020E-02 5.91363E-01  1
     8 3.92525E+00 4.38555E+01 3.06418E+01-1.76320E+00 1.02805E+00 1.99496E-01 5.93741E-02-1.17324E+00-1.34109E-01 6.45242E-01  1
     9 5.36525E+00 4.53623E+01 3.09155E+01-1.63775E+00 1.04922E+00 1.69428E-01 1.23426E-01-1.01176E+00-2.08711E-01 6.68938E-01  1
    10 6.80525E+00 4.68746E+01 3.11250E+01-1.41596E+00 1.05200E+00 1.26126E-01 1.66156E-01-8.31243E-01-2.20963E-01 6.72591E-01  1
    11 8.24525E+00 4.83874E+01 3.12748E+01-1.15983E+00 1.04909E+00 8.27578E-02 1.85158E-01-6.54460E-01-2.10590E-01 6.68972E-01  1
    12 9.68525E+00 4.98938E+01 3.13697E+01-8.88650E-01 1.04270E+00 5.20231E-02 1.89648E-01-4.94857E-01-1.87571E-01 6.61353E-01  1
    13 1.11252E+01 5.13917E+01 3.14313E+01-6.15195E-01 1.03901E+00 3.52843E-02 1.90781E-01-3.52296E-01-1.74602E-01 6.57093E-01  1
    14 1.25652E+01 5.28877E+01 3.14723E+01-3.38730E-01 1.03907E+00 2.03454E-02 1.93755E-01-2.13610E-01-1.75354E-01 6.57331E-01  1
    15 1.40052E+01 5.43844E+01 3.14893E+01-5.65734E-02 1.03907E+00 4.43977E-03 1.97578E-01-7.34310E-02-1.76745E-01 6.57808E-01  1
    16 1.54452E+01 5.58802E+01 3.14837E+01 2.30912E-01 1.03858E+00-1.22045E-02 2.01699E-01 6.78343E-02-1.77276E-01 6.58038E-01  1
    17 1.74452E+01 5.79561E+01 3.14346E+01 6.40449E-01 1.03719E+00-3.73257E-02 2.07963E-01 2.65654E-01-1.77074E-01 6.58116E-01  1
    18 1.94452E+01 6.00285E+01 3.13315E+01 1.06245E+00 1.03512E+00-6.66376E-02 2.13966E-01 4.66346E-01-1.76444E-01 6.58145E-01  1
    19 2.14452E+01 6.20963E+01 3.11626E+01 1.49518E+00 1.03257E+00-1.03955E-01 2.18593E-01 6.72460E-01-1.76909E-01 6.58677E-01  1
    20 2.34452E+01 6.41584E+01 3.09062E+01 1.93090E+00 1.02949E+00-1.55423E-01 2.15882E-01 8.88896E-01-1.78901E-01 6.59944E-01  1
    21 2.54452E+01 6.62149E+01 3.05285E+01 2.33853E+00 1.02737E+00-2.25703E-01 1.85836E-01 1.12473E+00-1.84319E-01 6.62639E-01  1
    22 2.74452E+01 6.82668E+01 3.00230E+01 2.63265E+00 1.02395E+00-2.67841E-01 9.89272E-02 1.37428E+00-1.62356E-01 6.55981E-01  1
    23 2.94452E+01 7.03067E+01 2.94859E+01 2.75007E+00 1.01426E+00-2.57909E-01 3.73514E-02 1.58354E+00-1.12946E-01 6.39842E-01  1
    24 3.12452E+01 7.21228E+01 2.90449E+01 2.79600E+00 1.00466E+00-2.41436E-01 7.20496E-03 1.72104E+00-7.07352E-02 6.26020E-01  1
    25 3.30452E+01 7.39219E+01 2.86252E+01 2.79236E+00 9.93842E-01-2.24603E-01-1.04436E-02 1.81830E+00-2.78547E-02 6.11998E-01  1
    26 3.48452E+01 7.57008E+01 2.82356E+01 2.76512E+00 9.82883E-01-2.08057E-01-1.75798E-02 1.87268E+00 1.34321E-02 5.98458E-01  1
    27 3.66452E+01 7.74603E+01 2.78754E+01 2.73308E+00 9.72225E-01-1.92275E-01-1.70291E-02 1.88583E+00 5.22141E-02 5.85691E-01  1
    28 3.86452E+01 7.93928E+01 2.75075E+01 2.70852E+00 9.60028E-01-1.75737E-01-4.92215E-03 1.85242E+00 9.44018E-02 5.71731E-01  1
    29 4.06452E+01 8.13055E+01 2.71680E+01 2.72239E+00 9.55052E-01-1.65548E-01 2.12989E-02 1.77915E+00 1.10348E-01 5.66243E-01  1
    30 4.26452E+01 8.32222E+01 2.68404E+01 2.78819E+00 9.64557E-01-1.63727E-01 4.02659E-02 1.70889E+00 7.98700E-02 5.75896E-01  1
    31 4.46452E+01 8.51633E+01 2.65147E+01 2.87374E+00 9.74187E-01-1.60095E-01 4.24437E-02 1.66732E+00 5.15491E-02 5.84899E-01  1
    32 4.66452E+01 8.71175E+01 2.62000E+01 2.95438E+00 9.79411E-01-1.54470E-01 3.93477E-02 1.64207E+00 3.78724E-02 5.89194E-01  1
    33 4.86452E+01 8.90793E+01 2.58974E+01 3.02893E+00 9.82186E-01-1.48066E-01 3.54434E-02 1.62115E+00 3.19051E-02 5.91014E-01  1
    34 5.06452E+01 9.10454E+01 2.56082E+01 3.09611E+00 9.83773E-01-1.41064E-01 3.19051E-02 1.59706E+00 2.95693E-02 5.91665E-01  1
*EOF
```

Figure 8-6 Example of STR Output File (continued on next page)

```
S02C1
 1 0.00000E+00 4.00000E+01 3.00000E+01 0.00000E+00 9.68364E-01 1.20621E-01 1.27058E-01-1.14082E+00 5.94970E-02 5.81888E-01  1
 2 2.52014E-02 4.00244E+01 3.00030E+01 3.20597E-03 9.68272E-01 1.21132E-01 1.27371E-01-1.14133E+00 5.95468E-02 5.81881E-01  1
 3 1.25201E-01 4.01212E+01 3.00153E+01 1.60064E-02 9.67909E-01 1.23204E-01 1.28646E-01-1.14336E+00 5.97185E-02 5.81863E-01  1
 4 3.25201E-01 4.03147E+01 3.00403E+01 4.20046E-02 9.67179E-01 1.27563E-01 1.31379E-01-1.14732E+00 5.99151E-02 5.81881E-01  1
 5 7.25201E-01 4.07013E+01 3.00933E+01 9.57789E-02 9.65756E-01 1.37274E-01 1.37701E-01-1.15473E+00 5.94654E-02 5.82219E-01  1
 6 1.52520E+00 4.14730E+01 3.02124E+01 2.12460E-01 9.63833E-01 1.61651E-01 1.55423E-01-1.16562E+00 5.14394E-02 5.85358E-01  1
 7 3.12520E+00 4.30352E+01 3.05208E+01 5.08845E-01 1.01034E+00 2.27373E-01 2.25616E-01-1.11479E+00-1.50285E-01 6.52251E-01  1
 8 3.84520E+00 4.37841E+01 3.06694E+01 6.69529E-01 1.07815E+00 1.67876E-01 2.09072E-01-9.95845E-01-3.40242E-01 7.12585E-01  1
 9 4.56520E+00 4.45701E+01 3.07596E+01 8.10999E-01 1.08423E+00 8.60046E-02 1.86892E-01-8.55334E-01-3.29359E-01 7.07806E-01  1
10 5.28520E+00 4.53458E+01 3.08019E+01 9.41460E-01 1.07650E+00 4.42250E-02 1.79708E-01-7.34274E-01-2.94527E-01 6.96053E-01  1
11 6.00520E+00 4.61187E+01 3.08258E+01 1.07021E+00 1.07076E+00 1.80390E-02 1.76252E-01-6.24522E-01-2.72047E-01 6.88588E-01  1
12 6.72520E+00 4.68881E+01 3.08311E+01 1.19641E+00 1.06653E+00-3.46160E-03 1.74448E-01-5.22027E-01-2.56789E-01 6.83573E-01  1
13 8.16520E+00 4.84175E+01 3.08010E+01 1.44655E+00 1.05746E+00-3.58649E-02 1.73423E-01-3.35021E-01-2.27474E-01 6.74071E-01  1
14 9.60520E+00 4.99332E+01 3.07324E+01 1.69757E+00 1.04753E+00-5.72316E-02 1.75549E-01-1.69189E-01-1.97639E-01 6.64495E-01  1
15 1.10452E+01 5.14406E+01 3.06406E+01 1.95314E+00 1.04779E+00-6.84984E-02 1.79570E-01-1.60814E-02-2.01670E-01 6.65913E-01  1
16 1.24852E+01 5.29516E+01 3.05258E+01 2.20897E+00 1.05076E+00-9.66454E-02 1.73471E-01 1.49720E-01-2.13420E-01 6.69892E-01  1
17 1.39252E+01 5.44660E+01 3.03649E+01 2.44912E+00 1.05187E+00-1.25028E-01 1.58935E-01 3.23817E-01-2.17318E-01 6.71332E-01  1
18 1.53652E+01 5.59811E+01 3.01669E+01 2.66408E+00 1.05238E+00-1.48523E-01 1.39008E-01 5.01655E-01-2.17845E-01 6.71668E-01  1
19 1.68052E+01 5.74966E+01 2.99390E+01 2.84861E+00 1.05230E+00-1.67074E-01 1.17213E-01 6.81261E-01-2.16015E-01 6.71242E-01  1
20 1.82452E+01 5.90114E+01 2.96875E+01 3.00115E+00 1.05162E+00-1.81881E-01 9.44008E-02 8.61123E-01-2.12236E-01 6.70194E-01  1
21 2.02452E+01 6.11123E+01 2.93079E+01 3.15864E+00 1.04863E+00-1.96444E-01 6.36237E-02 1.10726E+00-2.00539E-01 6.66651E-01  1
22 2.22452E+01 6.32057E+01 2.89050E+01 3.25670E+00 1.04498E+00-2.05834E-01 3.45725E-02 1.34518E+00-1.87140E-01 6.62564E-01  1
23 2.42452E+01 6.52910E+01 2.84875E+01 3.29654E+00 1.03987E+00-2.11116E-01 4.73935E-03 1.57240E+00-1.69106E-01 6.56997E-01  1
24 2.62452E+01 6.73618E+01 2.80657E+01 3.27743E+00 1.02964E+00-2.08803E-01-2.27458E-02 1.77738E+00-1.33366E-01 6.45639E-01  1
25 2.82452E+01 6.94090E+01 2.76547E+01 3.21177E+00 1.01811E+00-2.02015E-01-4.04931E-02 1.94378E+00-9.34833E-02 6.32848E-01  1
26 3.02452E+01 7.14340E+01 2.72594E+01 3.11953E+00 1.00637E+00-1.92907E-01-5.23793E-02 2.06946E+00-5.30283E-02 6.19815E-01  1
27 3.22452E+01 7.34345E+01 2.68840E+01 3.00742E+00 9.93886E-01-1.82180E-01-5.85164E-02 2.15211E+00-1.03189E-02 6.05991E-01  1
28 3.42452E+01 7.54098E+01 2.65309E+01 2.88983E+00 9.81548E-01-1.70886E-01-5.78396E-02 2.18879E+00 3.16551E-02 5.92320E-01  1
29 3.62452E+01 7.73608E+01 2.62004E+01 2.78015E+00 9.69299E-01-1.59701E-01-5.11981E-02 2.18003E+00 7.27914E-02 5.78850E-01  1
30 3.82452E+01 7.92876E+01 2.58912E+01 2.69203E+00 9.57837E-01-1.49937E-01-3.40082E-02 2.12534E+00 1.10401E-01 5.66410E-01  1
31 4.02452E+01 8.11981E+01 2.55962E+01 2.65032E+00 9.56586E-01-1.47627E-01-7.36502E-03 2.04013E+00 1.13933E-01 5.64967E-01  1
32 4.22452E+01 8.31209E+01 2.52977E+01 2.65718E+00 9.66336E-01-1.49833E-01 7.18560E-03 1.96663E+00 8.29409E-02 5.74828E-01  1
33 4.42452E+01 8.50647E+01 2.49980E+01 2.67010E+00 9.74527E-01-1.47890E-01 9.70232E-03 1.92011E+00 5.84813E-02 5.82620E-01  1
34 4.62452E+01 8.70169E+01 2.47085E+01 2.68771E+00 9.79225E-01-1.43027E-01 8.50643E-03 1.88773E+00 4.56906E-02 5.86650E-01  1
35 4.82452E+01 8.89777E+01 2.44286E+01 2.70345E+00 9.81789E-01-1.36876E-01 6.65580E-03 1.85990E+00 3.97374E-02 5.88477E-01  1
36 5.02452E+01 9.09429E+01 2.41617E+01 2.71506E+00 9.83262E-01-1.29957E-01 5.08096E-03 1.82961E+00 3.72098E-02 5.89196E-01  1
*EOF
```

Figure 8-6 Example of STR Output File

8.9 SURFACE FLOW PROPERTIES FOR BOUNDARY LAYER ANALYSIS

For boundary layer analysis, you can output surface flow properties to an A502 BL output file. Use the $BOUNDARY LAYER input data section to request such output. The boundary layer output from A502 needs to be processed into the A598 boundary layer analysis program (reference 34).

The BL output file is a binary file containing panel-center control-point location, velocity vector components, and other miscellaneous data. To help you understand the output file, the FORTRAN code used to produce the BL file and the printed output are given below. The RV parameter contains the control point location and velocity vector components. This data is output for all networks and repeated for each solution.

```
      DO 783 K=1,NNETT
      READ(ISCRCH)NROW,NCOL
      NCNT=ICNTBL(ICAS,K)
      IF(K.GT.1)        GO TO 710
      WRITE(17)(TITLE1(I),I=1,8),AMACH,ALPHA(IACASE),NNETT
 710  CONTINUE
      WRITE(6,3700)
3700  FORMAT(1H1,5HCHORD,7X1HI,10X2HXP,13X2HYP,13X2HZP,
     2                         13X2HUP,13X2HVP,13X2HWP)
      CALL ZERO(RV,6*NROW*NCOL)
      WRITE(17)NCOL
      DO 776 J=1,NCNT
      READ(ISCRCH) II,JJ,(RVPNT(I),I=1,6)
      IPK = II + (JJ-1)*NROW
      CALL SCOPY(6, RVPNT,1,RV(1,IPK),1)
 776  CONTINUE
      DO 780 JCOL = 1,NCOL
      L1 = 1 + (JCOL - 1)*NROW
      L2 = JCOL*NROW
      WRITE(17)NROW
      WRITE(17) ((RV(I,L),I=1,6),L=L1,L2)
      WRITE(6,3800) JCOL, (IROW, (RV(I,IROW+L1-1),I=1,6), IROW=1,NROW)
3800  FORMAT(1H,I5,5X,I5,6F15.5 ,/, (11X,I5,6F15.5) )
 780  CONTINUE
 783  CONTINUE
 785  CONTINUE
 790  CONTINUE
      RETURN
      END
```

9. EXAMPLE: WING-BODY CONFIGURATION

A simple wing-body configuration analysis is used in this section to illustrate inputs, printout, and output files. The wing-body configuration has been chosen to illustrate abutment processing output. The illustrated configuration uses a minimum number of panels to minimize the printout for documentation.

The paneling layout shown uses the most common boundary conditions. This type of layout is used repeatedly in modeling complex configurations, e.g., strut pod components are similar to wing-body configuration.

Figure 9-1 shows paneling used to represent the right half of the configuration and an exploded view of the panel networks, with network numbers as ordered for input into A502. The arrow identifies the direction of the points in the first point column. The following summarizes the A502 analysis of the wing-body configuration:

- Simple wing-body composite panel model
- Symmetric configuration and flow
- Mach no. = 0.6
- Compressibility angle of attack = 4.0 degrees
- Angles of attack = 4.0, 10.0, 0.0 degrees
- Force and moment reference area (full configuration) = 2400.
- Moment reference span = 60.
- Moment reference chord = 40.
- Moment reference length (for MZ) = 90.
- Calculate sectional properties of the wing at Y = 15. and Y = 25.
- Examine flow-field properties ahead of body and aft of wing tip
- Compute streamline properties about wing tip

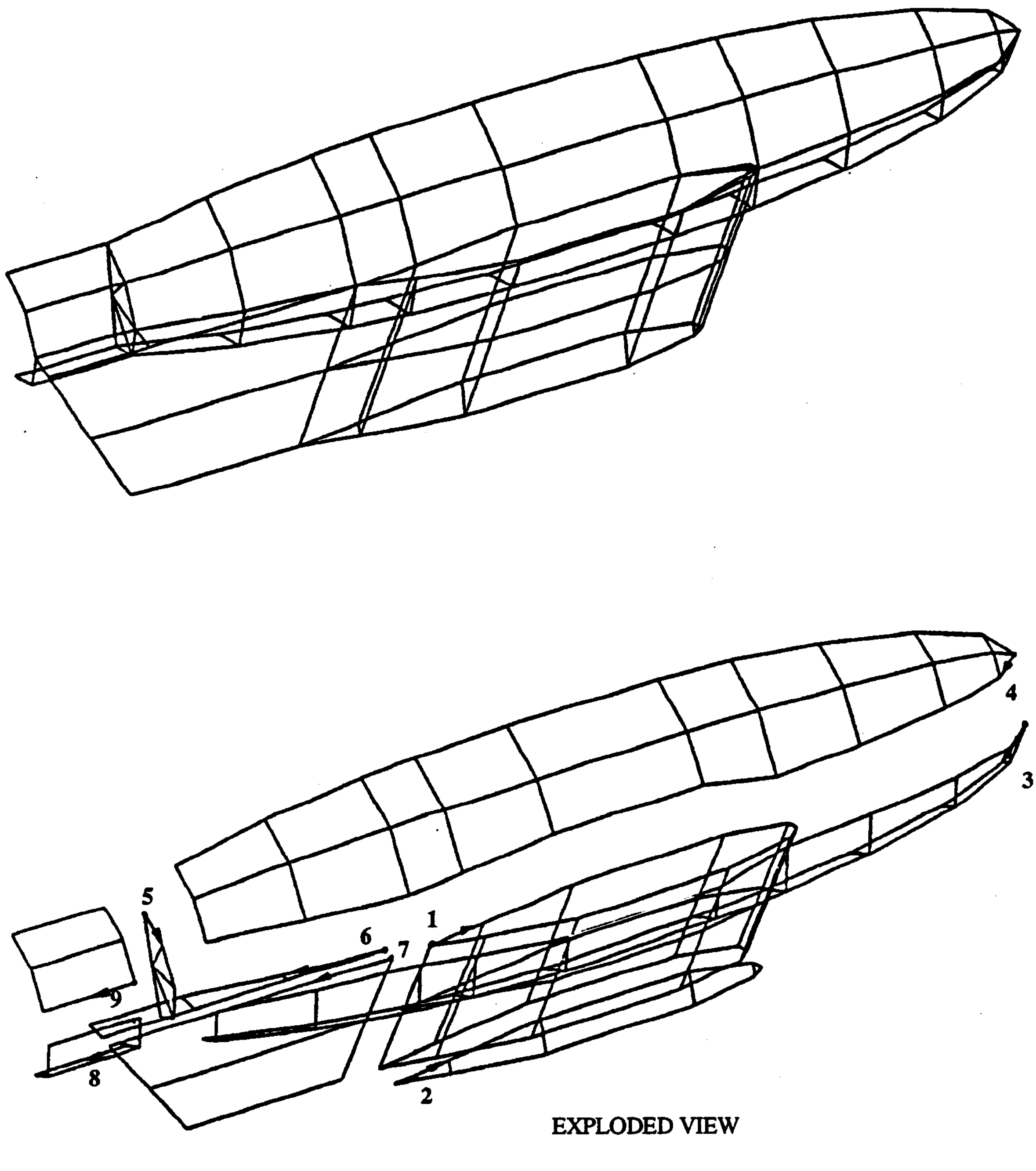

Figure 9-1 Input Paneling for Simple Wing-Body Configuration

To further illustrate the processing of this problem, figures have been added to the printout.

- Figure 9-2 displays network edge-point numbers. This information is of use in defining the partial network edge abutment data.
- Figure 9-3 gives input wing leading edge paneling along the body and the same paneling after partial network edge abutment processing.
- Figure 9-4 sketches the configuration abutment numbers defined by the program. Note that these numbers follow the order of the networks and are ordered within a network by edge numbers. The figure also illustrates the different types of abutments given in the abutment summary; i.e., abutments with another network edge and plane of symmetry, unabutted downstream wake edge, and exposed wake side edge.

  This sketch and the network edge numbers given in figure 9-5 are helpful in reading the abutment summary printout.
- Figure 9-6 gives surface pressures over the entire configuration.
- Figures 9-7 through 9-9 illustrate source distribution, doublet distribution, and doublet strength along the wake.

The following pages illustrate output files from the first A502 solution of the simple wing-body configuration.

The A502I files extension names are assigned by the A502 script used to execute A502. Thus, all files associated with the A502 job have the same root filename. The A502H filename has been provided for references used in the remainder of this section.

Filenames		Description	Page
A502I	A502H		
sbw.out	HSWBOUT	A502 Solution Printout	9-4
swb.log	- - -	Log file of Cray Y-MP processing	9-36
sbw.mpx	HSWBMPX	Configuration Paneling and Streamline Paths	9-39
sbw.bpf	HSWBPF	Data Base of Surface Flow Properties	9-42
sbw.pc	HSWBSPC	Pressure at Grid Points	9-48
sbw.spg	HSWBSPG	Sectional Pressures	9-51
sbw.sfg	HSWBSFG	Sectional Forces	9-52
sbw.fmg	HSWBFMG	Forces and Moments Summary	9-52
sbw.off	HSWBOFF	Off-Body Flow Properties	9-53
sbw.str	HSWBSTR	Streamline Flow Properties	9-54

Comments have been added and can easily be identified as enlarged text. Repetitive data has been omitted, as noted.

The printout parameters shown in this section are described in section 6. The remaining output files and instructions for their use are described in section 8.

9.1 HSWBOUT -- A502 SOLUTION PRINTOUT

```
1
 LENGTHS (IN NATIVE UNITS) OF INT AND R*8:   1   1

 ****************************************************************************************************

  DYNAMIC MEMORY MANAGEMENT INITIALIZATION

  MAX NO. LEVELS         15  MAX NO. ARRAYS        200  MAXIMUM SCRATCH STORAGE       1600000  TOTAL STORAGE PROVIDED  1600000
    ADDR(MAPLEV)          0    ADDR(MAPIWS)          0    ADDR(SCRATCH STORAGE)             1

 ****************************************************************************************************
  UPT CALLED WITH:A502I00   AND:D22012

 ******************************************************************************
 *                                                                            *
 *                     A502 - PAN-AIR TECHNOLOGY PROGRAM                      *
 *                                                                            *
 *                POTENTIAL FLOW ABOUT ARBITRARY CONFIGURATIONS               *
 *            [illegible]                                                     *
 *                                01/07/92                                    *
 *                                                                            *
 *                                                                            *
 * SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502I)                    *
 *.SAARIS  865-6150 M/S 7H-94                                                 *
 *                                                                            *
 *                                                                            *
 *                                                                            *
 ******************************************************************************
1
```

0*B*INPUT-DA

- LIST OF A502 INPUT DATA CARDS -

```
NO.   CARD IMAGES

 1    $TITLE
 2    SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
 3    SAARIS 865-6150 M/S 7K-04
 4    $SOLUTION
 5    $SYMMETRY - XZ PLANE OF SYMMETRY
 6    =MISYMM   MJSYMM
 7    1.        0.
 8    $MACH NUMBER
 9    =AMACH
10    .6
11    $CASES - NO. OF SOLUTIONS
12    =NACASE
13    3.
14    $ANGLES-OF-ATTACK
15    =ALPC
16    4.
17    =ALPHA(1) ALPHA(2)  ALPHA(3)
18    4.        10.       0.
19    $PRINTOUT OPTIONS
20    =ISINGS   IGEOMP    ISINGP    ICONTP    IBCONP    IEDGEP
21    0.        0.        0.        0.        0.        0.
22    =IPRAIC   NEXDGN    IOUTPR    IFMCPR
23    .0        .0        1.        0.
24    $REFERENCES FOR ACCUMULATED FORCES AND MOMENTS
25    =XREF     YREF      ZREF
26    46.       0.        0.
27    =SREF     BREF      CREF      DREF
28    2400.     60.       40.       90.
29    $POINTS - WING-BODY  WITH COMPOSITE PANELS
30    =KN
31    4.
32    =KT
33    1.
34    =NM       NN                                                          NETNAME
35    11.       3.                                                          WINGA
36    =X(1,1)   Y(1,1)    Z(1,1)    X(*,*)    Y(*,*)    Z(*,*)
37       69.4737    9.2105    0.0000   63.7818    9.5807    0.7831
38       53.7705    9.7741    1.9747   37.2370    9.4677    1.9614
39       30.2755    9.1527    0.8173   29.4086    9.1127   -0.0025
40       30.2800    9.1529   -0.8192   37.2409    9.4679   -1.9617
41       53.7722    9.7741   -1.9746   63.7823    9.5807   -0.7830
42       69.4737    9.2105    0.0000
43       76.6660   20.0000    0.0000   70.8460   20.1781    0.7831
44       60.7679   20.2711    1.9747   44.3403   20.1238    1.9614
45       37.4878   19.9722    0.8173   36.6347   19.9530   -0.0025
46       37.4922   19.9723   -0.8192   44.3441   20.1238   -1.9617
47       60.7695   20.2711   -1.9746   70.8465   20.1781   -0.7830
48       76.6660   20.0000    0.0000
49       83.3330   30.0000    0.0000   77.3943   30.0000    0.7831
50       67.2541   30.0000    1.9747   50.9248   30.0000    1.9614
51       44.1733   30.0000    0.8173   43.3330   30.0000   -0.0025
52       44.1776   30.0000   -0.8192   50.9286   30.0000   -1.9617
53       67.2557   30.0000   -1.9746   77.3948   30.0000   -0.7830
54       83.3330   30.0000    0.0000
55            6.        2.                                                  WINGTA
56       83.3330   30.0000    0.0000   77.3943   30.0000    0.7831
57       67.2541   30.0000    1.9747   50.9248   30.0000    1.9614
58       44.1733   30.0000    0.8173   43.3330   30.0000   -0.0025
59       83.3330   30.0000    0.0000   77.3948   30.0000   -0.7830
60       67.2557   30.0000   -1.9746   50.9286   30.0000   -1.9617
61       44.1776   30.0000   -0.8192   43.3330   30.0000   -0.0025
```

```
        11.        3.                                                   BODYL
     0.0000    0.0000    0.0000    3.0000    0.0000   -3.4147
    10.0000    0.0000   -6.0000   20.0000    0.0000   -8.0000
    29.4086    0.0000   -9.1127   37.2409    0.0000   -9.6690
    53.7722    0.0000   -9.9715   63.7823    0.0000   -9.6126
    69.4737    0.0000   -9.2105   80.0000    0.0000   -8.0000
    90.0000    0.0000   -6.0000
     0.0000    0.0000    0.0000    3.0000    2.4142   -2.4149
    10.0000    4.2421   -4.2432   20.0000    5.6561   -5.6576
    29.4086    6.4428   -6.4445   37.2409    6.8363   -6.8377
    53.7722    7.0506   -7.0513   63.7823    6.7970   -6.7973
    69.4737    6.5128   -6.5128   80.0000    5.6569   -5.6569
    90.0000    4.2427   -4.2427
     0.0000    0.0000    0.0000    3.0000    3.4147   -0.0009
    10.0000    6.0000   -0.0016   20.0000    8.0000   -0.0022
    29.4086    9.1127   -0.0025   37.2409    9.4679   -1.9617
    53.7722    9.7741   -1.9746   63.7823    9.5807   -0.7830
    69.4737    9.2105    0.0000   80.0000    8.0000    0.0000
    90.0000    6.0000    0.0000
        11.        3.                                                   BODYU
     0.0000    0.0000    0.0000    3.0000    3.4147   -0.0009
    10.0000    6.0000   -0.0016   20.0000    8.0000   -0.0022
    29.4086    9.1127   -0.0025   37.2370    9.4677    1.9614
    53.7705    9.7741    1.9747   63.7818    9.5807    0.7831
    69.4737    9.2105    0.0000   80.0000    8.0000    0.0000
    90.0000    6.0000    0.0000
     0.0000    0.0000    0.0000    3.0000    2.4149    2.4142
    10.0000    4.2432    4.2421   20.0000    5.6576    5.6561
    29.4086    6.4445    6.4428   37.2370    6.8376    6.8361
    53.7705    7.0513    7.0506   63.7818    6.7973    6.7970
    69.4737    6.5128    6.5128   80.0000    5.6569    5.6569
    90.0000    4.2427    4.2427
     0.0000    0.0000    0.0000    3.0000    0.0000    3.4147
    10.0000    0.0000    6.0000   20.0000    0.0000    8.0000
    29.4086    0.0000    9.1127   37.2370    0.0000    9.6688
    53.7705    0.0000    9.9716   63.7818    0.0000    9.6126
    69.4737    0.0000    9.2105   80.0000    0.0000    8.0000
    90.0000    0.0000    6.0000
$POINTS - BODYBASE WITH COMPOSITE PANELS
=KN
1.
=KT
5.
=NM       NN                                                            NETNAME
5.        2.                                                            BODYB
=X(1,1)   Y(1,1)    Z(1,1)    X(*,*)    Y(*,*)    Z(*,*)
    90.0000    0.0000    6.0000   90.0000    4.2427    4.2427
    90.0000    6.0000    0.0000   90.0000    4.2427   -4.2427
    90.0000    0.0000   -6.0000
    90.0000    0.0000    0.0000   90.0000    0.0000    0.0000
    90.0000    0.0000    0.0000   90.0000    0.0000    0.0000
    90.0000    0.0000    0.0000
$POINTS - BODY TO WING WAKES
=KN
1.
=KT
20.
=NM       NN                                                            NETNAME
4.        2.                                                            AWBW
=X(1,1)   Y(1,1)    Z(1,1)    X(*,*)    Y(*,*)    Z(*,*)
    69.4737    9.2105    0.0000   80.0000    8.0000    0.0000
    90.0000    6.0000    0.0000  100.0000    6.0000    0.0000
    69.4737    9.2105    0.0000   80.0000    9.2105    0.0000
    90.0000    9.2105    0.0000  100.0000    9.2105    0.0000
$TRAILING WAKES FROM WINGS
=KN
1.
=KT
18.
=INAT     INSD      XWAKE     TWAKE                                     NETNAME
WINGA     1.        100.      .0                                        WINGWK
$TRAILING WAKES FROM BODY
=KN
2.
=KT       MATCW
18.       1.
=INAT     INSD      XWAKE     TWAKE                                     NETNAME
BODYL     3.        100.      .0                                        BODYLWK
```

```
BODYU     3.        100.      .0                                      BODYUWK
$PEA - PARTIAL OR FULL NETWORK EDGE ABUTMENTS
=NFPA     IOPFOR    IPEAPT
2.        0.
=NNE      PEATOL
2.        .005
=NN       EN        EPINIT    EPIAST
WINGA     4.        6.        1.
BODYL     2.        5.        9.
2.
WINGA     4.        6.        11.
BODYU     4.        7.        3.
$EAT - LIBERALIZED ABUTMENTS
=EPSGEO   IGEOIS    IGEOUT    NWXREF    TRIINT    IABSUM
          0.        0.        0.        0.        0.
$SECTIONAL PROPERTIES
=NUMGRP
1.
*NETWORK SELECTION FOR SECTIONAL PROPERTIES
=NUMNET
1.
=NETDAT
1.
*CUT AND REFERENCE PRINTOUT FOR SECTIONAL PROPERTIES
=OPTCRD   OPTMRP    IPRINF    IPRTPP    ISECPR    IXYZOP    REFLEN
1.        1.        0.        1.                            30.
=NUMCUT
2.
=XC       YC        ZC        XCN       YCN       ZXN
.0        15.       .0        .0        1.        .0
=CHRD     REFRAC
          .25
.0        25.       .0        .0        1.        .0
          .25
$FLOWFIELD PROPERTIES
=NFLOWV   TPOFF
1.        0.
$XYZ COORDINATES OF OFF-BODY POINTS
=ISK1
3.
=XOF(1)   YOF(1)    ZOF(1)    XOF(*)    YOF(*)    ZOF(*)
-50.      0.        0.        -20.      0.        0.
-5.       0.        0.
$GRID - OFFBODY POINTS ENTERED AS A GRID OF POINTS
=NGT
1.
=OX       OY        OZ        3X        3Y        3Z
85.0      22.5      -7.5      95.0      22.5      -7.5
=2X       2Y        2Z        1X        1Y        1Z
85.0      37.5      -7.5      85.0      22.5      7.5
=D3       D2        D1        I3        I2        I1
5.        5.        5.        1.        4.        4.
$STREAMLINES IN THE FLOW FIELD
=NSTMLN
1.
=NUMPTS   HMIN      HMAX      MAXSTM    MAXORDR   ABSERR
2.        .1        2.        100.      6.        .01
=MAXARR1  ISPRNT    TPSL
10000.    0.        0.        1.
=X        Y         Z         DX        DY        DZ
40.       30.       -2.       50.       10.       10.
=FWDBK
1.
40.       30.       0.        50.       10.       10.
1.
$END OF A502 INPUTS
```

1

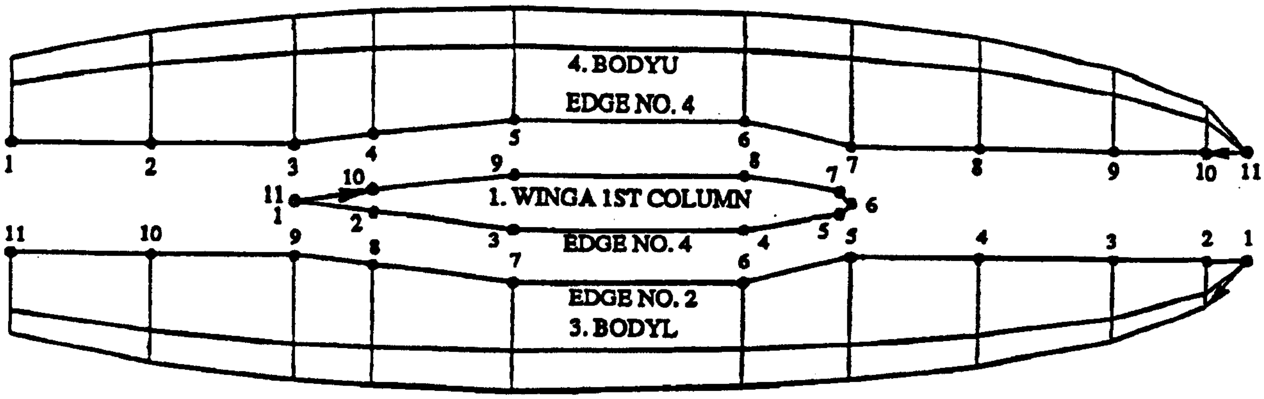

Figure 9-2 Edge-Point Numbers for Specifying Partial Network Edge Abutments ($PEA)

```
                         RECORD OF INPUT PROCESSING

$TITT
$SOL
$SYM
$MAC
$CAS
$ANG
$REF
$PRI
$POI
   KN,KT              4         1
  NETWORK # BEING PROCESSED  1   11.0000   3.0000   0.0000   0.0000   0.0000   0.0000   WINGA

  NETWORK # BEING PROCESSED  2    6.0000   2.0000   0.0000   0.0000   0.0000   0.0000   WINGTA

  NETWORK # BEING PROCESSED  3   11.0000   3.0000   0.0000   0.0000   0.0000   0.0000   BODYL

  NETWORK # BEING PROCESSED  4   11.0000   3.0000   0.0000   0.0000   0.0000   0.0000   BODYU

$POI
   KN,KT              1         5
  NETWORK # BEING PROCESSED  5    5.0000   2.0000   0.0000   0.0000   0.0000   0.0000   BODYB

$POI
   KN,KT              1        20
  NETWORK # BEING PROCESSED  6    4.0000   2.0000   0.0000   0.0000   0.0000   0.0000   AWBW

$TRA
   KN,KT              1        18
  NETWORK # BEING PROCESSED  7                                                          WINGWK

$TRA
   KN,KT              2        18
  NETWORK # BEING PROCESSED  8                                                          BODYLWK

  NETWORK # BEING PROCESSED  9                                                          BODYUWK

$PEA
$EAT
$SEC
*NET
*CUT
$FLO
$XYZ
$GRI
$STR
```

```
  —INDVSL          4
      1.           1         0         0         0
  —NCASSL          1
 $END


 TPCRIT, M     0.784004   0.600000
   IFORM-1         9
      1.           1         1         1         1         0         0         0         0         0
   IFORM-2         9
      1.           1         1         1         1         1         1         1         1         1


1               ***  QUICK SUMMARY OF A502 INPUT  ***
 TITLE1: SIMPLE WING-BODY WITH COMPOSITE PANEL. (RUN WITH A502H)
 TITLE2: SAARIS  865-6150  M/S 7K-04
0               PROCESSING OPTIONS
            0 = DATACHECK.     (0=REGULAR RUN,1=FULL DATACHECK,2=SHORT DATACHECK)
            0 = S.P. FLAG.     (0 ==> NO S.P. FILE (FT09) PROVIDED, 1 ==> LOCAL FILE FT09 WITH SINGULARITY VALUES IS PROVIDED)
            0 = AIC FLAG.      (0 ==>  NO AIC FILE (FT04) PROVIDED, 1 ==> LOCAL FILE FT04 WITH AIC-S IS PROVIDED BY THE USER)
            0 = B.L. FLAG      (0 ==> NO BOUNDARY LAYER FILE REQUESTED, 1 ==> BOUNDARY LAYER DATA WILL BE WRITTEN TO FILE FT17)
            0 = VELOCITY CORRECTION INDEX.   (0 ==> NO CORRECTION, 1 ==> MCLEAN CORRECTION, 2 ==>  BOCTOR CORRECTION)
            1 = FLOW VISUALIZATION FLAG.   (NONZERO ==> OFF-BODY AND STREAMLINE PROCESSING WILL BE PERFORMED)
            0 = OFF-BODY CALCULATION TYPE.  (0 ==> MASS FLUX, NONZERO ==> VELOCITY)
            0 = STREAMLINE CALCULATION TYPE.  (0 ==> MASS FLUX, NONZERO ==> VELOCITY)
           19 = NUMBER OF OFF-BODY POINTS.
            2 = NUMBER OF STREAMLINES TO BE TRACED.
0               CASE SUMMARY
            3 = NUMBER OF CASES
     0.600000 = MACH NUMBER
     4.000000 = COMPRESSIBILITY AXIS ANGLE OF ATTACK (ALPC)
     0.000000 = COMPRESSIBLIITY AXIS ANGLE OF SIDESLIP (BETC)
0 CASE       ALPHA         BETA       MAG(F-S-V)
  ----    ----------    ----------    ----------
     1     4.000000      0.000000      1.000000
     2    10.000000      0.000000      1.000000
     3     0.000000      0.000000      1.000000
0               SYMMETRY OPTIONS
            1 = NUMBER OF PLANES OF SYMMETRY
            1 = X-Z PLANE OF SYMMETRY FLAG (0 ==> NO SYMMETRY, 1==> FLOW SYMMETRY, -1 ==> FLOW ANTISYMMETRY)
            0 = X-Y PLANE OF SYMMETRY FLAG (0 ==> NO SYMMETRY, 1==> FLOW SYMMETRY, -1 ==> FLOW ANTISYMMETRY)
0               CONFIGURATION SUMMARY
            9 = TOTAL NUMBER OF NETWORKS READ IN
          147 = TOTAL NUMBER OF MESH POINTS
           78 = TOTAL NUMBER OF PANELS
```

ONETWORK ID&INDEX		#ROWS	#COLS	SOURCE	DOUBLT	NLOPT1	NROPT1	NLOPT2	NROPT2	IPOT	# PTS	# PANS	CPNORM	CUM PT	CUM PN
WINGA	1	11	3	1	12	5	3	7	-2	2	33	20	2	0	0
WINGTA	2	6	2	1	12	5	3	7	-2	2	12	5	2	33	20
BODYL	3	11	3	1	12	5	3	7	-2	2	33	20	2	45	25
BODYU	4	11	3	1	12	5	3	7	-2	2	33	20	2	78	45
BODYB	5	5	2	1	12	6	9	7	-2	2	10	4	2	111	65
AWBW	6	4	2	0	20	0	9	6	2	2	8	3	0	121	69
WINGWK	7	2	3	0	18	0	9	15	2	2	6	2	0	129	72
BODYLWK	8	2	3	0	18	0	9	6	2	2	6	2	0	135	74
BODYUWK	9	2	3	0	18	0	9	6	2	2	6	2	0	141	76

MATERIAL PROPERTIES OF NETWORK SURFACES

INDEX, NETWORK-ID		UPPER SURFACE		LOWER SURFACE	
1	WINGA	0	AIR	0	AIR
2	WINGTA	0	AIR	0	AIR
3	BODYL	0	AIR	0	AIR
4	BODYU	0	AIR	0	AIR
5	BODYB	0	AIR	0	AIR
6	AWBW	0	AIR	0	AIR
7	WINGWK	0	AIR	0	AIR
8	BODYLWK	0	AIR	0	AIR
9	BODYUWK	0	AIR	0	AIR

```
          MATERIAL PROPERTIES FOR THE VARIOUS VALUES OF SURFACE INDEX

   MATERIAL INDEX  TEMPERATURE RATIO  PRESSURE RATIO     G          P          R       K/V RATIO  K/W RATIO  K/P RATIO
                   -----------------  --------------  --------   --------   --------   --------   --------   --------
 AIR           0          1.00000          1.0000    1.00000    1.00000    1.00000    1.00000    1.00000    1.00000
                      FREE STREAM VECTORS FOR EACH MATERIAL
 MATERIAL & INDEXCASE 1 VX      VY      VZ  CASE 2 VX      VY      VZ  CASE 3 VX      VY      VZ  CASE 4 VX      VY      VZ
 --------   ---        ------  ------  ------          ------  ------  ------          ------  ------  ------      ------  ------  ------
 AIR           0     0.9976  0.0000  0.0698     0.9848  0.0000  0.1736     1.0000  0.0000  0.0000
0                 PRINT OPTIONS
              0 = SINGULARITY GRID PRINT FLAG
              0 = PANEL GEOMETRY PRINT FLAG
              0 = SPLINE DATA FLAG  ( 0 ==> OFF, NONZERO ==> ON )
              0 = CONTROL POINT INFORMATION PRINT FLAG
              0 = BOUNDARY CONDITION DATA PRINT FLAG
              0 = EDGE MATCHING INFORMATION PRINT FLAG
              0 = INDEX OF CONTROL POINT FOR WHICH AIC-S ARE PRINTED
              0 = EDGE CONTROL POINT FLOW PROPERTIES PRINT FLAG
              1 = OUTPUT CONTROL FLAG (-1 ==> NO SURFACE FLOW PROPERTIES, 0 ==> STANDARD OUTPUT, 1 ==> SHORT FORM OUTPUT )
              0 = FORCE/MOMENT CONTROL FLAG (-1 ==> NO FORCE AND MOMENT DATA, 0 ==> STANDARD OUTPUT, 1 ==> NW TOTALS ONLY )
              0 = PRINT FLAG FOR DETAILED COST INFORMATION DURING EXECUTION OF JOB
              0 = PRINT FLAG FOR SINGULARITY PARAMETER MAPS
0                 ABUTMENT PROCESSING OPTIONS
    0.0000E+00 = GLOBAL EDGE ABUTMENT TOLERANCE SPECIFIED BY USER.  IF THIS VALUE IS ZERO, A DEFAULT VALUE WILL BE CALCULATED
                  LATER.   THIS DEFAULT VALUE IS TAKEN AS:  .001  *  (MINIMUM PANEL DIAMETER)
              1 = PRINT FLAG CONTROLLING GEOMETRY PRINTOUT  B E F O R E  THE ABUTMENT PROCESSING.   ( NONZERO ==> DO PRINT )
              0 = PRINT FLAG CONTROLLING GEOMETRY PRINTOUT  A F T E R    THE ABUTMENT PROCESSING.   ( NONZERO ==> DO PRINT )
              0 = NETWORK/ABUTMENT/ABUTMENT-INTERSECTION PRINT FLAG.  ( NONZERO ==> GENERATE THE CROSS REFERENCED ABUTMENT LISTING
              0 = CONTROL INDEX FOR PANEL INTERSECTION CHECKING.   ( NONZERO ==> DO PERFORM THE CHECK. )
              1 = ABUTMENT/ABUTMENT-INTERSECTION (SHORT LISTING) PRINT FLAG ( 0 ==> SUPPRESS, NONZERO ==> GENERATE USUAL PRINT )

                  FORCE AND MOMENT REFERENCE PARAMETERS
    2.4000E+03 = REFERENCE AREA FOR FORCE AND MOMENT CALCULATIONS.     (SREF)
    6.0000E+01 = ROLLING MOMENT REFERENCE LENGTH  (BREF)
    4.0000E+01 = PITCHING MOMENT REFERENCE LENGTH (CREF)
    9.0000E+01 = YAWING MOMENT REFERENCE LENGTH   (DREF)
    4.6000E+01 = X - COORDINATE FOR THE POINT ABOUT WHICH MOMENTS WILL BE CALCULATED   (XREF)
    0.0000E+00 = Y - COORDINATE FOR THE POINT ABOUT WHICH MOMENTS WILL BE CALCULATED   (YREF)
    0.0000E+00 = Z - COORDINATE FOR THE POINT ABOUT WHICH MOMENTS WILL BE CALCULATED   (ZREF)
              3 = PRESSURE COEFFICIENT INDEX (NPRCOF) (1=LINEAR, 2=SLENDERBODY, 3=2ND, 4=ISENTROPIC)
0                 COORDINATES OF  19 OFF-BODY POINTS
                  1 X   19  (   1),      COLUMNS     1 THROUGH  10
  1   1 X  -50.000000  -20.000000   -5.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000
        Y    0.000000    0.000000    0.000000   22.500000   22.500000   22.500000   22.500000   27.500000   27.500000   27.500000
        Z    0.000000    0.000000    0.000000   -7.500000   -2.500000    2.500000    7.500000   -7.500000   -2.500000    2.500000
                  1 X   19  (   1),      COLUMNS    11 THROUGH  19
  1  11 X   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000   85.000000
        Y   27.500000   32.500000   32.500000   32.500000   32.500000   37.500000   37.500000   37.500000   37.500000
        Z    7.500000   -7.500000   -2.500000    2.500000    7.500000   -7.500000   -2.500000    2.500000    7.500000
0                 INPUT DATA FOR STREAMLINES.   NUMBER OF STREAMLINES =      2

     X(START)      Y(START)      Z(START)      DELX(MAX)     DELY(MAX)     DELZ(MAX)   UP/DOWN FLAG  (0==> DOWNSTREAM, #0==> UPSTREAM)
    ----------    ----------    ----------    ----------    ----------    ----------    ----------
    4.0000E+01    3.0000E+01   -2.0000E+00    5.0000E+01    1.0000E+01    1.0000E+01    1.0000E+00
    4.0000E+01    3.0000E+01    0.0000E+00    5.0000E+01    1.0000E+01    1.0000E+01    1.0000E+00
1

                       RECORD OF FORCED PARTIAL EDGE ABUTMENT PROCESSING
                            (ONLY CHANGED POINTS ARE REPORTED)


 INPUT GEOMETRY FOR PARTIAL EDGE ABUTMENT SPECIFICATION #    1
   1.  WINGA         NW.EDGE:    1.4      START:   1      END:    6
   EDGE PTS      3 X     6  (    3),      COLUMNS     1 THROUGH   6
    1   1.   69.473700   63.782300   53.772200   37.240900   30.280000   29.408600
    2   1.    9.210500    9.580700    9.774100    9.467900    9.152900    9.112700
    3   1.    0.000000   -0.783000   -1.974600   -1.961700   -0.819200   -0.002500
   2.  BODYL         NW.EDGE:    3.2      START:   5      END:    9
   EDGE PTS      3 X     5  (    3),      COLUMNS     1 THROUGH   5
    1   1.   29.408600   37.240900   53.772200   63.782300   69.473700
    2   1.    9.112700    9.467900    9.774100    9.580700    9.210500
    3   1.   -0.002500   -1.961700   -1.974600   -0.783000    0.000000

 NW NAME       NW.EDGE MAX CHG  CORRESPONDING EDGE POINTS.  MINUS (-) ==> POINT MOVED BY $PEA, (*) ==> EXCEEDS .2 OF A PANEL DIAMETER
 WINGA           1.4   5.81E-01    1    2    3    4   -5    6
                                   :    :    :    :  5E-1   :
 BODYL           3.2   0.00E+00    9    8    7    6    0    5
                                   :    :    :    :    :    :
```

```
ADJUSTED GEOMETRY FOR PARTIAL EDGE ABUTMENT SPECIFICATION #    1
  1. WINGA        NW.EDGE:   1.4    START:   1    END:   6
  EDGE PTS     3 X   6  (   3),     COLUMNS    1 THROUGH   6
   1   1.   69.473700   63.782300   53.772200   37.240900   30.420705   29.408600
   2   1.    9.210500    9.580700    9.774100    9.467900    9.158600    9.112700
   3   1.    0.000000   -0.783000   -1.974600   -1.961700   -0.255672   -0.002500
  2. BODYL        NW.EDGE:   3.2    START:   5    END:   9
  EDGE PTS     3 X   5  (   3),     COLUMNS    1 THROUGH   5
   1   1.   29.408600   37.240900   53.772200   63.782300   69.473700
   2   1.    9.112700    9.467900    9.774100    9.580700    9.210500
   3   1.   -0.002500   -1.961700   -1.974600   -0.783000    0.000000
```

```
INPUT GEOMETRY FOR PARTIAL EDGE ABUTMENT SPECIFICATION #    2
  1. WINGA        NW.EDGE:   1.4    START:   6    END:  11
  EDGE PTS     3 X   6  (   3),     COLUMNS    1 THROUGH   6
   1   1.   29.408600   30.275500   37.237000   53.770500   63.781800   69.473700
   2   1.    9.112700    9.152700    9.467700    9.774100    9.580700    9.210500
   3   1.   -0.002500    0.817300    1.961400    1.974700    0.783100    0.000000
  2. BODYU        NW.EDGE:   4.4    START:   3    END:   7
  EDGE PTS     3 X   5  (   3),     COLUMNS    1 THROUGH   5
   1   1.   69.473700   63.781800   53.770500   37.237000   29.408600
   2   1.    9.210500    9.580700    9.774100    9.467700    9.112700
   3   1.    0.000000    0.783100    1.974700    1.961400   -0.002500

NW NAME      NW.EDGE MAX CHG  CORRESPONDING EDGE POINTS.  MINUS (-) --> POINT MOVED BY $PEA,  (*) --> EXCEEDS .2 OF A PANEL DIAMETER
WINGA          1.4   5.84E-01    6   -7    8    9   10   11
                                 : 5E-1    :    :    :    :
BODYU          4.4   0.00E+00    7    0    6    5    4    3
                                 :    :    :    :    :    :

ADJUSTED GEOMETRY FOR PARTIAL EDGE ABUTMENT SPECIFICATION #    2
  1. WINGA        NW.EDGE:   1.4    START:   6    END:  11
  EDGE PTS     3 X   6  (   3),     COLUMNS    1 THROUGH   6
   1   1.   29.408600   30.417412   37.237000   53.770500   63.781800   69.473700
   2   1.    9.112700    9.158447    9.467700    9.774100    9.580700    9.210500
   3   1.   -0.002500    0.250579    1.961400    1.974700    0.783100    0.000000
  2. BODYU        NW.EDGE:   4.4    START:   3    END:   7
  EDGE PTS     3 X   5  (   3),     COLUMNS    1 THROUGH   5
   1   1.   69.473700   63.781800   53.770500   37.237000   29.408600
   2   1.    9.210500    9.580700    9.774100    9.467700    9.112700
   3   1.    0.000000    0.783100    1.974700    1.961400   -0.002500
```

```
 FORCED PARTIAL EDGE ABUTMENTS PROCESSING COMPLETE


 OFF-BODY-POINTS NETWORK LIST,     9 NETWORKS
    1    2    3    4    5    6    7    8    9


 GEOMETRY INPUT COMPLETE

0*E*INPUT-DA
```

```
          LEADING EDGE CONDITIONS ON WAKE NETWORKS

          NW-ID   NW-NAME        CONDITION
          -----   -------        ---------
            7     WINGWK         VORTICITY MATCHING
            8     BODYLWK        DOUBLET MATCHING ONLY
            9     BODYUWK        DOUBLET MATCHING ONLY
0*B*LIBGEOAB
1           *****  LIBERALIZED GEOMETRY ABUTMENT ANALYSIS  *****
0 EDGE ABUTMENT TOLERANCE   =   1.1749E-03
  MINIMUM PANEL DIAMETER    =   1.1749E+00
  SYMMETRY CONDITION INDEX  =            1
       1 --> PHI(S-S)
       2 --> PHI(A-S)
       3 --> PHI(A-A)
       4 --> PHI(S-A)
```

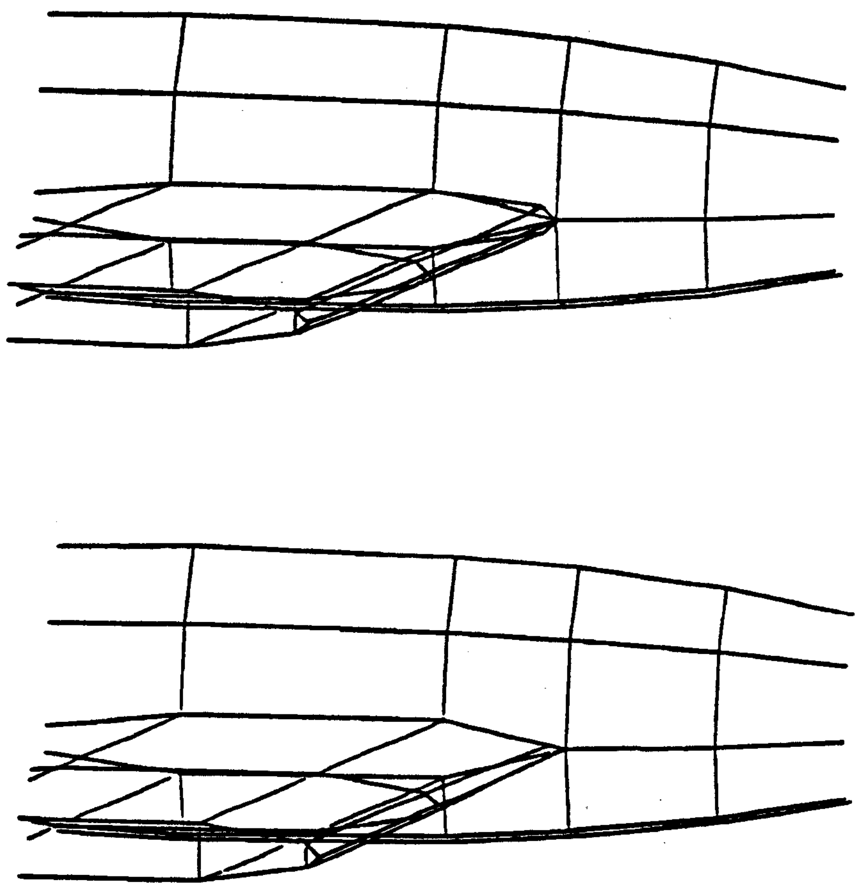

Figure 9-3 Wing Paneling Before and After Partial Network Edge Abutment Processing ($PEA)

```
0*B*GEOBFADJ
1          *****  GEOMETRY BEFORE LIBERALIZED GEOMETRY ADJUSTMENT (CONTROLLED BY $EAT)  *****
  NETWORK INDEX =    1  IDENTIFIER = WINGA
  ROW COL               NROW  NCOL     -------  COLUMNS  ------->                  BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
               11 X     3  (  11),     COLUMNS   1 THROUGH   3
   1   1 X  69.473700  76.666000  83.333000
         Y   9.210500  20.000000  30.000000
         Z   0.000000   0.000000   0.000000
   2   1 X  63.781800  70.846000  77.394300
         Y   9.580700  20.178100  30.000000
         Z   0.783100   0.783100   0.783100
   3   1 X  53.770500  60.767900  67.254100
         Y   9.774100  20.271100  30.000000
         Z   1.974700   1.974700   1.974700
   4   1 X  37.237000  44.340300  50.924800
         Y   9.467700  20.123800  30.000000
         Z   1.961400   1.961400   1.961400
   5   1 X  30.417412  37.487800  44.173300
         Y   9.158447  19.972200  30.000000
         Z   0.250579   0.817300   0.817300
   6   1 X  29.408600  36.634700  43.333000
         Y   9.112700  19.953000  30.000000
         Z  -0.002500  -0.002500  -0.002500
   7   1 X  30.420705  37.492200  44.177600
         Y   9.158600  19.972300  30.000000
         Z  -0.255672  -0.819200  -0.819200
   8   1 X  37.240900  44.344100  50.928600
         Y   9.467900  20.123800  30.000000
         Z  -1.961700  -1.961700  -1.961700
   9   1 X  53.772200  60.769500  67.255700
         Y   9.774100  20.271100  30.000000
         Z  -1.974600  -1.974600  -1.974600
  10   1 X  63.782300  70.846500  77.394800
         Y   9.580700  20.178100  30.000000
         Z  -0.783000  -0.783000  -0.783000
  11   1 X  69.473700  76.666000  83.333000
         Y   9.210500  20.000000  30.000000
         Z   0.000000   0.000000   0.000000

  NETWORK INDEX =    2  IDENTIFIER = WINGTA
  ROW COL               NROW  NCOL     -------  COLUMNS  ------->                  BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
                6 X     2  (   6),     COLUMNS   1 THROUGH   2
   1   1 X  83.333000  83.333000
         Y  30.000000  30.000000
         Z   0.000000   0.000000
   2   1 X  77.394300  77.394800
         Y  30.000000  30.000000
         Z   0.783100  -0.783000
   3   1 X  67.254100  67.255700
         Y  30.000000  30.000000
         Z   1.974700  -1.974600
   4   1 X  50.924800  50.928600
         Y  30.000000  30.000000
         Z   1.961400  -1.961700
   5   1 X  44.173300  44.177600
         Y  30.000000  30.000000
         Z   0.817300  -0.819200
   6   1 X  43.333000  43.333000
         Y  30.000000  30.000000
         Z  -0.002500  -0.002500

  NETWORK INDEX =    3  IDENTIFIER = BODYL
  ROW COL               NROW  NCOL     -------  COLUMNS  ------->                  BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
               11 X     3  (  11),     COLUMNS   1 THROUGH   3
   1   1 X   0.000000   0.000000   0.000000
         Y   0.000000   0.000000   0.000000
         Z   0.000000   0.000000   0.000000
   2   1 X   3.000000   3.000000   3.000000
         Y   0.000000   2.414200   3.414700
         Z  -3.414700  -2.414900  -0.000900
   3   1 X  10.000000  10.000000  10.000000
         Y   0.000000   4.242100   6.000000
         Z  -6.000000  -4.243200  -0.001600
   4   1 X  20.000000  20.000000  20.000000
         Y   0.000000   5.656100   8.000000
         Z  -8.000000  -5.657600  -0.002200
   5   1 X  29.408600  29.408600  29.408600
         Y   0.000000   6.442800   9.112700
         Z  -9.112700  -6.444500  -0.002500
```

```
  6   1 X   37.240900   37.240900   37.240900
        Y    0.000000    6.836300    9.467900
        Z   -9.669000   -6.837700   -1.961700
  7   1 X   53.772200   53.772200   53.772200
        Y    0.000000    7.050600    9.774100
        Z   -9.971500   -7.051300   -1.974600
  8   1 X   63.782300   63.782300   63.782300
        Y    0.000000    6.797000    9.580700
        Z   -9.612600   -6.797300   -0.783000
  9   1 X   69.473700   69.473700   69.473700
        Y    0.000000    6.512800    9.210500
        Z   -9.210500   -6.512800    0.000000
 10   1 X   80.000000   80.000000   80.000000
        Y    0.000000    5.656900    8.000000
        Z   -8.000000   -5.656900    0.000000
 11   1 X   90.000000   90.000000   90.000000
        Y    0.000000    4.242700    6.000000
        Z   -6.000000   -4.242700    0.000000

NETWORK INDEX =    4  IDENTIFIER = BODYU
ROW COL              NROW  NCOL      -------  COLUMNS  ------->                    BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
             11 X    3  (  11),      COLUMNS    1 THROUGH    3
  1   1 X    0.000000    0.000000    0.000000
        Y    0.000000    0.000000    0.000000
        Z    0.000000    0.000000    0.000000
  2   1 X    3.000000    3.000000    3.000000
        Y    3.414700    2.414900    0.000000
        Z   -0.000900    2.414200    3.414700
  3   1 X   10.000000   10.000000   10.000000
        Y    6.000000    4.243200    0.000000
        Z   -0.001600    4.242100    6.000000
  4   1 X   20.000000   20.000000   20.000000
        Y    8.000000    5.657600    0.000000
        Z   -0.002200    5.656100    8.000000
  5   1 X   29.408600   29.408600   29.408600
        Y    9.112700    6.444500    0.000000
        Z   -0.002500    6.442800    9.112700
  6   1 X   37.237000   37.237000   37.237000
        Y    9.467700    6.837600    0.000000
        Z    1.961400    6.836100    9.668800
  7   1 X   53.770500   53.770500   53.770500
        Y    9.774100    7.051300    0.000000
        Z    1.974700    7.050600    9.971600
  8   1 X   63.781800   63.781800   63.781800
        Y    9.580700    6.797300    0.000000
        Z    0.783100    6.797000    9.612600
  9   1 X   69.473700   69.473700   69.473700
        Y    9.210500    6.512800    0.000000
        Z    0.000000    6.512800    9.210500
 10   1 X   80.000000   80.000000   80.000000
        Y    8.000000    5.656900    0.000000
        Z    0.000000    5.656900    8.000000
 11   1 X   90.000000   90.000000   90.000000
        Y    6.000000    4.242700    0.000000
        Z    0.000000    4.242700    6.000000

NETWORK INDEX =    5  IDENTIFIER = BODYB
ROW COL              NROW  NCOL      -------  COLUMNS  ------->                    BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
              5 X    2  (   5),      COLUMNS    1 THROUGH    2
  1   1 X   90.000000   90.000000
        Y    0.000000    0.000000
        Z    6.000000    0.000000
  2   1 X   90.000000   90.000000
        Y    4.242700    0.000000
        Z    4.242700    0.000000
  3   1 X   90.000000   90.000000
        Y    6.000000    0.000000
        Z    0.000000    0.000000
  4   1 X   90.000000   90.000000
        Y    4.242700    0.000000
        Z   -4.242700    0.000000
  5   1 X   90.000000   90.000000
        Y    0.000000    0.000000
        Z   -6.000000    0.000000

NETWORK INDEX =    6  IDENTIFIER = AWBW
ROW COL              NROW  NCOL      -------  COLUMNS  ------->                    BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
              4 X    2  (   4),      COLUMNS    1 THROUGH    2
  1   1 X   69.473700   69.473700
        Y    9.210500    9.210500
        Z    0.000000    0.000000
```

```
  2   1 X   80.000000   80.000000
        Y    8.000000    9.210500
        Z    0.000000    0.000000
  3   1 X   90.000000   90.000000
        Y    6.000000    9.210500
        Z    0.000000    0.000000
  4   1 X  100.000000  100.000000
        Y    6.000000    9.210500
        Z    0.000000    0.000000

 NETWORK INDEX =    7  IDENTIFIER = WINGWK
 ROW COL                NROW  NCOL     -------  COLUMNS  -------->                  BEFORE ADJUSTMENT OF EDGE POINTS BY SEAT
             2 X        3  (   2),     COLUMNS   1 THROUGH   3
  1   1 X   69.473700   76.666000   83.333000
        Y    9.210500   20.000000   30.000000
        Z    0.000000    0.000000    0.000000
  2   1 X  100.000000  100.000000  100.000000
        Y    9.210500   20.000000   30.000000
        Z    0.000000    0.000000    0.000000

 NETWORK INDEX =    8  IDENTIFIER = BODYLWK
 ROW COL                NROW  NCOL     -------  COLUMNS  -------->                  BEFORE ADJUSTMENT OF EDGE POINTS BY SEAT
             2 X        3  (   2),     COLUMNS   1 THROUGH   3
  1   1 X   90.000000   90.000000   90.000000
        Y    0.000000    4.242700    6.000000
        Z   -6.000000   -4.242700    0.000000
  2   1 X  100.000000  100.000000  100.000000
        Y    0.000000    4.242700    6.000000
        Z   -6.000000   -4.242700    0.000000

 NETWORK INDEX =    9  IDENTIFIER = BODYUWK
 ROW COL                NROW  NCOL     -------  COLUMNS  -------->                  BEFORE ADJUSTMENT OF EDGE POINTS BY SEAT
             2 X        3  (   2),     COLUMNS   1 THROUGH   3
  1   1 X   90.000000   90.000000   90.000000
        Y    6.000000    4.242700    0.000000
        Z    0.000000    4.242700    6.000000
  2   1 X  100.000000  100.000000  100.000000
        Y    6.000000    4.242700    0.000000
        Z    0.000000    4.242700    6.000000

0*E*GEOBFADJ
 *** MULTIPLE ABUMTENT ***     NW  3, EDGE 2  MAY ABUT TO NW  4, EDGE 4  ALONG MORE THAN ONE ABUTMENT
 *** MULTIPLE ABUMTENT ***     NW  4, EDGE 4  MAY ABUT TO NW  3, EDGE 2  ALONG MORE THAN ONE ABUTMENT

 SURFACES ASSOCIATED WITH VARIOUS REGIONS OF THE CONFIGURATION
 REGION  NW-ID  NW-NAME    DBLT-TYPE    SURFACE    MATERIAL                 R/CTR
    1      1    WINGA      ANALYSIS      UPPER     AIR        44.591675   15.906725    0.492650
           2    WINGTA     ANALYSIS      UPPER     AIR
           3    BODYL      ANALYSIS      UPPER     AIR
           4    BODYU      ANALYSIS      UPPER     AIR
           6    AWBW       NT=20 WAKE    UPPER     AIR
           6    AWBW       NT=20 WAKE    LOWER     AIR
           7    WINGWK     NT=18 WAKE    UPPER     AIR
           7    WINGWK     NT=18 WAKE    LOWER     AIR
           8    BODYLWK    NT=18 WAKE    UPPER     AIR
           9    BODYUWK    NT=18 WAKE    UPPER     AIR

    2      1    WINGA      ANALYSIS      LOWER     AIR        53.673340   13.925380    0.394120
           2    WINGTA     ANALYSIS      LOWER     AIR
           3    BODYL      ANALYSIS      LOWER     AIR
           4    BODYU      ANALYSIS      LOWER     AIR
           5    BODYB      ANALYSIS      LOWER     AIR

    3      5    BODYB      ANALYSIS      UPPER     AIR        90.000000    6.000000    0.000000
           8    BODYLWK    NT=18 WAKE    LOWER     AIR
           9    BODYUWK    NT=18 WAKE    LOWER     AIR

0*B*EXTRA-CP

0 *****  SUMMARY OF EXTRA CONTROL POINTS  *****

       NW  EDGE  POINT  ROW  COL    FINE GRID LOCATION
   1.   1    2      6    6    3      11    5
   2.   1    4      6    6    1      11    1
   3.   3    2      5    5    3       9    5
   4.   3    2      9    9    3      17    5
   5.   4    4      3    9    1      17    1
   6.   4    4      7    5    1       9    1
   7.   5    4      3    3    1       5    1
0*E*EXTRA-CP
```

```
0*B*ABUTMENT
1                                        ABUTMENT SUMMARY

0ABUTMENT #   1
                   DBLT EDGE                          STARTS AT AI #   1      ENDS AT AI #   2
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   1.1  WINGA       12    4   VOR-MTCH                  1   2   3
   1.3  WINGA       12    4                             3   2   1
   7.1  WINGWK      18    5   MU-MATCH  VOR-MTCH        1   2   3
0ABUTMENT #   2
                   DBLT EDGE                          STARTS AT AI #   3      ENDS AT AI #   2
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   1.2  WINGA       12    4                             1   2   3   4   5   6
   2.4  WINGTA      12    4   MU-MATCH                  6   5   4   3   2   1
0ABUTMENT #   3
                   DBLT EDGE                          STARTS AT AI #   2      ENDS AT AI #   3
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   1.2  WINGA       12    4                             6   7   8   9  10  11
   2.2  WINGTA      12    4   MU-MATCH                  6   5   4   3   2   1
0ABUTMENT #   4
                   DBLT EDGE                          STARTS AT AI #   4      ENDS AT AI #   1
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   1.4  WINGA       12    4   MU-MATCH                  1   2   3   4   5   6
   3.2  BODYL       12    4                             9   8   7   6   0   5
0ABUTMENT #   5
                   DBLT EDGE                          STARTS AT AI #   1      ENDS AT AI #   4
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   1.4  WINGA       12    4   MU-MATCH                  6   7   8   9  10  11
   4.4  BODYU       12    4                             7   0   6   5   4   3
0ABUTMENT #   6
                   DBLT EDGE                          STARTS AT AI #   4      ENDS AT AI #   5
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   3.2  BODYL       12    4                             1   2   3   4   5
   4.4  BODYU       12    4   MU-MATCH                 11  10   9   8   7
0ABUTMENT #   7
                   DBLT EDGE                          STARTS AT AI #   6      ENDS AT AI #   1
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   3.2  BODYL       12    4                             9  10  11
   4.4  BODYU       12    4   MU-MATCH                  3   2   1
   6.4  AWBW        20    2                             4   3   2
0ABUTMENT #   8
                   DBLT EDGE                          STARTS AT AI #   7      ENDS AT AI #   6
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   3.3  BODYL       12    4                             1   2   3
   5.4  BODYB       12    4                             3   2   1
   8.1  BODYLWK     18    5   MU-MATCH                  3   2   1
0ABUTMENT #   9
 ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                   DBLT EDGE                          STARTS AT AI #   7      ENDS AT AI #   5
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   3.4  BODYL       12    4                             1   2   3   4   5   6   7   8   9  10  11
0ABUTMENT #  10
 ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                   DBLT EDGE                          STARTS AT AI #   5      ENDS AT AI #   8
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   4.2  BODYU       12    4                             1   2   3   4   5   6   7   8   9  10  11
0ABUTMENT #  11
                   DBLT EDGE                          STARTS AT AI #   6      ENDS AT AI #   8
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   4.3  BODYU       12    4                             1   2   3
   5.4  BODYB       12    4                             5   4   3
   9.1  BODYUWK     18    5   MU-MATCH                  3   2   1
0ABUTMENT #  12
 ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                   DBLT EDGE                          STARTS AT AI #   8      ENDS AT AI #   9
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   5.1  BODYB       12    4                             1   2
0ABUTMENT #  13
 ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                   DBLT EDGE                          STARTS AT AI #   9      ENDS AT AI #   7
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   5.3  BODYB       12    4                             1   2
0ABUTMENT #  14
                   DBLT EDGE                          STARTS AT AI #  10      ENDS AT AI #   1
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
   6.2  AWBW        20    2                             1   2   3   4
   7.4  WINGWK      18    2                             2   0   0   1
0ABUTMENT #  15    WAKE TRAILING EDGE UNABUTTED.  WAKE FILAMENTS WILL BE ADDED                         *** GENTLE REMINDER ***
                   DBLT EDGE                          STARTS AT AI #  10      ENDS AT AI #  11
  NW.EDGE  NW/ID   TYPE TYPE  MATCHING  KUTTA-FL      CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY SEAT
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   6.3  AWBW      20    2                           1   2
0ABUTMENT #  16
                 DBLT EDGE                         STARTS AT AI #  11       ENDS AT AI #   6
  NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL     CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   6.4  AWBW      20    2                           1   2
   8.2  BODYLWK   18    2                           2   1
   9.4  BODYUWK   18    2                           1   2
0ABUTMENT #  17    WAKE SIDE EDGE LEFT UNABUTTED                                                       ***  WARNING  ***
                 DBLT EDGE                         STARTS AT AI #   2       ENDS AT AI #  12
  NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL     CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   7.2  WINGWK    18    2                           1   2
0ABUTMENT #  18    WAKE TRAILING EDGE UNABUTTED.  WAKE FILAMENTS WILL BE ADDED                       *** GENTLE REMINDER ***
                 DBLT EDGE                         STARTS AT AI #  12       ENDS AT AI #  10
  NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL     CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   7.3  WINGWK    18    2                           1   2   3
0ABUTMENT #  19    WAKE TRAILING EDGE UNABUTTED.  WAKE FILAMENTS WILL BE ADDED                       *** GENTLE REMINDER ***
                 DBLT EDGE                         STARTS AT AI #  11       ENDS AT AI #  13
  NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL     CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   8.3  BODYLWK   18    2                           1   2   3
0ABUTMENT #  20
 ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                         STARTS AT AI #  13       ENDS AT AI #   7
  NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL     CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   8.4  BODYLWK   18    2                           1   2
0ABUTMENT #  21
 ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                         STARTS AT AI #   8       ENDS AT AI #  14
  NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL     CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   9.2  BODYUWK   18    2                           1   2
0ABUTMENT #  22    WAKE TRAILING EDGE UNABUTTED.  WAKE FILAMENTS WILL BE ADDED                       *** GENTLE REMINDER ***
                 DBLT EDGE                         STARTS AT AI #  14       ENDS AT AI #  11
  NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL     CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
   9.3  BODYUWK   18    2                           1   2   3
0*E*ABUTMENT


  *****  NO POINTS WERE MOVED BY THE LIBERALIZED GEOMETRY PROCESSOR (CONTROLLED BY $EAT)  *****



   ====     SUMMARY OF FREE WAKE TRAILING EDGES     ====
           (SEMI-INFINITE FILAMENTS TO BE ATTACHED)

   NW   NETWORK-ID   ABMT
   --   ----------   ----
    6   AWBW          15
    7   WINGWK        18
    8   BODYLWK       19
    9   BODYUWK       22
   T/ABTIDN     0.241143
  ABTCAL/ANL    0.000002
0*E*LIBGEOAB

NSNGN  NCTRN  NCTRNX   MXMN  MXMNFG    NABT  NFDSEG
   272    196    203     33    105       22      38
 NCTRW  NSNGW    NABTW  NFDSW   NNETT
   196    272      22     38      9
 NCTRN  NSNGN     NABT  NFDSEG  NEDGT
   196    272      22     38      9
   NX7   NX17    NX27    NX28
   152     88    1088    1088
0    SINGULARITY PARAMETER COUNTS
   NAIVE S.P. COUNT  (BASED ON NETWORKING)         272
   BASIC S.P. COUNT  (DUPLICATES SQUEEZED OUT)     257
        NO. OF UNKNOWN BASIC S.P.-S                164
        NO. OF  KNOWN  BASIC S.P.-S                 65
        NO. OF EQUIVALENCED BASIC S.P.-S            27
        NO. OF ZEROED  BASIC S.P.-S                  1
   FINAL S.P. COUNT  ( KNOWN + UNKNOWN )           229
                                                                         AFTER NW    1 HAVING   40 AIC ROWS,   40 CUM
                                                                         AFTER NW    2 HAVING    6 AIC ROWS,   46 CUM
                                                                         AFTER NW    3 HAVING   47 AIC ROWS,   93 CUM
                                                                         AFTER NW    4 HAVING   41 AIC ROWS,  134 CUM
                                                                         AFTER NW    5 HAVING   18 AIC ROWS,  152 CUM
                                                                         AFTER NW    6 HAVING    1 AIC ROWS,  153 CUM
                                                                         AFTER NW    7 HAVING    3 AIC ROWS,  156 CUM
                                                                         AFTER NW    8 HAVING    4 AIC ROWS,  160 CUM
                                                                         AFTER NW    9 HAVING    4 AIC ROWS,  164 CUM
```

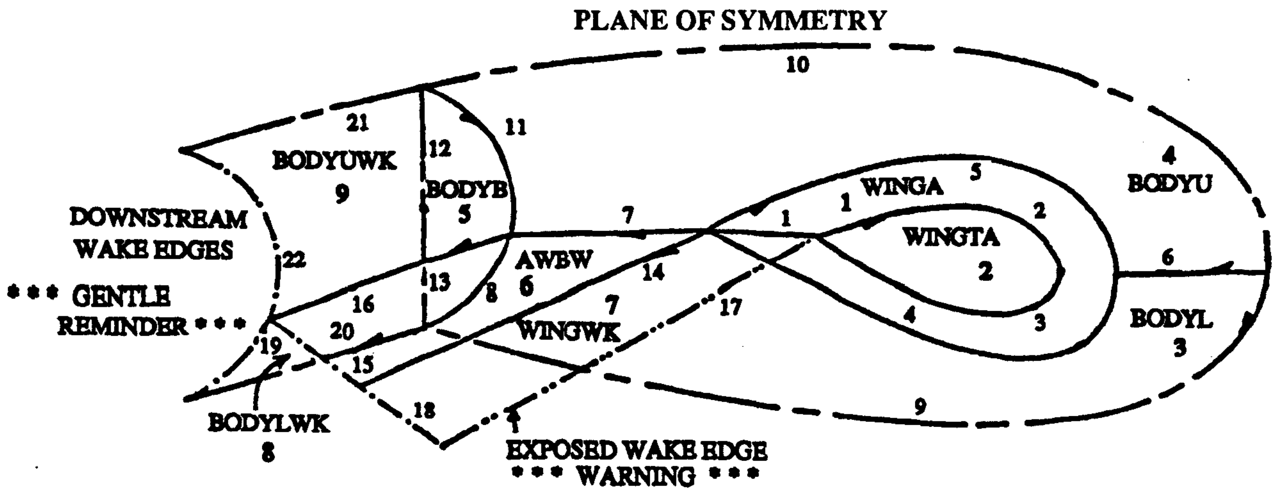

Figure 9-4 Sketch of Abutment Numbers for Simple Wing-Body Configuration

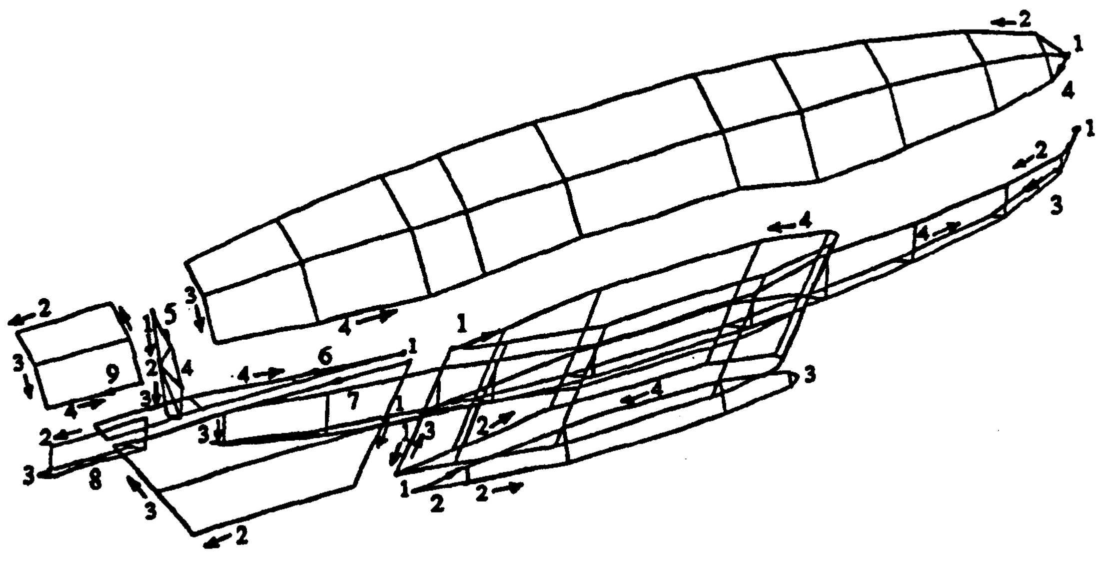

Figure 9-5 Network Edge Numbers and Direction of Network Edge Points Along an Edge

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1
0*B*PROBLEM

                                   PROBLEM AND NETWORK INDICES


 NNEIT =    9  NZMPT =  147  NPANT =   78  NSNGT =  229  NSNGU =  164  NSNGK =   65  NCTRT =  188  NBCOT =  229


 SYMMETRY DATA,  NSYMM =    1  NISYM =    2  NJSYM =    1  MISYM =    1  MJSYM =    0
0    NW  =    1    2    3    4    5    6    7    8    9
     NTS =    1    1    1    1    1    0    0    0    0
     NTD =   12   12   12   12   12   20   18   18   18
     NM  =   11    6   11   11    5    4    2    2    2
     NN  =    3    2    3    3    2    2    3    3    3
     NZ  =   33   12   33   33   10    8    6    6    6
     NP  =   20    5   20   20    4    3    2    2    2
     NSS =   20    5   20   20    4    0    0    0    0
     NSD =   50   21   50   50   19    1    4    4    4
     NC  =   50   17   47   47   14    1    4    4    4
     NABC=   60   11   67   61   18    1    3    4    4
     IPOT=    2    2    2    2    2    2    2    2    2
     NWOFB    1    2    3    4    5    6    7    8    9
     NCA =    0   50   67  114  161  175  176  180  184  188
     NBCA=    0   48   69  117  165  183  184  188  192  196
     MAPCA    0   50   71  121  171  190  191  195  199  203
     NXSP=    2    0    2    2    1    0    0    0    0

 SIZE OF RECORDS WRITTEN BY PVINFC     539
     NPNGRP           1
       1.        78
     NSPGRP           1
       1.       229
     NPTGRP           1
       1.       147
 MXCPGP:     138 MXCPBK:     138  KCPBK:      138
  I/O CALLS          1          1        160
  I/O WORDS     154112     154112      41220
       MXRWS       MXCLS       MXBLKS      NRPB      NCPBKC      NCPBKW      NCPGP      NPABK      NPAGP
         300         512         200        300           1           1          1          0          1
  STRNS CALLS   TYPE 5/6 =     78  TYPE 6 =     78

    PIC COUNTS                                  PANEL/SOURCE  PANEL/DOUBLET   BLOCK/SOURCE  BLOCK/DOUBLET

    NO INFLUENCE                                          0              0              0              0
    MONOPOLE FAR FIELD                                 1056           1056              0              0
    DIPOLE FAR FIELD                                   5166           6010              0              0
    QUADRUPOLE FAR FIELD                               4247           4732              0              0
    ONE SUB-PANEL INTERMEDIATE FIELD                   5783           6349              0              0
    TWO SUB-PANEL INTERMEDIATE FIELD                   2257           2778              0              0
    EIGHT SUB-PANEL NEAR FIELD                          535            603              0              0



                  INFLUENCE COEFFICIENT GENERATION I/O COUNT
   NCALG=       0  NWRDG=           0  NCALT=        0  NWRDT=        0
   N56CHG:      4
      1       0   1048    1359    1048

 LOGICAL FLAGS FOR CP/2 ITERATION:
        F = BKPRNT, PRINT FLAG FOR SOLVER STATISTICS
0
               ************************************
               *                                  *
               *      CONDITION INDICATORS        *
               *                                  *
               *  UNIFORM SOLUTION 0.365930E-11   *
               *                                  *
               ************************************
```

1
0*B*SOLUTION

SIMULTANEOUS SOLUTION NUMBER 1

MACH NUMBER = 0.60000 ANGLE OF ATTACK = 4.00000 SIDESLIP ANGLE = 0.00000 FREESTREAM SPEED = 1.00000
COMPRESSIBILITY FACTOR = 0.80000 COMPRESSIBILITY ANGLE OF ATTACK = 4.00000 COMPRESSIBILITY ANGLE OF SIDESLIP = 0.00000
FREESTREAM VELOCITY = (0.99756, 0.00000, 0.06976) COMPRESSIBILITY DIRECTION = (0.99756, 0.00000, 0.06976)
1 NETWORK ID:WINGA INDEX: 1 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 10 NUMBER COLUMNS = 2

JC	IP	X	Y	Z	WX	WY	WZ	CP2NDU	CPISNU	LMACHU	SOURCE	DOUBLET
15	1	70.2006	14.7247	0.3889	0.9806	-0.0280	-0.1318	0.0545	0.0539	0.5848	-0.1989	3.8196
16	2	62.3039	14.9272	1.3756	1.0601	-0.0562	-0.1292	-0.1996	-0.1981	0.6666	-0.1854	3.3459
17	3	49.0449	14.8798	1.9681	1.1241	-0.0619	0.0005	-0.4122	-0.4091	0.7348	-0.0694	1.0861
18	4	37.3803	14.6624	1.2518	1.1376	-0.0857	0.2083	-0.5256	-0.5190	0.7734	0.0963	-1.4239
19	5	33.4887	14.5451	0.2681	0.9794	-0.0004	0.7712	-0.5891	-0.5592	0.8152	0.5856	-2.4898
20	6	33.4820	14.5448	-0.2674	0.6618	0.3309	-0.4338	0.6037	0.5047	0.4346	0.6752	-2.9033
21	7	37.3399	14.6610	-1.2445	0.9945	0.0324	-0.1667	0.0040	0.0036	0.6018	0.2341	-3.0163
22	8	48.9759	14.8789	-1.9681	1.0745	-0.0056	-0.0012	-0.2382	-0.2375	0.6773	0.0709	-1.8185
23	9	62.2491	14.9280	-1.3821	1.0511	-0.0244	0.1253	-0.1873	-0.1869	0.6606	-0.0469	-0.0884
24	10	70.1612	14.7266	-0.3942	0.9771	-0.0062	0.1293	0.0467	0.0467	0.5852	-0.0610	0.2368
27	11	77.0685	25.0278	0.3889	0.9580	-0.1724	-0.1415	0.0918	0.0899	0.5747	-0.1989	2.8104
28	12	69.0775	25.0895	1.3757	1.0220	-0.1895	-0.1351	-0.1102	-0.1092	0.6395	-0.1853	2.7350
29	13	55.8370	25.0704	1.9681	1.0930	-0.1481	0.0007	-0.3229	-0.3204	0.7060	-0.0693	1.2905
30	14	44.2410	25.0060	1.3930	1.1468	-0.0821	0.2033	-0.5553	-0.5479	0.7834	0.0970	-0.8366
31	15	40.4081	24.9769	0.4111	0.9022	0.1925	0.7538	-0.3671	-0.3570	0.7436	0.5855	-2.0843
32	16	40.4025	24.9768	-0.4071	0.6563	0.5068	-0.3088	0.5540	0.4531	0.4540	0.6752	-2.4886
33	17	44.2019	25.0056	-1.3868	1.0366	0.1443	-0.1601	-0.1470	-0.1455	0.6511	0.2347	-2.2978
34	18	55.7712	25.0701	-1.9681	1.0660	0.0602	-0.0013	-0.2136	-0.2130	0.6695	0.0710	-0.9298
35	19	69.0244	25.0897	-1.3820	1.0228	0.0288	0.1177	-0.0934	-0.0933	0.6302	-0.0468	0.2706
36	20	77.0295	25.0283	-0.3941	0.9561	0.0990	0.1173	0.1043	0.1040	0.5672	-0.0610	0.2563

1
0*B*FOR-MOM-NET#- 1

FORCE / MOMENT DATA FOR NETWORK 1

TOTALS FOR COLUMN 1	AREA	FX	FY	FZ	MX	MY	MZ
	861.57317	-0.00165	0.00067	0.03366	0.00823	0.00466	-0.00006
	861.57317	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	861.57317	-0.00165	0.00067	0.03366	0.00823	0.00466	-0.00006

TOTALS FOR COLUMN 2	AREA	FX	FY	FZ	MX	MY	MZ
	802.62916	-0.00238	0.00159	0.02303	0.00935	-0.00052	0.00066
	802.62916	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	802.62916	-0.00238	0.00159	0.02303	0.00935	-0.00052	0.00066

TOTALS FOR NETWORK	AREA	FX	FY	FZ	MX	MY	MZ
	1664.20232	-0.00403	0.00226	0.05669	0.01758	0.00413	0.00060
	1664.20232	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1664.20232	-0.00403	0.00226	0.05669	0.01758	0.00413	0.00060

TOTALS FOR ALL NETWORKS SO FAR	AREA	FX	FY	FZ	MX	MY	MZ
	1664.20232	-0.00403	0.00226	0.05669	0.01758	0.00413	0.00060
	1664.20232	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1664.20232	-0.00403	0.00226	0.05669	0.01758	0.00413	0.00060

0*E*FOR-MOM

1 NETWORK ID:WINGTA INDEX: 2 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 5 NUMBER COLUMNS = 1

JC	IP	X	Y	Z	WX	WY	WZ	CP2NDU	CPISNU	LMACHU	SOURCE	DOUBLET
58	21	80.3672	30.0000	0.0035	0.9626	0.0000	0.8698	-0.7071	-0.6636	0.8618	0.0000	0.9418
59	22	72.3356	30.0000	0.0109	1.0041	0.0000	0.4186	-0.2186	-0.2152	0.6765	0.0000	0.9145
60	23	59.1066	30.0000	0.0158	1.0327	0.0000	0.3172	-0.2273	-0.2250	0.6764	0.0000	0.2736
61	24	47.5609	30.0000	0.0093	1.0687	0.0000	0.3019	-0.3357	-0.3320	0.7113	0.0000	-0.6041
62	25	43.7563	30.0000	0.0004	1.2937	0.0000	0.3160	-1.1800	-1.1281	1.0133	0.0000	-1.2088

1
0*B*FOR-MOM-NET#- 2

FORCE / MOMENT DATA FOR NETWORK 2

TOTALS FOR COLUMN 1	AREA	FX	FY	FZ	MX	MY	MZ
	116.33974	0.00000	0.01260	0.00000	0.00000	0.00000	0.00207
	116.33974	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	116.33974	0.00000	0.01260	0.00000	0.00000	0.00000	0.00207

TOTALS FOR NETWORK	AREA	FX	FY	FZ	MX	MY	MZ
	116.33974	0.00000	0.01260	0.00000	0.00000	0.00000	0.00207
	116.33974	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	116.33974	0.00000	0.01260	0.00000	0.00000	0.00000	0.00207

TOTALS FOR ALL NETWORKS SO FAR	AREA	FX	FY	FZ	MX	MY	MZ
	1780.54207	-0.00403	0.01486	0.05669	0.01758	0.00413	0.00267
	1780.54207	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1780.54207	-0.00403	0.01486	0.05669	0.01758	0.00413	0.00267

0*E*FOR-MOM
1 NETWORK ID:BODYL INDEX: 3 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 10 NUMBER COLUMNS = 2

JC	IP	X	Y	Z	WX	WY	WZ	CP2NDU	CPISNU	LMACHU	SOURCE	DOUBLET
80	26	1.4965	0.5975	-1.4560	0.4918	0.1963	-0.4792	0.9349	0.7180	0.3285	0.7678	-3.4868
81	27	6.4885	1.6514	-4.0192	0.9479	0.1374	-0.2934	0.0777	0.0733	0.5835	0.3834	-3.2404
82	28	14.9827	2.4571	-5.9790	0.9932	0.1017	-0.1568	0.0011	0.0008	0.6030	0.2449	-2.9554
83	29	24.6851	3.0060	-7.3092	1.0024	0.0723	-0.0888	-0.0111	-0.0111	0.6052	0.1726	-2.6930
84	30	33.3060	3.3020	-8.0220	1.0153	0.0248	-0.0620	-0.0451	-0.0449	0.6155	0.1298	-2.5185
85	31	45.4807	3.4477	-8.3919	1.0418	0.0159	-0.0127	-0.1298	-0.1296	0.6422	0.0815	-1.8961
86	32	58.7558	3.4424	-8.3670	1.0495	0.0389	0.0534	-0.1644	-0.1642	0.6531	0.0316	-0.8229
87	33	66.6121	3.3131	-8.0403	1.0344	0.0371	0.0882	-0.1227	-0.1226	0.6396	-0.0005	-0.2840
88	34	74.7167	3.0245	-7.3548	1.0171	0.0081	0.1200	-0.0751	-0.0750	0.6243	-0.0410	0.0896
89	35	84.9827	2.4599	-5.9846	0.9734	-0.0294	0.1822	0.0364	0.0363	0.5890	-0.1176	0.3396
91	36	1.4965	1.4519	-0.6072	0.5203	0.5884	-0.0106	0.7944	0.6225	0.3781	0.7416	-3.4137
92	37	6.4885	4.0095	-1.6748	0.9584	0.3685	0.0324	-0.0095	-0.0110	0.6105	0.3483	-3.0504
93	38	14.9827	5.9649	-2.4911	0.9967	0.2285	0.0691	-0.0493	-0.0491	0.6186	0.2080	-2.6717
94	39	24.6851	7.2935	-3.0438	0.9762	0.1510	0.0851	0.0394	0.0392	0.5886	0.1352	-2.4257
95	40	33.3075	7.9567	-3.8248	0.9866	0.0914	-0.0538	0.0372	0.0370	0.5893	0.1356	-2.8112
96	41	45.4855	8.2719	-4.4747	1.0572	0.0242	0.0063	-0.1818	-0.1815	0.6590	0.0503	-2.0608
97	42	58.7582	8.2925	-4.1701	1.0646	0.0035	0.1312	-0.2336	-0.2330	0.6757	-0.0207	-0.4799
98	43	66.6125	8.0199	-3.5390	1.0178	-0.0297	0.1607	-0.0927	-0.0925	0.6303	-0.0616	0.1845
99	44	74.7167	7.3393	-3.0620	0.9965	-0.0732	0.0994	-0.0095	-0.0095	0.6034	-0.0786	0.2506
100	45	84.9827	5.9711	-2.4923	0.9671	-0.1496	0.1051	0.0623	0.0619	0.5813	-0.1548	0.3390

1
0*B*FOR-MOM-NET#- 3

FORCE / MOMENT DATA FOR NETWORK 3

	AREA	FX	FY	FZ	MX	MY	MZ
TOTALS FOR COLUMN 1							
	569.78485	0.00182	0.00565	-0.01364	0.00005	0.00475	0.00087
	569.78485	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	569.78485	0.00182	0.00565	-0.01364	0.00005	0.00475	0.00087
TOTALS FOR COLUMN 2	AREA	FX	FY	FZ	MX	MY	MZ
	516.76377	0.00116	0.01071	-0.00565	-0.00001	0.00108	0.00098
	516.76377	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	516.76377	0.00116	0.01071	-0.00565	-0.00001	0.00108	0.00098
TOTALS FOR NETWORK	AREA	FX	FY	FZ	MX	MY	MZ
	1086.54861	0.00298	0.01636	-0.01929	0.00004	0.00583	0.00185
	1086.54861	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1086.54861	0.00298	0.01636	-0.01929	0.00004	0.00583	0.00185
TOTALS FOR ALL NETWORKS SO FAR	AREA	FX	FY	FZ	MX	MY	MZ
	2867.09068	-0.00105	0.03122	0.03740	0.01762	0.00996	0.00452
	2867.09068	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	2867.09068	-0.00105	0.03122	0.03740	0.01762	0.00996	0.00452

0*E*FOR-MOM
1 NETWORK ID:BODYU INDEX: 4 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 10 NUMBER COLUMNS = 2

JC	IP	X	Y	Z	WX	WY	WZ	CP2NDU	CPISNU	LMACHU	SOURCE	DOUBLET
129	46	1.4965	1.4560	0.5973	0.5627	0.5120	0.3119	0.6952	0.5694	0.4065	0.7050	-3.3134
130	47	6.4885	4.0192	1.6508	0.9792	0.2720	0.2171	-0.0709	-0.0705	0.6278	0.2971	-2.7860
131	48	14.9827	5.9790	2.4562	1.0085	0.1259	0.1836	-0.0881	-0.0877	0.6298	0.1553	-2.2594
132	49	24.6851	7.3092	3.0049	1.0080	0.0428	0.1850	-0.0731	-0.0729	0.6243	0.0820	-1.8414
133	50	33.3055	7.9722	3.7910	1.0497	0.0161	0.2315	-0.2293	-0.2280	0.6753	0.0771	-1.5121
134	51	45.4827	8.2923	4.4370	1.1060	-0.0126	0.0637	-0.3554	-0.3537	0.7155	-0.0158	0.5460
135	52	58.7571	8.3098	4.1356	1.0828	-0.0258	-0.0746	-0.2660	-0.2644	0.6872	-0.0828	2.7523
136	53	66.6123	8.0325	3.5104	1.0254	-0.0592	-0.0955	-0.0826	-0.0822	0.6282	-0.1174	3.5573
137	54	74.7167	7.3548	3.0245	0.9989	-0.1079	-0.0161	-0.0044	-0.0044	0.6024	-0.1317	3.6713
138	55	84.9827	5.9846	2.4599	0.9670	-0.1880	-0.0123	0.0694	0.0687	0.5801	-0.2073	3.8233
140	56	1.4965	0.6070	1.4519	0.5912	0.1248	0.6218	0.5853	0.4870	0.4414	0.6788	-3.2412
141	57	6.4885	1.6742	4.0095	0.9939	0.0437	0.3500	-0.1302	-0.1289	0.6460	0.2621	-2.5924
142	58	14.9827	2.4902	5.9649	1.0232	0.0026	0.2040	-0.1285	-0.1280	0.6423	0.1183	-1.9445
143	59	24.6851	3.0426	7.2935	1.0348	-0.0335	0.1366	-0.1387	-0.1385	0.6450	0.0446	-1.3105
144	60	33.3041	3.3374	8.0068	1.0569	-0.0653	0.1024	-0.2031	-0.2026	0.6658	0.0013	-0.6620
145	61	45.4779	3.4959	8.3715	1.0747	-0.0336	0.0339	-0.2440	-0.2433	0.6791	-0.0472	0.7122
146	62	58.7547	3.4822	8.3504	1.0637	-0.0015	-0.0374	-0.2006	-0.1999	0.6654	-0.0973	2.2674
147	63	66.6119	3.3426	8.0281	1.0409	-0.0039	-0.0718	-0.1269	-0.1264	0.6419	-0.1292	2.9410
148	64	74.7167	3.0620	7.3393	1.0202	-0.0359	-0.1022	-0.0645	-0.0642	0.6224	-0.1693	3.4030
149	65	84.9827	2.4923	5.9711	0.9732	-0.0714	-0.1648	0.0656	0.0645	0.5823	-0.2444	3.7455

1

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0*B*FOR-MOM-NET#-  4
                                   FORCE / MOMENT DATA FOR NETWORK     4


 TOTALS FOR COLUMN      1         AREA         FX           FY          FZ           MX           MY           MZ

                               516.78133    -0.00037      0.02599     0.01303      0.00001      0.00080     -0.00096
                               516.78133     0.00000      0.00000     0.00000      0.00000      0.00000      0.00000
                               516.78133    -0.00037      0.02599     0.01303      0.00001      0.00080     -0.00096

 TOTALS FOR COLUMN      2         AREA         FX           FY          FZ           MX           MY           MZ

                               569.87885    -0.00085      0.01284     0.03101     -0.00001      0.00289     -0.00054
                               569.87885     0.00000      0.00000     0.00000      0.00000      0.00000      0.00000
                               569.87885    -0.00085      0.01284     0.03101     -0.00001      0.00289     -0.00054

 TOTALS FOR NETWORK               AREA         FX           FY          FZ           MX           MY           MZ

                              1086.66019    -0.00122      0.03883     0.04403     -0.00001      0.00369     -0.00149
                              1086.66019     0.00000      0.00000     0.00000      0.00000      0.00000      0.00000
                              1086.66019    -0.00122      0.03883     0.04403     -0.00001      0.00369     -0.00149

 TOTALS FOR ALL NETWORKS SO FAR    AREA         FX           FY          FZ           MX           MY           MZ

                              3953.75087    -0.00228      0.07005     0.08144      0.01761      0.01365      0.00303
                              3953.75087     0.00000      0.00000     0.00000      0.00000      0.00000      0.00000
                              3953.75087    -0.00228      0.07005     0.08144      0.01761      0.01365      0.00303
0*E*FOR-MOM
1   NETWORK ID:BODYB      INDEX:   5   SOURCE TYPE =  1    DOUBLET TYPE = 12     NUMBER ROWS =    4    NUMBER COLUMNS =    1

   JC   IP        X          Y          Z         WX         WY         WZ       CP2NDU     CPISNU     LMACHU     SOURCE    DOUBLET

   170   66    90.0000    1.0563     2.5713     0.7946    -0.0271    -0.0515     0.5776     0.5650     0.4124    -0.2030    -0.1794
   171   67    90.0000    2.5651     1.0713     0.7978    -0.0558    -0.0154     0.5674     0.5561     0.4155    -0.1998    -0.0747
   172   68    90.0000    2.5713    -1.0563     0.7987    -0.0588     0.0322     0.5610     0.5508     0.4173    -0.1989     0.0737
   173   69    90.0000    1.0713    -2.5651     0.8009    -0.0246     0.0635     0.5533     0.5440     0.4196    -0.1966     0.1789
1
0*B*FOR-MOM-NET#-  5
                                   FORCE / MOMENT DATA FOR NETWORK     5


 TOTALS FOR COLUMN      1         AREA         FX           FY          FZ           MX           MY           MZ

                                50.91240    -0.01198      0.00000     0.00000      0.00000     -0.00001      0.00032
                                50.91240     0.00000      0.00000     0.00000      0.00000      0.00000      0.00000
                                50.91240    -0.01198      0.00000     0.00000      0.00000     -0.00001      0.00032

 TOTALS FOR NETWORK               AREA         FX           FY          FZ           MX           MY           MZ

                                50.91240    -0.01198      0.00000     0.00000      0.00000     -0.00001      0.00032
                                50.91240     0.00000      0.00000     0.00000      0.00000      0.00000      0.00000
                                50.91240    -0.01198      0.00000     0.00000      0.00000     -0.00001      0.00032

 TOTALS FOR ALL NETWORKS SO FAR    AREA         FX           FY          FZ           MX           MY           MZ

                              4004.66327    -0.01426      0.07005     0.08144      0.01761      0.01364      0.00335
                              4004.66327     0.00000      0.00000     0.00000      0.00000      0.00000      0.00000
                              4004.66327    -0.01426      0.07005     0.08144      0.01761      0.01364      0.00335
0*E*FOR-MOM
```

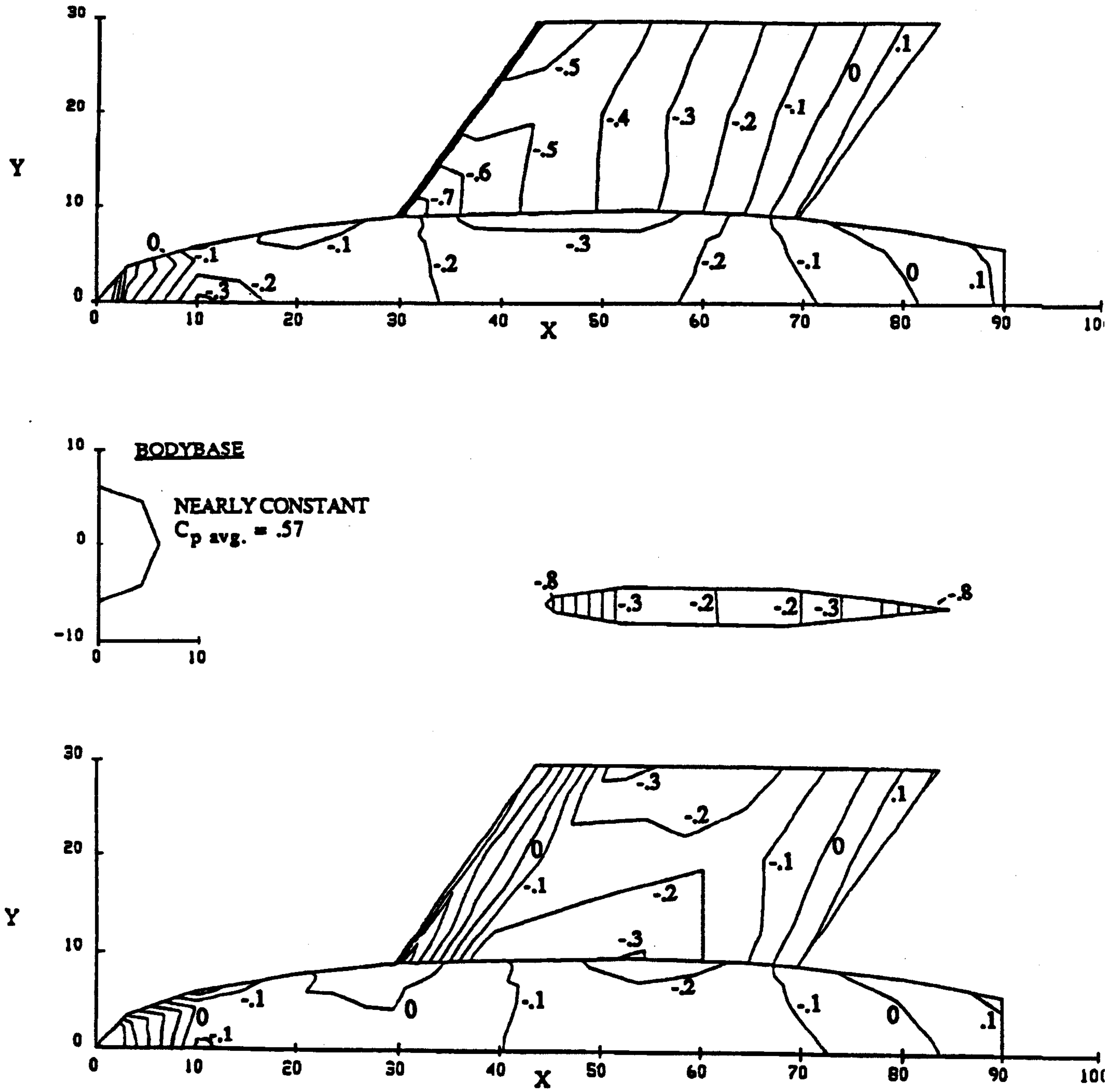


Figure 9-6 Pressure Distribution on Simple Wing-Body Configuration

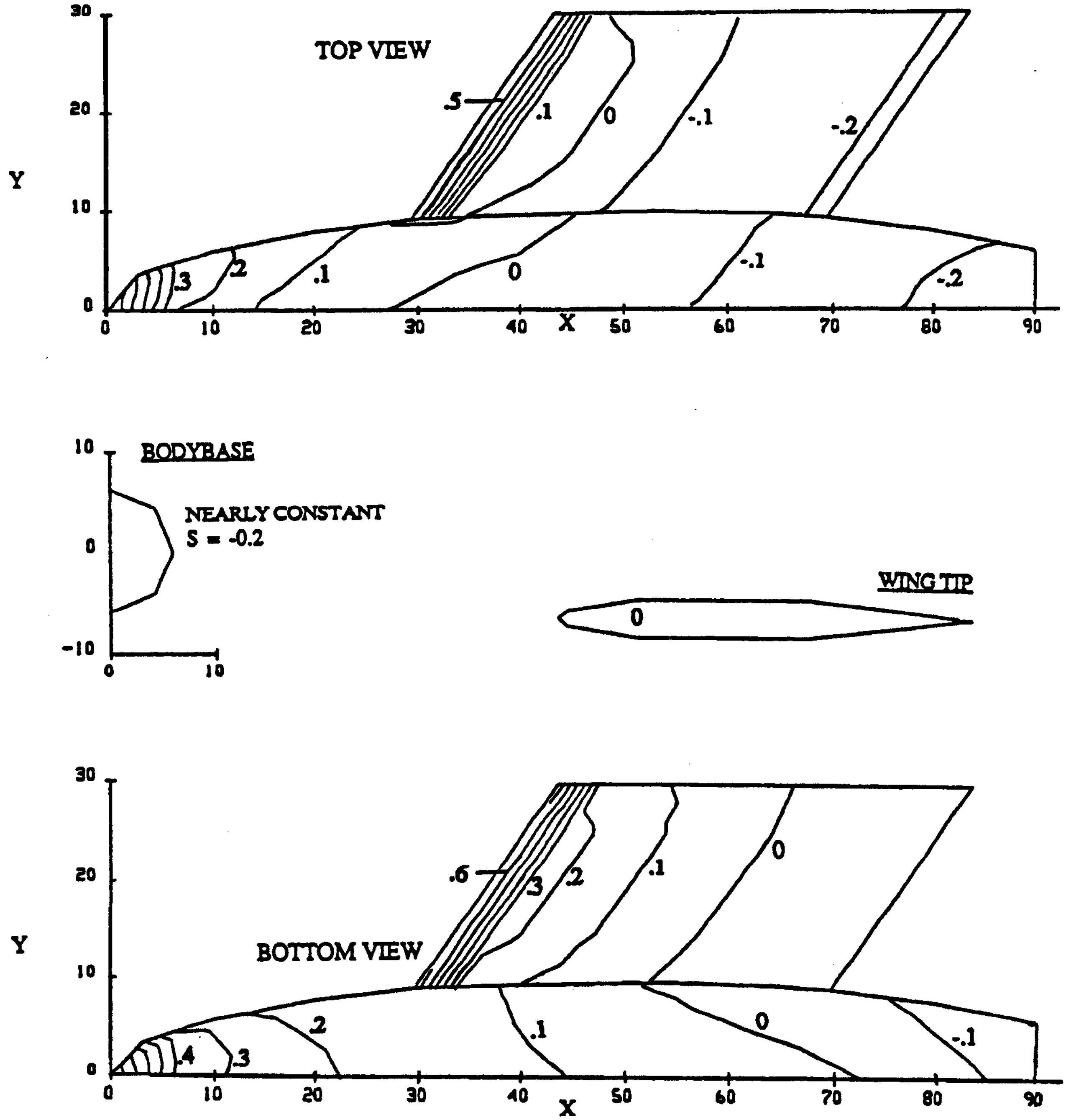


Figure 9-7 Source Distribution on Simple Wing-Body Configuration

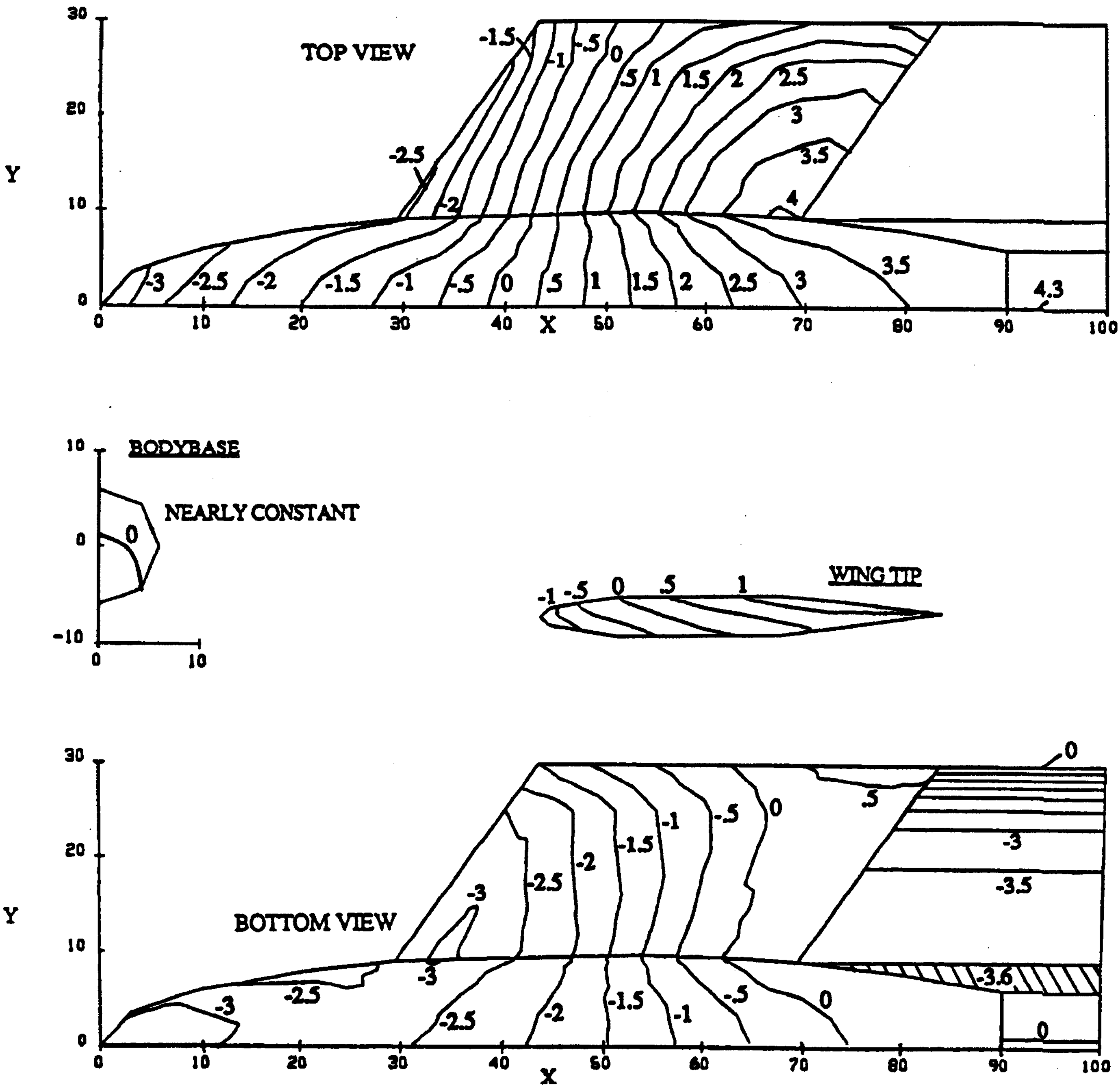
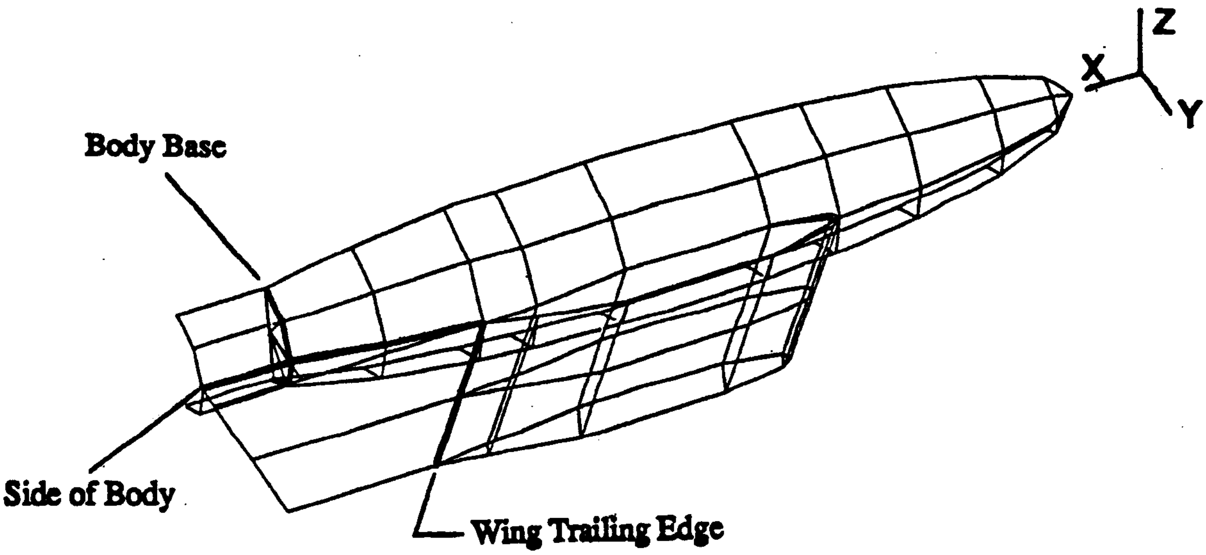


Figure 9-8 Doublet Distribution on Simple Wing-Body Configuration



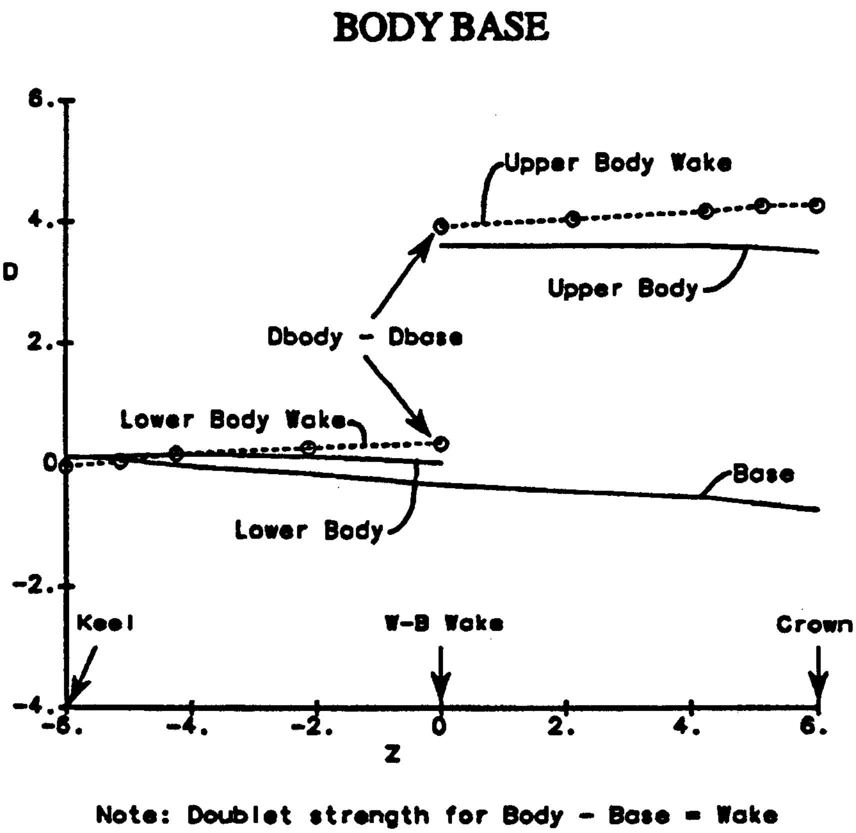
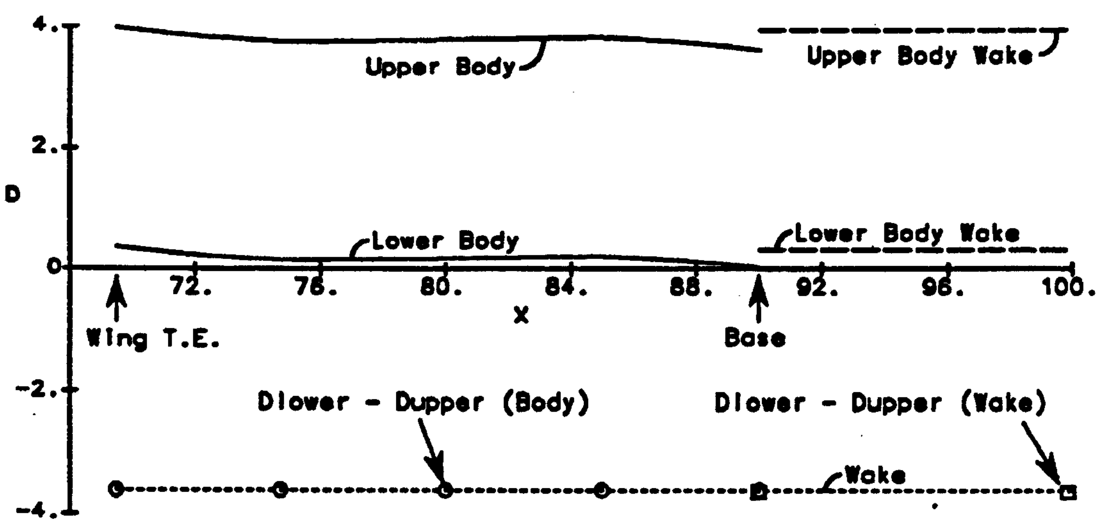


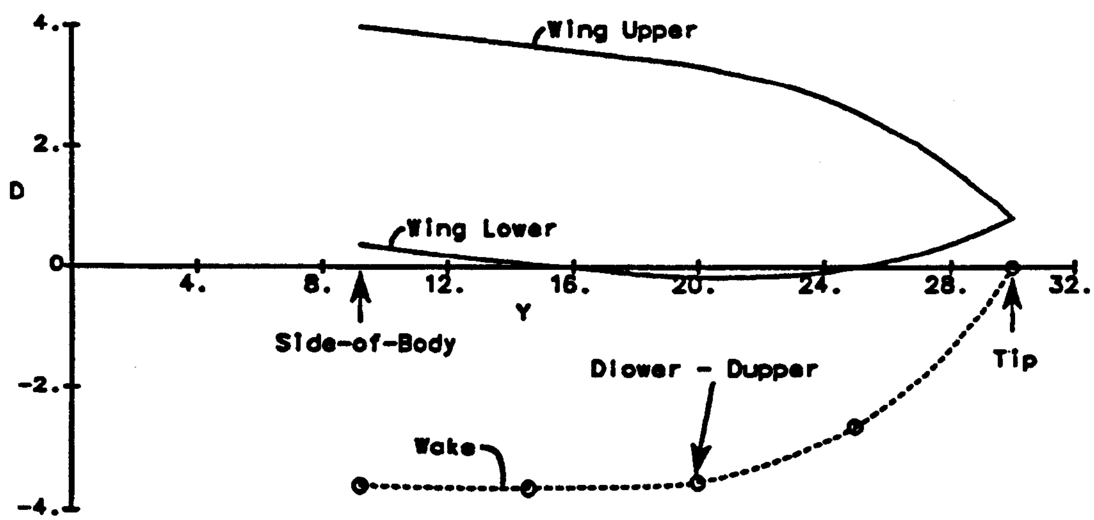
Figure 9-9a, Doublet Strengths Along Wake Abutments

SIDE OF BODY



Note: Doublet strength for Body Lower - Body Upper = Wake

WING TRAILING EDGE



Note: Doublet strength for Wing Upper - Wing Lower = Wake

Figure 9-9b, Doublet Strengths Along Wake Abutments

0*B*SECTION
0 SECTIONAL PROPERTIES - CUT DEFINITIONS AND REFERENCE DATA, SOLUTION NUMBER 1, GROUP NO. 1

0REFERENCE LENGTH FOR ETA = 30.00000

0CUT NO.	ETA	XC	YC	ZC	XCN	YCN	ZCN	XR	YR	ZR	CHORD
1	5.000E-01	0.000E+00	1.500E+01	0.000E+00	0.000E+00	1.000E+00	0.000E+00	4.333E+01	1.500E+01	-1.875E-03	4.000E+01
2	8.333E-01	0.000E+00	2.500E+01	0.000E+00	0.000E+00	1.000E+00	0.000E+00	5.000E+01	2.500E+01	-1.875E-03	4.000E+01

0

GROUP NO. 1 USES THE FOLLOWING NETWORKS (BY NUMBER) AND SURFACE (SURF) PRESSURE DISTRIBUTION FOR COMPUTATIONS -

NET NO	NET ID	SURFACE
1	WINGA	UPPER

NOTE - THE SAME PRESSURE DISTRIBUTION USED IN CALCULATING THE 3-D FORCES AND MOMENTS IS USED TO CALCULATE THE SECTIONAL PROPERTIES. CURRENTLY, THE SECOND ORDER PRESSURE COEFFICIENT IS USED WITHOUT VELOCITY CORRECTIONS.

1 SECTIONAL PROPERTIES - CUT FORCE AND MOMENT DATA, SOLUTION NUMBER 1, GROUP NO. 1

0FORCE (X,Y,Z) AND MOMENT (X,Y,Z) IN GLOBAL COORDINATES.
FORCE (L,D) IN CUT PLANE. FORCE (N) NORMAL TO CUT PLANE.
DIRECTION OF POSITIVE CL IS: FREE STREAM VECTOR CROSSED INTO THE CUT PLANE NORMAL
DIRECTION OF POSITIVE CN IS: SAME AS CUT PLANE NORMAL
DIRECTION OF POSITIVE CD IS: CUT PLANE NORMAL CROSSED INTO THE LIFT (CL) VECTOR
SECTIONAL MOMENT NORMAL TO CUT.

0 CUT NO. / ETA	CFX / CDC	CFY / CNC	CFZ / CLC	CMX / CLC*CHORD/CREF	CMY / CMC	CMZ / CUT-LENGTH
1	-0.008944	0.003597	0.185128	-0.000381	0.001584	-0.004017
0.500000	0.003991	0.003597	0.185301	0.185300	0.001584	80.481757
2	-0.014936	0.009958	0.136095	-0.000374	-0.001797	-0.001584
0.833333	-0.005406	0.009958	0.136806	0.136806	-0.001797	80.659352

1 SECTIONAL PROPERTIES - PANEL FORCE AND MOMENT DATA, SOLUTION NUMBER 1, GROUP NO. 1

0CUT NUMBER 1

0 NET NO.	PANEL NO.	X	Y	Z	CP	FXP	FYP	FZP	CUT-SEGMENT
0 1									
	1	7.03636E+01	1.50000E+01	3.91550E-01	5.53491E-02	-1.07174E-03	7.14422E-04	-8.12763E-03	5.94701E+00
	2	6.23242E+01	1.50000E+01	1.37890E+00	-1.99336E-01	5.88346E-03	-3.92193E-03	5.00665E-02	1.01464E+01
	3	4.90895E+01	1.50000E+01	1.96805E+00	-4.11865E-01	-1.36828E-04	9.12099E-05	1.67993E-01	1.63154E+01
	4	3.75808E+01	1.50000E+01	1.25906E+00	-5.22938E-01	-1.84070E-02	9.86690E-03	8.65574E-02	6.81085E+00
	5	3.37849E+01	1.50000E+01	2.77110E-01	-5.63644E-01	-6.96344E-03	4.28794E-03	1.18250E-02	1.02031E+00
	6	3.37868E+01	1.50000E+01	-2.81291E-01	5.80365E-01	6.98052E-03	-4.29843E-03	1.19365E-02	9.98027E-01
	7	3.75846E+01	1.50000E+01	-1.26089E+00	8.18203E-03	2.84446E-04	-1.52610E-04	1.34057E-03	6.74102E+00
	8	4.90922E+01	1.50000E+01	-1.96815E+00	-2.37255E-01	-7.64462E-05	5.09590E-05	-9.67560E-02	1.63126E+01
	9	6.23253E+01	1.50000E+01	-1.37880E+00	-1.85947E-01	5.52048E-03	-3.67995E-03	-4.69723E-02	1.02047E+01
	10	7.03639E+01	1.50000E+01	-3.91500E-01	4.91508E-02	-9.57850E-04	6.38502E-04	7.26424E-03	5.98555E+00

0CUT NUMBER 2

0 NET NO.	PANEL NO.	X	Y	Z	CP	FXP	FYP	FZP	CUT-SEGMENT
0 1									
	11	7.70301E+01	2.50000E+01	3.91550E-01	9.10898E-02	-1.76379E-03	1.17592E-03	-1.33759E-02	5.94703E+00
	12	6.89907E+01	2.50000E+01	1.37890E+00	-1.11074E-01	3.27839E-03	-2.18570E-03	2.78981E-02	1.01463E+01
	13	5.57560E+01	2.50000E+01	1.96805E+00	-3.23874E-01	-1.07596E-04	7.17342E-05	1.32103E-01	1.63154E+01
	14	4.42155E+01	2.50000E+01	1.38935E+00	-5.55532E-01	-1.57647E-02	1.05103E-02	9.30291E-02	6.83589E+00
	15	4.04197E+01	2.50000E+01	4.07400E-01	-3.67031E-01	-6.28517E-03	4.19030E-03	6.44234E-03	1.08198E+00
	16	4.04218E+01	2.50000E+01	-4.10850E-01	5.54643E-01	9.19543E-03	-6.13054E-03	9.50974E-03	1.05148E+00
	17	4.42196E+01	2.50000E+01	-1.39045E+00	-1.47542E-01	-4.14641E-03	2.76441E-03	-2.45008E-02	6.77840E+00
	18	5.57587E+01	2.50000E+01	-1.96815E+00	-2.13203E-01	-6.86964E-05	4.57998E-05	-8.69470E-02	1.63125E+01
	19	6.89918E+01	2.50000E+01	-1.37880E+00	-9.31214E-02	2.76462E-03	-1.84317E-03	-2.35235E-02	1.02047E+01
	20	7.70304E+01	2.50000E+01	-3.91500E-01	1.04604E-01	-2.03852E-03	1.35908E-03	1.54600E-02	5.98557E+00

0*E*SECTION
1
0*B*SOLUTION

SIMULTANEOUS SOLUTION NUMBER 2

MACH NUMBER = 0.60000 ANGLE OF ATTACK = 10.00000 SIDESLIP ANGLE = 0.00000 FREESTREAM SPEED = 1.00000

COMPRESSIBILITY FACTOR = 0.80000 COMPRESSIBILITY ANGLE OF ATTACK = 4.00000 COMPRESSIBILITY ANGLE OF SIDESLIP = 0.00000
FREESTREAM VELOCITY = (0.98481, 0.00000, 0.17365) COMPRESSIBILITY DIRECTION = (0.99756, 0.00000, 0.06976)
1 NETWORK ID:WINGA INDEX: 1 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 10 NUMBER COLUMNS = 2

JC	IP	X	Y	Z	WX	WY	WZ	CP2NDU	CPISNU	LMACHU	SOURCE	DOUBLET
15	1	70.2006	14.7247	0.3889	0.9692	-0.0444	-0.1317	0.0834	0.0811	0.5754	-0.2998	6.4802
16	2	62.3039	14.9272	1.3756	1.0518	-0.0798	-0.1301	-0.1830	-0.1805	0.6606	-0.2868	5.8932
17	3	49.0449	14.8798	1.9681	1.1497	-0.1024	0.0005	-0.5194	-0.5110	0.7698	-0.1733	3.2549

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0

REMAINDER OF SOLUTIONS 2 AND ALL OF SOLUTION 3 ARE OMITTED

0*E*SECTION
1
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INPUT CONFIGURATION FORCES AND MOMENTS SUMMARY

SOL-NO	ALPHA	BETA	CL	CDI	CY	FX / MX	FY / MY	FZ / MZ	AREA
1	4.0000	0.0000	0.08140	0.00341	0.07005	-0.00228	0.07005	0.08144	
						0.01761	0.01365	0.00303	3953.75087
2	10.0000	0.0000	0.19981	0.02400	0.10904	-0.01106	0.10904	0.20094	
						0.04341	0.03349	0.00734	3953.75087
3	0.0000	0.0000	-0.00001	-0.00062	0.06218	-0.00062	0.06218	-0.00001	
						0.00000	0.00017	0.00215	3953.75087

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0

FULL CONFIGURATION FORCES AND MOMENTS SUMMARY

SYMMETRY CONDITIONS: MISYMM = 1 MJSYMM = 0

SOL-NO	ALPHA	BETA	CL	CDI	CY	FX / MX	FY / MY	FZ / MZ	AREA
1	4.0000	0.0000	0.16279	0.00682	0.00000	-0.00455	0.00000	0.16287	
						0.00000	0.02731	0.00000	7907.50174
2	10.0000	0.0000	0.39962	0.04801	0.00000	-0.02211	0.00000	0.40189	
						0.00000	0.06699	0.00000	7907.50174
3	0.0000	0.0000	-0.00001	-0.00123	0.00000	-0.00123	0.00000	-0.00001	
						0.00000	0.00033	0.00000	7907.50174

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1

CONFIGURATION IS COMPOSED OF THE FOLLOWING SELECTED NETWORKS
1 WINGA 2 WINGTA 3 BODYL 4 BODYU

NOTE: THESE NETWORKS ARE ALL KT=1 TYPES

REFERENCE CONDITIONS ARE:
SREF = 2400.00000 XREF = 46.00000 YREF = 0.00000 ZREF = 0.00000
CREF = 40.00000 BREF = 60.00000 DREF = 90.00000

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1

O*B*OFF-BODY

OFF BODY FLOW CHARACTERISTICS

SOLN	PT	X	Y	Z	WX	WY	WZ	PPOT	CP/2ND	MACH
1	1	-50.0000	0.0000	0.0000	0.9942	0.0000	0.0705	-0.2550	0.0103	0.5967
1	2	-20.0000	0.0000	0.0000	0.9834	0.0000	0.0719	-0.5787	0.0435	0.5860
1	3	-5.0000	0.0000	0.0000	0.9229	0.0000	0.0772	-1.3178	0.2225	0.5284
1	4	85.0000	22.5000	-7.5000	0.9818	0.0286	0.0520	-0.2237	0.0514	0.5835
1	5	85.0000	22.5000	-2.5000	0.9762	0.0534	-0.0061	-0.4314	0.0736	0.5768
1	6	85.0000	22.5000	2.5000	0.9763	-0.1115	-0.0246	2.2963	0.0647	0.5804
1	7	85.0000	22.5000	7.5000	0.9824	-0.0843	0.0123	1.9334	0.0491	0.5848
1	8	85.0000	27.5000	-7.5000	0.9837	0.0417	0.0825	-0.0345	0.0381	0.5879
1	9	85.0000	27.5000	-2.5000	0.9744	0.1190	0.0857	0.0375	0.0535	0.5836
1	10	85.0000	27.5000	2.5000	0.9726	-0.1762	0.0652	1.5483	0.0468	0.5867
1	11	85.0000	27.5000	7.5000	0.9833	-0.0942	0.0491	1.4760	0.0394	0.5879
1	12	85.0000	32.5000	-7.5000	0.9876	0.0222	0.1053	0.1332	0.0214	0.5932
1	13	85.0000	32.5000	-2.5000	0.9816	0.0157	0.1518	0.4057	0.0247	0.5924
1	14	85.0000	32.5000	2.5000	0.9802	-0.0775	0.1391	0.8731	0.0277	0.5917
1	15	85.0000	32.5000	7.5000	0.9871	-0.0726	0.0817	1.0481	0.0245	0.5924
1	16	85.0000	37.5000	-7.5000	0.9916	0.0035	0.1027	0.1916	0.0101	0.5968
1	17	85.0000	37.5000	-2.5000	0.9897	-0.0118	0.1150	0.3890	0.0125	0.5961
1	18	85.0000	37.5000	2.5000	0.9895	-0.0372	0.1089	0.6106	0.0136	0.5958
1	19	85.0000	37.5000	7.5000	0.9917	-0.0465	0.0882	0.7541	0.0119	0.5963
2	1	-50.0000	0.0000	0.0000	0.9814	0.0000	0.1761	-0.2544	0.0094	0.5970
2	2	-20.0000	0.0000	0.0000	0.9706	0.0000	0.1798	-0.5750	0.0407	0.5870
2	3	-5.0000	0.0000	0.0000	0.9106	0.0000	0.1930	-1.3067	0.2117	0.5322
2	4	85.0000	22.5000	-7.5000	0.9706	0.1080	0.1119	-1.6337	0.0543	0.5827
2	5	85.0000	22.5000	-2.5000	0.9668	0.1748	-0.0153	-2.3941	0.0696	0.5793
2	6	85.0000	22.5000	2.5000	0.9659	-0.2315	-0.0336	4.2385	0.0500	0.5871
2	7	85.0000	22.5000	7.5000	0.9702	-0.1623	0.0730	3.3165	0.0514	0.5844
2	8	85.0000	27.5000	-7.5000	0.9721	0.1379	0.1876	-0.9898	0.0137	0.5968
2	9	85.0000	27.5000	-2.5000	0.9635	0.3367	0.2057	-1.0324	-0.0632	0.6267
2	10	85.0000	27.5000	2.5000	0.9575	-0.3926	0.1855	2.5958	-0.0763	0.6328
2	11	85.0000	27.5000	7.5000	0.9694	-0.1890	0.1548	2.4044	0.0191	0.5956
2	12	85.0000	32.5000	-7.5000	0.9748	0.0885	0.2474	-0.4039	-0.0140	0.6060
2	13	85.0000	32.5000	-2.5000	0.9674	0.0838	0.3709	0.1017	-0.0763	0.6291
2	14	85.0000	32.5000	2.5000	0.9634	-0.1441	0.3582	1.1564	-0.0678	0.6268
2	15	85.0000	32.5000	7.5000	0.9726	-0.1373	0.2240	1.5611	-0.0054	0.6035
2	16	85.0000	37.5000	-7.5000	0.9782	0.0369	0.2445	-0.1054	-0.0162	0.6063
2	17	85.0000	37.5000	-2.5000	0.9757	0.0060	0.2808	0.2608	-0.0290	0.6111
2	18	85.0000	37.5000	2.5000	0.9751	-0.0539	0.2747	0.7210	-0.0261	0.6102
2	19	85.0000	37.5000	7.5000	0.9778	-0.0786	0.2298	1.0306	-0.0117	0.6049
3	1	-50.0000	0.0000	0.0000	0.9966	0.0000	0.0000	-0.2570	0.0105	0.5966
3	2	-20.0000	0.0000	0.0000	0.9858	0.0000	0.0000	-0.5811	0.0439	0.5859
3	3	-5.0000	0.0000	0.0000	0.9254	0.0000	0.0002	-1.3210	0.2240	0.5279
3	4	85.0000	22.5000	-7.5000	0.9827	-0.0276	0.0200	0.8575	0.0507	0.5836
3	5	85.0000	22.5000	-2.5000	0.9759	-0.0286	0.0088	0.9315	0.0726	0.5766
3	6	85.0000	22.5000	2.5000	0.9767	-0.0288	-0.0097	0.9349	0.0717	0.5771
3	7	85.0000	22.5000	7.5000	0.9839	-0.0275	-0.0197	0.8520	0.0501	0.5841
3	8	85.0000	27.5000	-7.5000	0.9851	-0.0260	0.0171	0.7213	0.0438	0.5858
3	9	85.0000	27.5000	-2.5000	0.9754	-0.0278	0.0102	0.7912	0.0742	0.5761
3	10	85.0000	27.5000	2.5000	0.9764	-0.0287	-0.0102	0.7915	0.0727	0.5767
3	11	85.0000	27.5000	7.5000	0.9862	-0.0258	-0.0165	0.7161	0.0431	0.5863
3	12	85.0000	32.5000	-7.5000	0.9900	-0.0251	0.0121	0.5898	0.0294	0.5905
3	13	85.0000	32.5000	-2.5000	0.9849	-0.0307	0.0066	0.6377	0.0452	0.5855
3	14	85.0000	32.5000	2.5000	0.9854	-0.0306	-0.0061	0.6360	0.0448	0.5857
3	15	85.0000	32.5000	7.5000	0.9906	-0.0247	-0.0116	0.5858	0.0293	0.5907
3	16	85.0000	37.5000	-7.5000	0.9946	-0.0214	0.0075	0.4708	0.0158	0.5949
3	17	85.0000	37.5000	-2.5000	0.9930	-0.0243	0.0031	0.4974	0.0209	0.5933
3	18	85.0000	37.5000	2.5000	0.9931	-0.0242	-0.0029	0.4965	0.0209	0.5933
3	19	85.0000	37.5000	7.5000	0.9949	-0.0211	-0.0072	0.4685	0.0161	0.5949

O*E*OFF-BODY

NPICSL	7						
1.	0	220	1131	834	624	135	20

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0*B*STREAML
1


      NO. OF STREAMLINES IN CORE         (ICORE ) =    92
      STORAGE REQD. PER STREAMLINE       (IPTSEQ) =   108
      GLOBAL STORAGE REQUIRED.           (IABSPS) =    21
      STORAGE REQUIRED FOR ARRAY ARR1    (ITOTAL) =  9957     (+ 100 FOR ARRAY IWRK)


      NSTMLN, NUMPTS, HMIN, HMAX                  =     1       2    0.10000E+00     0.20000E+01
      MAXSTM, MXORDR, ABSERR, MXARR1, ISPRNT      =   100       6    0.10000E-01     10000      0


                              *** MAP OF ARRAY ARR1 IN OCTAL ***

         ISTMLN     ITINP     ITOUT    IRELER    IABSER    IPHIMX     IIPOS    IRELPS    IABSPS        IY
              1        15       574        16        17        18        19        20        21        22

             IT    IIFLAG       IYY        IP       IYP      IPHI    IALPHA     IBETA      ISIG        IV
            298      1034      1218      1494      1770      2046      4254      4806      5358      6002

             IW        IG    IAPHSE      IPSI        IX        IH     IHOLD    IASTRT     ITOLD    IDELSN
           6554      7106      7750      7842      8394      8486      8578      8670      8762      8854

            INS    IIFAIL        IK     IKOLD    IICOMP    IIPTS1    IIPTS2     IKNEW      IEPS    IICRSH
           8946      9038      9130      9222      9314      9406      9498      9590      9682      9774

         IACRSH    ITOTAL    IHMNST    IHMXST    IMORDR    IDUMST    IPOTEN
           9866      9957       390       482       666       758      1126


                              *** MAP OF ARRAY ARR1 IN DECIMAL NUMBERS ***

         ISTMLN     ITINP     ITOUT    IRELER    IABSER    IPHIMX     IIPOS    IRELPS    IABSPS        IY
              1        15       574        16        17        18        19        20        21        22

             IT    IIFLAG       IYY        IP       IYP      IPHI    IALPHA     IBETA      ISIG        IV
            298      1034      1218      1494      1770      2046      4254      4806      5358      6002

             IW        IG    IAPHSE      IPSI        IX        IH     IHOLD    IASTRT     ITOLD    IDELSN
           6554      7106      7750      7842      8394      8486      8578      8670      8762      8854

            INS    IIFAIL        IK     IKOLD    IICOMP    IIPTS1    IIPTS2     IKNEW      IEPS    IICRSH
           8946      9038      9130      9222      9314      9406      9498      9590      9682      9774

         IACRSH    ITOTAL    IHMNST    IHMXST    IMORDR    IDUMST    IPOTEN
           9866      9957       390       482       666       758      1126
1
0      STREAMLINE NO. =   1    INTEGRATION POINTS =    34    STARTING POSITION =  0.400000E+02  0.300000E+02 -0.200000E+01
      ENDING POSITION =  0.910479E+02  0.255717E+02  0.299432E+01    MIN. MAX. STEP SIZE =  0.252498E-01  0.200000E+01
      MAX. ORDER =  5    FORWARD BACKWARD FLAG = 1.00  (NON ZERO VALUE INDICATES BACKWARD)
0      STREAMLINE NO. =   2    INTEGRATION POINTS =    36    STARTING POSITION =  0.400000E+02  0.300000E+02  0.000000E+00
      ENDING POSITION =  0.907398E+02  0.241329E+02  0.255453E+01    MIN. MAX. STEP SIZE =  0.252021E-01  0.200000E+01
      MAX. ORDER =  6    FORWARD BACKWARD FLAG = 1.00  (NON ZERO VALUE INDICATES BACKWARD)
```

0*B*STREAML

MASS FLUX STREAMLINE NUMBER 1 FOR CASE 1 FORWARD/BACK = 1.00

INT. PT.	INDEP. VARIABLE	STREAMLINE LOCATION			DIRECTION(-V/-W, BACKWARD INT)			POTEN.	2ND ORDER CP	LOCAL MACH	ORDER
	S	X	Y	Z	WX	WY	WZ	PPOT	CP/2ND	MACH	K
1	0.0000	40.0000	30.0000	-2.0000	0.9699	0.1203	0.0766	-1.1969	0.0691	0.5786	0
2	0.0252	40.0245	30.0030	-1.9981	0.9698	0.1207	0.0764	-1.1976	0.0691	0.5786	1
3	0.1252	40.1215	30.0152	-1.9905	0.9697	0.1226	0.0759	-1.2002	0.0693	0.5786	2
4	0.3252	40.3154	30.0401	-1.9754	0.9694	0.1264	0.0747	-1.2055	0.0694	0.5786	3
5	0.7252	40.7031	30.0922	-1.9460	0.9693	0.1344	0.0720	-1.2152	0.0683	0.5791	4
6	1.5252	41.4791	30.2067	-1.8914	0.9710	0.1527	0.0635	-1.2281	0.0598	0.5821	5
7	2.3252	42.2583	30.3371	-1.8450	0.9786	0.1738	0.0521	-1.2363	0.0320	0.5914	4
8	3.9252	43.8559	30.6415	-1.7673	1.0281	0.1993	0.0582	-1.1730	-0.1338	0.6452	4
9	5.3652	45.3626	30.9149	-1.6437	1.0492	0.1694	0.1219	-1.0118	-0.2082	0.6688	4
10	6.8052	46.8749	31.1247	-1.4242	1.0520	0.1264	0.1646	-0.8315	-0.2204	0.6724	4
11	8.2452	48.3877	31.2750	-1.1703	1.0491	0.0832	0.1837	-0.6548	-0.2102	0.6688	3
12	9.6852	49.8942	31.3706	-0.9011	1.0428	0.0525	0.1883	-0.4951	-0.1872	0.6612	3
13	11.1252	51.3923	31.4329	-0.6296	1.0391	0.0358	0.1894	-0.3524	-0.1742	0.6570	4
14	12.5652	52.8883	31.4747	-0.3551	1.0391	0.0209	0.1924	-0.2136	-0.1749	0.6572	4
15	14.0052	54.3851	31.4925	-0.0750	1.0391	0.0050	0.1961	-0.0732	-0.1763	0.6576	5
16	15.4452	55.8810	31.4878	0.2104	1.0386	-0.0115	0.2002	0.0682	-0.1767	0.6578	4
17	17.4452	57.9570	31.4403	0.6169	1.0372	-0.0364	0.2064	0.2662	-0.1764	0.6579	3
18	19.4452	60.0295	31.3394	1.0359	1.0352	-0.0654	0.2124	0.4671	-0.1756	0.6579	3
19	21.4452	62.0973	31.1736	1.4657	1.0326	-0.1020	0.2173	0.6734	-0.1759	0.6583	3
20	23.4452	64.1595	30.9218	1.8997	1.0295	-0.1526	0.2156	0.8900	-0.1778	0.6596	3
21	25.4452	66.2160	30.5501	2.3091	1.0273	-0.2230	0.1883	1.1263	-0.1840	0.6625	4
22	27.4452	68.2679	30.0471	2.6089	1.0241	-0.2693	0.1010	1.3787	-0.1644	0.6567	4
23	29.4452	70.3084	29.5037	2.7270	1.0144	-0.2602	0.0366	1.5927	-0.1146	0.6404	5
24	31.2452	72.1247	29.0597	2.7704	1.0048	-0.2436	0.0054	1.7334	-0.0721	0.6265	5
25	33.0452	73.9240	28.6364	2.7631	0.9940	-0.2266	-0.0130	1.8337	-0.0290	0.6124	4
26	34.8452	75.7031	28.2432	2.7307	0.9829	-0.2099	-0.0206	1.8910	0.0126	0.5988	4
27	36.6452	77.4627	27.8798	2.6927	0.9722	-0.1941	-0.0205	1.9069	0.0517	0.5859	4
28	38.6452	79.3949	27.5082	2.6609	0.9598	-0.1775	-0.0087	1.8765	0.0947	0.5717	4
29	40.6452	81.3070	27.1651	2.6673	0.9546	-0.1675	0.0177	1.8061	0.1114	0.5660	4
30	42.6452	83.2231	26.8331	2.7261	0.9645	-0.1662	0.0367	1.7402	0.0799	0.5760	4
31	44.6452	85.1643	26.5018	2.8040	0.9743	-0.1631	0.0383	1.7057	0.0508	0.5852	4
32	46.6452	87.1189	26.1807	2.8755	0.9796	-0.1580	0.0345	1.6904	0.0368	0.5896	4
33	48.6452	89.0812	25.8704	2.9395	0.9825	-0.1523	0.0297	1.6831	0.0306	0.5915	3
34	50.6452	91.0479	25.5717	2.9943	0.9841	-0.1464	0.0252	1.6785	0.0279	0.5923	3

MASS FLUX STREAMLINE NUMBER 2 FOR CASE 1 FORWARD/BACK = 1.00

INT. PT.	INDEP. VARIABLE	STREAMLINE LOCATION			DIRECTION(-V/-W, BACKWARD INT)			POTEN.	2ND ORDER CP	LOCAL MACH	ORDER
	S	X	Y	Z	WX	WY	WZ	PPOT	CP/2ND	MACH	K
1	0.0000	40.0000	30.0000	0.0000	0.9684	0.1206	0.1261	-1.1382	0.0596	0.5818	0
2	0.0252	40.0244	30.0030	0.0032	0.9683	0.1211	0.1264	-1.1387	0.0597	0.5818	1
3	0.1252	40.1212	30.0153	0.0159	0.9680	0.1232	0.1277	-1.1407	0.0598	0.5818	2
4	0.3252	40.3147	30.0403	0.0417	0.9672	0.1275	0.1304	-1.1446	0.0601	0.5818	3
5	0.7252	40.7014	30.0932	0.0951	0.9658	0.1373	0.1367	-1.1520	0.0596	0.5822	4
6	1.5252	41.4731	30.2123	0.2109	0.9639	0.1617	0.1544	-1.1628	0.0517	0.5853	5
7	3.1252	43.0327	30.5212	0.5077	1.0102	0.2273	0.2244	-1.1116	-0.1491	0.6518	6
8	3.8048	43.7389	30.6626	0.6588	1.0760	0.1736	0.2100	-1.0008	-0.3354	0.7111	4
9	4.4845	44.4797	30.7529	0.7932	1.0852	0.0929	0.1872	-0.8670	-0.3340	0.7094	4
10	5.1641	45.2133	30.7969	0.9162	1.0777	0.0499	0.1795	-0.7503	-0.2991	0.6976	4
11	5.8437	45.9435	30.8232	1.0376	1.0719	0.0236	0.1758	-0.6449	-0.2758	0.6898	4
12	6.5234	46.6705	30.8321	1.1563	1.0678	0.0022	0.1739	-0.5464	-0.2607	0.6849	3
13	7.8826	48.1161	30.8114	1.3914	1.0593	-0.0302	0.1724	-0.3661	-0.2327	0.6758	2
14	9.2419	49.5498	30.7535	1.6264	1.0501	-0.0531	0.1737	-0.2047	-0.2049	0.6668	2
15	10.6012	50.9736	30.6733	1.8655	1.0455	-0.0625	0.1784	-0.0597	-0.1928	0.6630	2
16	11.9604	52.3965	30.5762	2.1074	1.0501	-0.0856	0.1760	0.0929	-0.2104	0.6688	3
17	13.3197	53.8259	30.4407	2.3403	1.0515	-0.1135	0.1654	0.2555	-0.2160	0.6708	3
18	14.6789	55.2556	30.2686	2.5542	1.0523	-0.1383	0.1483	0.4227	-0.2180	0.6716	3
19	16.0382	56.6861	30.0663	2.7423	1.0525	-0.1583	0.1281	0.5925	-0.2174	0.6716	3
20	18.0382	58.7907	29.7258	2.9671	1.0519	-0.1809	0.0966	0.8440	-0.2135	0.6706	3
21	20.0382	60.8923	29.3475	3.1285	1.0492	-0.1963	0.0650	1.0926	-0.2024	0.6673	3
22	22.0382	62.9871	28.9442	3.2284	1.0456	-0.2062	0.0355	1.3337	-0.1895	0.6633	3
23	24.0382	65.0738	28.5255	3.2696	1.0408	-0.2120	0.0054	1.5647	-0.1727	0.6582	3
24	26.0382	67.1468	28.1015	3.2510	1.0311	-0.2105	-0.0235	1.7756	-0.1388	0.6474	3
25	28.0382	69.1972	27.6864	3.1823	1.0195	-0.2040	-0.0424	1.9489	-0.0988	0.6346	4
26	30.0382	71.2244	27.2873	3.0848	1.0078	-0.1951	-0.0553	2.0816	-0.0584	0.6216	4
27	32.0382	73.2277	26.9074	2.9662	0.9953	-0.1845	-0.0625	2.1716	-0.0157	0.6078	3
28	34.0382	75.2057	26.5495	2.8396	0.9828	-0.1732	-0.0628	2.2156	0.0269	0.5940	3
29	36.0382	77.1589	26.2143	2.7189	0.9704	-0.1621	-0.0573	2.2140	0.0684	0.5804	4
30	38.0382	79.0875	25.9004	2.6172	0.9583	-0.1520	-0.0417	2.1660	0.1085	0.5672	4
31	40.0382	80.9980	25.6015	2.5590	0.9554	-0.1490	-0.0148	2.0838	0.1175	0.5639	4
32	42.0382	82.9173	25.3003	2.5521	0.9652	-0.1521	0.0012	2.0111	0.0862	0.5739	5
33	44.0382	84.8599	24.9943	2.5558	0.9740	-0.1510	0.0036	1.9685	0.0596	0.5823	5
34	46.0382	86.8128	24.6972	2.5599	0.9791	-0.1467	0.0017	1.9441	0.0455	0.5868	4
35	48.0382	88.7742	24.4093	2.5602	0.9820	-0.1412	-0.0013	1.9285	0.0387	0.5889	3
36	50.0382	90.7398	24.1329	2.5545	0.9836	-0.1351	-0.0043	1.9164	0.0356	0.5899	3

```
0*E*STREAML
1
0    *****  S/L VELOCITY EVALUATION STATISTICS  *****

     NO INFLUENCE           0
     MONOPOLE             933
     DIPOLE              6553
     QUADRUPOLE          6401
     QUASI-FAR FIELD     5723
     QUASI-NEAR FIELD    1542
     NEAR FIELD           532

     TIME IN PVCAL       4.001419
     TIME IN PIVW        2.288969
     NO. CALLS TO PVCAL        98
     PHI/V EVALUATIONS        139

  RWMS PKG, LLDICT:     0
      LLINDX          100
        1.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
       11.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
       21.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
       31.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
       41.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
       51.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
       61.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
       71.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
       81.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
       91.       -1    -1    -1    -1    -1    -1    -1    -1    -1    -1
      NRECMX          100
        1.        0     0     0     0     0     0     0     0     0     0
       11.        0     0     0     0     0     0     0     0     0     0
       21.        0     0     0     0     0     0     0     0     0     0
       31.        0     0     0     0     0     0     0     0     0     0
       41.        0     0     0     0     0     0     0     0     0     0
       51.        0     0     0     0     0     0     0     0     0     0
       61.        0     0     0     0     0     0     0     0     0     0
       71.        0     0     0     0     0     0     0     0     0     0
       81.        0     0     0     0     0     0     0     0     0     0
       91.        0     0     0     0     0     0     0     0     0     0
```

1 JOB COST SUMMARY BY FUNCTION

FUNCTION	ELAPSED-T	TOTAL-T	PRUT-SECS	CPU-SECS	CMP-UNITS	DSK-REQS	DSK-BLKS	SSD-UNITS	SSD-REQS	FCN CCUS	$'S @ P1
INITIALZ	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INPUT	0.11	0.12	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INIT	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GEOMETRY	0.41	0.53	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SINGULAR	0.28	0.81	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CNTRL PT	0.03	0.84	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BNDY CND	0.18	1.02	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FFGEN	0.10	1.12	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIC COST	3.29	4.41	3.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIC COST	0.09	4.50	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MTRXSOLN	0.06	4.55	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PPPDQ	0.13	4.68	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OUTPUT	0.71	5.39	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOFFBD	0.30	5.68	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S-L COMP	4.02	9.71	4.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S-L SORT	0.09	9.79	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS	(EXCL. LINE 1)		9.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CCU ESTIMATES FOR THE VARIOUS COST COMPONENTS

INITIALZ	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INPUT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INIT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GEOMETRY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SINGULAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CNTRL PT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BNDY CND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FFGEN	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIC COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIC COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MTRXSOLN	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PPPDQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OUTPUT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOFFBD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S-L COMP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S-L SORT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0TOTALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00

****

DYNAMIC MEMORY SUMMARY	USED	ALLOCATED
MAXIMUM NUMBER OF LEVELS	5	15
MAXIMUM NUMBER OF ARRAYS	25	200
MAXIMUM DYNAMIC MEMORY	310235	900000

****

9.1A SWB. LOG - A502 LOG FILE

```
          UNICOS 5.1.12 (Boeing Revision 43b) — The Boeing Y-MP8/4128

news: AutoLogout newqueues VIEWbatch SAToutage 6.laccess yproblems whytelnet
 ympinteractive send corrupt CWAdirchange ftpbatch qp92chng MOREman
You have mail.
##########################################################################

grs2756 logged on sn1028 at 16:40:45 on Thu Feb 13, 1992
^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
##########################################################################

                    A502 LOGFILE ... CASE id. = swb

##########################################################################

*** A502 environment variables ***
++
++ CASE=swb                          # A502 CASE id.
++ A502IN=cfdd31:a502/swb/swb.inp # A502 input file
++ YDIR=/u/ba/grs2756/a502/swb        # Y-MP directory to store LARGE files
++ SDIR=cfdd31:a502/swb       # directory to store SMALL files
++

*** list of A502 working files in $TMPDIR following A502 execution ***
aer418_aer418v -rw-------  1 grs2756    12974 Feb 13 16:41 agps
aer418_aer418v -rw-------  1 grs2756     1494 Feb 13 16:41 ffm
aer418_aer418v -rw-------  1 grs2756     2330 Feb 13 16:41 ffmf
aer418_aer418v -rw-------  1 grs2756      944 Feb 13 16:41 fmgp
aer418_aer418v -rw-------  1 grs2756    86016 Feb 13 16:40 fort.1
aer418_aer418v -rw-------  1 grs2756  1236992 Feb 13 16:41 fort.12
aer418_aer418v -rw-------  1 grs2756   221184 Feb 13 16:41 fort.19
aer418_aer418v -rw-------  1 grs2756   471040 Feb 13 16:41 fort.2
aer418_aer418v -rw-------  1 grs2756   221184 Feb 13 16:41 fort.20
aer418_aer418v -rw-------  1 grs2756   102400 Feb 13 16:41 fort.24
aer418_aer418v -rw-------  1 grs2756    12288 Feb 13 16:41 fort.26
aer418_aer418v -rw-------  1 grs2756    12288 Feb 13 16:41 fort.28
aer418_aer418v -rw-------  1 grs2756    53248 Feb 13 16:40 fort.3
aer418_aer418v -rw-------  1 grs2756   528384 Feb 13 16:41 fort.4
aer418_aer418v -rw-------  1 grs2756    65536 Feb 13 16:41 fort.49
aer418_aer418v -rw-------  1 grs2756   196608 Feb 13 16:41 fort.68
aer418_aer418v -rw-------  1 grs2756    16384 Feb 13 16:41 fort.88
aer418_aer418v -rw-------  1 grs2756    12288 Feb 13 16:41 fslout
aer418_aer418v -rw-------  1 grs2756     8192 Feb 13 16:41 ft08
aer418_aer418v -rw-------  1 grs2756     8192 Feb 13 16:41 ft09
aer418_aer418v -rw-------  1 grs2756   126850 Feb 13 16:41 ft13
aer418_aer418v -rw-------  1 grs2756   356352 Feb 13 16:41 ft18
aer418_aer418v -rw-------  1 grs2756     4096 Feb 13 16:41 ft31
aer418_aer418v -rw-------  1 grs2756   339968 Feb 13 16:41 ft32
aer418_aer418v -rw-------  1 grs2756     8192 Feb 13 16:41 ft33
aer418_aer418v -rw-------  1 grs2756     6932 Feb 13 16:41 ft34
aer418_aer418v -rw-------  1 grs2756     8192 Feb 13 16:41 ft89
aer418_aer418v -rw-------  1 grs2756     4096 Feb 13 16:41 ft93
aer418_aer418v -rw-------  1 grs2756    25701 Feb 13 16:41 ft98
aer418_aer418v -rw-------  1 grs2756     4096 Feb 13 16:41 ft99
aer418_aer418v -rw-------  1 grs2756     4291 Feb 13 16:41 iflggp
aer418_aer418v -rw-------  1 grs2756     1798 Feb 13 16:41 ispggp
aer418_aer418v -rw-------  1 grs2756     9849 Feb 13 16:41 mspntl
aer418_aer418v -rw-------  1 grs2756     9483 Feb 13 16:41 stmlin
aer418_aer418v -rw-------  1 grs2756     8307 Feb 13 16:40 swb.inp
```

```
*** HURRAY : A502 execution successful.  Save files ***

 ----------------------------------------------------------------------------
 |      *** A502 output files and their assigned storage locations ***       |
 ------------------------------+---------+-----------------------------------
 |      FILE DESCRIPTION       |FILE NAME|        FILE WAS SAVED AS:         |
 ------------------------------+---------+-----------------------------------
aic data                      | fort.4  | /u/ba/grs2756/a502/swb/swb.aic
singularity strengths         |  ft09   | /u/ba/grs2756/a502/swb/swb.sin
factored aic data             | fort.19 | /u/ba/grs2756/a502/swb/swb.fam
network geometry              | mspntl  | cfdd31:a502/swb/swb.mpx
pressures at panel corners    |  agps   | cfdd31:a502/swb/swb.pc
sectional pressures           | iflggp  | cfdd31:a502/swb/swb.spg
sectional forces              | ispggp  | cfdd31:a502/swb/swb.sfg
streamline data               | stmlin  | cfdd31:a502/swb/swb.str
offbody data                  |  ft34   | cfdd31:a502/swb/swb.off
INPUT configuration F&M data  |  ffm    | cfdd31:a502/swb/swb.fmgi
FULL configuration F&M data   |  ffmf   | cfdd31:a502/swb/swb.fmgf
F&M summary data              |  fmgp   | cfdd31:a502/swb/swb.fmg
surface flow properties       |  ft13   | /u/ba/grs2756/a502/swb/swb.pf
A502 output file              | stdout  | /u/ba/grs2756/a502/swb/swb.out
A502 error  file              | stderr  | /u/ba/grs2756/a502/swb/swb.err
 ------------------------------+---------+-----------------------------------


################################################################################


Job Accounting - Summary Report
-------------------------------

Job Accounting File Name        : /wrk/nqs.++++3BF_/.jacct12704
Operating System                : sn1028 sn1028 5.1 sea.43 CRAY Y-MP
User Name (ID)                  : grs2756 (2321)
Group Name (ID)                 : aer418_aer418v (412)
Account Name (ID)               : aer418_aer418v (412)
Job Name (ID)                   : STDIN (12704)
Report Starts                   : 02/13/92 16:40:39
Report Ends                     : 02/13/92 16:42:07
Elapsed Time                    :           88      Seconds
User CPU Time                   :           11.5919 Seconds
System CPU Time                 :            2.2596 Seconds
I/O Wait Time (Locked)          :            4.7390 Seconds
I/O Wait Time (Unlocked)        :            5.0548 Seconds
CPU Time Memory Integral        :           32.2756 Mword-seconds
SDS Time Memory Integral        :            0.0000 Mword-seconds
I/O Wait Time Memory Integral   :            4.0146 Mword-seconds
Data Transferred                :           52.6748 Mbytes
Logical I/O Requests            :         2584
Physical I/O Requests           :         2995
Number of Commands              :           75

Units                     Number        CRUs      Percent
CP seconds                13.851     153.613       91.371
Memory (Mword-seconds)    32.276      13.076        7.778
Megabytes transferred     52.675       1.430        0.851
Total CRUs                           168.119

Max memory used (decimal words)     2749440

Priority requested                      me

Turnaround level                         B
```

10. EXAMPLE: POWER-ON NACELLE

A simple power-on nacelle analysis is used to illustrate the boundary condition and problem details for processing a nacelle. An additional new option for solving flows with different total heads (see section E.3) has been included in this analysis. The geometry-generating feature of A502H (see section D.2) is used to define the network surfaces. For documentation purposes, the nacelle is represented by a minimum number of panels to reduce the amount of printout.

The aerodynamic objective of the powered nacelle problem is to simulate a low level of power-on thrust and predict the flow properties. The new feature, which allows for analysis of flow with different total pressure and/or total temperature from the freestream condition, is severely restricted in applications. The flow field in any region must not be dominated by transonic flow, because these transonic effects are not represented with A502. (The current case gives transonic flow results on the internal plume boundaries, because the total pressure condition specified for the exhaust plume is too large.) The boundary conditions (figure 10-1) used in this example without a total head change represent the preferred way to model a power-on nacelle in subsonic flow.

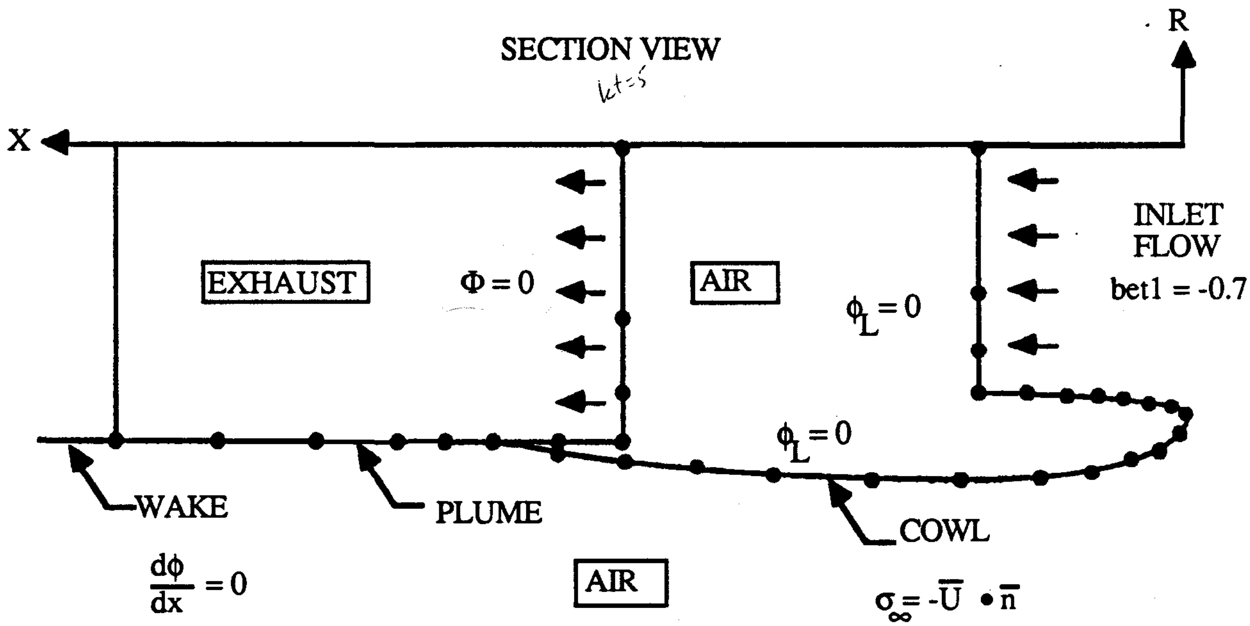

Figure 10-1 Input to Define Surfaces and Boundary Conditions

The power-on nacelle case is actually modeled by using a geometry-generating tool within A502, $CIRC (reference 1), to illustrate an alternate means of inputting simple geometry. The procedure calculates the mesh points of networks with circular cross-sections perpendicular to the XY plane. The resulting networks and an exploded view are shown in figure 10-2. The configuration is paneled with a minimum number of panels to reduce the amount of printout (not a recommended procedure).

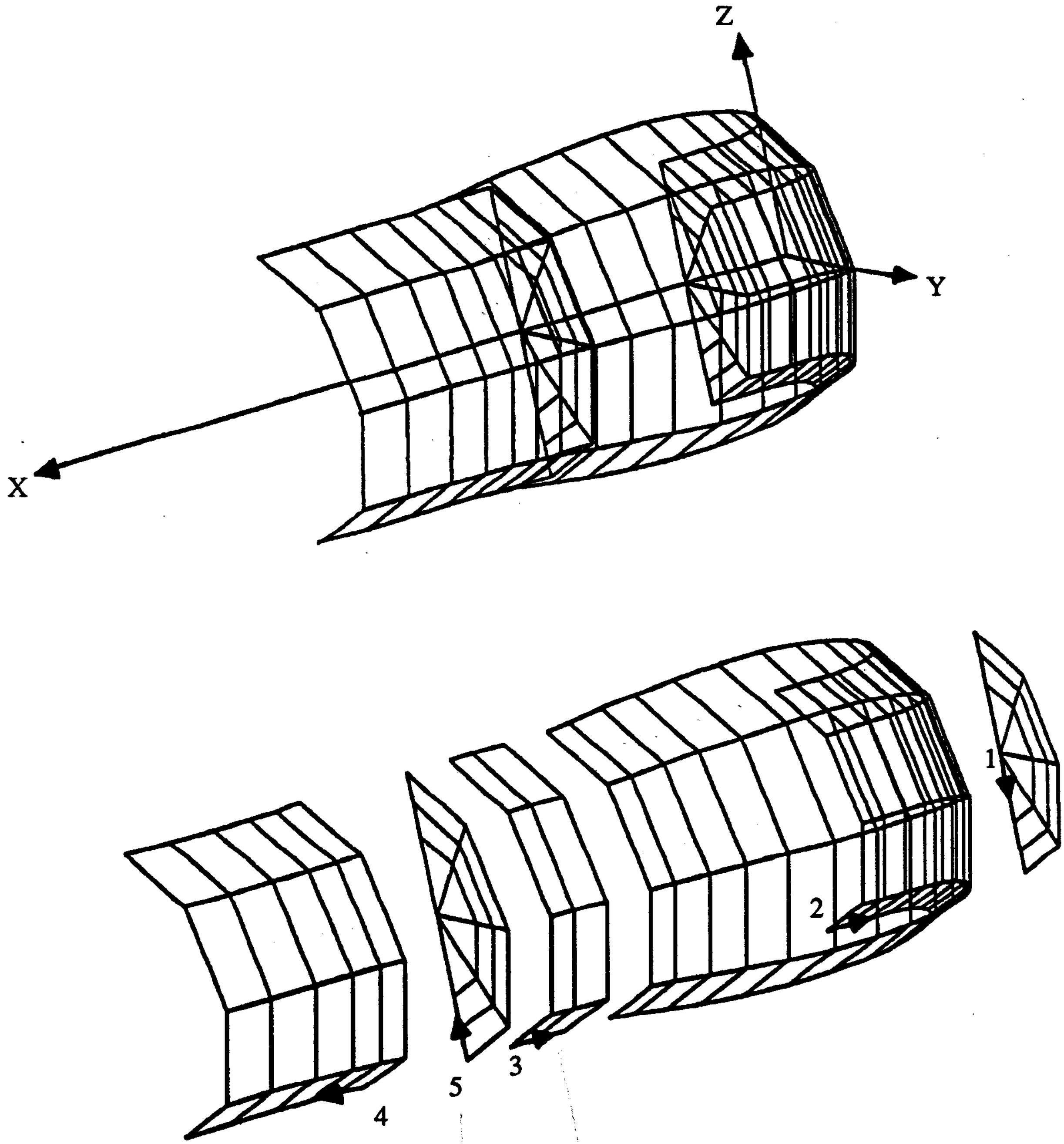

Figure 10-2 Input Paneling for Power-On Nacelle Configuration

The following comprise the A502 analysis of the power-on nacelle configuration:

- Power-on composite panel model
- Symmetric configuration and flow
- Mach number = 0.6
- Compressibility angle of attack = 0.0 degrees
- Angles of attack = 0.0, 4.0 degrees
- Boctor correction (see section 5.8) applied to velocity vectors (to correct inlet positive pressures)
- Force and moment reference area = 20.4 (frontal area)
- Moment reference span = 6.0 (cowl chord length)
- Moment reference chord = 6.0
- Moment reference length = 6.0
- Nondimensional normal mass flux into the nacelle = -0.7
- Calculate sectional properties of the cowl at four radial planes (through the plane centers of the panel columns)
- Examine flow-field properties ahead of inlet control points, aft of base, and at two locations inside the nacelle (immediately aft of inlet and ahead of plume base)
- Compute streamline properties about cowl lip

For a better understanding of the physics involved in the power-on nacelle case, off-body points, along with a streamline, are placed at specified locations in the flow. They are used to establish the mass flux into and out of the nacelle, as well as to indicate the stagnation location on the cowl lip. Upon analysis, the results indicate a mass flux of approximately 0.7 in the X direction ahead of the inlet, and a mass flux of 1.0 along the X axis inside the nacelle and right outside the base. Figure 10-3 illustrates the specified off-body points in the order of their input and printout in the output file. Figure 10-4 shows the computed streamlines, for which the starting point is defined to be near stagnation.

For further representation of the computed data, other results have been plotted. Pressure distribution along the nacelle surface on the XY plane is illustrated in figure 10-5, while pressure distribution along a sectional cut through the cowl is shown in figure 10-6.

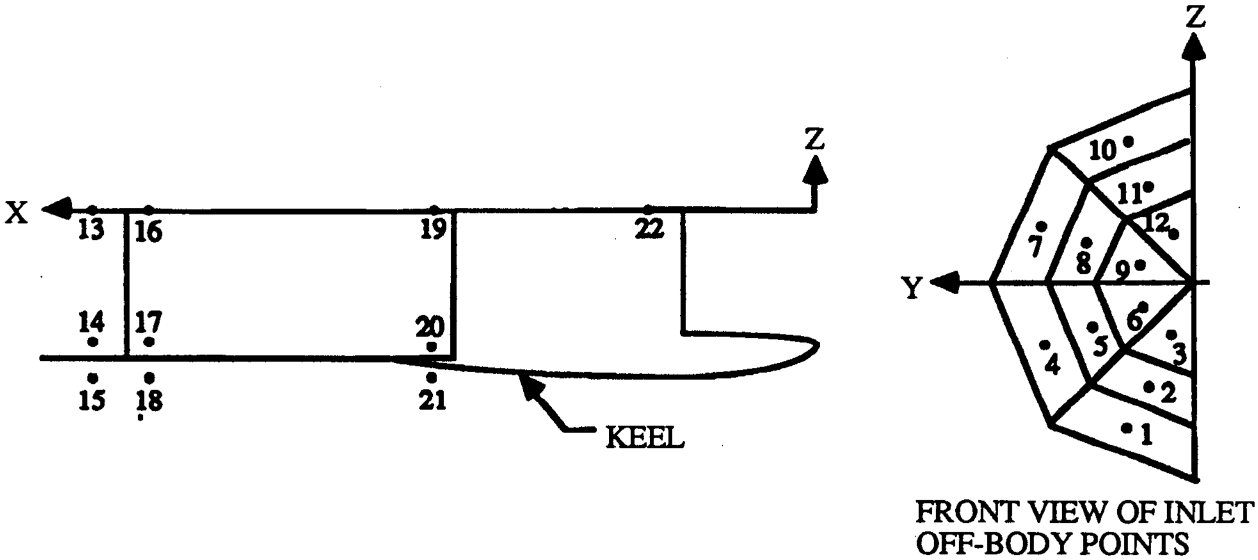

Figure 10-3 Off-Body Points Selected for Analysis

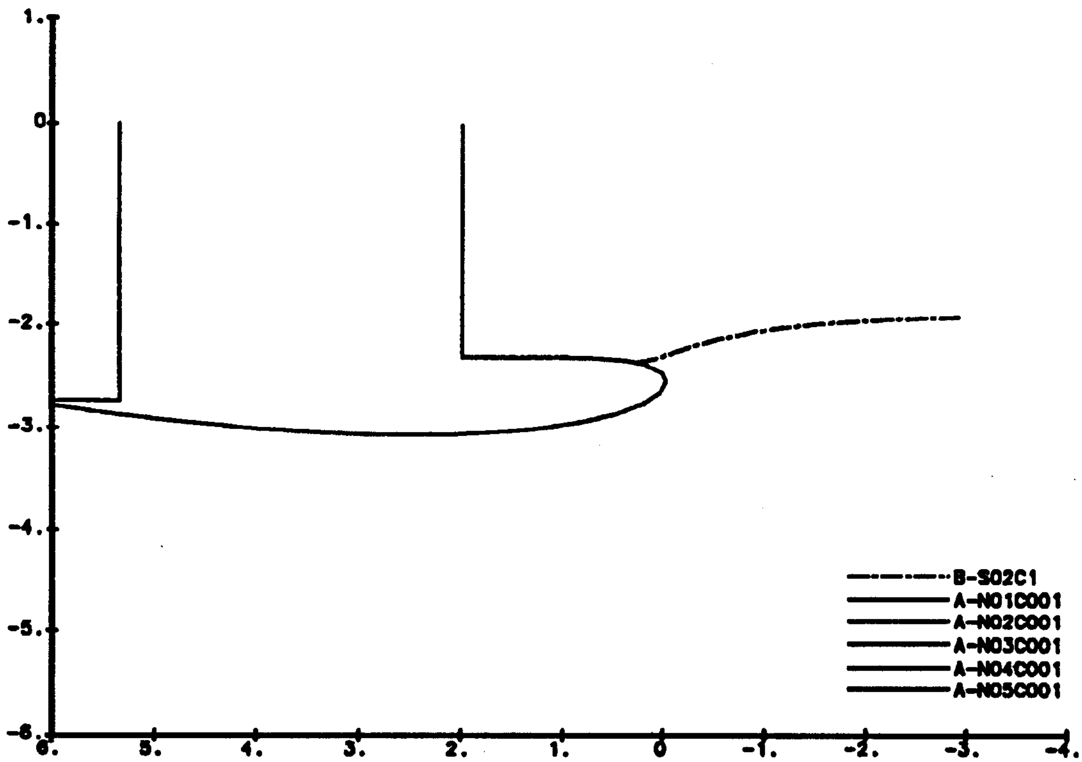

Figure 10-4 Streamline Plot Based on the STR File

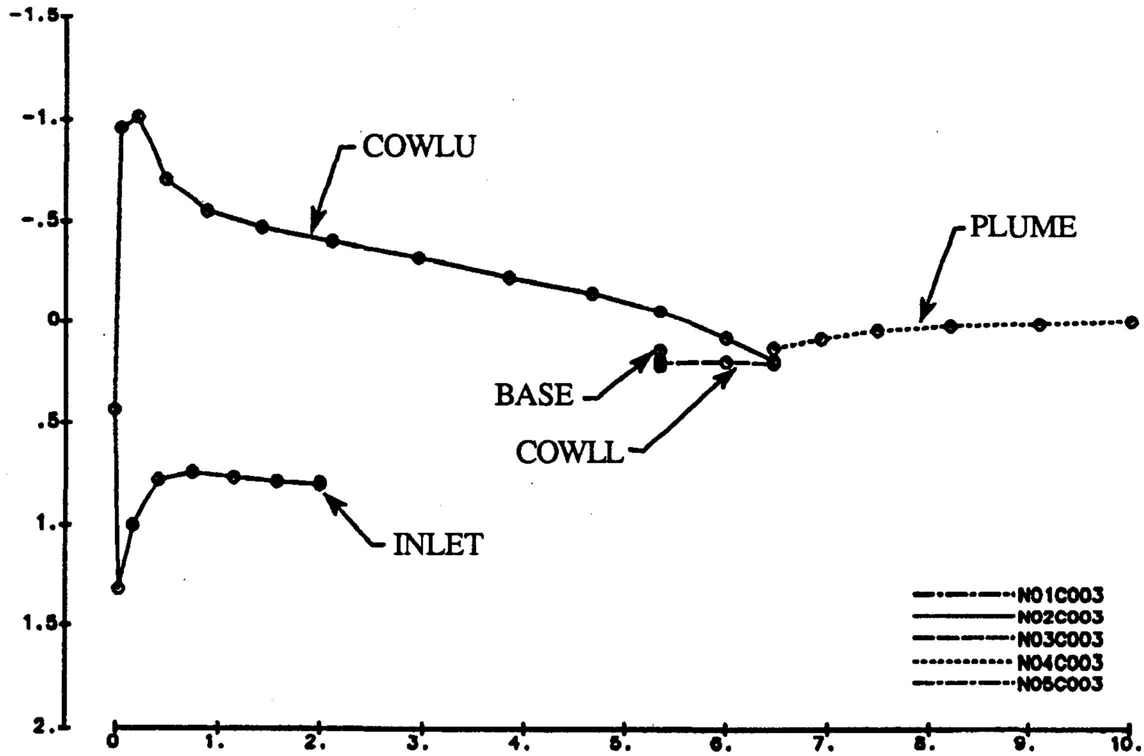

Figure 10-5 Pressure Distribution Along the Nacelle

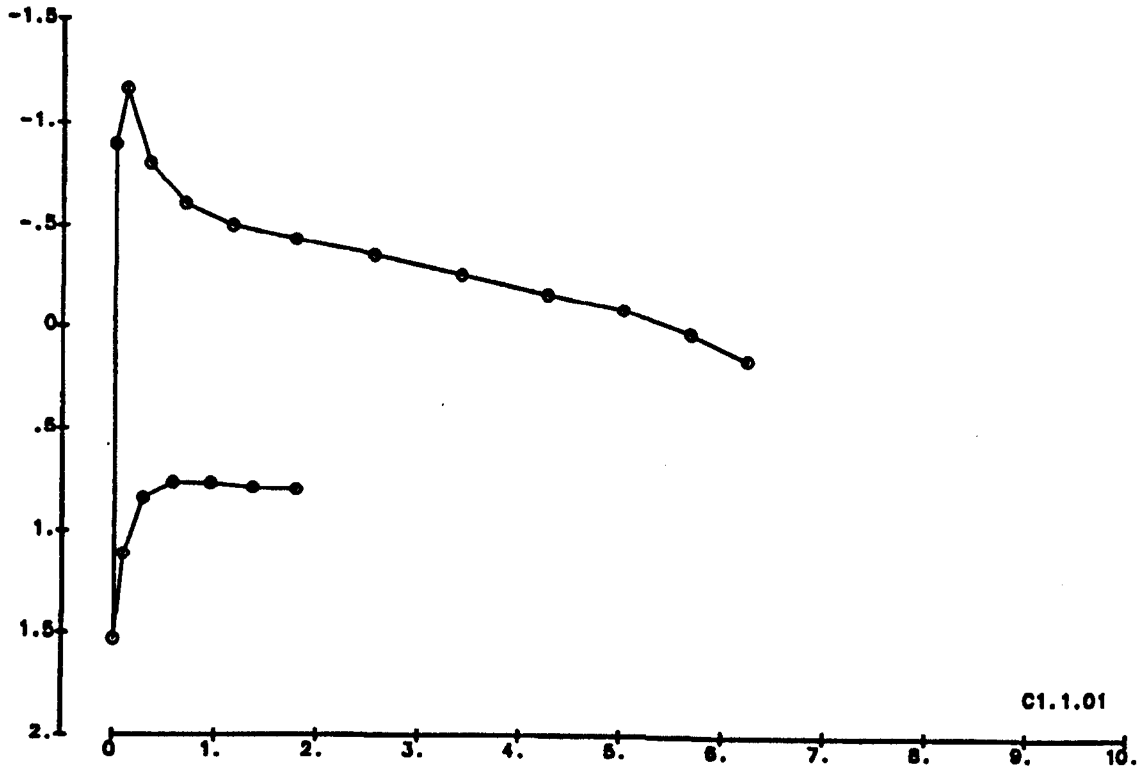

Figure 10-6 Pressure Distribution Along a Sectional Cut

An edited version of the output generated for this case is shown in the following pages. The initial portion of the output reflects the A502 input data cards and the sequential processing of the program. The section dealing with liberalized geometry abutment follows next, reiterating the input geometry. For this case, since all the network edges have been selected to abut, no points have been moved by the $EAT processor. After the statistics furnished for the problem and network indices, the printout provides us with detailed analysis results. This section of the printout is duplicated for the second solution (ALPHA = 4 degrees), although it is not illustrated here.

For a quick look at the results, you can skip over the detailed portion of the solution to the areas of primary interest, describing the sectional properties (cut force and moment data) and full configuration forces and moments summary. Note that the four cuts give results similar to those expected and that, for solution 1 (ALPHA = 0 degrees), the total lift is practically zero. The remainder of the output shows the off-body and streamline flow characteristics. Refer to section 6 for more details of A502 printout.

> **CAUTION:** The velocity correction and material properties are not applied to the A502 supplemental features, such as sectional cuts, off-body points, and streamlines. The results marked by the following do not represent the corrected values:
>
> ♦ No velocity correction
>
> ♦♦ No correction correction + no influence of material properties

- LIST OF A502 INPUT DATA CARDS -

```
NO.    CARD IMAGES

  1    $TITLE
  2    SIMPLE POWERED NACELLE WITH MACH NO. = 0.60
  3    SAARIS  865-6150  M.S. 7K-04 ...... COWL TE (90 DEG.)
  4    $SOLUTION
  5    $SYMMETRY - XZ PLANE OF SYMMETRY
  6    =MISYMM   MJSYMM
  7    1.        0.
  8    $MACH NUMBER
  9    =AMACH
 10    .6
 11    $CASES - NO. OF SOLUTIONS
 12    =NACASE
 13    2.
 14    $ANGLES-OF-ATTACK
 15    =ALPC
 16    0.
 17    =ALPHA(1) ALPHA(2)
 18    0.        4.
 19    $PRINTOUT OPTIONS
 20    =ISINGS   IGEOMP    ISINGP    ICONTP    IBCONP    IEDGEP
 21    .0        .0        .0        .0        .0        .0
 22    =IPRAIC   NEXDGN    IOUTPR    IFMCPR
 23    .0        .0        0.        0.
 24    $VELOCITY CORRECTION
 25    =IVCORR
 26    2.
 27    $REFERENCES FOR ACCUMULATED FORCES AND MOMENTS
 28    =XREF     YREF      ZREF
 29    1.5       0.        0.
 30    =SREF     BREF      CREF      DREF
 31    20.40     6.        6.        6.
 32    $CIRCULAR SECTIONS - NACELLE INLET
 33    =KN
 34    1.
 35    =KT
 36    9.
 37    =NOPT                                                               NETNAME
 38    0.                                                                  INLET
 39    =NM
 40    4.
 41    =XS(1)    RI(1)     XS(2)     RI(2)     XS(*)     RI(*)
 42    2.        0.000     2.        1.328     2.        1.878
 43    2.        2.300
 44    =NN
 45    5.
 46    =TH(1)    TH(2)     TH(3)     TH(4)     TH(5)
 47    -90.      -45.      0.        45.       90.
 48    =BET1(1)  BET1(2)
 49    # 12      1
 50    -.7       -.7
 51    $CIRCULAR SECTIONS - NACELLE WITH COMPOSITE PANELS
 52    =KN
 53    2.
 54    =KT
 55    1.
 56    =NOPT                                                               NETNAME
 57    0.                                                                  COWLU
 58    =NM
 59    20.
 60    =XS(1)    RI(1)     XS(2)     RI(2)     XS(*)     RI(*)
 61        2.0000    2.3000    1.5756    2.3000    1.1486    2.3000
 62        0.7460    2.3030    0.4069    2.3286    0.1624    2.3790
 63        0.0214    2.4542   -0.0200    2.5485    0.0388    2.6522
 64        0.2056    2.7554    0.4869    2.8522    0.8883    2.9413
 65        1.4250    3.0178    2.1188    3.0656    2.9586    3.0658
 66        3.8551    3.0175    4.6715    2.9439    5.3492    2.8700
 67        6.0000    2.7842    6.4687    2.7442
 68    =NN
 69    5.
 70    =TH(1)    TH(2)     TH(3)     TH(4)     TH(5)
 71    -90.      -45.      0.        45.       90.
 72    =NOPT                                                               NETNAME
 73    0.                                                                  COWLL
```

```
=NM
3.
=XS(1)    RI(1)     XS(2)     RI(2)     XS(*)     RI(*)
    6.4687    2.7442    6.0000    2.7442    5.3492    2.7442
=NN
5.
=TH(1)    TH(2)     TH(3)     TH(4)     TH(5)
-90.      -45.      0.        45.       90.
$CIRCULAR SECTIONS - PLUME
=KN
1.
=KT
19.
=NOPT                                                              NETNAME
0.                                                                 PLUME
=NM
6.
=XS(1)    RI(1)     XS(2)     RI(2)     XS(*)     RI(*)
    6.4687    2.7442    6.9360    2.7000    7.4906    2.7000
    8.2121    2.7000    9.0957    2.7000   10.0000    2.7000
=NN
5.
=TH(1)    TH(2)     TH(3)     TH(4)     TH(5)
-90.      -45.      0.        45.       90.
$CIRCULAR SECTIONS - NACELLE OUTLET
=KN
1.
=KT
5.
=NOPT                                                              NETNAME
0.                                                                 BASE
=NM
4.
=XS(1)    RI(1)     XS(2)     RI(2)     XS(*)     RI(*)
    5.3492    2.7442    5.3492    2.1634    5.3492    1.5296
    5.3492    0.0000
=NN
5.
=TH(1)    TH(2)     TH(3)     TH(4)     TH(5)
-90.      -45.      0.        45.       90.
$MATERIAL PROPERTIES
=NMAT
1.
=TRATIO(1)PRATIO(1) MAT-NAME(1)
1.        1.3       EXHAUST
=NMNET
3.
=NETNAME  SURFACE   MAT-NAME
COWLL     UPPER     EXHAUST
PLUME     LOWER     EXHAUST
BASE      UPPER     EXHAUST
$SECTIONAL PROPERTIES
=NUMGRP
1.
*NETWORK SELECTION FOR SECTIONAL PROPERTIES
=NUMNET
1.
=NETDAT
2.
*CUT AND REFERENCE PRINTOUT FOR SECTIONAL PROPERTIES
=OPTCRD   OPTMRP    IPRINF    IPRTPP    ISECPR    IXYZOP
1.        1.        0.
=NUMCUT
4.
=XC       YC        ZC        XCN       YCN       ZCN
2.        0.        0.        0.        .923      .383
=CHRD     REFRAC
          .25
2.        0.        0.        0.        .383      .923
          .25
2.        0.        0.        0.        -.383     .923
          .25
2.        0.        0.        0.        -.923     .383
          .25
$FLOWFIELD PROPERTIES
=NFLOWV   TPOFF
1.        0.
$XYZ COORDINATES OF OFF-BODY POINTS
=ISK1
22.
=XOF(1)   YOF(1)    ZOF(1)    XOF(*)    YOF(*)    ZOF(*)
```

```
1.      .799    -1.930  1.      .613    -1.481
1.      .254    -.613   1.      1.930   -.799
1.      1.481   -.613   1.      .613    -.254
1.      1.930   .799    1.      1.481   .613
1.      .613    .254    1.      .799    1.930
1.      .613    1.481   1.      .254    .613
11.     0.      0.      11.     0.      -2.5
11.     0.      -2.9    9.5     0.      0.
9.5     0.      -2.5    9.5     0.      -2.9
5.6     0.      0.      5.6     0.      -2.3
5.6     0.      -3.     2.5     0.      0.
$STREAMLINES IN THE FLOW FIELD
=NSTMLN
1.
=NUMPTS HMIN    HMAX    MAXSTM  MAXORDR ABSERR
2.      .1      .5      100.    6.      .01
=MAXARR1 ISPRNT TPSL
10000.  0.      0.      1.
=X      Y       Z       DX      DY      DZ
.01     0.      -2.28   3.      2.      2.
=FWDBK
-1.
.27     0.      -2.34   3.      2.      2.
-1.
$END OF A502 INPUTS
```

1

```
                               RECORD OF INPUT PROCESSING

$TITLE
$SOLUTION
$SYMMETRY - XZ PLANE OF SYMMETRY
$MACH NUMBER
$CASES - NO. OF SOLUTIONS
$ANGLES-OF-ATTACK
$PRINTOUT OPTIONS
$VELOCITY CORRECTION
$REFERENCES FOR ACCUMULATED FORCES AND MOMENTS
$CIRCULAR SECTIONS - NACELLE INLET
    KN,KT           1          9
   NETWORK # BEING PROCESSED   1                                            INLET

$CIRCULAR SECTIONS - NACELLE WITH COMPOSITE PANELS
    KN,KT           2          1
   NETWORK # BEING PROCESSED   2                                            COWLU

   NETWORK # BEING PROCESSED   3                                            COWLL

$CIRCULAR SECTIONS - PLUME
    KN,KT           1          19
   NETWORK # BEING PROCESSED   4                                            PLUME

$CIRCULAR SECTIONS - NACELLE OUTLET
    KN,KT           1          5
   NETWORK # BEING PROCESSED   5                                            BASE

$MATERIAL PROPERTIES
  GCONMAT           2
     1.          R           R
  PCONMAT           2
     1.          R           R
  RCONMAT           2
     1.    1.000000          0
$SECTIONAL PROPERTIES
*NETWORK SELECTION FOR SECTIONAL PROPERTIES
*CUT AND REFERENCE PRINTOUT FOR SECTIONAL PROPERTIES
$FLOWFIELD PROPERTIES
$XYZ COORDINATES OF OFF-BODY POINTS
$STREAMLINES IN THE FLOW FIELD
 —INDVSL            4
     1.          1           0           0           0
 —NCASSL          1
$END OF A502 INPUTS


TPCRIT, M    0.784004    0.600000
CHECKING  LINE     1  COWLL
CHECKING  LINE     2  PLUME
CHECKING  LINE     3  BASE
```

```
1              ***  QUICK SUMMARY OF A502 INPUT  ***
 TITLE1: SIMPLE POWERED NACELLE WITH MACH NO. = 0.60
 TITLE2: SAARIS  865-6150  M.S. 7K-04 ...... COWL TE (90 DEG.)

0              PROCESSING OPTIONS
           0 = DATACHECK.    (0=REGULAR RUN,1=FULL DATACHECK,2=SHORT DATACHECK)
           0 = S.P. FLAG.    (0 ==> NO S.P. FILE (FT09) PROVIDED, 1 ==> LOCAL FILE FT09 WITH SINGULARITY VALUES IS PROVIDED)
           0 = AIC FLAG.     (0 ==>  NO AIC FILE (FT04) PROVIDED, 1 ==> LOCAL FILE FT04 WITH AIC-S IS PROVIDED BY THE USER)
           0 = B.L. FLAG     (0 ==> NO BOUNDARY LAYER FILE REQUESTED, 1 ==> BOUNDARY LAYER DATA WILL BE WRITTEN TO FILE FT17)
           2 = VELOCITY CORRECTION INDEX.  (0 ==> NO CORRECTION, 1 ==> MCLEAN CORRECTION, 2 ==>  BOCTOR CORRECTION)
           1 = FLOW VISUALIZATION FLAG.  (NONZERO ==> OFF-BODY AND STREAMLINE PROCESSING WILL BE PERFORMED)
           0 = OFF-BODY CALCULATION TYPE. (0 ==> MASS FLUX, NONZERO ==> VELOCITY)
           0 = STREAMLINE CALCULATION TYPE. (0 ==> MASS FLUX, NONZERO ==> VELOCITY)
          22 = NUMBER OF OFF-BODY POINTS.
           2 = NUMBER OF STREAMLINES TO BE TRACED.

0              CASE SUMMARY
           2 = NUMBER OF CASES
    0.600000 = MACH NUMBER
    0.000000 = COMPRESSIBILITY AXIS ANGLE OF ATTACK (ALPC)
    0.000000 = COMPRESSIBLIITY AXIS ANGLE OF SIDESLIP (BETC)
```

0 CASE	ALPHA	BETA	MAG(F-S-V)
1	0.000000	0.000000	1.000000
2	4.000000	0.000000	1.000000

```
0              SYMMETRY OPTIONS
           1 = NUMBER OF PLANES OF SYMMETRY
           1 = X-Z PLANE OF SYMMETRY FLAG (0 ==> NO SYMMETRY, 1==> FLOW SYMMETRY, -1 ==> FLOW ANTISYMMETRY)
           0 = X-Y PLANE OF SYMMETRY FLAG (0 ==> NO SYMMETRY, 1==> FLOW SYMMETRY, -1 ==> FLOW ANTISYMMETRY)

0              CONFIGURATION SUMMARY
           5 = TOTAL NUMBER OF NETWORKS READ IN
         185 = TOTAL NUMBER OF MESH POINTS
         128 = TOTAL NUMBER OF PANELS
```

0NETWORK ID&	INDEX	#ROWS	#COLS	SOURCE	DOUBLT	NLOPT1	NROPT1	NLOPT2	NROPT2	IPOT	# PTS	# PANS	CPNORM	CUM PT	CUM PN
INLET	1	4	5	1	12	2	7	7	-2	2	20	12	2	0	0
COWLU	2	20	5	1	12	5	3	7	-2	2	100	76	2	20	12
COWLL	3	3	5	1	12	5	3	7	-2	2	15	8	2	120	88
PLUME	4	6	5	0	6	0	0	18	2	0	30	20	0	135	96
BASE	5	4	5	1	12	6	9	7	-2	2	20	12	2	165	116

NETWORK-ID&	INDEX	UPPER SURF,	INDEX	LOWER SURF,	INDEX
INLET	1	AIR	0	AIR	0
COWLU	2	AIR	0	AIR	0
COWLL	3	EXHAUST	1	AIR	0
PLUME	4	AIR	0	EXHAUST	1
BASE	5	EXHAUST	1	AIR	0

MATERIAL PROPERTIES FOR THE VARIOUS VALUES OF SURFACE INDEX

MATERIAL	INDEX	TEMPERATURE RATIO	PRESSURE RATIO	G	P	R	K/V RATIO	K/W RATIO	K/P RATIO
AIR	0	1.00000	1.0000	R	R	1.00000	1.00000	1.00000	1.00000
EXHAUST	1	1.00000	1.3000	R	R	1.07784	1.41530	1.52547	2.15899

FREE STREAM VECTORS FOR EACH MATERIAL

MATERIAL &	INDEX	CASE 1 VX	VY	VZ	CASE 2 VX	VY	VZ	CASE 3 VX	VY	VZ	CASE 4 VX	VY	VZ
AIR	0	1.0000	0.0000	0.0000	0.9976	0.0000	0.0698						
EXHAUST	1	1.4153	0.0000	0.0000	1.4118	0.0000	0.0987						

```
0              PRINT OPTIONS
           0 = SINGULARITY GRID PRINT FLAG
           0 = PANEL GEOMETRY PRINT FLAG
           0 = SPLINE DATA FLAG  ( 0 ==> OFF, NONZERO ==> ON )
           0 = CONTROL POINT INFORMATION PRINT FLAG
           0 = BOUNDARY CONDITION DATA PRINT FLAG
           0 = EDGE MATCHING INFORMATION PRINT FLAG
           0 = INDEX OF CONTROL POINT FOR WHICH AIC-S ARE PRINTED
           0 = EDGE CONTROL POINT FLOW PROPERTIES PRINT FLAG
           0 = OUTPUT CONTROL FLAG (-1 ==> NO SURFACE FLOW PROPERTIES, 0 ==> STANDARD OUTPUT, 1 ==> SHORT FORM OUTPUT )
           0 = FORCE/MOMENT CONTROL FLAG (-1 ==> NO FORCE AND MOMENT DATA, 0 ==> STANDARD OUTPUT, 1 ==> NW TOTALS ONLY )
           0 = PRINT FLAG FOR DETAILED COST INFORMATION DURING EXECUTION OF JOB
           0 = PRINT FLAG FOR SINGULARITY PARAMETER MAPS
```

```
0               ABUTMENT PROCESSING OPTIONS
   0.0000E+00 = GLOBAL EDGE ABUTMENT TOLERANCE SPECIFIED BY USER.  IF THIS VALUE IS ZERO, A DEFAULT VALUE WILL BE CALCULATED
                LATER.   THIS DEFAULT VALUE IS TAKEN AS:  .001  *  (MINIMUM PANEL DIAMETER)
            1 = PRINT FLAG CONTROLLING GEOMETRY PRINTOUT  B E F O R E  THE ABUTMENT PROCESSING.  ( NONZERO ==> DO PRINT )
            0 = PRINT FLAG CONTROLLING GEOMETRY PRINTOUT  A F T E R    THE ABUTMENT PROCESSING.  ( NONZERO ==> DO PRINT )
            0 = NETWORK/ABUTMENT/ABUTMENT-INTERSECTION PRINT FLAG.  ( NONZERO ==> GENERATE THE CROSS REFERENCED ABUTMENT LISTING
            0 = CONTROL INDEX FOR PANEL INTERSECTION CHECKING.  ( NONZERO ==> DO PERFORM THE CHECK. )
            1 = ABUTMENT/ABUTMENT-INTERSECTION (SHORT LISTING) PRINT FLAG ( 0 ==> SUPPRESS, NONZERO ==> GENERATE USUAL PRINT )

                FORCE AND MOMENT REFERENCE PARAMETERS
   2.0400E+01 = REFERENCE AREA FOR FORCE AND MOMENT CALCULATIONS.      (SREF)
   6.0000E+00 = ROLLING MOMENT REFERENCE LENGTH   (BREF)
   6.0000E+00 = PITCHING MOMENT REFERENCE LENGTH  (CREF)
   6.0000E+00 = YAWING MOMENT REFERENCE LENGTH    (DREF)
   1.5000E+00 = X - COORDINATE FOR THE POINT ABOUT WHICH MOMENTS WILL BE CALCULATED   (XREF)
   0.0000E+00 = Y - COORDINATE FOR THE POINT ABOUT WHICH MOMENTS WILL BE CALCULATED   (YREF)
   0.0000E+00 = Z - COORDINATE FOR THE POINT ABOUT WHICH MOMENTS WILL BE CALCULATED   (ZREF)
            3 = PRESSURE COEFFICIENT INDEX (NPRCOF) (1=LINEAR, 2=SLENDERBODY, 3=2ND, 4=ISENTROPIC)

0               COORDINATES OF  22 OFF-BODY POINTS
                1 X   22  (   1),      COLUMNS    1 THROUGH  10
  1   1 X    1.000000    1.000000    1.000000    1.000000    1.000000    1.000000    1.000000    1.000000    1.000000    1.000000
        Y    0.799000    0.613000    0.254000    1.930000    1.481000    0.613000    1.930000    1.481000    0.613000    0.799000
        Z   -1.930000   -1.481000   -0.613000   -0.799000   -0.613000   -0.254000    0.799000    0.613000    0.254000    1.930000
                1 X   22  (   1),      COLUMNS   11 THROUGH  20
  1  11 X    1.000000    1.000000   11.000000   11.000000   11.000000    9.500000    9.500000    9.500000    5.600000    5.600000
        Y    0.613000    0.254000    0.000000    0.000000    0.000000    0.000000    0.000000    0.000000    0.000000    0.000000
        Z    1.481000    0.613000    0.000000   -2.500000   -2.900000    0.000000   -2.500000   -2.900000    0.000000   -2.300000
                1 X   22  (   1),      COLUMNS   21 THROUGH  22
  1  21 X    5.600000    2.500000
        Y    0.000000    0.000000
        Z   -3.000000    0.000000

0               INPUT DATA FOR STREAMLINES.  NUMBER OF STREAMLINES =      2

     X(START)      Y(START)      Z(START)      DELX(MAX)     DELY(MAX)     DELZ(MAX)   UP/DOWN FLAG  (0==> DOWNSTREAM, #0==> UPSTREAM)
    ----------    ----------    ----------    ----------    ----------    ----------   ------------
    1.0000E-02    0.0000E+00   -2.2800E+00    3.0000E+00    2.0000E+00    2.0000E+00   -1.0000E+00
    2.7000E-01    0.0000E+00   -2.3400E+00    3.0000E+00    2.0000E+00    2.0000E+00   -1.0000E+00
  OFF-BODY-POINTS NETWORK LIST,      5 NETWORKS
     1     2     3     4     5


  GEOMETRY INPUT COMPLETE


0*E*INPUT-DA


          LEADING EDGE CONDITIONS ON WAKE NETWORKS

          NW-ID     NW-NAME         CONDITION
          -----     -------     -----------------
             4      PLUME       VORTICITY MATCHING

0*B*LIBGEOAB

1           *****  LIBERALIZED GEOMETRY ABUTMENT ANALYSIS  *****

0 EDGE ABUTMENT TOLERANCE    =   1.3279E-03
  MINIMUM PANEL DIAMETER     =   1.3279E+00
  SYMMETRY CONDITION INDEX   =            1
        1 ==> PHI(S-S)
        2 ==> PHI(A-S)
        3 ==> PHI(A-A)
        4 ==> PHI(S-A)
```

```
0*B*GEOBFADJ
1         *****  GEOMETRY BEFORE LIBERALIZED GEOMETRY ADJUSTMENT (CONTROLLED BY $EAT)  *****
   NETWORK INDEX =    1  IDENTIFIER = INLET
   ROW COL                 NROW  NCOL     -------  COLUMNS  ------->                      BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
                  4 X     5  (   4),     COLUMNS     1 THROUGH    5
    1    1 X    2.000000   2.000000   2.000000   2.000000   2.000000
           Y    0.000000   0.000000   0.000000   0.000000   0.000000
           Z    0.000000   0.000000   0.000000   0.000000   0.000000
    2    1 X    2.000000   2.000000   2.000000   2.000000   2.000000
           Y    0.000000   0.939038   1.328000   0.939038   0.000000
           Z   -1.328000  -0.939038   0.000000   0.939038   1.328000
    3    1 X    2.000000   2.000000   2.000000   2.000000   2.000000
           Y    0.000000   1.327947   1.878000   1.327947   0.000000
           Z   -1.878000  -1.327947   0.000000   1.327947   1.878000
    4    1 X    2.000000   2.000000   2.000000   2.000000   2.000000
           Y    0.000000   1.626346   2.300000   1.626346   0.000000
           Z   -2.300000  -1.626346   0.000000   1.626346   2.300000

   NETWORK INDEX =    2  IDENTIFIER = COWLU
   ROW COL                 NROW  NCOL     -------  COLUMNS  ------->                      BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
                 20 X     5  (  20),     COLUMNS     1 THROUGH    5
    1    1 X    2.000000   2.000000   2.000000   2.000000   2.000000
           Y    0.000000   1.626346   2.300000   1.626346   0.000000
           Z   -2.300000  -1.626346   0.000000   1.626346   2.300000
    2    1 X    1.575600   1.575600   1.575600   1.575600   1.575600
           Y    0.000000   1.626346   2.300000   1.626346   0.000000
           Z   -2.300000  -1.626346   0.000000   1.626346   2.300000
    3    1 X    1.148600   1.148600   1.148600   1.148600   1.148600
           Y    0.000000   1.626346   2.300000   1.626346   0.000000
           Z   -2.300000  -1.626346   0.000000   1.626346   2.300000
    4    1 X    0.746000   0.746000   0.746000   0.746000   0.746000
           Y    0.000000   1.628467   2.303000   1.628467   0.000000
           Z   -2.303000  -1.628467   0.000000   1.628467   2.303000
    5    1 X    0.406900   0.406900   0.406900   0.406900   0.406900
           Y    0.000000   1.646569   2.328600   1.646569   0.000000
           Z   -2.328600  -1.646569   0.000000   1.646569   2.328600
    6    1 X    0.162400   0.162400   0.162400   0.162400   0.162400
           Y    0.000000   1.682207   2.379000   1.682207   0.000000
           Z   -2.379000  -1.682207   0.000000   1.682207   2.379000
    7    1 X    0.021400   0.021400   0.021400   0.021400   0.021400
           Y    0.000000   1.735381   2.454200   1.735381   0.000000
           Z   -2.454200  -1.735381   0.000000   1.735381   2.454200
    8    1 X   -0.020000  -0.020000  -0.020000  -0.020000  -0.020000
           Y    0.000000   1.802062   2.548500   1.802062   0.000000
           Z   -2.548500  -1.802062   0.000000   1.802062   2.548500
    9    1 X    0.038800   0.038800   0.038800   0.038800   0.038800
           Y    0.000000   1.875389   2.652200   1.875389   0.000000
           Z   -2.652200  -1.875389   0.000000   1.875389   2.652200
   10    1 X    0.205600   0.205600   0.205600   0.205600   0.205600
           Y    0.000000   1.948362   2.755400   1.948362   0.000000
           Z   -2.755400  -1.948362   0.000000   1.948362   2.755400
   11    1 X    0.486900   0.486900   0.486900   0.486900   0.486900
           Y    0.000000   2.016810   2.852200   2.016810   0.000000
           Z   -2.852200  -2.016810   0.000000   2.016810   2.852200
   12    1 X    0.888300   0.888300   0.888300   0.888300   0.888300
           Y    0.000000   2.079813   2.941300   2.079813   0.000000
           Z   -2.941300  -2.079813   0.000000   2.079813   2.941300
   13    1 X    1.425000   1.425000   1.425000   1.425000   1.425000
           Y    0.000000   2.133907   3.017800   2.133907   0.000000
           Z   -3.017800  -2.133907   0.000000   2.133907   3.017800
   14    1 X    2.118800   2.118800   2.118800   2.118800   2.118800
           Y    0.000000   2.167707   3.065600   2.167707   0.000000
           Z   -3.065600  -2.167707   0.000000   2.167707   3.065600
   15    1 X    2.958600   2.958600   2.958600   2.958600   2.958600
           Y    0.000000   2.167848   3.065800   2.167848   0.000000
           Z   -3.065800  -2.167848   0.000000   2.167848   3.065800
   16    1 X    3.855100   3.855100   3.855100   3.855100   3.855100
           Y    0.000000   2.133695   3.017500   2.133695   0.000000
           Z   -3.017500  -2.133695   0.000000   2.133695   3.017500
   17    1 X    4.671500   4.671500   4.671500   4.671500   4.671500
           Y    0.000000   2.081652   2.943900   2.081652   0.000000
           Z   -2.943900  -2.081652   0.000000   2.081652   2.943900
   18    1 X    5.349200   5.349200   5.349200   5.349200   5.349200
           Y    0.000000   2.029396   2.870000   2.029396   0.000000
           Z   -2.870000  -2.029396   0.000000   2.029396   2.870000
   19    1 X    6.000000   6.000000   6.000000   6.000000   6.000000
           Y    0.000000   1.968727   2.784200   1.968727   0.000000
           Z   -2.784200  -1.968727   0.000000   1.968727   2.784200
   20    1 X    6.468700   6.468700   6.468700   6.468700   6.468700
           Y    0.000000   1.940442   2.744200   1.940442   0.000000
           Z   -2.744200  -1.940442   0.000000   1.940442   2.744200
```

```
NETWORK INDEX =    3  IDENTIFIER = COWLL
ROW COL               NROW  NCOL        ------  COLUMNS  ------->              BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
                3 X    5  (   3),      COLUMNS    1 THROUGH    5
  1   1 X   6.468700   6.468700   6.468700   6.468700   6.468700
        Y   0.000000   1.940442   2.744200   1.940442   0.000000
        Z  -2.744200  -1.940442   0.000000   1.940442   2.744200
  2   1 X   6.000000   6.000000   6.000000   6.000000   6.000000
        Y   0.000000   1.940442   2.744200   1.940442   0.000000
        Z  -2.744200  -1.940442   0.000000   1.940442   2.744200
  3   1 X   5.349200   5.349200   5.349200   5.349200   5.349200
        Y   0.000000   1.940442   2.744200   1.940442   0.000000
        Z  -2.744200  -1.940442   0.000000   1.940442   2.744200

NETWORK INDEX =    4  IDENTIFIER = PLUME
ROW COL               NROW  NCOL        ------  COLUMNS  ------->              BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
                6 X    5  (   6),      COLUMNS    1 THROUGH    5
  1   1 X   6.468700   6.468700   6.468700   6.468700   6.468700
        Y   0.000000   1.940442   2.744200   1.940442   0.000000
        Z  -2.744200  -1.940442   0.000000   1.940442   2.744200
  2   1 X   6.936000   6.936000   6.936000   6.936000   6.936000
        Y   0.000000   1.909188   2.700000   1.909188   0.000000
        Z  -2.700000  -1.909188   0.000000   1.909188   2.700000
  3   1 X   7.490600   7.490600   7.490600   7.490600   7.490600
        Y   0.000000   1.909188   2.700000   1.909188   0.000000
        Z  -2.700000  -1.909188   0.000000   1.909188   2.700000
  4   1 X   8.212100   8.212100   8.212100   8.212100   8.212100
        Y   0.000000   1.909188   2.700000   1.909188   0.000000
        Z  -2.700000  -1.909188   0.000000   1.909188   2.700000
  5   1 X   9.095700   9.095700   9.095700   9.095700   9.095700
        Y   0.000000   1.909188   2.700000   1.909188   0.000000
        Z  -2.700000  -1.909188   0.000000   1.909188   2.700000
  6   1 X  10.000000  10.000000  10.000000  10.000000  10.000000
        Y   0.000000   1.909188   2.700000   1.909188   0.000000
        Z  -2.700000  -1.909188   0.000000   1.909188   2.700000

NETWORK INDEX =    5  IDENTIFIER = BASE
ROW COL               NROW  NCOL        ------  COLUMNS  ------->              BEFORE ADJUSTMENT OF EDGE POINTS BY $EAT
                4 X    5  (   4),      COLUMNS    1 THROUGH    5
  1   1 X   5.349200   5.349200   5.349200   5.349200   5.349200
        Y   0.000000   1.940442   2.744200   1.940442   0.000000
        Z  -2.744200  -1.940442   0.000000   1.940442   2.744200
  2   1 X   5.349200   5.349200   5.349200   5.349200   5.349200
        Y   0.000000   1.529755   2.163400   1.529755   0.000000
        Z  -2.163400  -1.529755   0.000000   1.529755   2.163400
  3   1 X   5.349200   5.349200   5.349200   5.349200   5.349200
        Y   0.000000   1.081591   1.529600   1.081591   0.000000
        Z  -1.529600  -1.081591   0.000000   1.081591   1.529600
  4   1 X   5.349200   5.349200   5.349200   5.349200   5.349200
        Y   0.000000   0.000000   0.000000   0.000000   0.000000
        Z   0.000000   0.000000   0.000000   0.000000   0.000000

0*E*GEOBFADJ


SURFACES ASSOCIATED WITH VARIOUS REGIONS OF THE CONFIGURATION
REGION  NW-ID  NW-NAME   DBLT-TYPE   SURFACE   MATERIAL                 R/CTR
   1      1    INLET     ANALYSIS     UPPER    AIR          1.102800   2.041700   0.000000
          2    COWLU     ANALYSIS     UPPER    AIR
          4    PLUME     DSGN-WAKE    UPPER    AIR

   2      1    INLET     ANALYSIS     LOWER    AIR          3.388700   2.247750   0.000000
          2    COWLU     ANALYSIS     LOWER    AIR
          3    COWLL     ANALYSIS     LOWER    AIR
          5    BASE      ANALYSIS     LOWER    AIR

   3      3    COWLL     ANALYSIS     UPPER    EXHAUST      5.674600   2.453800   0.000000
          4    PLUME     DSGN-WAKE    LOWER    EXHAUST
          5    BASE      ANALYSIS     UPPER    EXHAUST
```

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0*B*ABUTMENT
1                                  ABUTMENT SUMMARY


 0ABUTMENT #   1
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #   1      ENDS AT AI #   2
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    1.2  INLET     12   4                            1  2  3  4
 0ABUTMENT #   2
                 DBLT EDGE                        STARTS AT AI #   3      ENDS AT AI #   2
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    1.3  INLET     12   4   MU-MATCH                 1  2  3  4  5
    2.1  COWLU     12   4                            5  4  3  2  1
 0ABUTMENT #   3
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #   3      ENDS AT AI #   1
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    1.4  INLET     12   4                            1  2  3  4
 0ABUTMENT #   4
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #   2      ENDS AT AI #   4
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    2.2  COWLU     12   4                            1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20

 0ABUTMENT #   5
                 DBLT EDGE                        STARTS AT AI #   5      ENDS AT AI #   4
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    2.3  COWLU     12   4   VOR-MTCH                 1  2  3  4  5
    3.1  COWLL     12   4                            5  4  3  2  1
    4.1  PLUME      6   5   MU-MATCH  VOR-MTCH       5  4  3  2  1
 0ABUTMENT #   6
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #   5      ENDS AT AI #   3
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    2.4  COWLU     12   4                            1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20

 0ABUTMENT #   7
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #   4      ENDS AT AI #   6
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    3.2  COWLL     12   4                            1  2  3
 0ABUTMENT #   8
                 DBLT EDGE                        STARTS AT AI #   7      ENDS AT AI #   6
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    3.3  COWLL     12   4   MU-MATCH                 1  2  3  4  5
    5.1  BASE      12   4                            5  4  3  2  1
 0ABUTMENT #   9
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #   7      ENDS AT AI #   5
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    3.4  COWLL     12   4                            1  2  3
 0ABUTMENT #  10
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #   4      ENDS AT AI #   8
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    4.2  PLUME      6   4                            1  2  3  4  5  6
 0ABUTMENT #  11    WAKE TRAILING EDGE UNABUTTED.  WAKE FILAMENTS WILL BE ADDED                     *** GENTLE REMINDER ***
                 DBLT EDGE                        STARTS AT AI #   8      ENDS AT AI #   9
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    4.3  PLUME      6   2                            1  2  3  4  5
 0ABUTMENT #  12
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #   9      ENDS AT AI #   5
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    4.4  PLUME      6   4                            1  2  3  4  5  6
 0ABUTMENT #  13
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #   6      ENDS AT AI #  10
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    5.2  BASE      12   4                            1  2  3  4
 0ABUTMENT #  14
  ABUTMENT LIES ON FIRST  PLANE(S) OF SYMMETRY
                 DBLT EDGE                        STARTS AT AI #  10      ENDS AT AI #   7
   NW.EDGE  NW/ID  TYPE TYPE  MATCHING  KUTTA-FL   CORRESPONDING EDGE POINTS ( MINUS (-) INDICATES POINT MOVED BY $EAT
    5.4  BASE      12   4                            1  2  3  4
 0*E*ABUTMENT
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***** NO POINTS WERE MOVED BY THE LIBERALIZED GEOMETRY PROCESSOR (CONTROLLED BY $EAT) *****


   ----    SUMMARY OF FREE WAKE TRAILING EDGES   ----
          (SEMI-INFINITE FILAMENTS TO BE ATTACHED)

   NW   NETWORK-ID   ABMT
   --   ----------   ----
    4   PLUME          11
  T/ABTIDN    0.163939
 ABTCAL/ANL   0.000002
0*E*LIBGEOAB
0     SINGULARITY PARAMETER COUNTS
   NAIVE S.P. COUNT  (BASED ON NETWORKING)         354
   BASIC S.P. COUNT  (DUPLICATES SQUEEZED OUT)     344
        NO. OF UNKNOWN BASIC S.P.-S                248
        NO. OF  KNOWN  BASIC S.P.-S                 84
        NO. OF EQUIVALENCED BASIC S.P.-S            12
        NO. OF ZEROED  BASIC S.P.-S                  0
   FINAL S.P. COUNT ( KNOWN + UNKNOWN )            332
                                                              AFTER NW    1 HAVING   31 AIC ROWS,   31 CUM
                                                              AFTER NW    2 HAVING  126 AIC ROWS,  157 CUM
                                                              AFTER NW    3 HAVING   18 AIC ROWS,  175 CUM
                                                              AFTER NW    4 HAVING   36 AIC ROWS,  211 CUM
                                                              AFTER NW    5 HAVING   37 AIC ROWS,  248 CUM


1
0*B*PROBLEM
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                                              PROBLEM AND NETWORK INDICES


     NNETT =     5  NZMPT =  185  NPANT =  128  NSNGT =  332  NSNGU =  248  NSNGK =   84  NCTRT =  242  NBCOT =  332


   SYMMETRY DATA,  NSYMM =    1  NISYM =    2  NJSYM =    1  MISYM =    1  MJSYM =    0

0        NW  =    1    2    3    4    5
         NTS =    1    1    1    0    1
         NID =   12   12   12    6   12
         NM  =    4   20    3    6    4
         NN  =    5    5    5    5    5
         NZ  =   20  100   15   30   20
         NP  =   12   76    8   20   12
         NSS =   12   76    8    0   12
         NSD =   30  126   24   36   30
         NC  =   25  126   24   42   25
         NABC=   31  202   26   36   37
         IPOT=    2    2    2    0    2
         NWOFB    1    2    3    4    5
         NCA =    0   25  151  175  217  242
         NBCA=    0   30  156  180  222  252
         MAPCA    0   30  156  180  222  252
         NXSP=    0    0    0    0    0
    I/O CALLS          27         27        214
    I/O WORDS      476928     476928      68890
         MXRWS      MXCLS     MXBLKS       NRPB     NCPBKC     NCPBKW       NCPGP      NPABK      NPAGP
           100        192        192         91          0          0           5          0          3
    STRNS CALLS  TYPE 5/6 =    0   TYPE 6 =    1


      PIC COUNTS                                           PANEL/SOURCE  PANEL/DOUBLET   BLOCK/SOURCE  BLOCK/DOUBLET

      NO INFLUENCE                                                    0              0              0              0
      MONOPOLE FAR FIELD                                              0              0              0              0
      DIPOLE FAR FIELD                                             5192           7686              0              0
      QUADRUPOLE FAR FIELD                                        15410          18145              0              0
      ONE SUB-PANEL INTERMEDIATE FIELD                            20170          22913              0              0
      TWO SUB-PANEL INTERMEDIATE FIELD                             4836           5372              0              0
      EIGHT SUB-PANEL NEAR FIELD                                    616            668              0              0



                          INFLUENCE COEFFICIENT GENERATION I/O COUNT
     NCALG=        0  NWRDG=          0  NCALT=        0  NWRDT=              0

0LOGICAL FLAGS FOR CP/2 ITERATION:
          F = BKPRNT, PRINT FLAG FOR SOLVER STATISTICS
0
                  ***********************************
                  *                                 *
                  *      CONDITION INDICATORS       *
                  *                                 *
                  *  UNIFORM SOLUTION 0.111200E-10  *
                  *                                 *
                  ***********************************
1
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0*B*SOLUTION
                                        SIMULTANEOUS SOLUTION NUMBER    1


MACH NUMBER =   0.60000   ANGLE OF ATTACK =   0.00000   SIDESLIP ANGLE =   0.00000   FREESTREAM SPEED =   1.00000
COMPRESSIBILITY FACTOR =   0.80000   COMPRESSIBILITY ANGLE OF ATTACK =   0.00000   COMPRESSIBILITY ANGLE OF SIDESLIP =   0.00000
FREESTREAM VELOCITY = (   1.00000,   0.00000,   0.00000)   COMPRESSIBILITY DIRECTION = (   1.00000,   0.00000,   0.00000)
1
  NETWORK ID:INLET       INDEX:   1   SOURCE TYPE =  1    DOUBLET TYPE = 12     NUMBER ROWS =   3    NUMBER COLUMNS =   4

 JC   IP       X          Y          Z          DO         DX         DY         DZ         SO         ANX        ANY        ANZ
 IMACHU       WXU        WYU        WZU        PHEU       VXU        VYU        VZU        CPLINU     CPSINU     CP2NDU     CPISNU
 IMACHL       WXL        WYL        WZL        PHEL       VXL        VYL        VZL        CPLINL     CPSINL     CP2NDL     CPISNL
   WNU        WNL        PWNU       PWNL       VTU        VTL        PVTU       PVTL       CPLIND     CPSIND     CP2NDD     CPISND

   6    1    2.0000     0.2324    -0.5658    -2.0208     0.0000     0.0001     0.0000     0.2988    -0.0306     0.0000     0.0000
  0.3698     0.7012     0.0001     0.0000    -2.0208     0.6306     0.0001     0.0000     0.7389     0.7389     0.6515     0.6358
  0.6000     1.0000     0.0000     0.0000     0.0000     1.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
 -0.7012    -1.0000     0.2988     0.0000     0.0001     0.0000     0.0001     0.0000     0.9338     0.9338     0.7943     0.7631

   7    2    2.0000     0.5644    -1.3673    -2.0206     0.0000     0.0008    -0.0003     0.2992    -0.0306     0.0000     0.0000
  0.3695     0.7008     0.0008    -0.0003    -2.0206     0.6302     0.0008    -0.0003     0.7397     0.7397     0.6521     0.6363
  0.6000     1.0000     0.0000     0.0000     0.0000     1.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
 -0.7008    -1.0000     0.2992     0.0000     0.0008     0.0000     0.0008     0.0000     0.9350     0.9350     0.7952     0.7639

   8    3    2.0000     0.7365    -1.7822    -2.0202     0.0000     0.0016    -0.0007     0.2996    -0.0306     0.0000     0.0000
  0.3693     0.7004     0.0016    -0.0007    -2.0202     0.6298     0.0016    -0.0007     0.7404     0.7404     0.6527     0.6368
  0.6000     1.0000     0.0000     0.0000     0.0000     1.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
 -0.7004    -1.0000     0.2996     0.0000     0.0018     0.0000     0.0018     0.0000     0.9361     0.9361     0.7959     0.7645

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•
•

0*B*FOR-MOM-NET#-  1
                                     FORCE / MOMENT DATA FOR NETWORK    1


TOTALS FOR COLUMN      1        AREA          FX           FY           FZ           MX           MY           MZ

                              1.87030      0.07291      0.00000      0.00000      0.00000     -0.01591     -0.00659
                              1.87030      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
                              1.87030      0.07291      0.00000      0.00000      0.00000     -0.01591     -0.00659
•
•
•

                              1.87030      0.07290      0.00000      0.00000      0.00000      0.01591     -0.00659
                              1.87030      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
                              1.87030      0.07290      0.00000      0.00000      0.00000      0.01591     -0.00659

TOTALS FOR NETWORK              AREA          FX           FY           FZ           MX           MY           MZ

                              7.48119      0.29163      0.00000      0.00000      0.00000      0.00000     -0.04500
                              7.48119      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
                              7.48119      0.29163      0.00000      0.00000      0.00000      0.00000     -0.04500

TOTALS FOR ALL NETWORKS SO FAR  AREA          FX           FY           FZ           MX           MY           MZ

                              7.48119      0.29163      0.00000      0.00000      0.00000      0.00000     -0.04500
                              7.48119      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
                              7.48119      0.29163      0.00000      0.00000      0.00000      0.00000     -0.04500
0*E*FOR-MOM
1
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NETWORK ID:COWLU INDEX: 2 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 19 NUMBER COLUMNS = 4

JC IP	X	Y	Z	DO	DX	DY	DZ	SO	ANX	ANY	ANZ
IMACHU	WXU	WYU	WZU	PHEU	VXU	VYU	VZU	CPLINU	CPSINU	CP2NDU	CPISNU
IMACHL	WXL	WYL	WZL	PHEL	VXL	VYL	VZL	CPLINL	CPSINL	CP2NDL	CPISNL
WNU	WNL	PWNU	PWNL	VTU	VTL	PVTU	PVTL	CPLIND	CPSIND	CP2NDD	CPISND
48 13	1.7895	0.8116	−1.9638	−1.9216	−0.4678	0.0013	0.0005	0.0000	0.0000	−0.0140	0.0338
0.3694	0.7006	0.0013	0.0005	−1.9216	0.6300	0.0013	0.0005	0.7400	0.7400	0.6524	0.6365
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.6300	1.0000	0.3700	0.0000	0.9355	0.9355	0.7955	0.7641
49 14	1.3638	0.8116	−1.9638	−1.7234	−0.4615	0.0007	0.0003	0.0000	0.0000	−0.0141	0.0340
0.3720	0.7047	0.0007	0.0003	−1.7234	0.6342	0.0007	0.0003	0.7316	0.7316	0.6460	0.6306
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.6342	1.0000	0.3658	0.0000	0.9229	0.9229	0.7866	0.7565
50 15	0.9489	0.8122	−1.9651	−1.5334	−0.4478	−0.0004	−0.0023	0.0067	−0.0002	−0.0133	0.0321
0.3775	0.7134	−0.0029	0.0039	−1.5334	0.6434	−0.0029	0.0039	0.7133	0.7132	0.6318	0.6176
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
−0.0002	−0.0069	0.0067	0.0000	0.6434	1.0000	0.3566	0.0000	0.8956	0.8956	0.7673	0.7396
51 16	0.5779	0.8174	−1.9771	−1.3707	−0.4426	0.0050	−0.0193	0.0692	−0.0021	−0.0113	0.0272
0.3788	0.7137	−0.0214	0.0446	−1.3707	0.6437	−0.0214	0.0446	0.7127	0.7102	0.6290	0.6145
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
−0.0004	−0.0696	0.0692	0.0000	0.6455	0.9976	0.3521	0.0000	0.8947	0.8923	0.7642	0.7364
52 17	0.2857	0.8311	−2.0093	−1.2384	−0.4787	0.0102	−0.0589	0.1862	−0.0041	−0.0083	0.0199
0.3586	0.6711	−0.0607	0.1123	−1.2384	0.5995	−0.0607	0.1123	0.8010	0.7847	0.6820	0.6602
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
−0.0008	−0.1871	0.1862	0.0000	0.6128	0.9823	0.3699	0.0000	1.0280	1.0117	0.8426	0.7991
53 18	0.0925	0.8536	−2.0627	−1.1347	−0.5773	0.0440	−0.1788	0.4402	−0.0063	−0.0049	0.0118
0.2841	0.4966	−0.1186	0.2136	−1.1347	0.4306	−0.1186	0.2136	1.1388	1.0791	0.8716	0.8076
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
−0.0018	−0.4420	0.4402	0.0000	0.4943	0.8970	0.4044	0.0000	1.5733	1.5136	1.1176	0.9692
54 19	0.0009	0.8838	−2.1348	−1.0457	−0.5016	0.2984	−0.6075	0.9018	−0.0082	−0.0015	0.0036
0.0750	−0.0590	0.0887	−0.1013	−1.0457	−0.0496	0.0887	−0.1013	2.0993	2.0812	1.3760	1.0688
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
−0.0014	−0.9032	0.9018	0.0000	0.1431	0.4292	0.5673	0.0000	3.3095	3.2914	1.5389	0.5813
55 20	0.0091	0.9187	−2.2193	−0.9449	0.6087	0.3033	−0.5614	0.8536	−0.0093	0.0022	−0.0053
0.9948	0.7591	0.5347	−1.1201	−0.9449	0.6924	0.5347	−1.1201	0.6153	−0.9252	−0.9858	−0.9296
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0014	−0.8523	0.8536	0.0000	1.4200	0.5231	0.8978	0.0000	0.7529	−0.7876	−0.8783	−0.8542
56 21	0.1214	0.9550	−2.3078	−0.8358	0.5843	0.0875	−0.1951	0.4976	−0.0097	0.0065	−0.0156
1.0216	1.2005	0.2689	−0.6330	−0.8358	1.3133	0.2689	−0.6330	−0.6267	−1.0997	−1.1625	−1.0743
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0013	−0.4963	0.4976	0.0000	1.4815	0.8682	0.6134	0.0000	−0.6267	−1.0997	−1.1625	−1.0743
57 22	0.3450	0.9899	−2.3933	−0.7210	0.3956	0.0192	−0.0792	0.3036	−0.0094	0.0113	−0.0273
0.8746	1.1923	0.1337	−0.3556	−0.7210	1.3004	0.1337	−0.3556	−0.6008	−0.7452	−0.8029	−0.7745
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0006	−0.3030	0.3036	0.0000	1.3544	0.9530	0.4015	0.0000	−0.6008	−0.7452	−0.8029	−0.7745
58 23	0.6859	1.0224	−2.4729	−0.6031	0.2944	0.0023	−0.0409	0.2012	−0.0089	0.0167	−0.0403
0.8019	1.1622	0.0788	−0.2257	−0.6031	1.2534	0.0788	−0.2257	−0.5068	−0.5640	−0.6051	−0.5935
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0003	−0.2009	0.2012	0.0000	1.2759	0.9796	0.2965	0.0000	−0.5068	−0.5640	−0.6051	−0.5935
59 24	1.1545	1.0513	−2.5438	−0.4787	0.2415	−0.0012	−0.0225	0.1308	−0.0079	0.0230	−0.0554
0.7660	1.1435	0.0487	−0.1431	−0.4787	1.2243	0.0487	−0.1431	−0.4486	−0.4714	−0.5036	−0.4977
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0003	−0.1306	0.1308	0.0000	1.2335	0.9914	0.2423	0.0000	−0.4486	−0.4714	−0.5036	−0.4977
60 25	1.7692	1.0729	−2.5971	−0.3414	0.2062	−0.0021	−0.0100	0.0638	−0.0050	0.0303	−0.0731
0.7424	1.1294	0.0223	−0.0688	−0.3414	1.2022	0.0223	−0.0688	−0.4043	−0.4096	−0.4357	−0.4325
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0002	−0.0635	0.0638	0.0000	1.2043	0.9980	0.2064	0.0000	−0.4043	−0.4096	−0.4357	−0.4325
61 26	2.5356	1.0810	−2.6179	−0.1973	0.1687	−0.0018	−0.0008	0.0004	0.0000	0.0370	−0.0892
0.7156	1.1079	−0.0016	−0.0012	−0.1973	1.1687	−0.0016	−0.0012	−0.3373	−0.3373	−0.3555	−0.3539
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0002	−0.0002	0.0004	0.0000	1.1687	1.0000	0.1687	0.0000	−0.3373	−0.3373	−0.3555	−0.3539
62 27	3.4036	1.0725	−2.5976	−0.0689	0.1268	−0.0001	0.0043	−0.0496	0.0051	0.0392	−0.0945
0.6847	1.0795	−0.0191	0.0501	−0.0689	1.1243	−0.0191	0.0501	−0.2486	−0.2515	−0.2613	−0.2606
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0001	0.0497	−0.0496	0.0000	1.1256	0.9988	0.1268	0.0000	−0.2486	−0.2515	−0.2613	−0.2606

NETWORK ID:COWLU INDEX: 2 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 19 NUMBER COLUMNS = 4

JC IP	X	Y	Z	DO	DX	DY	DZ	SO	ANX	ANY	ANZ
IMACHU	WXU	WYU	WZU	PHEU	VXU	VYU	VZU	CPLINU	CPSINU	CP2NDU	CPISNU
IMACHL	WXL	WYL	WZL	PHEL	VXL	VYL	VZL	CPLINL	CPSINL	CP2NDL	CPISNL
WNU	WNL	PWNU	PWNL	VTU	VTL	PVTU	PVTL	CPLIND	CPSIND	CP2NDD	CPISND
63 28	4.2603	1.0511	-2.5456	0.0225	0.0854	0.0023	0.0059	-0.0829	0.0076	0.0349	-0.0843
0.6548	1.0503	-0.0294	0.0824	0.0225	1.0785	-0.0294	0.0824	-0.1571	-0.1647	-0.1687	-0.1683
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0001	0.0830	-0.0829	0.0000	1.0821	0.9965	0.0856	0.0000	-0.1571	-0.1647	-0.1687	-0.1683
64 29	5.0078	1.0255	-2.4825	0.0727	0.0497	0.0051	0.0056	-0.1002	0.0074	0.0283	-0.0683
0.6299	1.0254	-0.0332	0.0980	0.0727	1.0396	-0.0332	0.0980	-0.0793	-0.0900	-0.0910	-0.0908
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0001	0.1002	-0.1002	0.0000	1.0448	0.9950	0.0503	0.0000	-0.0793	-0.0900	-0.0910	-0.0908
65 30	5.6721	0.9973	-2.4143	0.0933	-0.0059	0.0072	0.0025	-0.1210	0.0084	0.0264	-0.0638
0.5925	0.9868	-0.0390	0.1140	0.0933	0.9798	-0.0390	0.1140	0.0405	0.0260	0.0257	0.0256
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
-0.0001	0.1209	-0.1210	0.0000	0.9871	0.9927	0.0094	0.0000	0.0411	0.0266	0.0263	0.0263
66 31	6.2324	0.9756	-2.3603	0.0675	-0.0741	0.0081	-0.0007	-0.0787	0.0038	0.0186	-0.0449
0.5538	0.9486	-0.0220	0.0720	0.0675	0.9242	-0.0220	0.0720	0.1517	0.1460	0.1423	0.1420
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
-0.0001	0.0786	-0.0787	0.0000	0.9272	0.9969	0.0701	0.0000	0.1605	0.1548	0.1507	0.1504

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0*B*FOR-MOM-NET#- 2

FORCE / MOMENT DATA FOR NETWORK 2

TOTALS FOR COLUMN 1	AREA	FX	FY	FZ	MX	MY	MZ
	18.60808	-0.01138	0.13747	-0.33188	-0.00034	-0.00474	0.00096
	18.60808	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	18.60808	-0.01138	0.13747	-0.33188	-0.00034	-0.00474	0.00096

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TOTALS FOR NETWORK	AREA	FX	FY	FZ	MX	MY	MZ
	74.43232	-0.04278	0.93829	-0.00010	0.00000	0.00005	-0.00556
	74.43232	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	74.43232	-0.04278	0.93829	-0.00010	0.00000	0.00005	-0.00556

TOTALS FOR ALL NETWORKS SO FAR	AREA	FX	FY	FZ	MX	MY	MZ
	81.91351	0.24884	0.93829	-0.00010	0.00000	0.00004	-0.05056
	81.91351	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	81.91351	0.24884	0.93829	-0.00010	0.00000	0.00004	-0.05056

0*E*FOR-MOM
1

NETWORK ID:COWLL INDEX: 3 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 2 NUMBER COLUMNS = 4

JC IP	X	Y	Z	DO	DX	DY	DZ	SO	ANX	ANY	ANZ
IMACHU	WXU	WYU	WZU	PHEU	VXU	VYU	VZU	CPLINU	CPSINU	CP2NDU	CPISNU
IMACHL	WXL	WYL	WZL	PHEL	VXL	VYL	VZL	CPLINL	CPSINL	CP2NDL	CPISNL
WNU	WNL	PWNU	PWNL	VTU	VTL	PVTU	PVTL	CPLIND	CPSIND	CP2NDD	CPISND
157 89	6.2363	0.9685	-2.3431	0.2915	-0.0422	-0.0017	-0.0007	0.0000	0.0000	-0.0185	0.0446
0.8335	1.4842	-0.0025	-0.0011	0.2915	1.3574	-0.0024	-0.0010	0.1767	0.1767	0.1744	0.1758
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	1.3574	1.0000	0.0580	0.0000	0.1823	0.1823	0.1799	0.1814
158 90	5.6771	0.9679	-2.3433	0.3134	-0.0397	-0.0030	-0.0012	0.0000	0.0000	-0.0256	0.0619
0.8363	1.4867	-0.0045	-0.0019	0.3134	1.3608	-0.0042	-0.0017	0.1663	0.1663	0.1642	0.1655
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	1.3608	1.0000	0.0547	0.0000	0.1713	0.1712	0.1691	0.1704

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0*B*FOR-MOM-NET#- 3

FORCE / MOMENT DATA FOR NETWORK 3

TOTALS FOR COLUMN 1	AREA	FX	FY	FZ	MX	MY	MZ
	2.35131	0.00000	0.00766	-0.01848	-0.00003	0.01361	0.00564
	2.35131	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	2.35131	0.00000	0.00766	-0.01848	-0.00003	0.01361	0.00564

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TOTALS FOR NETWORK	AREA	FX	FY	FZ	MX	MY	MZ
	9.40523	0.00000	0.05388	-0.00024	0.00001	0.00016	0.03968
	9.40523	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	9.40523	0.00000	0.05388	-0.00024	0.00001	0.00016	0.03968

TOTALS FOR ALL NETWORKS SO FAR	AREA	FX	FY	FZ	MX	MY	MZ
	91.31874	0.24884	0.99217	-0.00034	0.00001	0.00020	-0.01088
	91.31874	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	91.31874	0.24884	0.99217	-0.00034	0.00001	0.00020	-0.01088

0*E*FOR-MOM
1

NETWORK ID:PLUME INDEX: 4 SOURCE TYPE = 0 DOUBLET TYPE = 6 NUMBER ROWS = 5 NUMBER COLUMNS = 4

JC IP	X	Y	Z	DO	DX	DY	DZ	SO	ANX	ANY	ANZ
IMACHU	WXU	WYU	WZU	PHEU	VXU	VYU	VZU	CPLINU	CPSINU	CP2NDU	CPISNU
IMACHL	WXL	WYL	WZL	PHEL	VXL	VYL	VZL	CPLINL	CPSINL	CP2NDL	CPISNL
WNU	WNL	PWNU	PWNL	VTU	VTL	PVTU	PVTL	CPLIND	CPSIND	CP2NDD	CPISND
184 97	6.7004	0.9607	-2.3243	-0.2412	-0.0324	0.0051	0.0002	0.0000	0.0042	0.0183	-0.0441
0.5631	0.9613	-0.0044	0.0161	0.0301	0.9422	-0.0044	0.0161	0.1157	0.1154	0.1133	0.1132
0.8494	1.4981	-0.0146	0.0243	0.2713	1.3765	-0.0135	0.0225	0.1183	0.1176	0.1166	0.1172
0.0672	0.1025	-0.0198	-0.0303	0.9400	1.3736	0.0562	0.0366	0.0000	0.0005	-0.0008	-0.0015
185 98	7.2111	0.9526	-2.3054	-0.2535	-0.0181	0.0030	0.0013	0.0000	0.0000	0.0215	-0.0519
0.5790	0.9784	-0.0026	0.0100	0.0077	0.9671	-0.0026	0.0100	0.0658	0.0657	0.0650	0.0650
0.8633	1.5102	-0.0086	0.0133	0.2613	1.3934	-0.0079	0.0124	0.0667	0.0664	0.0661	0.0663
-0.0102	-0.0156	-0.0102	-0.0156	0.9671	1.3934	0.0329	0.0220	0.0000	0.0001	-0.0003	-0.0005
186 99	7.8487	0.9521	-2.3056	-0.2623	-0.0108	0.0029	0.0012	0.0000	0.0000	0.0280	-0.0675
0.5873	0.9871	-0.0010	0.0061	-0.0088	0.9802	-0.0010	0.0061	0.0396	0.0395	0.0393	0.0393
0.8706	1.5164	-0.0060	0.0075	0.2535	1.4022	-0.0055	0.0069	0.0399	0.0398	0.0397	0.0398
-0.0060	-0.0092	-0.0060	-0.0092	0.9802	1.4022	0.0198	0.0133	0.0000	0.0000	-0.0001	-0.0002

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 187   100     8.6508    0.9517   -2.3058   -0.2689   -0.0062    0.0028    0.0012    0.0000    0.0000    0.0343   -0.0827
   0.5927     0.9926    0.0001    0.0032   -0.0211    0.9886    0.0001    0.0032    0.0228    0.0228    0.0227    0.0227
   0.8753     1.5203   -0.0041    0.0032    0.2478    1.4078   -0.0038    0.0029    0.0229    0.0229    0.0229    0.0229
  -0.0030    -0.0045   -0.0030   -0.0045    0.9886    1.4078    0.0115    0.0079    0.0000    0.0000    0.0000   -0.0001

 188   101     9.5447    0.9517   -2.3058   -0.2731   -0.0035    0.0027    0.0011    0.0000    0.0000    0.0351   -0.0846
   0.5958     0.9958    0.0008    0.0014   -0.0289    0.9935    0.0008    0.0014    0.0130    0.0130    0.0129    0.0129
   0.8780     1.5225   -0.0029    0.0004    0.2442    1.4110   -0.0026    0.0004    0.0130    0.0130    0.0130    0.0130
  -0.0010    -0.0015   -0.0010   -0.0015    0.9935    1.4110    0.0066    0.0048    0.0000    0.0000    0.0000    0.0000
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  PANEL CENTER PRESSURES, NW NAME: PLUME        INDEX:    4   [CPU/CPL/CPD]
                  5 X    4  (   5),     COLUMNS     1 THROUGH   4
  1    1 X    0.118242    0.117787    0.117782    0.118238
         Y    0.119031    0.118519    0.118513    0.119029
         Z   -0.000789   -0.000732   -0.000732   -0.000791
  2    1 X    0.066629    0.066324    0.066324    0.066633
         Y    0.066893    0.066558    0.066557    0.066898
         Z   -0.000264   -0.000234   -0.000233   -0.000265
  3    1 X    0.039889    0.039753    0.039752    0.039892
         Y    0.039981    0.039825    0.039824    0.039984
         Z   -0.000092   -0.000072   -0.000072   -0.000092
  4    1 X    0.022931    0.022865    0.022866    0.022936
         Y    0.022962    0.022886    0.022886    0.022967
         Z   -0.000031   -0.000021   -0.000020   -0.000031
  5    1 X    0.013011    0.012966    0.012967    0.013015
         Y    0.013020    0.012971    0.012973    0.013024
         Z   -0.000009   -0.000006   -0.000006   -0.000009
1
0*B*FOR-MOM-NET#-   4
                                         FORCE / MOMENT DATA FOR NETWORK      4



 TOTALS FOR COLUMN      1           AREA          FX            FY            FZ            MX            MY            MZ

                                  7.30901     -0.00049      -0.00594       0.01434       0.00005      -0.01412      -0.00585
                                  7.30901      0.00050       0.00596      -0.01440      -0.00005       0.01417       0.00587
                                  7.30901      0.00000       0.00002      -0.00006       0.00000       0.00005       0.00002
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 TOTALS FOR NETWORK                 AREA          FX            FY            FZ            MX            MY            MZ

                                 29.23605     -0.00197      -0.04045       0.00000       0.00000       0.00000      -0.03984
                                 29.23605      0.00198       0.04060       0.00000       0.00000       0.00000       0.03997
                                 29.23605      0.00001       0.00015       0.00000       0.00000       0.00000       0.00013

 TOTALS FOR ALL NETWORKS SO FAR      AREA          FX            FY            FZ            MX            MY            MZ

                                120.55479      0.24687       0.95173      -0.00034       0.00001       0.00020      -0.05072
                                120.55479      0.00198       0.04060       0.00000       0.00000       0.00000       0.03997
                                120.55479      0.24885       0.99232      -0.00034       0.00001       0.00020      -0.01075
0*E*FOR-MOM
1
```

NETWORK ID:BASE INDEX: 5 SOURCE TYPE = 1 DOUBLET TYPE = 12 NUMBER ROWS = 3 NUMBER COLUMNS = 4

JC IP LMACHU LMACHL WNU	X WXU WXL WNL	Y WYU WYL PWNU	Z WZU WZL PWNL	DO PHEU PHEL VTU	DX VXU VXL VTL	DY VYU VYL PVTU	DZ VZU VZL PVTL	SO CPLINU CPLINL CPLIND	ANX CPSINU CPSINL CPSIND	ANY CP2NDU CP2NDL CP2NDD	ANZ CPISNU CPISNL CPISND
224 117	5.3492	0.8664	−2.0972	0.3254	0.0000	−0.0013	−0.0029	−0.0237	0.0494	0.0000	0.0000
0.8391	1.4893	−0.0020	−0.0044	0.3254	1.3643	−0.0019	−0.0040	0.1557	0.1557	0.1539	0.1550
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1.4893	1.0000	−0.0362	0.0000	0.0045	0.0000	0.0045	0.0000	0.1600	0.1600	0.1581	0.1593
225 118	5.3492	0.6517	−1.5788	0.3254	0.0000	−0.0006	−0.0002	−0.0237	0.0406	0.0000	0.0000
0.8391	1.4893	−0.0010	−0.0002	0.3254	1.3642	−0.0009	−0.0002	0.1558	0.1558	0.1540	0.1551
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1.4893	1.0000	−0.0362	0.0000	0.0009	0.0000	0.0009	0.0000	0.1601	0.1601	0.1582	0.1594
226 119	5.3492	0.2693	−0.6555	0.3254	0.0000	0.0004	−0.0004	−0.0220	0.0405	0.0000	0.0000
0.8421	1.4919	0.0006	−0.0005	0.3254	1.3679	0.0006	−0.0005	0.1447	0.1447	0.1432	0.1441
0.6000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1.4919	1.0000	−0.0336	0.0000	0.0007	0.0000	0.0007	0.0000	0.1485	0.1485	0.1469	0.1479

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0*B*FOR-MOM-NET#- 5

FORCE / MOMENT DATA FOR NETWORK 5

TOTALS FOR COLUMN 1	AREA	FX	FY	FZ	MX	MY	MZ
	2.66248	−0.02033	0.00000	0.00000	0.00000	0.00531	0.00229
	2.66248	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	2.66248	−0.02033	0.00000	0.00000	0.00000	0.00531	0.00229

•
•
•

TOTALS FOR NETWORK	AREA	FX	FY	FZ	MX	MY	MZ
	10.64992	−0.08610	0.00000	0.00000	0.00000	−0.00001	0.01681
	10.64992	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	10.64992	−0.08610	0.00000	0.00000	0.00000	−0.00001	0.01681

TOTALS FOR ALL NETWORKS SO FAR	AREA	FX	FY	FZ	MX	MY	MZ
	131.20472	0.16077	0.95173	−0.00034	0.00001	0.00019	−0.03391
	131.20472	0.00198	0.04060	0.00000	0.00000	0.00000	0.03997
	131.20472	0.16275	0.99232	−0.00034	0.00001	0.00019	0.00606

0*E*FOR-MOM

```
1
0*B*SECTION
0           SECTIONAL PROPERTIES - CUT DEFINITIONS AND REFERENCE DATA, SOLUTION NUMBER    1, GROUP NO.    1

0REFERENCE LENGTH FOR ETA =             1.00000
0CUT NO.        ETA         XC          YC          ZC         XCN         YCN         ZCN          XR          YR          ZR       CHORD

      1  0.000E+00  2.000E+00  0.000E+00  0.000E+00  0.000E+00  9.236E-01  3.833E-01  1.602E+00  9.197E-01 -2.216E+00  6.491E+00
      2  0.000E+00  2.000E+00  0.000E+00  0.000E+00  0.000E+00  3.833E-01  9.236E-01  1.602E+00  2.216E+00 -9.197E-01  6.491E+00
      3  0.000E+00  2.000E+00  0.000E+00  0.000E+00  0.000E+00 -3.833E-01  9.236E-01  1.602E+00  2.216E+00  9.197E-01  6.491E+00
      4  0.000E+00  2.000E+00  0.000E+00  0.000E+00  0.000E+00 -9.236E-01  3.833E-01  1.602E+00  9.197E-01  2.216E+00  6.491E+00
0

 GROUP NO.   1  USES THE FOLLOWING NETWORKS (BY NUMBER) AND SURFACE (SURF) PRESSURE DISTRIBUTION FOR COMPUTATIONS -

   2 UPPER


 NOTE - THE SAME PRESSURE DISTRIBUTION USED IN CALCULATING THE 3-D FORCES AND
        MOMENTS IS USED TO CALCULATE THE SECTIONAL PROPERTIES.  CURRENTLY, THE SECOND
        ORDER PRESSURE COEFFICIENT IS USED WITHOUT VELOCITY CORRECTIONS.

1                SECTIONAL PROPERTIES - CUT FORCE AND MOMENT DATA, SOLUTION NUMBER    1, GROUP NO.    1

0FORCE (X,Y,Z) AND MOMENT (X,Y,Z) IN GLOBAL COORDINATES.
 FORCE (L,D) IN CUT PLANE. FORCE (N) NORMAL TO CUT PLANE.
   DIRECTION OF POSITIVE CL IS: FREE STREAM VECTOR CROSSED INTO THE CUT PLANE NORMAL
   DIRECTION OF POSITIVE CN IS: SAME AS CUT PLANE NORMAL
   DIRECTION OF POSITIVE CD IS: CUT PLANE NORMAL CROSSED INTO THE LIFT (CL) VECTOR
 SECTIONAL MOMENT NORMAL TO CUT.

0          CUT NO.          CFX          CFY          CFZ            CMX          CMY*          CMZ
               ETA          CDC          CNC          CLC  CLC*CHORD/CREF          CMC   CUT-LENGTH
       -----------  -----------  -----------  -----------  -------------  -----------  -----------

♦                1    -0.013236     0.209767    -0.506422      -0.000003    -0.023109    -0.009571
          0.000000    -0.013236    -0.000345    -0.548147      -0.593024    -0.025013     8.643618

♦                2    -0.011286     0.505991    -0.209588       0.000003    -0.009309    -0.022477
          0.000000    -0.011286     0.000345    -0.547680      -0.592519    -0.024328     8.643618

♦                3    -0.011294     0.506028     0.209604      -0.000003     0.009314    -0.022489
          0.000000    -0.011294    -0.000345    -0.547721      -0.592563    -0.024341     8.643618

♦                4    -0.013184     0.209695     0.506248       0.000003     0.023141    -0.009584
          0.000000    -0.013184     0.000345    -0.547958      -0.592820    -0.025048     8.643618

0*E*SECTION
1
```

♦ No velocity correction.

SOLUTION NUMBER 2 OMITTED

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INPUT CONFIGURATION FORCES AND MOMENTS SUMMARY

SOL-NO	ALPHA	BETA	CL	CDI	CY	FX MX	FY MY	FZ MZ	AREA
1	0.0000	0.0000	-0.00034	-0.04278	0.99217	-0.04278 0.00001	0.99217 0.00020	-0.00034 0.03412	83.83755
2	4.0000	0.0000	0.11769	-0.03831	0.99963	-0.04642 -0.00544	0.99963 0.00126	0.11473 0.04086	83.83755

****

0

FULL CONFIGURATION FORCES AND MOMENTS SUMMARY

SYMMETRY CONDITIONS: MISYMM = 1 MJSYMM = 0

SOL-NO	ALPHA	BETA	CL	CDI	CY	FX MX	FY MY	FZ MZ	AREA
1	0.0000	0.0000	-0.00068	-0.08557	0.00000	-0.08557 0.00000	0.00000 0.00040	-0.00068 0.00000	167.67511
2	4.0000	0.0000	0.23538	-0.07661	0.00000	-0.09285 0.00000	0.00000 0.00252	0.22947 0.00000	167.67511

****

1

CONFIGURATION IS COMPOSED OF THE FOLLOWING SELECTED NETWORKS
2 COWLU 3 COWLL

NOTE: THESE NETWORKS ARE ALL KT=1 TYPES

REFERENCE CONDITIONS ARE:

SREF =	20.40000	XREF =	1.50000	YREF =	0.00000	ZREF =	0.00000
		CREF =	6.00000	BREF =	6.00000	DREF =	6.00000

****

1

0*B*OFF-BODY

OFF BODY FLOW CHARACTERISTICS

	SOLN	PT	X	Y	Z	WX	WY	WZ	PPOT	CP/2ND	MACH
♦	1	1	1.0000	0.7990	-1.9300	0.7094	-0.0023	0.0009	-1.5595	0.7762	0.3415
♦	1	2	1.0000	0.6130	-1.4810	0.6992	-0.0035	0.0043	-1.5581	0.7986	0.3333
♦	1	3	1.0000	0.2540	-0.6130	0.6983	-0.0007	0.0004	-1.5576	0.8005	0.3326
♦	1	4	1.0000	1.9300	-0.7990	0.7113	0.0004	-0.0001	-1.5593	0.7720	0.3430
♦	1	5	1.0000	1.4810	-0.6130	0.7008	-0.0047	0.0019	-1.5583	0.7952	0.3345
♦	1	6	1.0000	0.6130	-0.2540	0.6981	-0.0015	0.0002	-1.5577	0.8010	0.3324
♦	1	7	1.0000	1.9300	0.7990	0.7113	0.0003	0.0001	-1.5593	0.7719	0.3430
♦	1	8	1.0000	1.4810	0.6130	0.7008	-0.0047	-0.0019	-1.5584	0.7951	0.3345
♦	1	9	1.0000	0.6130	0.2540	0.6981	-0.0015	-0.0002	-1.5577	0.8010	0.3324
♦	1	10	1.0000	0.7990	1.9300	0.7093	-0.0023	-0.0008	-1.5595	0.7764	0.3414
♦	1	11	1.0000	0.6130	1.4810	0.6992	-0.0036	-0.0043	-1.5581	0.7986	0.3333
♦	1	12	1.0000	0.2540	0.6130	0.6983	-0.0007	-0.0004	-1.5576	0.8005	0.3326
♦♦	1	13	11.0000	0.0000	0.0000	0.9985	0.0000	0.0000	0.0447	0.0046	0.5985
♦♦	1	14	11.0000	0.0000	-2.5000	0.9988	0.0000	0.0009	0.0077	0.0038	0.5988
♦	1	15	11.0000	0.0000	-2.9000	0.9989	0.0000	0.0010	-0.0038	0.0035	0.5989
♦♦	1	16	9.5000	0.0000	0.0000	0.9966	0.0000	0.0000	0.1421	0.0106	0.5966
♦♦	1	17	9.5000	0.0000	-2.5000	0.9979	0.0000	-0.0005	0.1902	0.0065	0.5979
♦	1	18	9.5000	0.0000	-2.9000	0.9963	0.0000	0.0010	-0.0612	0.0116	0.5963
♦♦	1	19	5.6000	0.0000	0.0000	0.9794	0.0000	0.0000	0.3043	0.0637	0.5795
♦♦	1	20	5.6000	0.0000	-2.3000	0.9757	0.0000	-0.0053	0.3083	0.0749	0.5759
♦	1	21	5.6000	0.0000	-3.0000	0.9964	0.0000	0.1040	0.0484	0.0004	0.6005
♦	1	22	2.5000	0.0000	0.0000	0.9989	0.0000	0.0000	-0.0049	0.0034	0.5989
♦	2	1	1.0000	0.7990	-1.9300	0.7331	-0.0042	0.0006	-1.4504	0.7211	0.3613
♦	2	2	1.0000	0.6130	-1.4810	0.7193	-0.0037	0.0178	-1.4777	0.7518	0.3502
♦	2	3	1.0000	0.2540	-0.6130	0.7064	-0.0006	0.0263	-1.5211	0.7800	0.3399
♦	2	4	1.0000	1.9300	-0.7990	0.7213	0.0076	0.0156	-1.5094	0.7474	0.3518
♦	2	5	1.0000	1.4810	-0.6130	0.7092	-0.0014	0.0251	-1.5202	0.7739	0.3421
♦	2	6	1.0000	0.6130	-0.2540	0.7015	-0.0013	0.0275	-1.5371	0.7907	0.3360
♦	2	7	1.0000	1.9300	0.7990	0.7016	-0.0069	0.0157	-1.5904	0.7913	0.3358
♦	2	8	1.0000	1.4810	0.6130	0.6925	-0.0081	0.0212	-1.5776	0.8107	0.3286
♦	2	9	1.0000	0.6130	0.2540	0.6946	-0.0017	0.0270	-1.5594	0.8057	0.3304
♦	2	10	1.0000	0.7990	1.9300	0.6857	-0.0003	-0.0010	-1.6498	0.8264	0.3229
♦	2	11	1.0000	0.6130	1.4810	0.6792	-0.0034	0.0091	-1.6197	0.8400	0.3177
♦	2	12	1.0000	0.2540	0.6130	0.6902	-0.0008	0.0253	-1.5752	0.8155	0.3268
♦♦	2	13	11.0000	0.0000	0.0000	0.9961	0.0000	0.0488	0.0447	0.0071	0.5976
♦♦	2	14	11.0000	0.0000	-2.5000	0.9963	0.0000	0.0531	-0.0028	0.0060	0.5980
♦	2	15	11.0000	0.0000	-2.9000	0.9964	0.0000	0.0550	-0.0233	0.0055	0.5981
♦♦	2	16	9.5000	0.0000	0.0000	0.9942	0.0000	0.0239	0.1417	0.0149	0.5950
♦♦	2	17	9.5000	0.0000	-2.5000	0.9955	0.0000	-0.0363	0.4052	0.0100	0.5966
♦	2	18	9.5000	0.0000	-2.9000	0.9939	0.0000	0.0037	-0.2121	0.0162	0.5945
♦♦	2	19	5.6000	0.0000	0.0000	0.9770	0.0000	0.0025	0.3035	0.0685	0.5777
♦♦	2	20	5.6000	0.0000	-2.3000	0.9779	0.0000	-0.0103	0.4786	0.0655	0.5787
♦	2	21	5.6000	0.0000	-3.0000	0.9975	0.0000	0.1096	-0.1128	-0.0068	0.6026
♦	2	22	2.5000	0.0000	0.0000	0.9965	0.0000	0.0706	-0.0049	0.0032	0.5990

0*E*OFF-BODY

NPICSL	7						
1.	0	0	1140	1766	2256	416	54

♦ No velocity correction.

♦♦ No velocity correction + no influence of material properties.

0*B*STREAML

STREAMLINE INTRODUCTORY DATA OMITTED

0*B*STREAML

MASS FLUX STREAMLINE NUMBER 1 FOR CASE 1 FORWARD/BACK = -1.00

	INT. PT.	INDEP. VARIABLE S	STREAMLINE LOCATION X	Y	Z	DIRECTION(-V/-W, BACKWARD INT) WX	WY	WZ	POTEN. PPOT	2ND ORDER CP CP/2ND	LOCAL MACH MACH	ORDER K
♦	1	0.0000	0.0100	0.0000	-2.2800	0.5470	0.0000	-0.1693	-1.0094	1.0663	0.2313	0
♦	2	-0.0330	-0.0082	0.0000	-2.2743	0.5528	0.0000	-0.1757	-0.9976	1.0542	0.2369	1
♦	3	-0.1330	-0.0645	0.0000	-2.2559	0.5759	0.0000	-0.1927	-0.9627	1.0072	0.2577	2
♦	4	-0.3330	-0.1856	0.0000	-2.2153	0.6366	0.0000	-0.2075	-0.8966	0.8862	0.3060	3
♦	5	-0.7330	-0.4636	0.0000	-2.1372	0.7420	0.0000	-0.1801	-0.7797	0.6697	0.3827	4
♦	6	-1.1330	-0.7751	0.0000	-2.0739	0.8059	0.0000	-0.1402	-0.6815	0.5280	0.4297	3
♦	7	-1.5330	-1.1062	0.0000	-2.0249	0.8472	0.0000	-0.1073	-0.5988	0.4296	0.4617	3
♦	8	-1.9330	-1.4512	0.0000	-1.9876	0.8770	0.0000	-0.0801	-0.5285	0.3542	0.4861	3
♦	9	-2.4330	-1.8967	0.0000	-1.9535	0.9035	0.0000	-0.0593	-0.4552	0.2835	0.5089	3
♦	10	-2.9330	-2.3536	0.0000	-1.9279	0.9234	0.0000	-0.0430	-0.3954	0.2283	0.5267	3
♦	11	-3.4330	-2.8192	0.0000	-1.9095	0.9385	0.0000	-0.0315	-0.3463	0.1853	0.5405	3
♦	12	-3.9330	-3.2914	0.0000	-1.8958	0.9500	0.0000	-0.0234	-0.3060	0.1518	0.5512	3

MASS FLUX STREAMLINE NUMBER 2 FOR CASE 1 FORWARD/BACK = -1.00

	INT. PT.	INDEP. VARIABLE S	STREAMLINE LOCATION X	Y	Z	DIRECTION(-V/-W, BACKWARD INT) WX	WY	WZ	POTEN. PPOT	2ND ORDER CP CP/2ND	LOCAL MACH MACH	ORDER K
♦	1	0.0000	0.2700	0.0000	-2.3400	0.5791	0.0000	-0.0117	-1.1952	1.0384	0.2379	0
♦	2	-0.0328	0.2513	0.0000	-2.3396	0.5612	0.0000	-0.0151	-1.1827	1.0701	0.2238	1
♦	3	-0.1328	0.1982	0.0000	-2.3370	0.4996	0.0000	-0.0402	-1.1439	1.1709	0.1753	2
♦	4	-0.3328	0.1021	0.0000	-2.3194	0.5200	0.0000	-0.1515	-1.0701	1.1171	0.2073	3
♦	5	-0.5328	-0.0071	0.0000	-2.2833	0.5496	0.0000	-0.1795	-0.9968	1.0582	0.2355	3
♦	6	-0.7328	-0.1217	0.0000	-2.2451	0.6029	0.0000	-0.2072	-0.9282	0.9516	0.2809	3
♦	7	-0.9328	-0.2486	0.0000	-2.2029	0.6662	0.0000	-0.2079	-0.8650	0.8258	0.3284	3
♦	8	-1.3328	-0.5372	0.0000	-2.1264	0.7610	0.0000	-0.1711	-0.7531	0.6282	0.3966	3
♦	9	-1.7328	-0.8542	0.0000	-2.0666	0.8178	0.0000	-0.1319	-0.6593	0.5001	0.4389	3
♦	10	-2.1328	-1.1892	0.0000	-2.0208	0.8560	0.0000	-0.0986	-0.5800	0.4078	0.4688	3
♦	11	-2.5328	-1.5373	0.0000	-1.9865	0.8834	0.0000	-0.0744	-0.5125	0.3377	0.4914	3
♦	12	-3.0328	-1.9854	0.0000	-1.9544	0.9080	0.0000	-0.0557	-0.4422	0.2711	0.5129	3
♦	13	-3.5328	-2.4443	0.0000	-1.9303	0.9268	0.0000	-0.0405	-0.3847	0.2187	0.5298	3
♦	14	-4.0328	-2.9114	0.0000	-1.9130	0.9411	0.0000	-0.0298	-0.3376	0.1779	0.5429	3

0*E*STREAML

JOB COST SUMMARY AND DAYFILE OMITTED

♦ No velocity correction.

APPENDIX A. A502 SUPPORT PROGRAMS

The following A502 support programs and files are available to help in processing a subsonic/supersonic flow analysis.

A.1 A502 FILES ON UN=D22CMTG

A502IN	A502H00 sample input deck containing all necessary labeled parameters. Start with this input deck and insert the parameter values below the parameter labels. Delete lines that do not apply (see section 5).
A502HJ	A502H00 CRAY COS job deck.
A502HLJ	A502H00 CRAY COS large job deck. This sample job deck is set up for a problem whose size exceeds 2000 panels.
HSWB	Input deck used for the wing-body configuration example, section 9.
NAC	Input deck used for the engine-on nacelle example, section 10.

A.2 GEOMETRY PROGRAMS

AGPS Panel Editor Package	A package designed to assist the AGPS user in geometry manipulation. The panel editor can be accessed through the AGPS program. See BCA D6-53881-TN by Kevin Smit and Roger Pomeroy.
AEDIT/UN=D8WA22N	General program to manipulate network geometry on EKS. To execute programs AEDIT, INFILE, OUTFILE, where INFILE contains one or more networks. Screen selection of options. C. S. AERO-B8181-C84-049 by Roger Pomeroy.

A.3 PREPARING OUTPUT FLOW PROPERTIES FOR PLOTTING

A594/UN=AEROSYS (or EFP)	Program to extract requested flow properties from the A502 CIDPF file. This program is used in the EFPJ job deck and is explained in section 8.2
EFPJ/UN=D22CMTG	Sample A502 extract program job deck. Extract surface flow properties from A502 CIDPF file for making a GGP file.

A.4 DISPLAYING THE PLOTTING FILES

AGPS	Aero Grid and Paneling System. The program can be used to display configurations and surface pressures (reference 6).
ETAGS, PEGASUS, QGS	Programs to make gridded plots on the APOLLO.
DOCPLT	Program to make gridded plots on the VAX.
MPIX	Program available on the PDP and APOLLO. Requires .MPX or .MPR files as inputs for displaying the configuration.
GGP	General graphics package residing on the VAX and the PDP. Can be used to generate two-dimensional plots from all GGP-formatted files.

A.5 OUTPUTTING FILES

FICHE/UN=D22CMTG	Job deck for making a microfiche copy of a file.
LASER/UN=D22CMTG	Job deck for making a Xerox laser printout of a file on the Cyber computer.

A.6 FILE MANAGEMENT

TAPEUM/UN=AEROSYS	Program to copy permanent files to tape.
DYREAD/UN=AEROSYS	Program to create a tape directory from the read dayfile generated from TAPEUM.
OFFTAPE/UN=AEROSYS	Program to retrieve files from tape.

APPENDIX B. DETAILED PRINTOUT FOR LOCATING PROGRAM ERRORS

The printout discussed in this appendix is available for understanding the detailed processing of the A502 program. This printout was used by the developers to debug the program during the initial program validation. It is still used occasionally for identifying an unusual condition that is not being properly processed. However, for the everyday user, the printout described here is not of particular interest.

B.1 PANEL DATA (IGEOMP = 1.0)

A502 outputs coordinate transformations used to compute coordinates of panel corner points in various coordinate systems. Corner point coordinates and unit normal vectors referred to in the coordinate systems are also printed. Input igeomp = 1.0 to allow output in the following format:

PANEL DATA

PANEL NO. = 1 NETWORK NO. = 1 ROW = 1 COLUMN = 1 NETWORK PANEL NO. = 1 ORDER OF SURFACE FIT = 1

	XG	YG	ZG	XL	YL	ZL
CP1	69.4737000000	9.2105000000	0.0000000000	-0.7534696939	-4.4321922519	-0.0000012123
CP2	76.6660000000	20.0000000000	0.0000000000	6.5151856578	4.1299179297	0.0000012123
CP3	70.8460000000	20.1781000000	0.7831000000	0.6887401122	4.3559709755	-0.0000012123
CP4	63.7818000000	9.5807000000	0.7831000000	-6.4504560761	-4.0536966533	0.0000012123
RO	70.1918750000	14.7423250000	0.3915500000	0.0000000000	0.0000000000	0.0000000000
NO	0.1302386113	-0.0868170124	0.9876743950	0.0706500985	0.0000000000	0.8057536002

DIAM= 15.42775 XMX= 6.51519 YMX= 4.43219 D13= 8.90572 D24= 15.33230 AREA= 51.07084

PANEL NO. = 2 NETWORK NO. = 1 ROW = 2 COLUMN = 1 NETWORK PANEL NO. = 2 ORDER OF SURFACE FIT = 1

	XG	YG	ZG	XL	YL	ZL
CP1	63.7818000000	9.5807000000	0.7831000000	1.4613802012	-4.3269299596	0.0000029736
CP2	70.8460000000	20.1781000000	0.7831000000	8.5879678119	4.0934251914	-0.0000029736
CP3	60.7679000000	20.2711000000	1.9747000000	-1.4950760660	4.2870423666	0.0000029736
CP4	53.7705000000	9.7741000000	1.9747000000	-8.5542719470	-4.0535375984	-0.0000029736
RO	62.2915500000	14.9510000000	1.3789000000	0.0000000000	0.0000000000	0.0000000000
NO	0.1163582778	-0.0775648305	0.9901739485	0.0659080937	0.0000000000	0.8049823363

DIAM= 19.02728 XMX= 8.58797 YMX= 4.32693 D13= 9.10720 D24= 18.97971 AREA= 85.87446

PANEL NO. = 3 NETWORK NO. = 1 ROW = 3 COLUMN = 1 NETWORK PANEL NO. = 3 ORDER OF SURFACE FIT = 1

	XG	YG	ZG	XL	YL	ZL
CP1	53.7705000000	9.7741000000	1.9747000000	4.7377127769	-4.1079182736	0.0000000255
CP2	60.7679000000	20.2711000000	1.9747000000	11.7287274701	4.2898930007	-0.0000000255
CP3	44.3403000000	20.1238000000	1.9614000000	-4.6848110980	4.1715598723	0.0000000255
CP4	37.2370000000	9.4677000000	1.9614000000	-11.7816291490	-4.3535345994	-0.0000000255
RO	49.0289250000	14.9091750000	1.9680500000	0.0000000000	0.0000000000	0.0000000000
NO	-0.0008144849	0.0005429373	0.9999995209	0.0247819726	0.0000000000	0.8006853501

DIAM= 25.12051 XMX= 11.78163 YMX= 4.35353 D13= 12.54327 D24= 25.04887 AREA= 138.04819

Header Name	Output Description
XG,YG,ZG XL,YL,ZL	Coordinates of panel corner points in global and local coordinate systems.
CP1,CP2,CP3,CP4	Panel corner point numbers.
RO	Coordinates of panel center in global and local coordinate systems.
NO	Components of panel center normal.
DIAM	Diameter of compressible panel.
XMX	Maximum value of X coordinate of corner point in panel coordinate system.
YMX	Maximum value of Y coordinate of corner point in panel coordinate system.
D13	Length of diagonal 1-3.
D24	Length of diagonal 2-4.
AREA	Area of panel.

The parameters are mainly of interest for diagnostic purposes. While panel data is being computed, certain diagnostic information is also computed and listed, regardless of the value of igeomp. The following message usually results from long, narrow panels of wake networks and can be ignored for this type of panel:

```
PANEL XX OF NETWORK X HAS AN ASPECT RATIO OF   .XXXXXXXX.
```

However, if this message occurs on a nonwake panel, alter your paneling so that the aspect ratio of the particular panel is changed. No firm guideline is available to indicate what panel-aspect ratio is tolerable. Aspect ratio values will at some point cause numerical errors, resulting in a bad local solution. The aspect ratio message is generated for any panel with an aspect ratio of .0001 or less.

An additional message that may be printed, depending on panel geometry, is:

```
PANEL XX OF NETWORK XX IS EXCESSIVELY TWISTED
```

If you receive this message, a local increase in panel density may be required, or the message could be due to a paneling error or to geometry changes caused by $EAT, $PEA, or $ABU.

B.2 SINGULARITY DISTRIBUTION DEFINITION (ISINGP = 1.0)

Singularity distribution definition output comes in two parts for each network. The first part contains panel distribution quantities, and the second includes the coefficients of the singularity spline. A singularity spline data file is printed if isingp = 1.0. Typical output data is shown below:

SINGULARITY DISTRUBUTION DEFINITION

PANEL DISTRIBUTION QUANTITIES

PANEL NO. = 1 NETWORK NO. = 1 DISTRIBUTION ORDER = 1 NUMBER OF SINGULARITY PARAMETERS = 4

IS	WEIGHT	KSE	ETA	ZETA	A	AKS	AET	AKSKS	AKSET	AETET
1	0.100E+05	0.00000	0.00000	0.00000	1.00000	-0.08710	0.14531	0.00000	0.00000	0.00000
2	0.100E+01	7.90383	0.13913	0.00000	0.00000	0.08441	-0.02546	0.00000	0.00000	0.00000
11	0.100E+01	-6.50300	-8.52781	0.00000	0.00000	-0.04114	-0.04752	0.00000	0.00000	0.00000
12	0.100E+01	1.48948	-8.27226	0.00000	0.00000	0.04383	-0.07233	0.00000	0.00000	0.00000

PANEL NO. = 2 NETWORK NO. = 1 DISTRIBUTION ORDER = 1 NUMBER OF SINGULARITY PARAMETERS = 6

IS	WEIGHT	KSE	ETA	ZETA	A	AKS	AET	AKSKS	AKSET	AETET
1	0.100E+01	-7.91244	0.07963	0.00000	0.00000	-0.01736	0.01130	0.00000	0.00000	0.00000
2	0.100E+05	0.00000	0.00000	0.00000	1.00000	-0.01243	0.12843	0.00000	0.00000	0.00000
3	0.100E+01	13.19126	0.24416	0.00000	0.00000	0.02842	-0.01663	0.00000	0.00000	0.00000
11	0.100E+01	-14.64894	-8.26493	0.00000	0.00000	-0.02062	-0.02824	0.00000	0.00000	0.00000
12	0.100E+01	-6.64444	-8.23041	0.00000	0.00000	-0.00322	-0.03899	0.00000	0.00000	0.00000
13	0.100E+01	6.51463	-8.03513	0.00000	0.00000	0.02520	-0.05586	0.00000	0.00000	0.00000

Header Name	Output Description
DISTRIBUTION ORDER	=1 Linear
	=2 Quadratic
NO. OF SING. PARAMETERS	Number of neighboring singularity parameters used to construct the spline for the current panel
IS	Indices of neighboring source or doublet singularity parameters (these are not the final indices that show up in the singularity parameter maps)
WEIGHT	Value of the weight used in the spline
KSE	ξ local coordinate of source parameter point
ETA	η local coordinate of source parameter point
ZETA	ζ local coordinate of source parameter point
A, AKS, AET	Dependence of $\sigma_0, \sigma_\xi, \sigma_\eta$ upon neighboring source parameters ($\sigma(\xi,\eta) = \sigma_0 + \sigma_\xi \cdot \sigma_\eta \cdot \eta$)
AKSKS, AKSET, AETET	Always zero

PANEL NO. = 1 NETWORK NO. = 1 DISTRIBUTION ORDER = 2 NUMBER OF SINGULARITY PARAMETERS = 15

IS	A1	A2	A3	A4	A5	A6	A7	A8	A9
21	0.10000E+01	-0.17431E+00	0.00000E+00	-0.55831E-02	0.00000E+00	-0.48221E-01	0.36571E-02	0.00000E+00	0.00000E+00
22	0.00000E+00	0.00000E+00	-0.88239E-01	0.55889E+00	0.00000E+00	-0.87377E-01	0.57683E-02	0.10000E+01	0.00000E+00
23	0.00000E+00	0.00000E+00	-0.85842E-01	0.49744E+00	0.00000E+00	-0.42784E-01	0.46358E-02	0.00000E+00	0.00000E+00
24	0.00000E+00	0.00000E+00	0.00000E+00	-0.50749E-01	0.00000E+00	0.00000E+00	-0.19037E-01	0.00000E+00	0.00000E+00
33	0.00000E+00	0.67003E+00	-0.36815E-02	0.00000E+00	0.10000E+01	0.41548E-01	-0.26410E-02	0.00000E+00	0.00000E+00
34	0.00000E+00	0.00000E+00	0.34911E+00	0.00000E+00	0.00000E+00	0.59530E+00	0.52567E+00	0.00000E+00	0.10000E+01
35	0.00000E+00	0.00000E+00	0.35269E+00	0.00000E+00	0.00000E+00	0.41319E-01	0.50349E+00	0.00000E+00	0.00000E+00
36	0.00000E+00	0.00000E+00	-0.30431E-01	0.00000E+00	0.00000E+00	0.00000E+00	-0.22574E-01	0.00000E+00	0.00000E+00
45	0.00000E+00	0.66182E+00	-0.27635E-02	0.00000E+00	0.00000E+00	0.43123E-01	0.19353E-02	0.00000E+00	0.00000E+00
46	0.00000E+00	0.00000E+00	0.37027E+00	0.00000E+00	0.00000E+00	0.57109E+00	0.53021E-02	0.00000E+00	0.00000E+00
47	0.00000E+00	0.00000E+00	0.31951E+00	0.00000E+00	0.00000E+00	0.39569E-01	0.70386E-02	0.00000E+00	0.00000E+00
48	0.00000E+00	0.00000E+00	-0.23319E-01	0.00000E+00	0.00000E+00	0.00000E+00	-0.13247E-01	0.00000E+00	0.00000E+00
57	0.00000E+00	-0.15753E+00	0.00000E+00	0.00000E+00	0.00000E+00	-0.36501E-01	0.00000E+00	0.00000E+00	0.00000E+00
58	0.00000E+00	0.00000E+00	-0.79738E-01	0.00000E+00	0.00000E+00	-0.78958E-01	0.00000E+00	0.00000E+00	0.00000E+00
59	0.00000E+00	0.00000E+00	-0.77571E-01	0.00000E+00	0.00000E+00	-0.38102E-01	0.00000E+00	0.00000E+00	0.00000E+00

PANEL NO. = 2 NETWORK NO. = 1 DISTRIBUTION ORDER = 2 NUMBER OF SINGULARITY PARAMETERS = 18

IS	A1	A2	A3	A4	A5	A6	A7	A8	A9
22	0.55889E+00	-0.88239E-01	0.00000E+00	-0.60543E-01	0.57683E-02	-0.49615E-01	-0.99291E-02	0.00000E+00	0.00000E+00
23	0.49744E+00	-0.85842E-01	-0.86315E-01	0.62345E+00	0.46358E-02	-0.84993E-01	0.19293E-01	0.10000E+01	0.00000E+00
24	-0.50749E-01	0.00000E+00	-0.86917E-01	0.54360E+00	-0.19037E-01	-0.45898E-01	0.17967E-01	0.00000E+00	0.00000E+00
21	-0.55831E-02	0.00000E+00	0.00000E+00	0.00000E+00	0.36571E-02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
25	0.00000E+00	0.00000E+00	0.00000E+00	-0.10651E+00	0.00000E+00	0.00000E+00	-0.33557E-01	0.00000E+00	0.00000E+00
33	0.00000E+00	-0.36815E-02	0.00000E+00	0.00000E+00	-0.26410E-02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
34	0.00000E+00	0.34911E+00	-0.34718E-01	0.00000E+00	0.52567E+00	0.39710E-01	-0.31449E-01	0.00000E+00	0.00000E+00
35	0.00000E+00	0.35269E+00	0.39382E+00	0.00000E+00	0.50349E+00	0.60511E+00	0.56537E+00	0.00000E+00	0.10000E+01
36	0.00000E+00	-0.30431E-01	0.36053E+00	0.00000E+00	-0.22574E-01	0.40272E-01	0.52153E+00	0.00000E+00	0.00000E+00
37	0.00000E+00	0.00000E+00	-0.54773E-01	0.00000E+00	0.00000E+00	0.00000E+00	-0.52110E-01	0.00000E+00	0.00000E+00
45	0.00000E+00	-0.27635E-02	0.00000E+00	0.00000E+00	0.19353E-02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
46	0.00000E+00	0.37027E+00	-0.30794E-01	0.00000E+00	0.53021E-02	0.43484E-01	-0.13495E-01	0.00000E+00	0.00000E+00
47	0.00000E+00	0.31951E+00	0.39899E+00	0.00000E+00	0.70386E-02	0.55685E+00	0.20522E-01	0.00000E+00	0.00000E+00
48	0.00000E+00	-0.23319E-01	0.34832E+00	0.00000E+00	-0.13247E-01	0.41407E-01	0.23307E-01	0.00000E+00	0.00000E+00
49	0.00000E+00	0.00000E+00	-0.51496E-01	0.00000E+00	0.00000E+00	0.00000E+00	-0.27449E-01	0.00000E+00	0.00000E+00
58	0.00000E+00	-0.79738E-01	0.00000E+00	0.00000E+00	0.00000E+00	-0.33650E-01	0.00000E+00	0.00000E+00	0.00000E+00
59	0.00000E+00	-0.77571E-01	-0.78128E-01	0.00000E+00	0.00000E+00	-0.76805E-01	0.00000E+00	0.00000E+00	0.00000E+00
60	0.00000E+00	0.00000E+00	-0.78513E-01	0.00000E+00	0.00000E+00	-0.35869E-01	0.00000E+00	0.00000E+00	0.00000E+00

Header Name	Output Description
A1,A2,...,A9	Dependence of μ at the nine canonical panel points upon the neighboring doublet parameter

B.3 PANEL NORMALS

A502 data check run automatically provides information about the direction of the normal on a given network, as determined by the program. These results can be used to verify that all the normals point toward the flow domain of interest. The output is arranged in an array similar to the network points. A portion of a typical output is shown below:

```
*B*NETNORML
 — PANEL NORMALS FOR NW #    1, WINGA
                               10 X    2      ( 10)      COLUMN 1 THROUGH 2
   1.  1.X     0.130239     0.130238
        .Y    -0.086817    -0.086830
        .Z     0.987674     0.987673

   2.  1.X     0.116358     0.116358
        .Y    -0.077565    -0.077576
        .Z     0.990174     0.990173

   3.  1.X    -0.000814    -0.000814
        .Y     0.000543     0.000543
        .Z     1.000000     1.000000

   4.  1.X    -0.206724    -0.166051
        .Y     0.110813     0.110706
        .Z     0.972104     0.979883

   5.  1.X    -0.484335    -0.633074
        .Y     0.298243     0.422068
        .Z     0.822478     0.648904

   6.  1.X    -0.482063    -0.630690
        .Y     0.296842     0.420478
        .Z    -0.824318    -0.652248

   7.  1.X    -0.206287    -0.165840
        .Y     0.110677     0.110565
        .Z    -0.972212    -0.979935

   8.  1.X    -0.000790    -0.000790
        .Y     0.000527     0.000527
        .Z    -1.000000    -1.000000

   9.  1.X     0.116371     0.116371
        .Y    -0.077573    -0.077584
        .Z    -0.990172    -0.990171

  10.  1.X     0.130233     0.130232
        .Y    -0.086813    -0.086826
        .Z    -0.987675    -0.987674

   — PANEL NORMALS FOR NW #    2, WINGTA
                               5 X    1     ( 5)      COLUMN 1 THROUGH 1
   1.  1.X     0.000000
        .Y     1.000000
        .Z     0.000000

   2.  1.X     0.000000
        .Y     1.000000
        .Z     0.000000

   3.  1.X     0.000000
        .Y     1.000000
        .Z     0.000000

   4.  1.X     0.000000
        .Y     1.000000
        .Z     0.000000

   5.  1.X     0.000000
        .Y     1.000000
        .Z     0.000000
```

B.4 CONTROL POINTS (ICONTP = 1.0 & 2.0)

A502 computes information regarding panel control points according to the type of network being used. This control point information provides the direction that the program determines for the normal on a given network. Coordinates of the control point position vector and the surface normal vector are included in the output data. Set icontp = 1.0 to obtain output to check for any errors, keeping in mind that all A502 preprocessors expect a normal that points toward the flow domain of interest.

Setting icontp = 1.0 or 2.0 gives you the following data output:

1. Control points, etc. and if icontp = 2.0, control point map for each network
2. Control point map (see section B.5.3) and singularity parameter map (see section B.5.4)

Some of the maps are the same as given for ibconp = 1.0 and are explained in the next section.

The only difference between icontp = 1.0 and 2.0 is that a map of the control points is provided after each network. The last small block of data gives the control point numbers arranged as points on the network. This provides a quick means for locating the control points on the network. Also given are the extra control point numbers.

Typical control point output is shown below, followed by descriptions of the headers:

0 CONTROL POINTS FOR NETWORK : 1

JC	JC/NAIVE		ZC			ZNC			NW	PANEL.SP	JZC	IFN	JFN	IZDC	ABUT	FSEG	TAU
1	1	69.257421	9.657244	0.067789	0.130239	-0.086818	0.987674		1	1.1	1	1	1	4	5	6	1.0000
2	2	66.740794	9.699136	0.403324	0.130239	-0.086817	0.987674		1	1.8	2	2	1	4	5	6	0.9288
3	3	58.860251	10.205590	1.410393	0.116358	-0.077565	0.990174		1	2.8	3	4	1	4	5	6	0.7331
4	4	45.454262	10.275188	1.967654	-0.000814	0.000543	1.000000		1	3.8	4	6	1	4	5	6	0.4041
5	5	33.940363	9.673142	1.089008	-0.206724	0.110813	0.972104		1	4.8	5	8	1	4	5	6	0.1127
6	6	29.946466	9.189778	0.124088	-0.484335	0.298243	0.822478		1	5.8	6	10	1	4	5	6	0.0129
7	50	29.592755	9.218568	-0.031798	-0.246375	0.164232	-0.955158		1	6.1	-2	11	1	4	4	5	1.0000
8	7	29.952906	9.190184	-0.131818	-0.482063	0.296842	-0.824318		1	6.8	7	12	1	4	4	5	0.9871
9	8	34.168659	9.680850	-1.138526	-0.206287	0.110677	-0.972212		1	7.8	8	14	1	4	4	5	0.8872
10	9	46.286324	10.286695	-1.968415	-0.000790	0.000527	-1.000000		1	8.8	9	16	1	4	4	5	0.5959
11	10	59.320294	10.198986	-1.355841	0.116371	-0.077573	-0.990172		1	9.8	10	18	1	4	4	5	0.2669
12	11	66.897914	9.691637	-0.381930	0.130233	-0.086813	-0.987675		1	10.8	11	20	1	4	4	5	0.0712
13	12	69.257434	9.657220	-0.067782	0.130234	-0.086814	-0.987675		1	10.4	12	21	1	3	1	4	0.0000
14	13	72.594460	14.448902	0.048944	1.000000	0.000000	0.000000	TK	1	1.5	13	1	2	9	-1	1	0.2595
15	14	70.200585	14.724724	0.388854	0.130239	-0.086817	0.987674		1	1.5	14	2	2	0	0	0	0.0000
16	15	62.303879	14.927195	1.375586	0.116358	-0.077565	0.990174		1	2.5	15	4	2	0	0	0	0.0000
17	16	49.044901	14.879812	1.968079	-0.000814	0.000543	1.000000		1	3.5	16	6	2	0	0	0	0.0000
18	17	37.380308	14.662393	1.251797	-0.206724	0.110813	0.972104		1	4.5	17	8	2	0	0	0	0.0000
19	18	33.488693	14.545096	0.268088	-0.484335	0.298243	0.822478		1	5.5	18	10	2	0	0	0	0.0000
20	19	33.481995	14.544849	-0.267390	-0.482063	0.296842	-0.824318		1	6.5	19	12	2	0	0	0	0.0000
21	20	37.339854	14.661015	-1.244457	-0.206287	0.110677	-0.972212		1	7.5	20	14	2	0	0	0	0.0000
22	21	48.975897	14.878876	-1.968122	-0.000790	0.000527	-1.000000		1	8.5	21	16	2	0	0	0	0.0000
23	22	62.249093	14.927993	-1.382114	0.116371	-0.077573	-0.990172		1	9.5	22	18	2	0	0	0	0.0000
24	23	70.161209	14.726613	-0.394195	0.130233	-0.086813	-0.987675		1	10.5	23	20	2	0	0	0	0.0000
25	24	72.863465	14.852403	-0.048937	0.130233	-0.086813	-0.987675		1	10.7	24	21	2	-1	0	4	0.2595
26	25	79.519863	24.837308	0.048944	1.000000	0.000000	0.000000	TK	1	11.5	25	1	4	9	-1	1	0.7595
27	26	77.068466	25.027754	0.388936	0.130238	-0.086830	0.987673		1	11.5	26	2	4	0	0	0	0.0000
28	27	69.077530	25.089486	1.375708	0.116358	-0.077576	0.990173		1	12.5	27	4	4	0	0	0	0.0000
29	28	55.837031	25.070372	1.968078	-0.000814	0.000543	1.000000		1	13.5	28	6	4	0	0	0	0.0000
30	29	44.240986	25.006040	1.392978	-0.166051	0.110706	0.979883		1	14.5	29	8	4	0	0	0	0.0000
31	30	40.408079	24.976877	0.411134	-0.633074	0.422068	0.648904		1	15.5	30	10	4	0	0	0	0.0000
32	31	40.402519	24.976811	-0.407130	-0.630690	0.420478	-0.652248		1	16.5	31	12	4	0	0	0	0.0000
33	32	44.201922	25.005586	-1.386827	-0.165840	0.110565	-0.979935		1	17.5	32	14	4	0	0	0	0.0000
34	33	55.771211	25.070065	-1.968123	-0.000790	0.000527	-1.000000		1	18.5	33	16	4	0	0	0	0.0000
35	34	69.024419	25.089737	-1.381992	0.116371	-0.077584	-0.990171		1	19.5	34	18	4	0	0	0	0.0000
36	35	77.029469	25.028349	-0.394114	0.130232	-0.086826	-0.987674		1	20.5	35	20	4	0	0	0	0.0000
37	36	79.785279	25.235364	-0.048937	0.130232	-0.086826	-0.987674		1	20.7	36	21	4	-1	0	4	0.7595
38	37	82.560381	29.584223	0.065328	0.130238	-0.086830	0.987673		1	11.2	37	1	5	2	2	2	0.0000
39	38	80.257210	29.690023	0.378334	0.130238	-0.086830	0.987673		1	11.6	38	2	5	-1	0	2	0.0739
40	39	72.260023	29.469327	1.344866	0.116358	-0.077576	0.990173		1	12.6	39	4	5	-1	0	2	0.2736
41	40	59.151698	29.389457	1.968432	-0.000814	0.000543	1.000000		1	13.6	40	6	5	-1	0	2	0.6008
42	41	47.444540	29.645382	1.411704	-0.166051	0.110706	0.979883		1	14.6	41	8	5	-1	0	2	0.8866
43	42	43.715070	29.938981	0.409938	-0.633074	0.422068	0.648904		1	15.6	42	10	5	-1	0	2	0.9855
44	49	43.354971	29.888641	-0.095535	-0.630695	0.420482	-0.652241		1	16.2	-1	11	5	-1	0	0	0.0000
45	43	43.712032	29.938874	-0.408417	-0.630690	0.420478	-0.652248		1	16.6	43	12	5	-1	0	3	0.0145
46	44	47.214532	29.642813	-1.373453	-0.165840	0.110565	-0.979935		1	17.6	44	14	5	-1	0	3	0.1134
47	45	58.355400	29.385864	-1.967891	-0.000790	0.000527	-1.000000		1	18.6	45	16	5	-1	0	3	0.3992
48	46	71.765275	29.471665	-1.403214	0.116371	-0.077584	-0.990171		1	19.6	46	18	5	-1	0	3	0.7264
49	47	80.079912	29.692739	-0.401935	0.130232	-0.086826	-0.987674		1	20.6	47	20	5	-1	0	3	0.9261
50	48	82.560425	29.584247	-0.065322	0.130233	-0.086826	-0.987674		1	20.3	48	21	5	2	3	3	1.0000

CONTRL,NW 1 12 11 3 50 1 1

	MAPC	12 X 4 (12),	COLUMNS	1 THROUGH 4	
1	1.	1	14	26	38
2	1.	2	15	27	39
3	1.	3	16	28	40
4	1.	4	17	29	41
5	1.	5	18	30	42
6	1.	6	19	31	43
7	1.	8	20	32	45
8	1.	9	21	33	46
9	1.	10	22	34	47
10	1.	11	23	35	48
11	1.	12	24	36	49
12	1.	13	25	37	50

XTRA-MAP 2

1. 44 7

Header Name	Output Description
JC	Control point number
JC/NAIVE	
ZC (X,Y,Z)	Control point X,Y,Z coordinates
ZNC (NX,NY,NZ)	Unit normal vector coordinates, NX, NY, NZ, at control point
NW	Network number
PANEL.SP	Panel number and subpanel number
JZC	
IFN	Fine grid row index of control point
JFN	Fine grid column index of control point
IZDC	Edge-matching indicator that assumes the following values: =0 Control point located at center of panel =-1 Control point on edge of network, using specified boundary condition =1-4 Control point on side (1-4) of network; used to match doublet strength on that side =9
ABUT	Index of abutment for which matching is performed by the control point (minus sign means that the matching condition is a Kutta condition, either vorticity matching or second-order pressure matching)
FSEG	Index of fundamental edge segment for the network that participates in abutment |ABUT|; not defined for a nonmatching corner control point
TAU	Fraction of distance along abutment |ABUT| (provided that ABUT $\neq$ 0)

B.5 BOUNDARY CONDITION DATA (IBCONP = 1.0)

A502 sets the generalized boundary condition equation by assigning values to various equation coefficients. If two boundary conditions are imposed at a control point, similar information about the second boundary condition is also printed. Output of boundary condition descriptors is not useful during the course of a "normal" run. However, unless you are confident that your model and inputs are correct, it is recommended that you turn on the ibconp option, at least for the datacheck run. Setting ibconp = 1.0 gives you the following four sets of data output for each network:

1. Boundary condition information
2. Boundary condition maps
3. Control point map
4. Singularity parameter maps

B.5.1 Boundary Condition Information

BOUNDARY CONDITION INFORMATION FOR NETWORK 1

AIC	JC	NW	IFN	JFN	NL	NR	CT	JCE	ZDC	ABUT	CU	CL	TUX	TUY	TUZ	TLX	TLY	TLZ	DU	DL
	BC										BET1	BET2	BET3	BET4						
0	1	1	1	1	0	3	2	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
0	1	1	1	1	0	2	4	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	2	1	2	1	0	3	2	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
0	2	1	2	1	0	2	4	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	3	1	4	1	0	3	2	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
0	3	1	4	1	0	2	4	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	4	1	6	1	0	3	2	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
0	4	1	6	1	0	2	4	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	5	1	8	1	0	3	2	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
1	5	1	8	1	8	2	4	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	-2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	6	1	10	1	0	3	2	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
2	6	1	10	1	8	2	4	0	4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	-2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	7	1	11	1	0	3	2	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
0	7	1	11	1	0	2	4	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	8	1	12	1	0	3	2	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
3	8	1	12	1	8	2	4	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	-2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	9	1	14	1	0	3	2	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
4	9	1	14	1	8	2	4	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	-2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	10	1	16	1	0	3	2	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
0	10	1	16	1	0	2	4	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	11	1	18	1	0	3	2	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
0	11	1	18	1	0	2	4	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	12	1	20	1	0	3	2	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						
0	12	1	20	1	0	2	4	0	4	4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	2	NE	0								0.0000	0.0000	0.0000	0.0000						
0	13	1	21	1	0	3	2	0	3	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1	NE	0								0.0000	0.0000	0.0000	0.0000						

Header Name	Output Description
AIC	AIC row number
BC	=1 First (source) boundary condition
	=2 Second (doublet) boundary condition
JC	Control point number
NW	Network number
IFN	Fine grid row index of control point
JFN	Fine grid column index of control point
NL	Parameter used to choose coefficients on left side of equation
NR	Parameter used to choose coefficients on right side of equation
CT	=1.0 Boundary condition involving normal components of perturbation mass flux vector; DU = DL = TU = TL = 0
	=4.0 Boundary condition involving perturbation potential only; CU = CL = TU = TL = 0
	0=2.0 Other boundary condition
JCE	Extra control point index (for two-point boundary conditions)
ZDC	Same as IZDC (see subsection B.4)
ABUT	Abutment number for which the control point does matching (negative if C_p or vorticity matching)
CU, CL	Coefficients of normal perturbation mass flux vector components on upper and lower surfaces, respectively

Header Name	Output Description
TUX,TUY,TUZ TLX,TLY,TLZ	Perturbation velocity vector coefficients on upper and lower surfaces, respectively
DU, DL	Perturbation potential coefficients on upper and lower surfaces, respectively
BET1,BET2,BET3,BET4	Value of right side of boundary condition equation

B.5.2 Boundary Condition Maps

BOUNDARY CONDITION MAPS FOR NETWORK : 1

AIC(BC1)		1.	2.	3.	4.	5.
1.	1.	0	0	0	0	0
2.	1.	0	0	0	0	0
3.	1.	0	0	0	0	0
4.	1.	0	0	0	0	0
5.	1.	0	0	0	0	0
6.	1.	0	0	0	0	0
7.	1.	0	0	0	0	0
8.	1.	0	0	0	0	0
9.	1.	0	0	0	0	0
10.	1.	0	0	0	0	0
11.	1.	0	0	0	0	0
12.	1.	0	0	0	0	0
13.	1.	0	0	0	0	0
14.	1.	0	0	0	0	0
15.	1.	0	0	0	0	0
16.	1.	0	0	0	0	0
17.	1.	0	0	0	0	0
18.	1.	0	0	0	0	0
19.	1.	0	0	0	0	0
20.	1.	0	0	0	0	0
21.	1.	0	0	0	0	0

AIC(BC2)		1.	2.	3.	4.	5.
1.	1.	0	6	0	18	0
2.	1.	0	7	0	19	30
3.	1.	0	0	0	0	0
4.	1.	0	8	0	20	31
5.	1.	0	0	0	0	0
6.	1.	0	9	0	21	32
7.	1.	0	0	0	0	0
8.	1.	1	10	0	22	33
9.	1.	0	0	0	0	0
10.	1.	2	11	0	23	34
11.	1.	0	0	0	0	35
12.	1.	3	12	0	24	36
13.	1.	0	0	0	0	0
14.	1.	4	13	0	25	37
15.	1.	0	0	0	0	0
16.	1.	0	14	0	26	38
17.	1.	0	0	0	0	0
18.	1.	0	15	0	27	39
19.	1.	0	0	0	0	0
20.	1.	0	16	0	28	40
21.	1.	5	17	0	29	0

Header Name	Output Description
AIC(BC1)	AIC row indices for first (source) boundary conditions
AIC(BC2)	AIC row indices for second (doublet) boundary conditions
SOURCE TYPE	Type of source network: =0.0 No sources exist on the particular network =1.0 Sources exist on network
DOUBLET TYPE	Type of doublet network: =0.0 No doublets exist on network =12.0 Regular doublets exist on network =18.0 Network is type 18 =20.0 Network is type 20
B. C. MAP	Map of first boundary condition; consists of sequence numbers of unknown singularity parameters associated with boundary conditions: =0.0 No boundary condition applied; associated singularity parameter directly specified via input ≠0.0 Boundary condition corresponds to sequence number of singularity parameter

B.5.3 Control Point Map

CONTROL POINT MAP FOR NETWORK : 1

C.P.	MAP	1.	2.	3.	4.	5.
1.	1.	1	14	0	26	38
2.	1.	2	15	0	27	39
3.	1.	0	0	0	0	0
4.	1.	3	16	0	28	40
5.	1.	0	0	0	0	0
6.	1.	4	17	0	29	41
7.	1.	0	0	0	0	0
8.	1.	5	18	0	30	42
9.	1.	0	0	0	0	0
10.	1.	6	19	0	31	43
11.	1.	7	0	0	0	44
12.	1.	8	20	0	32	45
13.	1.	0	0	0	0	0
14.	1.	9	21	0	33	46
15.	1.	0	0	0	0	0
16.	1.	10	22	0	34	47
17.	1.	0	0	0	0	0
18.	1.	11	23	0	35	48
19.	1.	0	0	0	0	0
20.	1.	12	24	0	36	49
21.	1.	13	25	0	37	50

Header Name	Output Description
C.P. MAP	Control point indices (JC values) for all control points in a network

B.5.4 Singularity Parameter Maps

Singularity parameter map data is identical to that listed for the boundary condition map. Integer values printed are singularity parameters, both known and unknown, associated with each control point of each network. The first matrix listed contains the source singularity parameter sequence numbers, while the second matrix includes singularity parameter sequence numbers for doublets.

> **Note:** Sequence numbers of the known singularity parameters follow those of the unknown singularity parameters. In other words, if numbers 1 to XXX identify all unknown singularity parameters (e.g., doublet singularities), numbers XXX+1 to nsngt identify all known singularity parameters in the problem; e.g., source singularities with indirect mass flux or velocity boundary conditions.

Singularity parameters are written to local file FTO9 as a binary file (see CYBER/CRAY binary file restriction noted above). This file is used with restart runs, in conjunction with or independent of the AIC file. Details of restarting an A502 run are given in section 5.

The singularity parameters are also written as a coded file to unit 98. Parameters are written network by network, with source singularities written first, followed by doublet singularities for each control point in the network. Each column of numbers on unit 98 represents singularity parameters for a different solution.

The following is an example of output for the singularity parameter maps:

SINGULARITY PARAMETER MAPS FOR NETWORK : 1

SRC	SP-S	1.	2.	3.	4.	5.
1.	1.	0	0	0	0	0
2.	1.	0	165	0	175	0
3.	1.	0	0	0	0	0
4.	1.	0	166	0	176	0
5.	1.	0	0	0	0	0
6.	1.	0	167	0	177	0
7.	1.	0	0	0	0	0
8.	1.	0	168	0	178	0
9.	1.	0	0	0	0	0
10.	1.	0	169	0	179	0
11.	1.	0	0	0	0	0
12.	1.	0	170	0	180	0
13.	1.	0	0	0	0	0
14.	1.	0	171	0	181	0
15.	1.	0	0	0	0	0
16.	1.	0	172	0	182	0
17.	1.	0	0	0	0	0
18.	1.	0	173	0	183	0
19.	1.	0	0	0	0	0
20.	1.	0	174	0	184	0
21.	1.	0	0	0	0	0

DBL	SP-S	1.	2.	3.	4.	5.
1.	1.	98	6	0	18	41
2.	1.	97	7	0	19	30
3.	1.	0	0	0	0	0
4.	1.	96	8	0	20	31
5.	1.	0	0	0	0	0
6.	1.	95	9	0	21	32
7.	1.	0	0	0	0	0
8.	1.	1	10	0	22	33
9.	1.	0	0	0	0	0
10.	1.	2	11	0	23	34
11.	1.	85	0	0	0	35
12.	1.	3	12	0	24	36
13.	1.	0	0	0	0	0
14.	1.	4	13	0	25	37
15.	1.	0	0	0	0	0
16.	1.	87	14	0	26	38
17.	1.	0	0	0	0	0
18.	1.	88	15	0	27	39
19.	1.	0	0	0	0	0
20.	1.	89	16	0	28	40
21.	1.	5	17	0	29	41

AFTER NW 1 HAVING 40 AIC ROWS, 40 CUM

Header Name	Output Description
SCR	Source singularity parameter maps
SP-S	Final singularity parameter (SP) indexing scheme

B.6 EDGE DOWNWASH CONDITIONS

Note: This printout section has been revised (iedgep = 1.0). A complete explanation of the output is not available at this time. The following describes the outdated version of the printout for edge downwash conditions.

The printout of edge downwash conditions consists of edge downwash condition data, in addition to panel center control point information printed for all edge control points. Set the parameter nexdgn = 1 to print associated parameters. Invoking this print option also affects the listing of aerodynamic data.

The following is a sample of the revised edge downwash condition printout:

```
- SUCCESS        1
EIVC MATCH:  JCN   5  NW  1  SIDE 4  ABUT   5  FD SEG   6  KSGN  1  TAU-JC  0.11271230
             PANEL: NW  1  ROW  4  COL  1  SIDE  4  LTH/EDGE  7.03770756  TAUMIN  0.02573334  TAUMAX  0.19969125
              SGN  1  LE  1  MATCH0000000000

- SUCCESS        1
EIVC MATCH:  JCN   5  NW  1  SIDE 4  ABUT   5  FD SEG   6  KSGN  1  TAU-JC  0.11271230
             PANEL: NW  4  ROW  5  COL  1  SIDE  4  LTH/EDGE  8.07878548  TAUMIN  0.00000000  TAUMAX  0.19969125
              SGN -1  LE  2  MATCH0000000001

MATCHING AT JC   5  NW   1  IFN,JFN   8   1   ZCH   33.827206    9.313074    1.105990
        SIGN   1  NW   1   PANEL     4   IPAN   4   JPAN   1   SIDE 4  WINGA
        SIGN  -1  NW   4   PANEL    50   IPAN   5   JPAN   1   SIDE 4  BODYU

- SUCCESS        1
EIVC MATCH:  JCN   6  NW  1  SIDE 4  ABUT   5  FD SEG   6  KSGN  1  TAU-JC  0.01286667
             PANEL: NW  1  ROW  5  COL  1  SIDE  4  LTH/EDGE  1.04107792  TAUMIN  0.00000000  TAUMAX  0.02573334
              SGN  1  LE  1  MATCH0000000000

- SUCCESS        1
EIVC MATCH:  JCN   6  NW  1  SIDE 4  ABUT   5  FD SEG   6  KSGN  1  TAU-JC  0.01286667
             PANEL: NW  4  ROW  5  COL  1  SIDE  4  LTH/EDGE  8.07878548  TAUMIN  0.00000000  TAUMAX  0.19969125
              SGN -1  LE  2  MATCH0000000001
```

Header Name	Output Description
IPC	Control point number
IP	Panel number
IS	Side number
WX,WY,WZ	Components of mass flux vectors

B.7 SINGULARITY PARAMETER SOLUTION FILE

Singularity parameters (source and doublet strength) are obtained from linear equation solutions. This data output provides singularity strengths and derivatives; i.e., the shed vorticity strength along the trailing edge of winglike surfaces. For normal runs this data is of littlle interest, but it may help confirm some local flow irregularities. The output options are ordered in from minimum to maximum amount of output. And the latter can be a very large amount of printout. The output options are accumulative, i.e., lower number option output is included in the higher number option output. All the singularity parameter data is output after the following:

```
                              SIMULTANEOUS SOLUTION NUMBER    1

MACH NUMBER =   0.60000    ANGLE OF ATTACK =   4.00000    SIDESLIP ANGLE =   0.00000    FREESTREAM SPEED =   1.00000
COMPRESSIBILITY FACTOR =   0.80000    COMPRESSIBILITY ANGLE OF ATTACK =   4.00000    COMPRESSIBILITY ANGLE OF SIDESLIP =   0.00000
FREESTREAM VELOCITY = (   0.99756,   0.00000,   0.06976)    COMPRESSIBILITY DIRECTION = (   0.99756,   0.00000,   0.06976)
```

B.7.1 Wake Singularity Grids (ISINGS ≥ 2.)

For isings ≥ 2. the singularity grids are output for all the wake singularities (type 6, 18, and 20 networks). The singularity grid is computed using singularity distribution definitions. Singularity distribution is evaluated at nine points over each panel. Data is given for three points, two edge points and a midpoint, in two directions with increasing row and column numbers. A printout sample follows:

SINGULARITY GRID

IP	I	J	X	Y	Z	SO	DO	DX	DY	DZ	DM	DN	DMP	DNP
73	1	1	69.47370	9.21050	0.00000	0.00000	-3.59370	0.00000	-0.02024	0.00000	0.00000	-0.01684	0.02024	0.01123
73	2	1	84.73685	9.21050	0.00000	0.00000	-3.59370	0.00000	-0.02024	0.00000	0.00000	-0.01920	0.02024	0.00640
73	3	1	100.00000	9.21050	0.00000	0.00000	-3.59370	0.00000	-0.02024	0.00000	0.00000	-0.02024	0.02024	0.00000
73	1	2	73.06985	14.60525	0.00000	0.00000	-3.63644	0.00000	0.00440	0.00000	0.00000	0.00366	-0.00440	-0.00244
73	2	2	86.53492	14.60525	0.00000	0.00000	-3.63644	0.00000	0.00440	0.00000	0.00000	0.00417	-0.00440	-0.00139
73	3	2	100.00000	14.60525	0.00000	0.00000	-3.63644	0.00000	0.00440	0.00000	0.00000	0.00440	-0.00440	0.00000
73	1	3	76.66600	20.00000	0.00000	0.00000	-3.54628	0.00000	0.02903	0.00000	0.00000	0.02416	-0.02903	-0.01610
73	2	3	88.33300	20.00000	0.00000	0.00000	-3.54628	0.00000	0.02903	0.00000	0.00000	0.02754	-0.02903	-0.00918
73	3	3	100.00000	20.00000	0.00000	0.00000	-3.54628	0.00000	0.02903	0.00000	0.00000	0.02903	-0.02903	0.00000
74	1	1	76.66600	20.00000	0.00000	0.00000	-3.54628	0.00000	0.01453	0.00000	0.00000	0.01209	-0.01453	-0.00806
74	2	1	88.33300	20.00000	0.00000	0.00000	-3.54628	0.00000	0.01453	0.00000	0.00000	0.01379	-0.01453	-0.00460
74	3	1	100.00000	20.00000	0.00000	0.00000	-3.54628	0.00000	0.01453	0.00000	0.00000	0.01453	-0.01453	0.00000
74	1	2	79.99950	25.00000	0.00000	0.00000	-2.62338	0.00000	0.35463	0.00000	0.00000	0.29506	-0.35463	-0.19672
74	2	2	89.99975	25.00000	0.00000	0.00000	-2.62338	0.00000	0.35463	0.00000	0.00000	0.33643	-0.35463	-0.11215
74	3	2	100.00000	25.00000	0.00000	0.00000	-2.62338	0.00000	0.35463	0.00000	0.00000	0.35463	-0.35463	0.00000
74	1	3	83.33300	30.00000	0.00000	0.00000	0.00000	0.00000	0.69472	0.00000	0.00000	0.57804	-0.69472	-0.38538
74	2	3	91.66650	30.00000	0.00000	0.00000	0.00000	0.00000	0.69472	0.00000	0.00000	0.65907	-0.69472	-0.21970
74	3	3	100.00000	30.00000	0.00000	0.00000	0.00000	0.00000	0.69472	0.00000	0.00000	0.69472	-0.69472	0.00000

Header Name	Output Description
IP	Panel number
I	Panel division counter corresponding to increases in same direction as row counter, NM; I = 1 to 3
J	Panel division counter corresponding to increases in same direction as column counter, NN; J = 1 to 3
X,Y,Z	Point coordinates
SO	Source strength
DO	Doublet strength
DX,DY,DZ	Gradients of doublet strength in user-defined coordinate system
DM	Gradient of doublet strength in row direction
DN	Gradient of doublet strength in column direction
DMP	Gradient of doublet strength normal to row direction
DNP	Gradient of doublet strength normal to column direction

B.7.2 Singularity Parameters (ISINGS ≥ 3.)

For isings ≥ 3.0, all the singularity parameters strengths for both doublet and source are output in a single array for a solution. They are listed in order by sequence number (given on the left side for the first column of data), as defined in the singularity map (see section B.5.4). The unknown strengths are listed first, followed by the known strengths. The list is given row by row, ten parameters per row.

For each wake network, a nondimensional integral of the doublet strength is evaluated along edge1 of a network (wake leading edge). The integral is evaluated as a vector. For a thin wing-like surface in the horizontal plane, the y component of the integral will be approximately equal to the lift coefficient of the input configuration.

The integral of doublet strength is listed at the end of this output. It is defined as:

$$\frac{1}{V_\infty \, \mathrm{sref}} \int_{\mathrm{edge1}} \mu \, \bar{t}_1 \, ds$$

where

μ is the doublet strength

$\bar{t}_1$ is a unit vector along edge 1

s is the distance along edge 1

A sample of the output follows:

```
                                                          S
  1.   -1.8386E+00 -2.5626E+00 -2.7435E+00 -3.1249E+00  3.8139E-01  3.6828E+00  3.8111E+00  3.3375E+00  1.0759E+00 -1.4330E+00
 11.   -2.4957E+00 -2.9080E+00 -3.0184E+00 -1.8170E+00 -9.1390E-02  2.2616E-01  4.4206E-02  2.6039E+00  2.8010E+00  2.7230E+00
 21.    1.2788E+00 -8.4638E-01 -2.0907E+00 -2.4930E+00 -2.2966E+00 -9.2797E-01  2.6411E-01  2.4216E-01 -2.7630E-02  1.3263E+00
 31.    1.5531E+00  8.0577E-01 -3.6551E-01 -1.2597E+00 -1.5402E+00 -1.4726E+00 -1.0223E+00 -1.7454E-01  5.9318E-01  7.0079E-01
 41.    8.1321E-01  9.2894E-01  9.0276E-01  2.6345E-01 -6.1253E-01 -1.2148E+00 -2.8759E+00 -3.4510E+00 -3.1333E+00 -2.9038E+00
 51.   -2.6465E+00 -2.4528E+00 -1.8508E+00 -8.9381E-01 -3.8061E-01 -7.0929E-03  2.6670E-01  7.6316E-02 -3.4903E+00 -3.2429E+00
 61.   -2.9578E+00 -2.6962E+00 -2.5223E+00 -1.8997E+00 -8.2662E-01 -2.8726E-01  7.8889E-02  3.2302E-01  1.1651E-01 -3.4163E+00
 71.   -3.0514E+00 -2.6726E+00 -2.4284E+00 -2.8161E+00 -2.0644E+00 -4.8276E-01  1.8159E-01  2.3858E-01  3.2171E-01  1.0736E-01
 81.   -3.3240E+00 -2.7982E+00 -2.3977E+00 -2.1385E+00 -2.6461E+00 -3.1127E+00 -2.2137E+00 -2.9719E-01  4.1705E-01  3.8139E-01
 91.    1.6435E-01  2.1182E-01  1.2541E-02 -1.9394E+00  5.8884E-01  3.1774E+00  4.0520E+00  3.9765E+00  3.7595E+00  3.8070E+00
101.    3.6077E+00 -3.3163E+00 -2.7876E+00 -2.2606E+00 -1.8428E+00 -1.5122E+00  5.4440E-01  2.7472E+00  3.5532E+00  3.6599E+00
111.    3.8079E+00  3.6122E+00 -3.2436E+00 -2.5934E+00 -1.9457E+00 -1.3121E+00 -6.6335E-01  7.1065E-01  2.2633E+00  2.9382E+00
121.    3.3920E+00  3.7296E+00  3.5805E+00 -3.1895E+00 -2.4392E+00 -1.8228E+00 -1.1686E+00 -5.2437E-01  7.5088E-01  2.1748E+00
131.    2.8239E+00  3.2940E+00  3.6478E+00  3.5055E+00 -9.0524E+01 -9.0437E+01 -9.0201E+01 -9.0090E+01 -8.9921E+01 -8.9697E+01
141.   -8.9652E+01 -8.9999E+01 -2.0355E-01 -8.9959E+01 -2.0033E-01 -8.9854E+01 -1.9938E-01 -8.9706E+01 -1.9714E-01 -8.9602E+01
151.   -8.9582E+01 -8.9718E+01 -3.5951E+00 -3.5951E+00 -3.6386E+00 -2.6316E+00  8.9729E+01  8.9814E+01  9.0028E+01  9.0102E+01
161.    9.3697E+01  9.3813E+01  9.4017E+01  9.4029E+01 -1.9882E-01 -1.8515E-01 -6.8944E-02  9.7293E-02  5.8629E-01  6.7467E-01
171.    2.3379E-01  7.0545E-02 -4.7017E-02 -6.1019E-02 -1.9882E-01 -1.8515E-01 -6.8944E-02  9.7293E-02  5.8627E-01  6.7465E-01
181.    2.3379E-01  7.0545E-02 -4.7016E-02 -6.1019E-02  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  7.6731E-01
191.    3.8315E-01  2.4464E-01  1.7242E-01  1.2962E-01  8.1297E-02  3.1379E-02 -6.7500E-04 -4.1303E-02 -1.1788E-01  7.4131E-01
201.    3.4743E-01  2.0753E-01  1.3490E-01  1.3554E-01  5.0113E-02 -2.0932E-02 -6.1829E-02 -7.8844E-02 -1.5501E-01  7.0450E-01
211.    2.9689E-01  1.5501E-01  8.1824E-02  7.6827E-02 -1.5971E-02 -8.2894E-02 -1.1754E-01 -1.3193E-01 -2.0751E-01  6.7847E-01
221.    2.6115E-01  1.1788E-01  4.4285E-02  1.0235E-03 -4.7553E-02 -9.7433E-02 -1.2927E-01 -1.6947E-01 -2.4463E-01


NON-DIMENSIONAL INTEGRAL OF DOUBLET STRENGTH = (     0.0346630,      0.0519967,      0.0000000)
```

Header Name	Output Description
S	Source and doublet strength at singularity parameter locations

B.7.3 Singularity Parameters in Network Form (ISINGS ≥ 4.)

For isings ≥ 4. the singularity parameters are output in an array form similar to their layout on the network. This is the same information as presented in the singularity parameter output (section B.7.2), but in a more useful form for locating the singularity value on a network. The first block contains the source strength at the panel center locations. The second block contains the doublet strength at the network points and at mid-points between the network points.

A printout sample follows:

```
NETWORK/SD            1          1
     SMAT    10 X    2  (  10),     COLUMNS    1 THROUGH   2
  1   1.   -0.198818  -0.198817
  2   1.   -0.185146  -0.185146
  3   1.   -0.068944  -0.068944
  4   1.    0.097293   0.097293
  5   1.    0.586292   0.586266
  6   1.    0.674669   0.674652
  7   1.    0.233794   0.233793
  8   1.    0.070545   0.070545
  9   1.   -0.047017  -0.047016
 10   1.   -0.061019  -0.061019
     DMAT    21 X    5  (  21),     COLUMNS    1 THROUGH   5
  1   1.    3.987110   3.691641   3.376666   2.610965   0.823998
  2   1.    4.054839   3.818822   3.511063   2.807562   1.335891
  3   1.    3.796946   3.719912   3.481685   2.838371   1.481028
  4   1.    3.182575   3.342791   3.220404   2.729700   1.560410
  5   1.    2.256702   2.572540   2.633245   2.278834   1.370391
  6   1.    0.594026   1.081173   1.309232   1.284090   0.810576
  7   1.   -1.096689  -0.620105  -0.300140  -0.102698   0.041489
  8   1.   -1.831903  -1.428219  -1.126080  -0.840837  -0.360432
  9   1.   -2.467716  -2.339414  -2.180130  -1.878145  -1.108360
 10   1.   -2.558319  -2.491421  -2.371892  -2.085889  -1.255019
 11   1.   -2.642381  -2.716922  -2.682290  -2.336719  -1.535699
 12   1.   -2.739995  -2.904336  -2.897086  -2.488590  -1.468138
 13   1.   -2.809403  -2.934165  -2.891395  -2.473323  -1.397020
 14   1.   -3.122460  -3.014875  -2.804152  -2.292568  -1.017124
 15   1.   -2.935520  -2.678206  -2.395136  -1.844059  -0.747799
 16   1.   -2.209231  -1.812131  -1.441343  -0.922555  -0.169226
 17   1.   -1.075484  -0.744644  -0.448657  -0.137617   0.346656
 18   1.   -0.291192  -0.085061   0.051045   0.273130   0.601669
 19   1.    0.200996   0.182039   0.195263   0.331900   0.702291
 20   1.    0.422144   0.235971   0.143168   0.256146   0.712255
 21   1.    0.393413   0.055205  -0.169609  -0.012414   0.823998
```

B.7.4 Singularity Grids (ISINGS = 5.)

For isings = 5. the singularity grids are output for all networks. This output is in the same form as the wake singularity grids (see section B.7.1) and thus, all the output parameters have been previouly defined.

A printout sample follows:

SINGULARITY GRID

IP	I	J	X	Y	Z	SO	DO	DX	DY	DZ	DM	DN	DMP	DNP
1	1	1	69.47370	9.21050	0.00000	-0.20388	3.97653	-0.08428	0.00353	0.00536	0.08428	-0.04381	0.00242	0.07204
1	2	1	66.62775	9.39560	0.39155	-0.19882	4.05198	0.02705	-0.06419	-0.00729	-0.03186	-0.03841	0.06234	-0.05853
1	3	1	63.78180	9.58070	0.78310	-0.19376	3.79311	0.14126	-0.09425	-0.01679	-0.14800	-0.00007	0.08436	-0.17035
1	1	2	73.06985	14.60525	0.00000	-0.20388	3.68278	-0.09616	0.00785	0.00645	0.09642	-0.04680	-0.00273	0.08434
1	2	2	70.19187	14.74232	0.39155	-0.19882	3.81108	-0.00798	-0.04593	-0.00358	0.00525	-0.04264	0.04646	-0.01916
1	3	2	67.31390	14.87940	0.78310	-0.19376	3.71332	0.06814	-0.07623	-0.01081	-0.07249	-0.02564	0.07275	-0.09945
1	1	3	76.66600	20.00000	0.00000	-0.20388	3.36962	-0.07407	-0.01047	0.00351	0.07353	-0.04980	0.01321	0.05569
1	2	3	73.75600	20.08905	0.39155	-0.19882	3.50394	-0.02037	-0.05750	-0.00386	0.01792	-0.05914	0.05841	-0.01536
1	3	3	70.84600	20.17810	0.78310	-0.19376	3.47492	0.03425	-0.08279	-0.00936	-0.03768	-0.04989	0.08179	-0.07497
2	1	1	63.78180	9.58070	0.78310	-0.23085	3.79311	0.08975	-0.05992	-0.00926	-0.09135	-0.00007	0.05789	-0.10815
2	2	1	58.77615	9.67740	1.37890	-0.19686	3.17743	0.15175	-0.04606	-0.01130	-0.15287	0.04584	0.04249	-0.15190
2	3	1	53.77050	9.77410	1.97470	-0.16288	2.25156	0.21302	-0.05750	-0.01530	-0.21440	0.07031	0.05246	-0.20922
2	1	2	67.31390	14.87940	0.78310	-0.21908	3.71332	0.03194	-0.05132	-0.00565	-0.03310	-0.02498	0.05084	-0.05529
2	2	2	62.29155	14.95100	1.37890	-0.18515	3.33752	0.11174	-0.07099	-0.01124	-0.11328	0.00291	0.06903	-0.13263
2	3	2	57.26920	15.02260	1.97470	-0.15122	2.56733	0.18941	-0.08770	-0.01649	-0.19125	0.03208	0.08429	-0.20653
2	1	3	70.84600	20.17810	0.78310	-0.20730	3.47492	0.01790	-0.07190	-0.00656	-0.01921	-0.04989	0.07185	-0.05516
2	2	3	65.80695	20.22460	1.37890	-0.17343	3.21436	0.08169	-0.10195	-0.01216	-0.08349	-0.03952	0.10108	-0.12500
2	3	3	60.76790	20.27110	1.97470	-0.13956	2.62762	0.14589	-0.11010	-0.01605	-0.14777	-0.01069	0.10833	-0.18291
3	1	1	53.77050	9.77410	1.97470	-0.17254	2.25156	0.20029	-0.04901	0.00516	-0.19935	0.07031	0.05272	-0.19384
3	2	1	45.50375	9.62090	1.96805	-0.08077	0.58884	0.20307	-0.01008	0.00521	-0.20285	0.10425	0.01384	-0.17456
3	3	1	37.23700	9.46770	1.96140	0.01099	-1.10283	0.20700	-0.03351	0.00532	-0.20635	0.08693	0.03734	-0.19083
3	1	2	57.26920	15.02260	1.97470	-0.16080	2.56733	0.17498	-0.08082	0.00453	-0.17386	0.02981	0.08322	-0.19043
3	2	2	49.02892	14.90917	1.96805	-0.06894	1.07587	0.19456	-0.06208	0.00502	-0.19369	0.05626	0.06475	-0.19633
3	3	2	40.78865	14.79575	1.96140	0.02291	-0.62510	0.21780	-0.07033	0.00562	-0.21681	0.06228	0.07333	-0.22024
3	1	3	60.76790	20.27110	1.97470	-0.14906	2.62762	0.14475	-0.10934	0.00377	-0.14376	-0.01069	0.11063	-0.18109
3	2	3	52.55410	20.19745	1.96805	-0.05711	1.30396	0.17940	-0.09723	0.00465	-0.17853	0.01860	0.09884	-0.20321
3	3	3	44.34030	20.12380	1.96140	0.03483	-0.30524	0.21417	-0.09754	0.00554	-0.21329	0.03763	0.09	

APPENDIX C: LIST OF ALL INPUT BOUNDARY CONDITIONS

To support program development and new applications, the original program specifications required execution of a wide variety of boundary conditions. However, years of experience in solving potential flow problems have demonstrated that only a few boundary conditions are effective and economical. The inputs for these conditions are given in section 5.9, "Fundamental Network Geometry and Boundary Conditions."

An occasional application by an expert user may require the specification of an unusual boundary condition. Therefore, all the inputs for boundary conditions for A502 are given in this appendix. Some of these boundary conditions have been used only in the early development stage of this program. Others, such as the wake boundary conditions, represent recent development work in wake modeling.

In exercising the different options described in appendix C, please review the first three sections. These sections describe the basic information needed to define these boundary conditions:

C.1 General Boundary Condition Equations

C.2 Velocity Computation

C.3 Input Data Common to All Networks and Boundary Conditions

The last three sections define the detailed input required to describe these boundary conditions. To help clarify all the possible options, they have been grouped by complexity and frequency of use, starting with the simplest, most frequently used conditions:

C.4 Defining a Surface Network and Commonly Used Boundary Conditions– Describes all the commonly input boundary condtions that can be specified by a single parameter (kt).

C.5 Defining a Surface Network and Boundary Conditions by Specifying the Left and Right Terms of the General Boundary Equations–Explains how to specify specific right and left-hand side terms of the general boundary condition.

C.6 Defining a Surface Network and Boundary Conditions by Specifying Coefficients of the General Boundary Equations–Gives the details for specifying the coefficients of the general boundary conditions. Thus, linear combinations of terms can be defined as boundary conditions. All of the simplified ways to input boundary conditions are eventually translated into this form and are available in the printout.

> **CAUTION:** While there are no known program problems with this area of the computer program, some of these options have not been used in some time and may not operate as stated. To check out an uncommon boundary condition, turn on the boundary condition diagnostic print option (ibconp=1.0 in $PRINT), and see section B.5 for explanation of the outputs. Also, the parameters used to

define the boundary conditions are output for each network in the Quick Summary of A502 Inputs. To see if the boundary conditions have been satisfied, check the appropriate surface flow properties given when ioutpr = 0.0 in $PRINT. Also, consider contacting A502 support personnel listed in the front of the A502 printout.

The restrictions and comments given for network inputs on the first page of section 5.9, "Fundamental Network Geometry and Boundary Conditions," still apply and are not repeated here.

The network geometry generated in A502, as described in appendix D, can be used in conjunction with all the boundary conditions specified in this appendix. To reduce the complexity of this presentation the network geometry has been assumed to be generated outside of A502. For additional details, see appendix D.

To start with, let us define the general boundary condition equations as formulated for the program.

C.1 GENERAL BOUNDARY CONDITION EQUATIONS

Two boundary conditions can be defined for each panel center control point of a network. This is possible since the network representation is composed of both linearly varying source and quadratically varying doublet singularities (two unknowns). Unless stated otherwise, it will be assumed that all networks are composite source/doublet networks.

- The first boundary condition is associated with the source singularity.
- The second is associated with the doublet singularity.

The general form of the boundary condition at a control point is

$$CU(\overline{w}_U \bullet \overline{n}) + TU \bullet \overline{v}_U + DU\ \phi_U + CL(\overline{w}_L \bullet \overline{n}) + TL \bullet \overline{v}_L + DL\ \phi_L = RHST$$

where

CU,CL	upper and lower surface mass flux coefficients
DU,DL	upper and lower surface potential coefficients
TU, TL	upper and lower surface velocity tangent vectors coefficients
$\overline{w}_U$, $\overline{w}_L$	upper and lower surface perturbation mass flux vectors
$\overline{v}_U$, $\overline{v}_L$	upper and lower surface perturbation velocity vectors
ϕ_U, ϕ_L	upper and lower surface perturbation potential
$\overline{n}$	upper surface unit normal vector (see page 3-14)
RHST	right-hand side term specified by nropt1 and nropt2 (see section C.5)

Two boundary condition equations of the above form are specified for each control point. These conditions are written in terms of upper and lower surface flow properties. Thus, complex boundary condition equations can be specified that involve a linear combination of the basic terms. Most of the equations specified will involve only one term on the left-hand side of the equation.

For the more complex boundary condition equations on a doublet network, the coefficients and specified flow data must be defined for all the control points (panel centers and network edge) in the order specified by the network points. For most of the commonly used doublet network boundary conditions, no additional data needs to be specified at the edge control points. The edge control points are assigned by the program to match the doublet strength across a network edge or set to be the same as the panel center control point.

The singularity parameter and control point locations for the source (nts) and different doublet (ntd) networks are illustrated in figures C-1 and C-2. The different network types are identified by the nts and ntd parameter values.

In formulating some boundary conditions, only one equation will be specified. Be careful to supply the data appropriate for either the specification of a source or a doublet singularity network. For singularities not included in the boundary condition, the nts or the ntd will be set to zero.

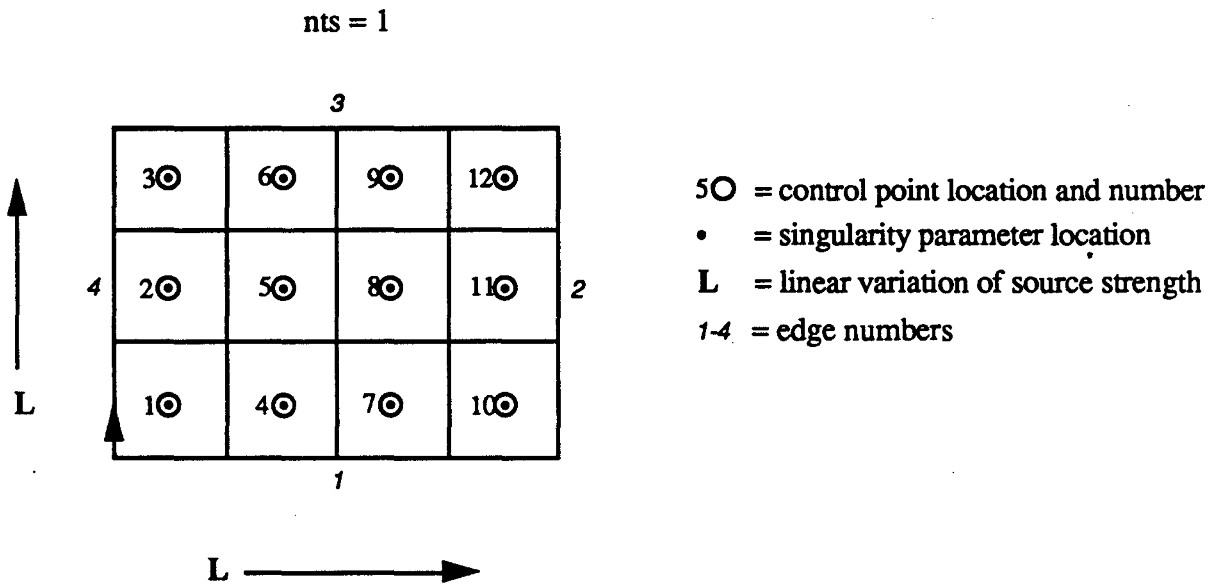


Figure C-1 Source Network Singularity Parameters and Boundary Condition Locations

5O = control point location and number
• = singularity parameter location

Q = quadratic variation of doublet strength
C = constant doublet strength
1-4 = edge numbers

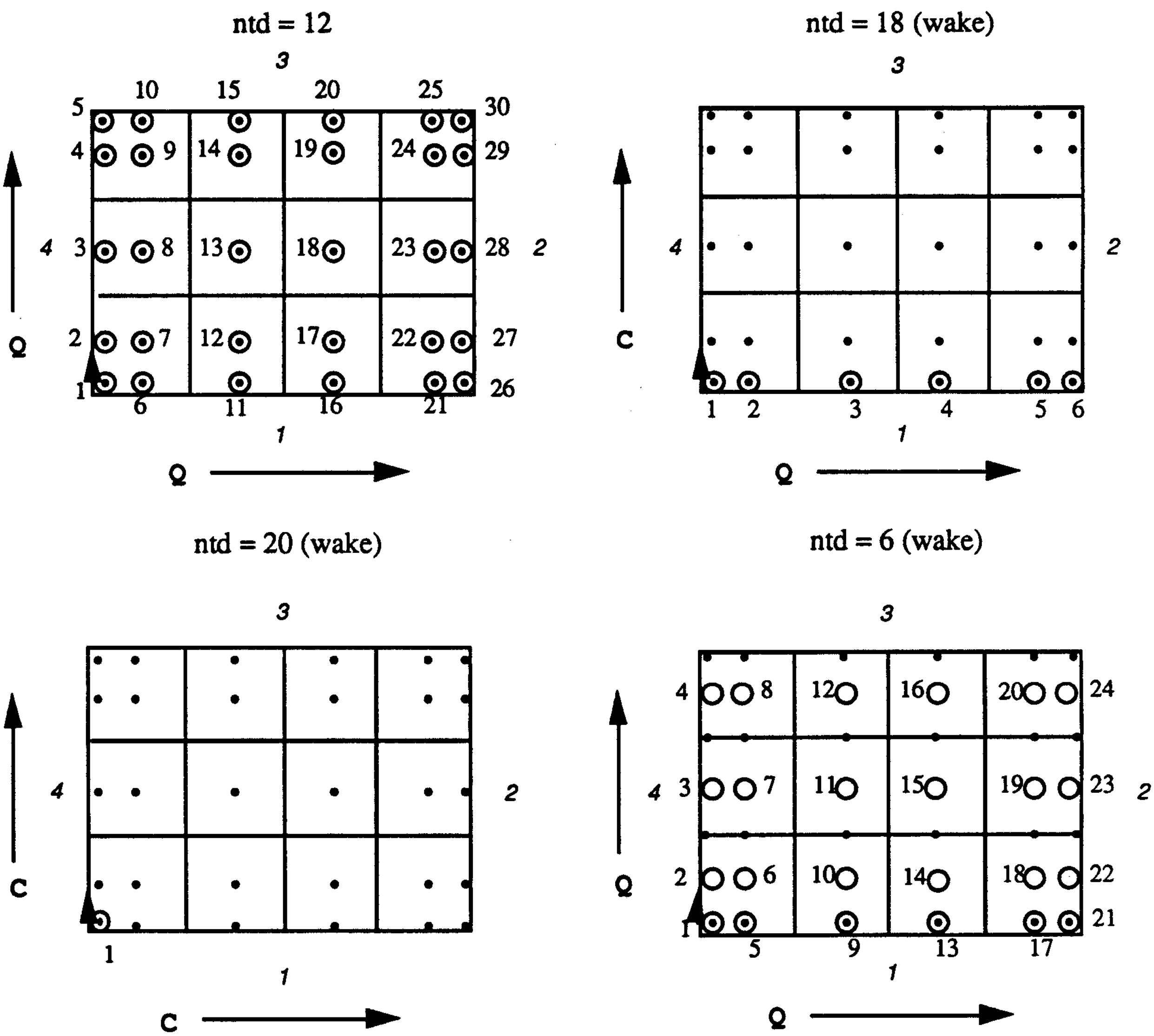


Figure C-2 Doublet Network Singularity Parameters and Boundary Condition Locations

C.2 VELOCITY COMPUTATION (ipot)

There are two methods of computing the surface velocity in A502:

1. The velocity influence coefficent method sums up the influences of all the singularities and the onset flow (ipot = 0.0). This approach is reliable but costly to compute in comparison with the second approach.
2. For closed surfaces (no holes or gaps) with interior flow equal to the onset flow ($\phi_L = 0.0$), the exterior velocity is calculated as the differences across the surface (ipot = 2.0 or -2.0). This is only a function of the local singularity strengths (source strength and doublet strength μ) and thus reduces the computer time. The upper and lower surface velocities are computed from

$$\bar{V}_u = \bar{V}_\infty + \bar{\nabla}\mu + \sigma\,\bar{n} \;,\; \bar{V}_L = \bar{V}_\infty$$

The velocity computation has been assumed for the boundary condition where kt < 30.0. The assumed values are given in the "Quick Summary of A502 Input" printout. If the selected method of computing the velocity is not acceptable, these conditions can be altered by user input. Any of the kt < 30.0 boundary conditions can be input as kt = 30.0 by specifying the individual terms and the method for computing velocity (see section C.5, page C-15, ipot parameter).

On occasion when the ϕ_L boundary condition is employed on thin closed surfaces (i.e, trailing edge flapped surfaces), the interior flow may differ from the freestream; thus the velocity computed as a function of the local singularity strength will be in error. For these regions, the best velocity computation will be from the velocity influence coefficent method. Since any boundary condition can be specified as a kt = 30.0 type of boundary condition, the general boundary condition option can be used along with specifying the method of velocity calculation (ipot = 0.0).

An option (ipot = 1.0) is available to compare upper surface flow properties computed from the singularity strength with the velocity influence coefficient method. This additional line of surface from properties printout is the second line and can be compared with the third line.

C.3 INPUT DATA COMMON TO ALL NETWORKS AND BOUNDARY CONDITIONS

! kn	Number of networks input for this group. A group network will have the boundary conditions.	
! cpnorm	=2.0, 0.0 or blank	Uses original surface normal on panels before being distorted by forced abutments (default). Printout option is listed as cpnorm = 2.0.
	= -1.0	Planar panel normal vectors are to be used in the boundary conditions (old default). Printout option is listed as cpnorm = –1.0.
	=1.0	If the curved panel normal vectors are to be used in the boundary conditions.

! Option to interchange network rows and columns.

! mnswch	=0.0	No change to network (default).
	=1.0	Network rows and columns are to be interchanged.
		CAUTION: This option changes the direction of the upper surface unit normal and the network edge numbers etc.

! Option to increase or decrease network panel density
! Simple linear interpolation is used to increase the number of panels.

! dnsmsh	=0.0	No change to the network.(default).
	=1.0	If panel density is to be changed (e.g., doubled, halved, etc).
! dn	Parameter to specify alteration of the number of panel columns.	
	= 1.0	Do not change the number of panel columns.
	= 2.0	Double the number of panel columns.
	= 3.0	Triple the number of panel columns.
	=etc.	
	= minus a number will reduce the number of panel columns. The number must be exactly divisible by the number of panel columns (nn-1).	
! dm	Parameter to alter the number of panel rows. Inputs are the same as dn, but applied to the panel rows.	
! nm	Number of points in a network point column (rows).	
! nn	Number of point columns in a network.	
! netname	Network name; placed in columns 71-80.	
! x,y,z	Orthogonal coordinates of a network point; first point of each column starts on a new line; see figure 5-8 for order of points.	
! bet1(i)	Specified flow quantity for the right-hand side of the *first boundary condition*. One line of input for each panel center control point of the *source network*. Each line contains one to four values, corresponding to the number of solutions (i = 1, nacase).	
! bet2(i)	Same as bet1(i) but applied to the *second boundary condition*. One line of input for each panel center and edge control point of the *doublet network*. The order of the data is in the same as the numbering of control points for a network.	

C.4 DEFINING A SURFACE NETWORK AND COMMONLY USED BOUNDARY CONDITIONS

Some of the more frequently used boundary conditions can be specified with a single input (kt). This collection of boundary conditions has a kt value less than 30. Because of the additional inputs required, the kt = 30 option is described in the next two sections of this appendix. The boundary conditions are presented in four categories and described in the following tables:

- Table C-1, Mass Flux
- Table C-2, Velocity
- Table C-3, Potential
- Table C-4, Wake

Within each category, the most used conditions are given first, with the older conditions at the end. Some of these parameters are defined in sections C.1 through C.3. Tables C-1 through C-4 list the following:

- Descriptions of boundary conditions.
- Comments concerning usage.
- Boundary condition equations. The first equation is associated with the source singularity and the second equation with the doublet singularity.
- Program parameters used to describe boundary conditions. (These are the same parameters as used in defining kt = 30.0 boundary conditions, sections C.5 and C.6.)

A summary is given below of the input data necessary to define network boundary conditions using kt values.

Input Data for Network Geometry and Boundary Conditions

```
$POINTS                                                        P1
kn                                           cpnorm            P2
kt        thw/matchw               mnswch    dnsmsh            P3
nm        nn                                          netname  P4
x11       y11       z11     x12    y12       z12               P5
x13       y13       z13 . . .                                  P5
x21       y21       z21 . . .                                  P5
:
! Data to alter panel density. Input only if dnsmsh = 1.
dn        dm                                                   P6
! First boundary condition right-hand side specified flow
! Input only if kt = 9., 4., or 14.;or thw = 1. and kt = 2. or 12.
betl(1)   betl(2)   betl(3) betl(4)   First control point      BC4
betl(1)   betl(2)   betl(3) betl(4)   Second control point     BC4
:
! To define additional networks with the same boundary conditons and
! options, repeat P4 through BC4 as required.
```

Table C-1 Mass Flux Boundary Conditions

kt	Description	Comments	Source & Doublet Boundary Conditions
1.0	Indirect condition on an impermeable thick surface.	Preferred for satisfying impermeability; substantially cheaper than the direct mass flux boundary condition option (kt = 8.0). (ipot = 2.0)	$(\overline{w}_U - \overline{w}_L) \cdot \overline{n} = -\nabla_\infty \cdot \overline{n}$ $\phi_L = 0$ [1:(5,3), 12:(7,2), 2]*
8.0	Direct condition on an impermeable thick surface.	Mathematically equivalent to kt=1.0, but numerically more robust. Useful on networks with sparse paneling and/or strong variation of flow properties; i.e., leading or trailing edge wing flaps. Significantly more expensive than kt=1.0. (ipot = 2.0)	$\overline{w}_U \cdot \overline{n} = -\nabla_\infty \cdot \overline{n}$ $\phi_L = 0$ [1:(2,3), 12:(7,2), 2]
7.0	Impermeable surface represented by sources alone. (Source network)	Can be used on nonlifting surfaces; i.e., a thick vertical fin in the plane of symmetry, or placed over doublet or composite surfaces; i.e., a radome on a fuselage. As a source network, it need not abut adjacent networks.	$\overline{w}_U \cdot \overline{n} = -\nabla_\infty \cdot \overline{n}$ [1:(2,3), 0:(0,-), 0]
9.0	Flow through surface, fanface, inlet, etc.	Commonly used to represent flow into or out from a surface; i.e., an inlet. The flow into a surface is specified at each panel center control point by inputting bet1(i) equal to minus nondimensional mass flux into the surface. (ipot = 2.0)	$\overline{w}_U \cdot \overline{n} = -\nabla_\infty \cdot \overline{n} + \text{bet1(i)}$ $\phi_L = 0$ [1:(2,7), 12:(7,2), 2]
2.0	Thin surface without thickness. (Doublet network)	Represents lifting surfaces without thickness.	$0.5\,(\overline{w}_U + \overline{w}_L) \cdot \overline{n} = -\nabla_\infty \cdot \overline{n}$ [0:(0,-), 12:(4,3), 0]

* Program parameters used to implement the boundary condition (see section C.5):
[nts:(nlopt1,nropt1), ntd:(nlopt2,nropt2), ipot]

(continued)

Table C-1 Mass Flux Boundary Conditions (continued)

kt	Description	Comments	Source & Doublet Boundary Conditions
2.0 tkw = 1.0	Thin surface with simulated thickness.	Represents lifting surface with linearized thickness. Thickness is represented by transpiration normal to the surface, and is specified by betl(i) = two times thickness slope at each panel center control point.	$(\overline{w}_U - \overline{w}_L) \bullet \overline{n} =$ betl(i) $0.5\ (\overline{w}_U + \overline{w}_L) \bullet \overline{n} = -\overline{V}_\infty \bullet \overline{n}$ [1:(5,1), 12:(4,3), 0]
3.0	Superinclined surface.	Used only on surfaces inclined ahead of the Mach cone in super-sonic flow. Boundary conditions are specified on the downstream side of the network. Causes flow to vanish into the network.	$\overline{w}_L \bullet \overline{n} = 0$ $\phi_L = 0$ [1:(3,2), 12:(7,2), 0]
4.0	Flow through a surface by specifying a perturbation mass flux.	Obsolete condition for representing flow across a surface (inlet); replaced by kt=9.0.	$\overline{w}_U \bullet \overline{n} =$ betl(i) $\phi_L = 0$ [1:(2,1), 12:(7,2), 0]

* Program parameters used to implement the boundary condition (see section C.5):
[nts:(nlopt1,nropt1), ntd:(nlopt2,nropt2), ipot]

Table C-2 Velocity Boundary Conditions

kt	Description	Comments	Source & Doublet Boundary Conditions
11.0	Velocity impermeability on a thick surface.	Standard specification of velocity impermeability, frequently used in supersonic analysis. (ipot = 2.0)	$(\overline{v}_U - \overline{v}_L) \cdot \overline{n} = -\nabla_\infty \cdot \overline{n}$ $\phi_L = 0$ [1:(14,3), 12:(7,2), 2]
15.0	Velocity impermeability on a thick surface.	Mathematically equivalent to kt=11. Possibily more robust. Similar cost. (ipot = 2.0)	$\overline{v}_U \cdot \overline{n} = -\nabla_\infty \cdot \overline{n}$ $\phi_L = 0$ [1:(11,3), 12:(7,2), 2]
17.0	Impermeable surface represented by sources alone. (Source network)	Can be used on nonlifting surfaces, i.e. a thick vertical fin in the plane of symmetry, or placed over doublet or composite surfaces; i.e., a radome on a fuselage. As a source network it need not abut adjacent networks.	$\overline{v}_U \cdot \overline{n} = -\nabla_\infty \cdot \overline{n}$ [1:(11,3), 0:(0,-), 0]
12.0	Thin surface without thickness. (Doublet network)	Represents lifting surfaces without thickness.	$0.5\ (\overline{v}_U + \overline{v}_L) \cdot \overline{n} = -\nabla_\infty \cdot \overline{n}$ [0:(0,-), 12:(13,3), 0]
12.0 tkw= 1.0	Thin surface with simulated thickness	Represents lifting surface with linearized thickness. Thickness is represented by transpiration normal to the surface, and is specified by bet1(i) = 2 times thickness slope; at each panel center control point.	$(\overline{v}_U - \overline{v}_L) \cdot \overline{n} =$ bet1(i). $0.5\ (\overline{v}_U + \overline{v}_L) \cdot \overline{n} = -\nabla_\infty \cdot \overline{n}$ [1:(14,1), 12:(13,3), 0]
13.0	Superinclined surface	Used only on surfaces inclined ahead of the Mach cone in supersonic flow. Causes flow to vanish into the network.	$\overline{v}_L \cdot \overline{n} = 0$ $\phi_L = 0$ [1:(12,2), 12:(7,2), 0]
14.0	Flow through a surface by specifying perturbation mass flux.	Obsolete condition for representing flow across a surface (inlet); use kt=30 option to specify [1:(11,7),12:(7,2),0].	$\overline{v}_U \cdot \overline{n} =$ bet1(i). $\phi_L = 0$ [1:(11,1), 12:(7,2), 0]

Table C-3 Perturbation Potential Boundary Conditions

kt	Description	Comments	Source & Doublet Boundary Conditions
5.0	Base surface condition.	Used to represent the aft facing blunt base on a body or wing with a thick trailing edge. Trailing wakes must be shed downstream from the external edges of the wake network. The network surface normal is pointing downstream. (ipot = 2.0)	$\phi_U = - \nabla_\infty \cdot (\overline{R} - \overline{R}_{ctr})$ $\phi_L = 0$ [1:(6,9), 12:(7,2), 2] for $M_\infty < 1$, and $\overline{w}_U \cdot \overline{n} = 0$ $\phi_U = 0$ [1:(2,2), 12:(6,2), 2] for $M_\infty > 1$
21.0	Impermeable thick surface represented by doublets alone.	Least expensive specification of mass flux impermeability. Not as robust as kt=1.	$\phi_L = -\vec{V}_\infty \cdot \begin{pmatrix} 1/1-M_\infty^2 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} (\overline{R} - \overline{R}_{ctr})$ [0:(0,-), 12:(7,4), 4]

Table C-4 Wake Surface Boundary Conditions Imposed on Neighboring Upstream Network Edges

For linear wake networks (kt=18.) the doublet strength is constant along the direction of the downstream panel edges. Thus, the wake vorticity is assumed to be straight back in the same direction. The following matchw options impose different conditions on the attached upstream network edges.

kt	Description	Comments	Doublet Boundary Conditions
18.0	Vorticity matching Kutta condition used for sharp trailing edges	Commonly used for wings with different upper and lower surfaces (nlopt2=15.)	[0:(0,-), 18:(15,2), 2]
18.0 matchw = 1.0	Doublet matching condition used to provide continuity of doublet strength.	Commonly used to represent wakes from blunt surfaces with a base (i.e. bodies, nacelles) Also used to connect with an upstream wake (kt= 18.), and doublet cambered surfaces (kt=2.).	[0:(0,-), 18:(6,2), 2]
18.0* and matchw =2.0	Second-order pressure matching Kutta condition along a sharp trailing edge	The second-order pressure coefficient difference between the upper and lower surface at the trailing edge set to zero by an iterative process. New condition. (nlopt2=16.)	[0:(0,-), 18:(16,2), 2]
18.0* and matchw =3.0	Isentropic pressure matching Kutta condition along a sharp trailing edge	The isentropic pressure coefficient difference between the upper and lower surface at the trailing edge set to zero by an iterative process. New condition. (nlopt2=17.)	[0:(0,-), 18:(17,2), 2]
20.0	Constant strength doublet wake.	Commonly used as a connector or filler wake between the wing wake and body.	[0:(0,-), 20:(6,2), 2]

*New option, which has not been completely proven via application.

Note: For second-order wake networks (kt=19.) the doublet strength is unknown and is solved by setting the pressure jump across the wake to zero at the doublet panel center control points. These conditions are satisfied by an iterative process. This wake has the same options as the linear wake (kt=18.) plus the additional option to specify the pressure coefficient rule used at the panel center control points. Because this is new A502H capability and has limited application, it is described in appendix E.

C.5 Defining a Surface Network and Boundary Conditions by Specifying the Left and Right Terms of the General Boundary Equations

With this form of input, a user can select the left -hand (nlopt1 and nlopt2) and the right-hand (nropt1 and nropt2) terms of the two boundary conditions from a list of terms. A description of these parameters is given in tables C-5 and C-6. Additional input parameters are required to specify:

- The presence of source (nts) and doublet (ntd) singularities
- Type of doublet (ntd).
- How velocities are calculated (ipot).

The input terminology used in defining boundary conditions for this section is summarized in the Quick Summary of A502 Input printout (see section 6.5). The left-side terms are placed into categories: mass flux, potential, velocity, and wake.

> **CAUTION:** For this method of boundary condition input, the user assumes responsibility for formulating a meaningful boundary value problem.

Input Data for Network Geometry and Boundary Conditions

```
$POINTS                                                              P1
kn                                                     cpnorm        P2
kt        nts       ntd       ipot       mnswch        dnsmsh        P3
nlopt1    nropt1    nlopt2    nropt2                                 BC1
nm        nn                                                netname  P4
x11       y11       z11       x12        y12           z12           P5
x13       y13       z13 . . .                                        P5
x21       y21       z21 . . .                                        P5
:
! Data to alter panel density. Input only if dnsmsh = 1.
dn        dm                                                         P6
! First boundary condition right-hand side specified flow
! Input only if nropt1 = 1., 7., or 8.
bet1(1)   bet1(2)   bet1(3)  bet1(4)     First control point         BC4
bet1(1)   bet1(2)   bet1(3)  bet1(4)     Second control point        BC4
:
! Second boundary condition right-hand side specified flow
! Input only if nropt2 = 1., 7., or 8.
bet2(1)   bet2(2)   bet2(3)  bet2(4)     First control point         BC7
bet2(1)   bet2(2)   bet2(3)  bet2(4)     Second control point        BC7
:
! To define additional networks with the same boundary conditons and
! options, repeat P4 through BC7 as required.
```

! kt	= 30	Boundary condition terms and the singularity options are to be input.
! nts	= 0.0	If no source singularities.
	= 1.0	Linearly varying source distribution on the network.
! ntd	= 0.0	If no doublet singularities.

	= 12.0	Quadratically varying doublet distribution for a nonwake network.
	= 18.0	Constant/quadratically varying doublet wake network.
	= 20.0	Constant strength doublet wake network.
	= 6.0	Quadratically varying doublet distribution for a design wake network.
! ipot	= 0.0	Resultant velocities are calculated using the velocity influence coefficients.
	= ±1.0	Resultant velocities are also to be calculated using both the surface sources and doublets *(archaic)*. Used for comparison of ipot = 0.0 and ± 2.0. Use +1.0 only if the upper surface is the "wetted" surface and the lower surface has a zero perturbation potential. The additional line of upper surface flow properties is inserted ahead of line 2 in the four-line printout of surface flow properties (ioutpr = 0). Use –1.0 only if the *lower* surface is the "wetted" surface and the upper surface has a zero perturbation potential. The additional line of lower surface flow properties is inserted ahead of line 3 in the four-line printout of surface flow properties (ioutpr = 0).
	= +2.0	Upper surface resultant velocities are calculated only from surface sources and doublets. (Use only if the lower surface perturbation potential is zero.)
	= -2.0	Lower surface resultant velocities are calculated only from surface sources and doublets. (Use only if the upper surface perturbation potential is zero.)
	= ±3.0	Resultant velocities are calculated using both the surface sources and doublets and the velocity influence coefficients *(archaic)*. Used for comparison of ipot = 0.0 and ± 4.0. Use +3.0 when the lower surface has a zero value of total mass flux, as obtained by a kt = 21.0 (ntd = 12.0, nlopt2 = 7.0, nropt2 = 4.0) doublet boundary condition. The additional line of lower surface flow properties is inserted ahead of line 2 in the four-line printout of surface flow properties (ioutpr = 0). Use –3.0 when the upper surface has a zero value of total mass flux, as obtained by a (ntd = 12.0, nlopt2 = 6.0, nropt2 = 4.0) doublet boundary condition. The additional line of upper surface flow properties is inserted ahead of line 3 in the four-line printout of surface flow properties (ioutpr = 0).
	= ±4.0	Resultant velocities calculated using only the surface sources and doublets *(archaic)*. Use +4.0 when the lower surface has a zero value of total mass flux, as obtained by a kt = 21.0 (ntd = 12.0, nlopt2 = 7.0, nropt2 = 4.0) doublet boundary condition. Use –4.0 when the upper surface has a zero value of total mass flux, as obtained by a (ntd = 12.0, nlopt2 = 6.0, nropt2 = 4.0) doublet boundary condition.

Note: The velocity calculation approach using ipot = ± 2.0 and ± 4.0 eliminates the need for calculating the velocity components from a matrix multiply, and thus reduces the computer run cost.

Table C-5 Left-hand Side Terms in the First and Second Boundary Equation

nlopt1 nlopt2	Terms	Description
0.0		No boundary condition is to be specified.
1.0		Used to define coefficients of the left-hand side for the general boundary condition (see section C.6).
		----MASS FLUX TERMS----
2.0	$\overline{w}_U \cdot \overline{n}$	Upper surface perturbation normal mass flux.
3.0	$\overline{w}_L \cdot \overline{n}$	Lower surface perturbation normal mass flux.
4.0	$0.5\ (\overline{w}_U + \overline{w}_L) \cdot \overline{n}$	Average of upper and lower surface normal perturbation mass flux.
5.0	$(\overline{w}_U - \overline{w}_L) \cdot \overline{n}$	Upper minus lower surface normal perturbation mass flux (equal to the source strength).
		----POTENTIAL TERMS----
6.0	ϕ_U	Upper surface perturbation potential.
7.0	ϕ_L	Lower surface perturbation potential.
8.0	$0.5\ (\phi_U + \phi_L)$	Average of the upper and lower surface perturbation potential.
9.0	$(\phi_U - \phi_L)$	Upper minus lower surface perturbation potential (equal to the doublet strength).
		----VELOCITY TERMS----
11.0	$\overline{v}_U \cdot \overline{n}$	Upper surface perturbation velocity.
12.0	$\overline{v}_L \cdot \overline{n}$	Lower surface perturbation velocity.
13.0	$0.5\ (\overline{v}_U + \overline{v}_L) \cdot \overline{n}$	Average of the upper and lower surface perturbation velocities.
14.0	$(\overline{v}_U - \overline{v}_L) \cdot \overline{n}$	Upper minus lower surface perturbation velocities.

(continued)

Table C-5 Left-hand Side Terms in the First and Second Boundary Equation (cont.)

WAKE CONDITIONS
(APPLIED TO NEIGHBORING UPSTREAM NETWORK EDGES)

nlopt2	Terms	Description
15.0		Vorticity matching Kutta condition for doublet network type (ntd = 18.0). See figure C-3.
16.0		Second-order pressure matching Kutta condition for doublet network type (ntd = 18.0). See figure C-4.
17.0		Isentropic pressure matching Kutta condition for doublet network type (ntd = 18.0). See figure C-4.
18.0		Vorticity matching Kutta condition for doublet network type (ntd = 19.0). See figure C-3.
19.0		Second-order pressure matching Kutta condition for doublet network type (ntd = 19.0). See figure C-4.
20.0		Isentropic pressure matching Kutta condition for doublet network type (ntd = 19.0). See figure C-4.

Table C-6 Right-hand Side Terms in the First and Second Boundary Equation

nropt1 nropt2	Terms	Description
1.0	bet1(i) or bet2(i)	Specified input value at each control point of a network; bet1 for first equation, bet2 for second.
2.0	0	Zero
3.0	$-\bar{V}_\infty \cdot \bar{n}$	Minus component of freestream along surface normal. Generally used on upper surfaces.
4.0	$-\bar{V}_c \cdot [(x/(1-M_\infty^2), y, z) - (x_{ctr}/(1-M_\infty^2), y_{ctr}, z_{ctr})]$	where (x_{ctr}, y_{ctr}, z_{ctr}) is the center location of a network
6.0	$+\bar{V}_\infty \cdot \bar{n}$	nropt = 3.0 for lower surfaces.
7.0	$-\bar{V}_\infty \cdot \bar{n}$ + bet1(i) or $-\bar{V}_\infty \cdot \bar{n}$ + bet2(i)	nropt = 3.0 with specified flow normal to surface. Generally used on upper surfaces.
8.0	$+\bar{V}_\infty \cdot \bar{n}$ +bet1(i) or $+\bar{V}_\infty \cdot \bar{n}$ + bet2(i)	nropt = 7.0 for lower surfaces.
9.0	$-\bar{V}_\infty \cdot (\bar{R} - \bar{R}_{ctr})$	$\bar{R}$ is a position vector in space, and $\bar{R}_{ctr}$ is a position vector of the network center.

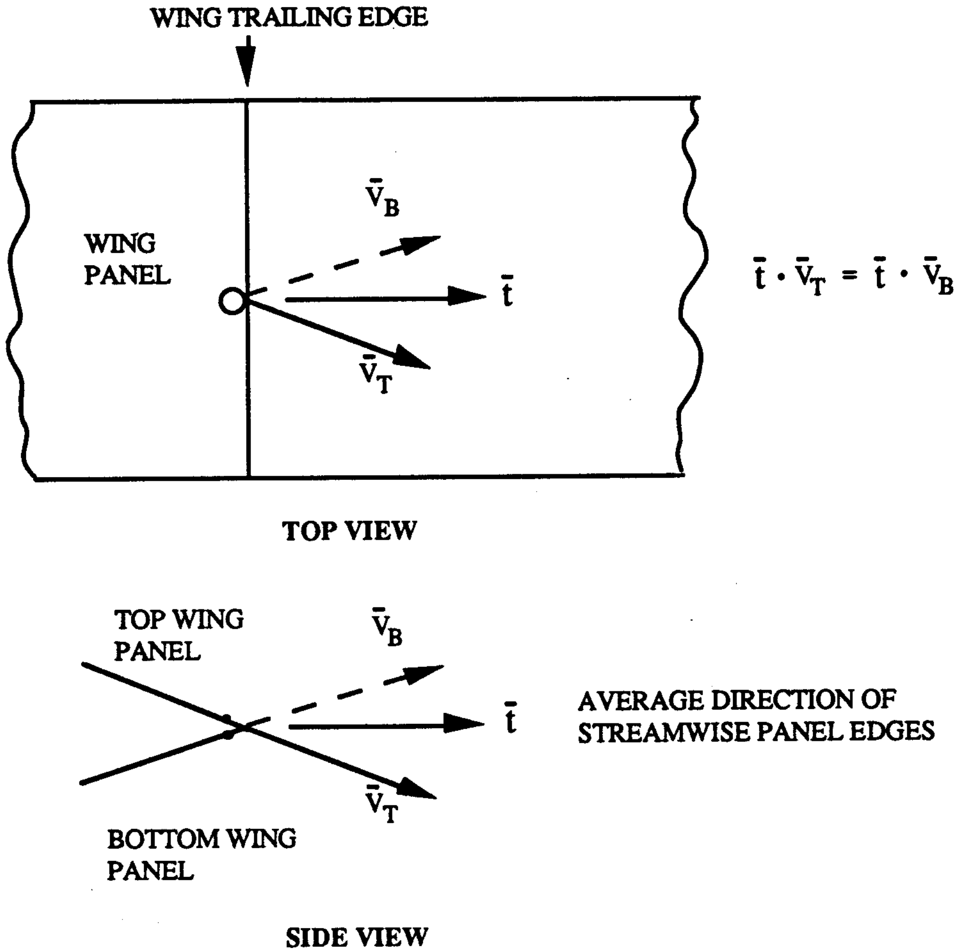
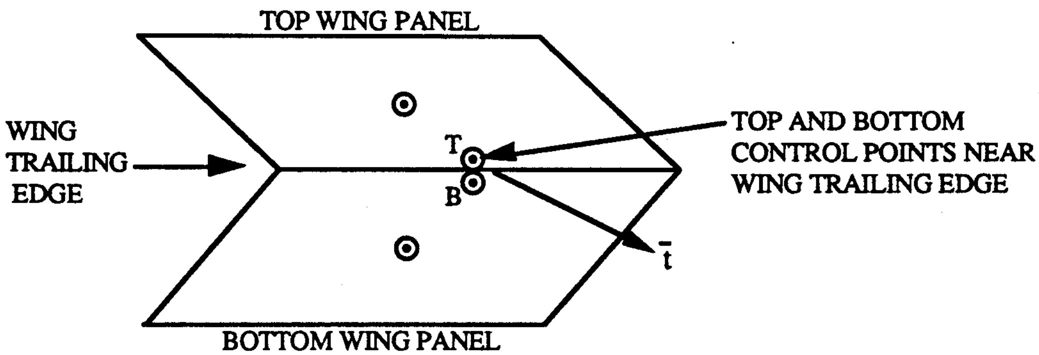


Figure C-3 Wake Vorticity Matching Kutta Condition Along a Thick Wing Trailing Edge Panel



OBLIQUE REAR VIEW OF WING PANELS ALONG TRAILING EDGE

Second-Order Pressure Matching	Isentropic Pressure Matching
$C_{p2NDT} = C_{p2NDB}$	$C_{pISNT} = C_{pISNB}$

Figure C-4 Wake Higher-Order Pressure Matching Kutta Condition Along a Thick Wing Trailing Edge Panel

C.6 Defining a Surface Network and Boundary Conditions by Specifying Coefficients of the General Boundary Equations

This input form of the boundary conditions requires the detailed specification of all the coefficients to the two general boundary conditions for each control point. This form can be used to define boundary conditions as linear combinations of the basic terms. With the additional amount of input required to specify these boundary conditions, this form of input is only used if the boundary conditions cannot be specified with the previous forms.

The boundary conditions for each control point of a network are eventually translated into the terms specified by the general boundary condition. The values used by the program can be checked by reviewing the boundary condition data printout (ibconp=1.0). (See section B.5.)

> **CAUTION:** For this method of boundary condition input, the user assumes responsibility for formulating a meaningful boundary value problem.

If a network contains only source singularities, then only the first boundary condition needs to be specified. If a network contains only doublet singularities, then only the second boundary condition needs to be specified.

Defining the boundary conditions using these inputs involves developing coefficients for each control point of a network. Because of the large amount of input data required and because most commonly used boundary conditions have a simplified form of input, this approach is not normally used. Specifying wind-tunnel porous wall boundary conditions is one application that requires this method of defining boundary conditions.

Input Data for Network Geometry and Boundary Conditions

```
$POINTS                                                          P1
kn                                                 cpnorm        P2
kt        nts       ntd       ipot      mnswch     dnsmsh        P3
nloptl    nroptl    nlopt2    nropt2                             BC1
nm        nn                                           netname   P4
x11       y11       z11       x12       y12        z12           P5
x13       y13       z13 . . .                                    P5
x21       y21       z21 . . .                                    P5
:
! Data to alter panel density. Input only if dnsmsh = 1.
dn        dm                                                     P6
! First boundary condition coefficients for source network
! One set of data (BC2 and BC3) for each source control point.
! Input if nloptl = 1.
nctl      cul       cll       tulx      tuly       tulz          BC2
tllx      tlly      tllz      dul       dll    First control point BC3
nctl      cul       cll       tulx      tuly       tulz          BC2
tllx      tlly      tllz      dul       dll   Second control point BC3
 :
! First boundary condition right-hand side specified flow
! Input only if nroptl = 1., 7., or 8.
betl(1)   betl(2)   betl(3)   betl(4)    First control point     BC4
betl(1)   betl(2)   betl(3)   betl(4)    Second control point    BC4
:
! Second boundary condition for doublet network
! One set of data (BC5 and BC6) for each doublet control point.
! Input if nlopt2 = 1.
nct2      cu2       cl2       tu2x      tu2y       tu2z          BC5
tl2x      tl2y      tl2z      du2       dl2    First control point BC6
nct2      cu2       cl2       tu2x      tu2y       tu2z          BC5
tl2x      tl2y      tl2z      du2       dl2   Second control point BC6
 :
! Second boundary condition right-hand side specified flow
! Input only if nropt2 = 1., 7., or 8.
bet2(1)   bet2(2)   bet2(3)   bet2(4)    First control point     BC7
bet2(1)   bet2(2)   bet2(3)   bet2(4)    Second control point    BC7
:
! To define additional networks with the same boundary conditions and
! options, repeat P4 through BC7 as required.
```

! kt	= 30.0	Boundary conditions and the singularity options are to be input
! nts	= 0.0	If no source singularities.
	= 1.0	Linearly varying source distribution on the network.
! ntd	= 0.0	If no doublet singularities.
	= 12.0	Quadratically varying doublet distribution for a nonwake network.
	= 18.0	Constant/quadratically varying doublet wake network.
	= 20.0	Constant strength doublet wake network.
	= 6.0	Quadratically varying doublet distribution for a wake network.
! ipot	= 0.0	Resultant velocities are calculated using the velocity influence coefficients.
	= ±1.0	Resultant velocities are also to be calculated using the doublet gradients.
	= +2.0	Upper surface resultant velocities are calculated only from doublet gradients. (Use only if the lower surface perturbation potential is zero.)
	= -2.0	Lower surface resultant velocities are calculated only from doublet gradients. (Use only if the upper surface perturbation potential is zero.)
		Note: The last approach eliminates the need for calculating the velocity components from a matrix multiply, thus reducing computer run cost. For additional options, see section c.5.
! nlopt1 and nlopt2		Parameters used to define the left-hand side terms in the first and second boundary condition equation.
= 0.0		No boundary condition is to be specified.
= 1.0		Used to define coefficients of the left-hand side for the general boundary condition. (Additional options from the previous section may be used to define one of the boundary conditions.)
! nropt1 and nropt2		Parameters used to define the right-hand side terms in the first and second boundary condition equation (see table C-6).
! nct1	= 1.0	If the DU=DL=TU=TL=0.0 (i.e. the boundary condition involves only the normal component of the perturbation mass flux vector).
	= 4.0	If the CU=CL=TU=TL=0.0 (i.e. the boundary condition involves only the perturbation potential).
	= 2.0	Otherwise.
! cu1, cl1		Coefficients (CU, CL) of the perturbation normal mass flux on the upper and lower surfaces.
! tu1x, tu1y, tu1z, ! tl1x, tl1y, tl1z		Reference system component coefficients (TU,TL) for the perturbation velocity on the upper and lower surfaces.
! du1, dl1		Coefficients (DU, DL) of the perturbation potential on the upper and lower surfaces.

APPENDIX D. GEOMETRY-GENERATING AND -MODIFYING TOOLS

Most configurations analyzed in A502 represent complex surface geometry. These surfaces are best paneled and represented by describing a rectangular mesh of surface points defined in the reference coordinate system. To produce these surface definitions requires that the surfaces be lofted and the appropriate paneling points be extracted. The inputs for using this approach to representing surfaces have been explained in previous sections (sections 5.9 and appendix C).

Some simple configurations can be defined directly as panels from a minimum number of inputs. These inputs are then preprocessed to produce the reference coordinates of the surface. The geometry-generating tools can generate networks with:

- Circular sections from cylindrical coordinates ($CIR)
- Elliptical sections from elliptical data ($ELL)
- Quadrilateral networks from four points ($QUA)
- Gothic networks from the leading edge line ($GOT)
- Camber can be added to the networks generated with $QUA and $GOT by specifying chord fraction location and vertical height-chord fraction ($CAM).

Any existing networks can be rotated, scaled and/or translated in the A502 program ($REA)

> **Note:** In using any of these geometry-generating or manipulation processors in combination with any other networks, you are responsible for satisfying the necessary abutments.
>
> **CAUTION:** Careful reviewing of the input information is necessary to insure the proper orientation of the network rows and columns and the upper surface unit normal vector.

D.1 GENERAL COMMENTS ON INPUTS

The geometry-generating inputs can be used with any type of boundary conditions. These inputs replace the following lines:

```
$POINTS                                                              P1


nm      nn                                                  netname  P4
x11     y11      z11      x12      y12      z12                      P5
x13     y13      z13 ...                                             P5
x21     y21      z21 ...                                             P5
:
```

All other inputs defined for $POINTS can be used with this geometry-generating surfaces. Only the replacement inputs for the above data are given in the following sections.

D.2 CIRCULAR SECTIONS ($CIR)

This preprocessor generates a network of surface points for a body with circular cross-sections. Cylindrical coordinate inputs are used to describe the network points. All cross-sections are constructed perpendicular to the x-y plane but can be displaced above or below the x-y plane, see figure D-1.

Replacement Input Data for Network with Circular Sections

```
$CIR                                                         CR1


nopt                                                netname  CR4
nm                                                           CR5
xs1       ri1       xs2       ri2       ...                  CR6
z1        z2        z3        ...                  (nopt=1)  CR7
nn                                                           CR8
th1       th2       th3       ...                            CR9
```

! Option to vertically displace the circular section.		
! nopt	= 0.0	No displacement (omit CR7)
	= 1.0	Specify the vertical displacement (z(i)) of each section.
! nm	Number of x stations on the body (also, number of points in a column of the network - rows).	
! xs(i),ri(i)	x stations location and section radius (nm pairs).	
! z(i)	Vertical displacement (z coordinate) for each section (nm values).	
! nn	Number of azimuthal stations (also, number columns in the network).	
! th(j)	Azimuthal angles in degrees for locating network points (nn values). The y axis corresponds to th(j) = 0.0 and the z axis corresponds to th(j) = 90.0 degrees.	

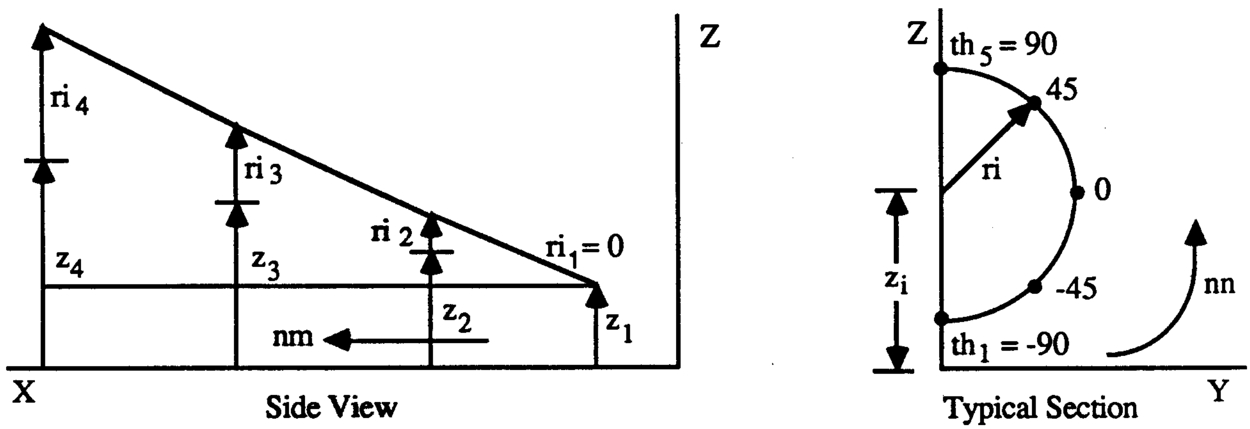


Figure D-1 Example of Circular Body Parameters ($CIR)

D.3 ELLIPTICAL SECTIONS ($ELL)

This preprocessor generates a network of surface points for a body with elliptic cross-sections. Cylindrical coordinates with two radii are input to describe the network points (see figure D-2). All cross-sections are constructed perpendicular to the x-y plane but can be displaced above or below the x-y plane. This is identical to the circular section input except for the extra radius to specify the elliptic section.

Replacement Input Data for Network with Elliptical Sections

```
$ELL                                                          EL1

nopt                                                 netname  EL4
nm                                                            EL5
xs1     ry1     rz1     xs2     ry2     rz2                   EL6
xs3     ry3     rz3     ...                                   EL6
z1      z2      z3      ...                         (nopt=1)  EL7
nn                                                            EL8
th1     th2     th3     ...                                   EL9
```

! Option to vertically displace the circular section.

! nopt	= 0.0	No displacement (omit CR7)
	= 1.0	Specify the vertical displacement (z(i)) of each section.

! nm	Number of x stations on the body (also, number of points in a column of the network - rows).
! xs(i), ryi(i), ! rzi(i)	x stations location and semi-axes of the ellipse in the y and z directions (nm sets).
! z(i)	Vertical displacement (z coordinate) for each section (nm values).
! nn	Number of azimuthal stations (also, number columns in the network).
! th(j)	Azimuthal angles in degrees for locating network points (nn values). The y axis corresponds to th(j) = 0.0 and the z axis corresponds to th(j) = 90.0 degrees.

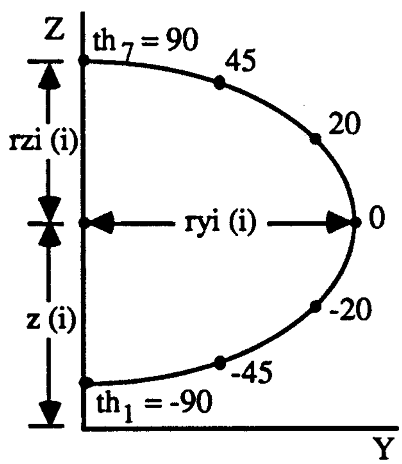


Figure D-2 Example of Elliptical Section Parameters ($ELL)

D.4 QUADRILATERAL NETWORK ($QUA)

This preprocessor generates a mesh points for a quadrilateral network (e.g., a wing) when the four corner points of the quadrilateral and the percentage lines along which the column and row edges are to be located are provided. See figure D-3.

> **Note:** There is a restriction on these networks so that the projection of these networks on x-y plane must be a quadrilateral. Vertical networks (i.e. perpendicular to x-y plane) must first be created in the x-y plane, and then rotated/translated into the desired position with $REARRANGE.

Replacement Input Data for Quadrilateral Network

```
$QUA                                                              Q1

sc11    sc21    sc31    sc12    sc22    sc32            netname  Q4
sc13    sc23    sc33    sc14    sc24    sc34                     Q4
nrow                                                             Q5
ypc1    ypc2    ypc3    ...                                      Q6
ncol                                                             Q7
xpc1    xpc2    xpc3    ...                                      Q8
```

! sc(k,j)	(x,y,z) coordinates of the four corner points of the quadrilateral. k = 1,3 and j = 1,4. (see figure D-3). Input order of corner points will determine the network layout, and thus the upper surface unit normal.
! nrow	Number of points in the column of the network - rows (nm).
! ypc(i)	Fractional values (0.0 to 1.0) for placement of points on sides 2 and 4, i = 1,nrow
! ncol	Number of columns in the network (nn).
! xpc(j)	Fractional values (0.0 to 1.0) for placement of points on sides 1 and 3, j = 1,ncol.

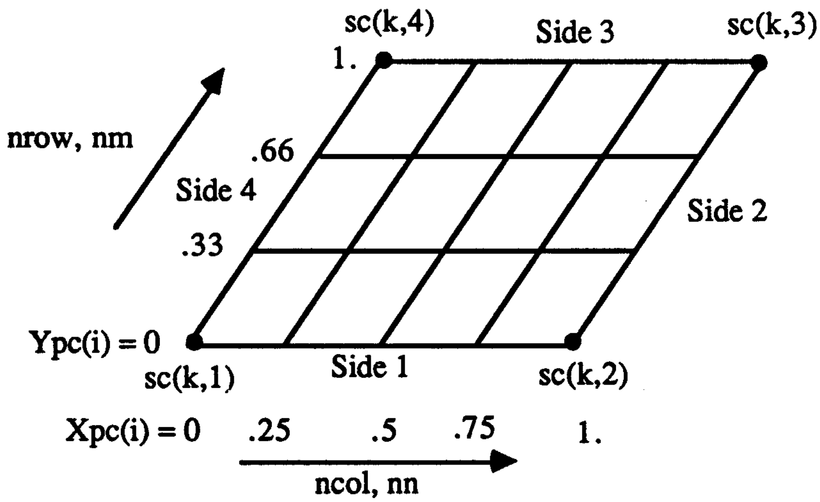


Figure D-3 Example of Quadrilateral Network Parameters ($QUA)

D.5 GOTHIC NETWORK ($GOT)

This preprocessor is designed to calculate the mesh points for a wing with curved leading edge, see figure D-4.

> **CAUTION:** Because this option is of limited usefulness, it has not been exercised. The write-up does not explain everything needed to know about this option. It is provided for completeness of the documentation. You may use this option at your own risk.

Replacement Input Data for Gothic Network

```
$GOT                                                        G1

ncol                                              netname G4
sc11   sc21   sc31   sc12   sc22   sc32                     G5
sc13   sc23   sc33   sc14   sc24   sc34                     G5
nrow                                                        G6
ypc1   ypc2   ypc3   ...                                    G7
ncen                                                        G8
```

! ncol — Number of corner points along the leading edge, side 3.

! sc(k,j) — (x,y,z) coordinates of corner points along the leading edge from nose to tail. k = 1,3 and j = 1,ncol.

! nrow — Number of spanwise cuts.

! ypc(i) — Fractional values (0.0 to 1.0) for the spanwise location of points.i = 1,nm

! ncen — Number of corner points along the wing center line. Ncen should be less than or equal to ncol. If ncen < ncol, the wing geometry with swept trailing edge is included. Also, if ncen < ncol, the side 1 has a bend in it and the generated network abutments should be carefully examined.

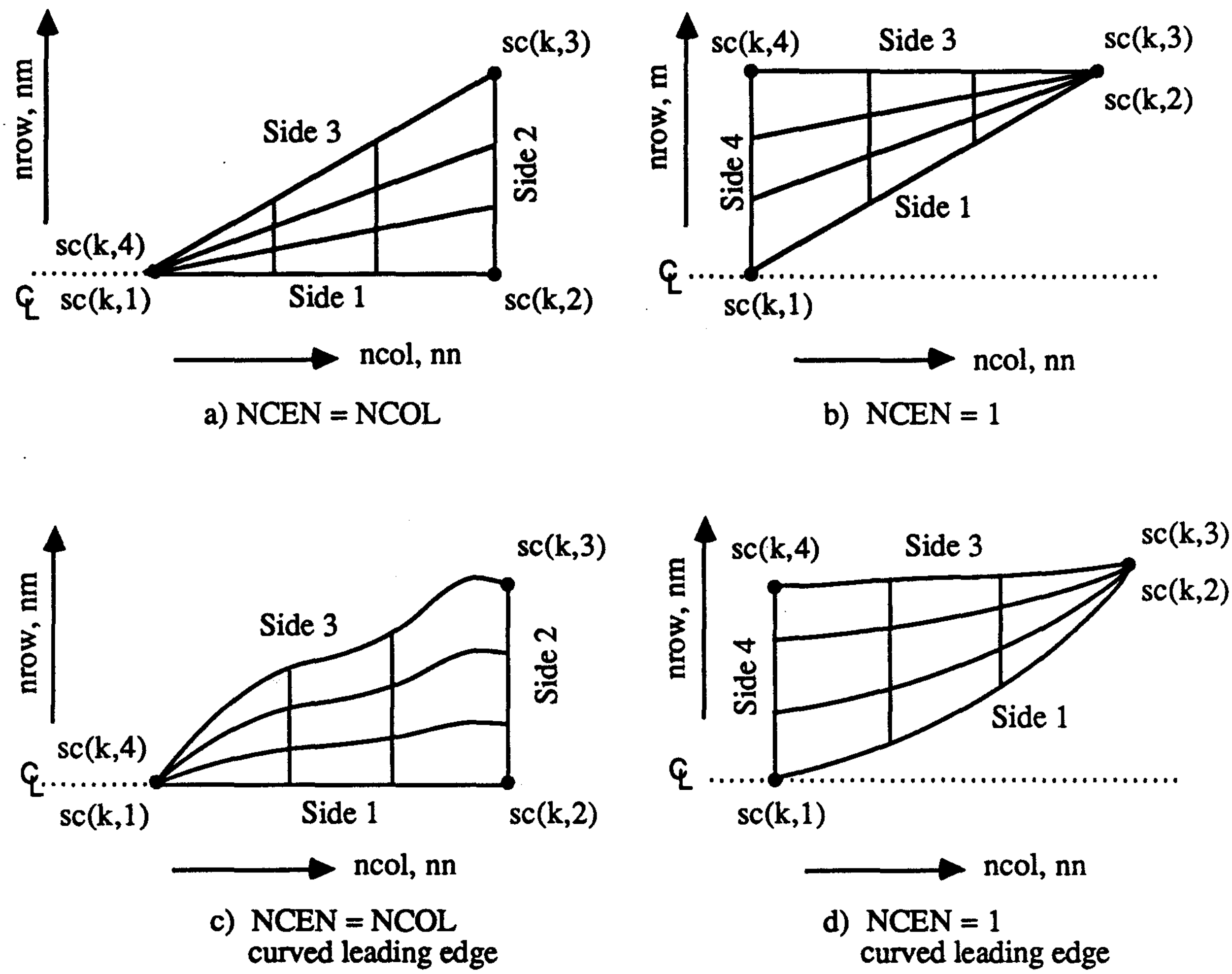


Figure D-4 Examples of Gothic Network Parameters ($GOT)

D.6 ADDING CAMBER TO $QUA AND/OR $GOT NETWORKS ($CAM)

This preprocessor is designed to add camber to wing networks generated by the $QUAD or the $GOTHIC. It is normally used for adding camber to *thin wings*. This option should not be used for thick wing configurations. It is necessary that corner 1 must be at the apex and side 1 be along the centerline (see figure D-5). Therefore, the sides cannot be switched during the original preprocessor ($QUAD or $GOTHIC).

The $CAM input must immediately follow $QUAD or $GOTHIC. The development of camber will apply only to one network.

Input Data for Adding Camber

```
$CAM                                                                CM1
cntrl                                                               CM2
! enter cards CM3 - CM5 only if cntrl is 1.0
npct    ncen    amnsw                                               CM3
xpc1    xpc2    xpc3    ...                                         CM4
zpc1    zpc2    zpc3    ...                                         CM5
! enter cards CM6 - CM9 only if cntrl is 2.0
npct    ncen    amnsw   nyst                                        CM6
xpc1    xpc2    xpc3    ...                                         CM7
! enter cards CM8 - CM9 nyst times
ysta                                                                CM8
zpc1    zpc2    zpc3    ...                                         CM9
```

! cntrl	= 1.0	If a single mean line is to be used for all the spanwise stations.
	= 2.0	If different camber lines are to be used at different spanwise stations.
! npct	Number of x/c stations on the camber line.	
! ncen	The number of mesh points along the center line.	
	= 0.0	For quadrilateral networks.
	= 1.0	For Gothic type 2 or 3 networks.
	= ncol	For Gothic type 1 or 3 networks.
! amnsw	= 0.0	For no switching.
	= 1.0	To switch rows and columns.
! xpc(i)	Chord fractional (x/c) (0.0 to 1.0) for defining camber of (npct values).	
! zpc(i)	Camber nondimensionalized by chord (z/c) (npct values).	
! nyst	Number of spanwise stations for specifying z/c.	
! ysta	y location at which the current z/c values apply.	

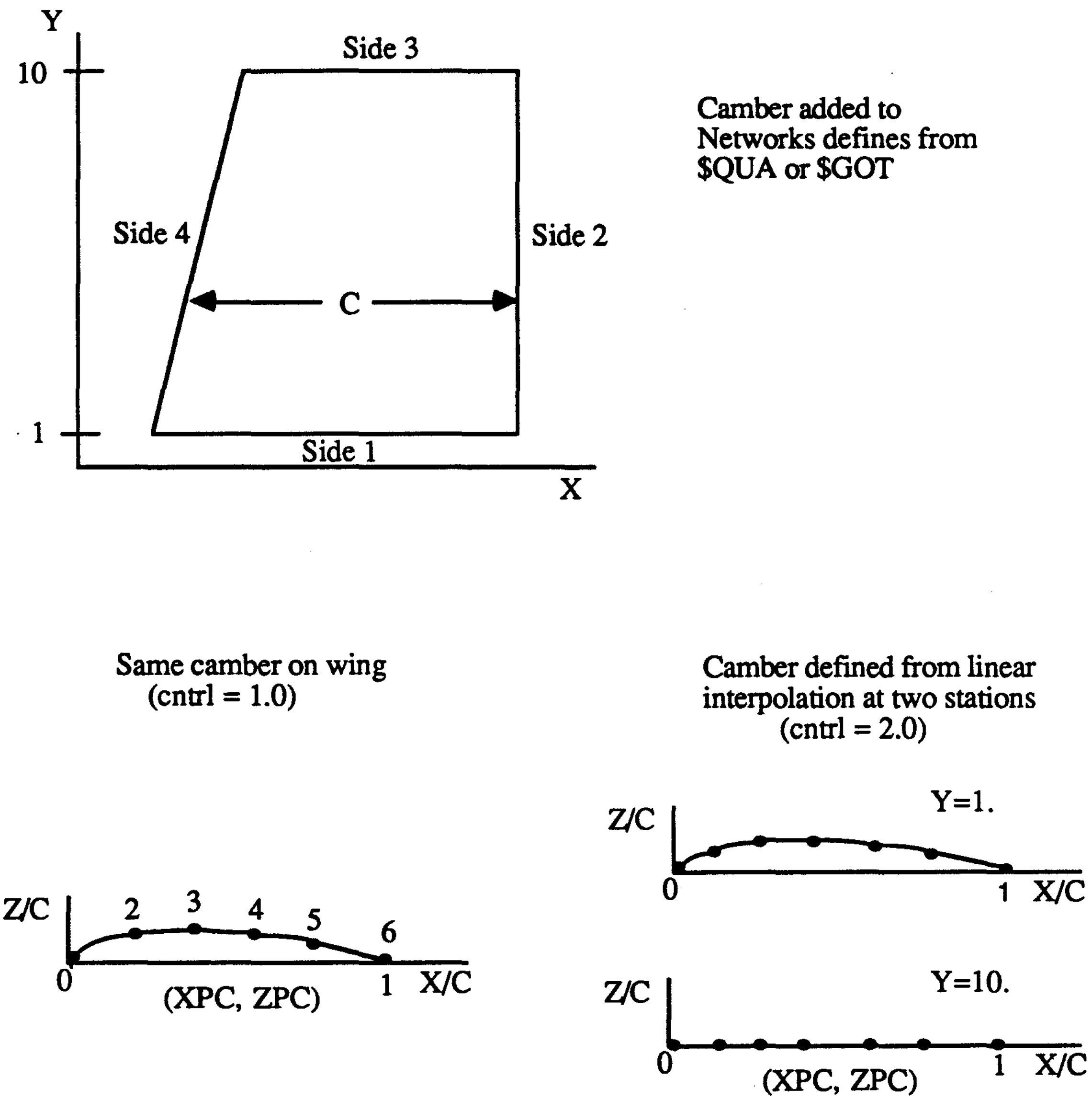


Figure D-5 Examples of Parameters for Adding Camber ($CAM)

D.7 ROTATE, SCALE, OR TRANSLATE AN EXISTING NETWORK ($REA)

This preprocessor is designed to rotate, scale, and/or translate existing networks. The input is set up to apply one simple operation at a time. Multiple operations can then be input sequentially in the same block of data. Each operation can operate on one or more consecutive networks. The input requires the specification of the first and last network number.

Since the network numbers must be input, this data should be specified after all the networks have been defined.

Input Data for Rearranging and Existing Network

```
$REA                                                                RE1
nrearr                                                              RE2
! Repeat RE3 - RE13 as required, nrearr times.
ntr                                                                 RE3
! Rotation about a line. (ntr=1., input RE4 - RE6)
k1      k2                                                          RE4
x1      y1      z1      x2      y2      z2                          RE5
phi                                                                 RE6
! One to three orthogonal rotations (ntr=2., input RE7 - RE9)
k1      k2                                                          RE7
phx     phy     phz     a1      a2      a3                          RE8
xo      yo      zo                                                  RE9
! Scale (ntr=3., input (RE10 - RE11)
k1      k2                                                          RE10
sx      sy      sz                                                  RE11
! Translate (ntr=4., input RE12 - RE13)
k1      k2                                                          RE12
tx      ty      tz                                                  RE13
```

! nrearr	Number of operations to be performed.	
! ntr	Parameter to select the operation.	
	= 1.0	Rotated about a given line through a given angle (see figure D-6)
	= 2.0	One to three orthogonal rotations about specified point. The axes system used for the rotations are parallel to the reference coordinate system (see figure D-7).
	= 3.0	Scale x,y, z about the origin (see figure D-8)
	= 4.0	Translate (see figure D-9)
! k1,k2	First and last network number to be operated on.	
! x1,y1,z1 x2,y2,z2	Coordinates of two points defining the axis of rotation.	
! phi	Angle of rotation in degrees. Positive rotation follows the right-hand rule with the direction of the thumb going from point 1 to 2.	
! phx,phy,phz	Angles of rotation in degrees about axes parallel to the x, y, z reference axes and running through the specified point.	

! a1,a2,a3	Parameters to define the first, second, and third rotations.
!	= (1.,2.,3.) Order of rotation phx, phy, phz.
	= (2.,3.,1.) Order of rotation phy, phz, phx.
	etc.
! xo,yo,zo	Coordinates defining the center of rotation (origin) for the orthogonal rotations.
! sx,sy,sz	x, y, z scale factors applied to the reference coordinates.
! tx,ty,tz	x, y, z translation values (added to an existing network to produce a modified network)

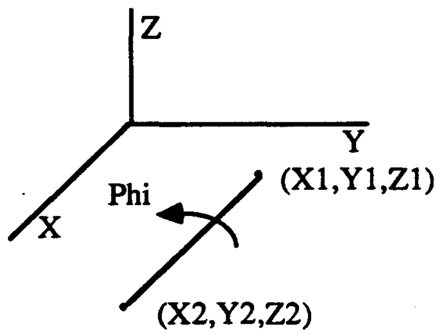


Figure D-6 Example of Parameters for Rotation about a Line ($REA)

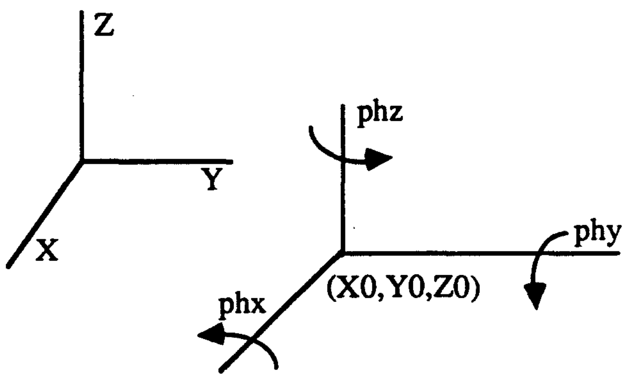


Figure D-7 Example of Parameters for Orthogonal Rotations ($REA)

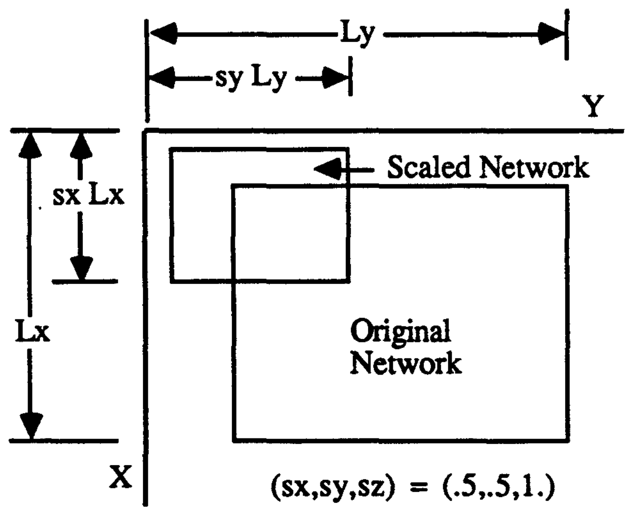


Figure D-8 Example of Parameters for Scaling About the Origin ($REA)

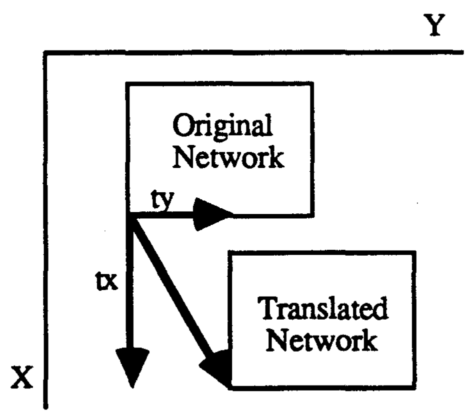


Figure D-9 Example of Parameters for Translation ($REA)

APPENDIX E: PARTIALLY DEVELOPED CAPABILITIES

The new capabilities described in this appendix expand the original problem scope of the A502 program. However, the new features are not fully developed. To preserve what has been developed thus far, it has been documented in this appendix.

These new capabilities include the following features:

1. Higher-order wakes with pressure jump boundary conditions at panel center control points (kt=19.0)
2. Represents regions with different total pressure and temperature than freestream ($MAT).
3. Controls the number of nonlinear iteration cycles and iteration solution printout - optional ($ITE) when higher-order Kutta and/or wake conditions are specified.
4. Induced drag and lift from Trefftz plane analysis for wings with flat wakes in the direction of the onset flow.

> **CAUTION:** The user is responsible for validating any particular application employing these new features. Only a limited number of tested cases have been run. Note also that some of the supporting options will give answers that have not been upgraded to work with the new capability.

E.1 HIGHER-ORDER WAKE (KT=19.0)

To support the application of different total pressure and temperature regions, a wake network is needed to separate the regions and to enforce the condition of no change in the pressure across a wake. Studies have shown that the commonly used wake (kt=18.0, ntd=18.0) is not adequate for this purpose. To represent the interfacing boundary surface between regions with different total flow properties, a doublet wake (kt=19.0 and ntd=6.0) has been incorporated.

This wake allows for a quadratic variation in doublet strength in both the lateral and streamwise directions. In addition to the upstream control points on a wake network, there are control point at the panel centers (for details, see ntd=6.0 in appendix C). These wake networks can be applied to other potential flow problems. The wakes could be used for specifying a pressure jump across the wake at the panel centers. And because they have panel center control points, they could be used to define a more accurate wake shape. The flow properties at the panel centers can be used to redefine the wake shape for a subsequent analysis. Also, they can improve the flow modeling for a configuration with large spanwise variations in vorticity (i.e., high lift wings).

The commonly used wake modeling in A502 (first-order wake, kt =18.0), has boundary conditions along the upstream network edge, and the doublet strength has a constant value in the downstream direction. With this model, the vorticity is shed straight back in a direction parallel to the wake side edges. The upstream network edge boundary condition is a linear Kutta condition. There are options to satisfy a second-order or isentropic pressure Kutta condition (matchw = 2.0 or 3.0) along the trailing edge control points. These conditions have not shown any particular advantage when used with the first-order wake. A summary of the kt = 18.0 wake model is shown in figure E-1.

The higher-order wake (kt =19.0) has boundary conditions on the upstream network edge and boundary condition at each panel center and along the side edges. The upstream conditions are the same as the first-order wake. The panel center condition is defaulted to assume zero pressure jump across the wake. The condition can be set to a user-defined pressure at each panel center (nropt2' = 1.0). The pressure coefficient form used for the panel center can be linear, second-order, or isentropic (nlopt2' = 18.0, 19.0, or 20.0). For the higher-order wake, the doublet strength is determined by the boundary conditions in the wake and is allowed to vary in a quadratic manner in both directions. Thus, the direction of the vorticity in the wake can vary. A summary of the kt = 19.0 wake model is shown in figure E-2.

A current program limitation is that the wake doublet strength along an exposed side edge will be zero. This is the same condition as modeled with the first-order wake (kt = 18.0). Thus, the wake is not allowed to have a concentrated vortex along the wake side edge.

While numerous combinations of Kutta and panel center wake conditions are possible and not completely checked out, it is recommended that they be made identical. That is, if the second-order Kutta condition is used, then the second-order, panel center boundary condition should be used.

Any of the higher-order Kutta or panel center boundary conditions are non-linear conditions, which are solved by iterating the system linear and non-linear equations for all the singularity strengths.

CAUTION: The program is limited to a maximum of 1000 non-linear conditions. (Some non-linear conditions are written from the second-order Kutta condition, kt = 18.0 and matctw = 2.0 or 3.0)

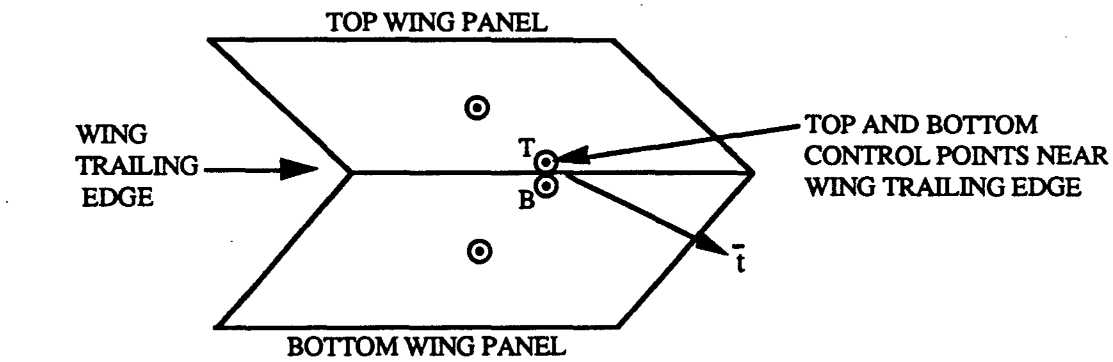
Higher-order wakes are input as a network of panels over a wake region of interest. Aft of that, the wake filaments will automatically continue the doublet strength downstream and be constant in that direction. Thus, the higher-order wake should be terminated a short distance aft of the configuration, when there is little or no variation of the doublet strength in the downstream direction. (This is equivalent to a lateral variation of the vorticity strength.)

The following gives the inputs for the higher-order wake and defines the terms that are unique to this type of network. All the other terms are defined in appendix C. This type of network could be specified with the $TRAILING used to generate a wake and dnsmsh used to increase the streamwise panel density.

A recommended approach to using a higher-order wake is to take a two-step approach:

1. First solve the potential flow problem with a vorticity matching Kutta condition and a linear wake (input kt=19.0, matchw=0.0).
2. Then with the restart capability, change to a second-order Kutta condition and second-order wake boundary conditions (input kt=19.0, matchw=2.0, nlopt2'=19.0, nropt2'=2.0). This approach is conservative and allows for verification of the higher-order wake in A502 It is possible to directly specify the higher-order wake without making a restart run.

Note: As in all wake networks, side one must abut the configuration edge from where the wake is shed.



OBLIQUE REAR VIEW OF WING PANELS ALONG TRAILING EDGE

Kutta Condition Options

<u>Vorticity</u>	<u>Second-Order Pressure</u>	<u>Isentropic Pressure</u>
$\bar{t} \cdot \bar{V}_T = \bar{t} \cdot \bar{V}_B$	$C_{p2NDT} = C_{p2NDB}$	$C_{pISNT} = C_{pISNB}$
matchw = 0.0	matchw = 2.0	matchw =3.0

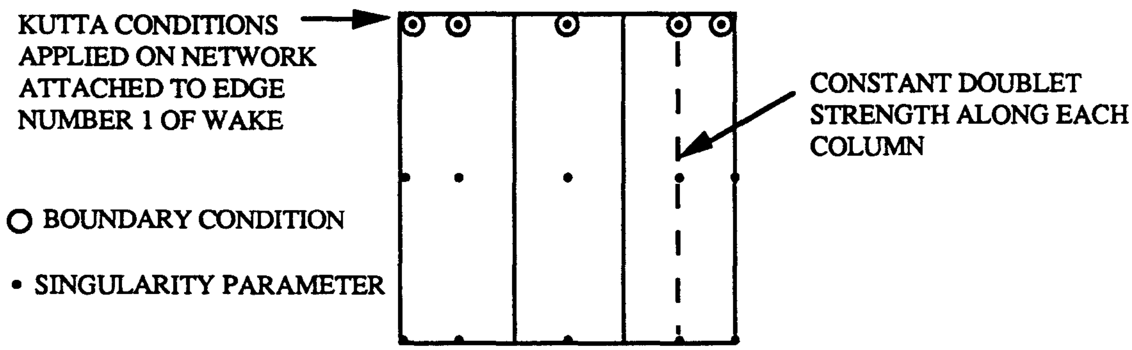
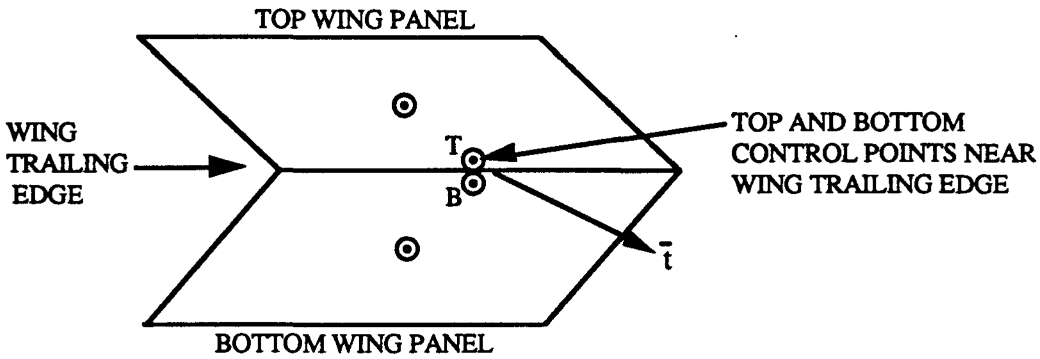


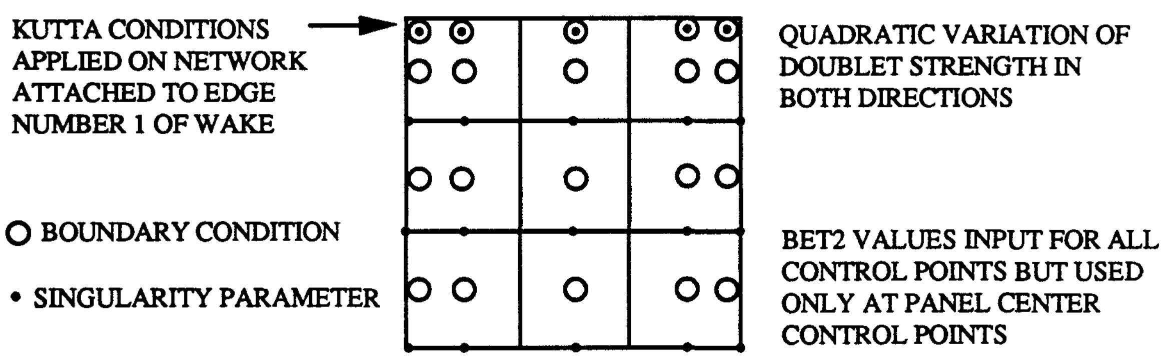
Figure E-1 Linear Wake Options (kt = 18.0 and ntd = 18.0)



OBLIQUE REAR VIEW OF WING PANELS ALONG TRAILING EDGE

Kutta Condition Options

<u>Vorticity</u>	<u>Second-Order Pressure</u>	<u>Isentropic Pressure</u>
$\bar{t} \cdot \bar{V}_T = \bar{t} \cdot \bar{V}_B$	$Cp_{2NDT} = Cp_{2NDB}$	$Cp_{ISNT} = Cp_{ISNB}$
matchw = 0.0	matchw = 2.0	matchw =3.0



Condition Applied to Panel Center $\Delta CP \equiv Cp_{UPPER} - Cp_{LOWER} = 0$ (nropt2' = 2.0) or
$= bet2$ (nropt2' = 1.0)

Pressure Coefficient Evaluation Options

$Cp = Cp_{LIN}$	$Cp = Cp_{2ND}$	$Cp = Cp_{ISN}$
nlopt2' = 18.0	nlopt2' = 19.0	nlopt2' = 20.0

Figure E-2 Higher Order Wake Options (Kt = 19.0 and ntd = 6.0)

Input Data for Higher-order Wake

```
$POINTS                                                                  P1
kn                                                       cpnorm          P2
kt         matchw     nlopt2'   nropt2'    mnswch        dnsmsh          P3
nm         nn                                                   netname  P4
x11        y11        z11       x12        y12           z12             P5
x13        y13        z13 . . .                                          P5
x21        y21        z21 . . .                                          P5
:
! Data to alter panel density. Input only if dnsmsh = 1.
dn         dm                                                            P6
! First boundary condition right hand side specified flow
! Input only if kt = 19. and nropt2' = 1.0
bet2(1)    bet2(2)    bet2(3)   bet2(4)   First control point            BC4
bet2(1)    bet2(2)    bet2(3)   bet2(4)   Second control point           BC4
:
```

! kt	=19.0	Higher-order wake.
!nm	Number of points in a network point column (rows).	
!nn	Number of point columns in a network.	
	Note: Both nm and nn must be greater than or equal to 4.	
! matchw	=0.0 or blank	Vorticity matching Kutta condition used for sharp trailing edges. This wake is commonly used for wings with different upper and lower surfaces. (nlopt2=15.)
	= 1.0	Doublet matching condition used to provide continuity of doublet strength. Commonly used for representing wakes from blunt surfaces with a base (i.e. bodies, nacelles). Also used to connect with an upstream wake (kt = 18.), and doublet cambered surfaces (kt=2.).
	= 2.0	Second-order pressure matching Kutta condition along a sharp trailing edge. The second-order pressure coefficient difference between the upper and lower surface at the trailing edge set to zero by an iterative process. (nlopt2=16.)
	= 3.0	Isentropic pressure matching Kutta condition along a sharp trailing edge The isentropic pressure coefficient difference between the upper and lower surface at the trailing edge set to zero by an iterative process. (nlopt2=17.)

! The following two terms define the panel center pressure boundary conditions.

! nlopt2'		Wake panel center control point pressure coefficient rule option. Used to define the difference pressure across the wake (upper minus lower surface).
	= 18.0 or blank	linear
	= 19.0	second-order (recommended)
	= 20.0	isentropic

! nropt2'	Right hand side of the pressure difference equation	
	= 2.0 or blank	zero
	=1.0	input bet2 (pressure difference value) at each panel center control point
! bet2(i)		Upper minus lower surface pressure at all wake control points. Values are input in the same order as the control points. Each line contains one to four values, corresponding to the number of solutions (i=1, nacase)

E.2 TOTAL PRESSURE AND TEMPERATURE REPRESENTATION ($MATERIAL PROPERTIES)

As originally developed, the A502 program represented boundary value problems with the same total flow conditions. To represent a region with different total properties (i.e., engine exhaust), the boundary of the region is represented by a solid-surface boundary condition.

A recent addition to the program allows for the representation of regions with different total pressure and/or temperature to be analyzed. This capability was developed to check out the concept for TRANAIR. While A502H can represent and solve for regions with a wide variety of different total flow properties to model engine exhaust flows, only a narrow range of different total flow properties may physically be useful. For example, increasing the total pressure may result in regions of transonic flow, which are not accounted for in A502 theory. For many power-on nacelle-strut-wing problems, this capability has limited usefulness, because the exhaust flow is transonic. The potential usefulness of this capability for the nacelle integration problem has not been fully examined. Only a minimum amount of effort has gone into the program checkout for this capability. It was left in the program and documented for the possible future development and application.

To apply the different total conditions, the flow regions to which these conditions apply must be identified. Except for the downstream side, the region must be enclosed by network surfaces (solid, base, wake surfaces). Along with the total conditions, the boundary of the region and all surfaces in the region must be identified via network name or number and upper or lower side. More than one region with different total properties can be defined. The following data are defined to denote different regions of total pressure and/or temperature than the total onset flow conditions.

To better understand this modeling, review the simple power-on nacelle example given in section 10. This example gives the details required for input and the limitations of the output.

The output surface flow properties (velocity, mass flux and pressure coefficients) for regions with different total flow properties are referenced to the freestream quantities. These flow properties are calculated as scaled properties of the freestream. The velocity (V'), mass flux (W'), and the second-order pressure coefficient ($C_{p2nd'}$) for a region with different total pressure and temperature are computed from the corresponding properties in freestream (V, W, C_{p2nd}) from the following relationships:

$$\vec{V}' = K_V \vec{V} \qquad K_V = q_o/q_\infty$$

$$\vec{W}' = K_W \vec{W} \qquad K_W = R\,K_V$$

$$C_{p2nd'} = K_p\, C_{p2nd} \qquad K_p = R\,K_V^2 = K_V\,K_W$$

where

$$q_o/q_\infty = \frac{2\,TT}{(\gamma-1)M_\infty^2}\left[1 + \frac{(\gamma-1)M_\infty^2}{2} - TP^{(1-\gamma)/\gamma}\right]$$

TT = total temperature ratio (current region to freestream)
TP = total pressure ratio (current to frestream)
γ = ratio of specific heats in air (1.4)
M_∞ = freestream Mach number

$R = TP^{\gamma-1} / TT$ = density ratio = ρ_o/ρ_∞

Input Data for Material Properties

```
$MATERIAL PROPERTIES                                                  M1
! Define total temperature and pressure ratios for specific
regions
nmat                                                                  M2
tratio(1)  pratio(1)  mat-name(1)                                     M3
tratio(2)  pratio(2)  mat-name(2)                                     M3
:
! Define networks and surfaces associated with different regions
nmnet                                                                 M4
netname    surface    mat-name or mat-index                           M5
netname    surface    mat-name or mat-index                           M5
:
```

! nmat	Number of material properties to be specified (1. to 10.)	
! tratio	Total temperature ratio (specified region to onset flow)	
! pratio	Total pressure ratio (specified region to onset flow)	
! mat-name	Input name assigned to region (1 to 10 characters)	
! nmnet	Number of input network surfaces required to define the regions with different material properties (1 to 300)	
! netname or network no.	Network name assigned from input or network number based on the input network order	
! surface	=upper	Property assigned to upper side of network.
	=lower	Property assigned to lower side of network

The output flow properties and the surface force and moments will reflect the specified material properties. The network surfaces are assumed to the onset flow total conditions. Network surfaces exposed to different total conditions specified in the input are identified the Quick Summary of A502 Inputs. Except for this, there is no special output section for this option.

E.3 CONTROLLING THE NUMBER OF NON-LINEAR ITERATION CYCLES AND ITERATION SOLUTION PRINTOUT–OPTIONAL

To solve a boundary value problem with a second-order and/or isentropic Kutta conditions (kt=18.0 and matchw= 2.0 or 3.0), and/or second-order and/or isentropic wakes (kt=19.0 and matchw= 2.0 or 3.0) requires the solution to a set of non-linear equations. These equations are solved by iteration to a specified tolerance or to a specified number of iteration cycles, whichever comes first.

If this block of data is not provided, the program assumes fifteen iteration cycles and some standard printout. Input the following data block only to modify the default values for the number of iteration cycles and non-linear iteration printout options.

Input Data for Non-Linear Iteration Cycles and Printout Control

```
$ITE - NON-LINEAR ITERATION CYCLE AND PRINTOUT CONTROL
nit         exprt       stdprt
```

! nit	=	Number of iteration cycles to be used in solving the non-linear equations
! exprt	=1.0	Extra iteration printout
	=0.0	Omit extra iteration printout
! stdprt	=1.0 or 0.0	Standard iteration printout
	=2.0	stdprt = 1.0 plus more
	=-1.0	Omit standard iteration printout

CAUTION: The program is limited to 1000 control points having non-linear equations. This is the sum of all the second-order and isentropic Kutta conditions, and second-order and isentropic wakes (kt=18.0 or 19.0 and matchw= 2.0 or 3.0) control points.

E.4 INDUCED DRAG AND LIFT CALCULATED FROM TREFFTZ PLANE ANALYSIS OF FLAT WAKES ALIGNED WITH THE ONSET FLOW

The calculation of the forces from the integration of the pressures on the surface has not always resulted in consistently accurate drag. Using the shed vorticity of the shed wakes of an A502 configuration, a Trefftz plane analysis can be performed to calculate the induced drag and the lift of a configuration. This computation has been checked out with a limited number of validation cases. Great care is required to the details of the modeling and the analysis to obtain quality answers.

Because the Trefftz plane analysis represents the lift and drag on the configuration and the wakes, an accurate induced drag prediction requires no drag on the wake. An alternative to this approach is to calculate the forces on the wake and subtract them from the Trefftz plane analysis to produce the forces on the configuration. (A later version of the program will look at integration of the forces on the wakes.) Currently, the assumption that there is no drag on the wake must be employed. (Any lateral flow in the plane of the wake will create a lifting force. If the local lifting vectors are not parallel to the Trefftz plane, they will have a component in the direction of freestream flow, and thus a drag force.) To achieve the latter conditions wakes are shed off in the direction of the freestream flow. Thus, the wake has no drag. But the flow in the plane of the wake will result in an additional lift on the wake, and thus make the Trefftz plane lift approximate.

The Trefftz plane induced drag improves the accuracy of the induced drag calculation as compared with the integrated pressure induced drag.

The Trefftz plane lift is the total lift i.e., configuration lift and the lift on the wake surface. Thus, this computed lift is not as accurate as the integrated configuration lift. The Trefftz plane lift is provided for developmental evaluation.

The configuration lift based on integration of surface pressure is the most accurate computed lift coefficient. By altering the wake shape from the streamline wake, a small error is introduced into the configuration pressure distribution. This is largest along the wing trailing edge. But even with this change in wake shape, this is the most reliable value for lift coefficient.

The main operational experience for Trefftz plane analysis has been with simple wings, cruise wing/body, and wing/body/horizontal tail configurations at subsonic Mach numbers.

All options for different flow symmetry and anti-symmetry have been used and should be validated. The input wakes used in the analysis are reflected about the planes of symmetry so that the Trefftz plane analysis is performed about the full configuration wake. The wake section (plane) used for analysis is the projection of the wake onto the plane X = 0.0. The projection is parallel to the angle of attack.

The angle of attack analysis is only good for one angle of attack that corresponds to the wake having no wake drag. The results have looked reasonable with small variation in angle of attack (+2° and -2°) from the no wake drag angle of attack.

The wakes used for the Trefftz plane analysis are automatically assumed by the program to be the semi-infinite wake filaments attached to the configuration wakes. Recall that all the input wakes should be terminated a short distance downstream of the the configuration.

The semi-infinite wake filaments are automatically attached to all downstream wake edges, and go downstream in the direction of the compressibility axis (alpc and betc).

The only input data required for this analysis is given below.

Input Data for Trefftz Plane Analysis

$TREFFTZ PLANE ANALYSIS - PERFORMS ANALYSIS ON THE SHED WAKE NETWORKS

The resulting output is given in three different locations in the A502 output file. Sample printouts along with definition of the output symbols are given in the following text.

The first section of Trefftz plane analysis output gives a listing of the input wake networks which are used in the analysis. Some of the output ahead of the network listing is given to help locate the data and to show the similarities to the wake filaments.

```
0*E*ABUTMENT

 *****  NO POINTS WERE MOVED BY THE LIBERALIZED GEOMETRY PROCESSOR (CONTROLLED BY $EAT)  *****

   ----     SUMMARY OF FREE WAKE TRAILING EDGES     ----
            (SEMI-INFINITE FILAMENTS TO BE ATTACHED)

   NW   NETWORK-ID   ABMT
   --   ----------   ----
    6   awbw           15
    7   wingwk         18
    8   bodylwk        19
    9   bodyuwk        22

 NWLTRF/IN             4
       1.         6         7         8         9

  ----   SUMMARY OF NETWORKS FOR TREFFTZ PLANE ANALYSIS   ----

   NW   NETWORK-ID
   --   ----------
 NWLTRF/OUT            4
       1.         6         7         8         9

   6   awbw
   7   wingwk
   8   bodylwk
   9   bodyuwk

  T/ABTIDN     0.216480
```

The second section of Trefftz plane analysis output gives the details of the analysis. The wake location doublet gradients, incremental induced drag, final result, and other information is given. The analysis is performed over the complete configuration wake. For this example their are four input wakes and eight wakes used for the Trefftz plane analysis of the full configuration (one plane of flow symmetry). This output is provide for every solution right before the detailed surface flow properties.

```
NON-DIMENSIONAL INTEGRAL OF DOUBLET STRENGTH = (     0.0000000,     0.0209411,     -0.0205434)


TREFFTZ PLANE LIFT AND DRAG ANALYSIS,  ENGINEERING ANALYSIS PERFORMED BY GUNTER BRUNE
NOTE: ANALYSIS MODIFIED 5/12/91 TO TREAT FLOW ANTISYMMETRY
      RESULTS FOR SYMMETRIC CONFIGURATIONS WILL DIFFER FROM
      EARLIER VERSIONS BY FACTORS OF 2|4 FOR SYMMETIC CASES

REFERENCE AREAS, ASPECT RATIO AND SYMMETRY PARAMETERS

    BREF      SREF       AR      NSYMM     MISYM     MJSYM
  60.0000 2400.0000   1.5000       1         1         0
     FSV           3
     1.  9.9756E-01  0.0000E+00  6.9756E-02

AARG, BARG:    0.069813    0.000000
      ATRF      3 X    3  (   3),      COLUMNS    1 THROUGH   3
  1   1.     0.997564    0.000000    0.069756

  2   1.     0.000000    1.000000    0.000000

  3   1.    -0.069756    0.000000    0.997564

FSVHAT-LOC           3
     1.  1.0000E+00  0.0000E+00  0.0000E+00

simple wing-body with composite panel. (run with a502i)


  FSYMM       SREF      AR      NW
  0.000002400.00000  1.50000  8.00000

   NP
  1.00000

     Y            Z           DMDY          DMDZ
 0.600000E+01  -0.697565E+01  -0.508191E-13  -0.986932E-15
 0.921050E+01  -0.697565E+01   0.753518E-13   0.599687E-15

   NP
  2.00000

     Y            Z           DMDY          DMDZ
 0.921050E+01  -0.697565E+01  -0.202392E-01  -0.134582E-15
 0.200000E+02  -0.697565E+01   0.290295E-01   0.163892E-15
 0.200000E+02  -0.697565E+01   0.145301E-01  -0.378108E-16
 0.300000E+02  -0.697565E+01   0.694727E+00   0.127158E-14

   NP
  2.00000

     Y            Z           DMDY          DMDZ
 0.000000E+00  -0.129610E+02   0.295173E-01   0.122175E-01
 0.424270E+01  -0.112080E+02   0.487248E-01   0.201677E-01
 0.424270E+01  -0.112080E+02   0.201565E-01   0.486311E-01
 0.600000E+01  -0.697565E+01   0.964242E-02   0.232640E-01

   NP
  2.00000

     Y            Z           DMDY          DMDZ
 0.600000E+01  -0.697565E+01  -0.189013E-01   0.456026E-01
 0.424270E+01  -0.274328E+01  -0.202607E-01   0.488824E-01
 0.424270E+01  -0.274328E+01  -0.489766E-01   0.202719E-01
 0.000000E+00  -0.990263E+00   0.987069E-02  -0.408558E-02

   NP
  1.00000

     Y            Z           DMDY          DMDZ
-0.921050E+01  -0.697565E+01  -0.753518E-13   0.599687E-15
-0.600000E+01  -0.697565E+01   0.508191E-13  -0.986932E-15

   NP
  2.00000
```

```
       Y               Z              DMDY            DMDZ
 -0.300000E+02   -0.697565E+01   -0.694727E+00    0.127158E-14
 -0.200000E+02   -0.697565E+01   -0.145301E-01   -0.378108E-16
 -0.200000E+02   -0.697565E+01   -0.290295E-01    0.163892E-15
 -0.921050E+01   -0.697565E+01    0.202392E-01   -0.134582E-15

    NP
  2.00000

       Y               Z              DMDY            DMDZ
 -0.600000E+01   -0.697565E+01   -0.964242E-02    0.232640E-01
 -0.424270E+01   -0.112080E+02   -0.201565E-01    0.486311E-01
 -0.424270E+01   -0.112080E+02   -0.487248E-01    0.201677E-01
  0.000000E+00   -0.129610E+02   -0.295173E-01    0.122175E-01

    NP
  2.00000

       Y               Z              DMDY            DMDZ
  0.000000E+00   -0.990263E+00   -0.987069E-02   -0.408558E-02
 -0.424270E+01   -0.274328E+01    0.489766E-01    0.202719E-01
 -0.424270E+01   -0.274328E+01    0.202607E-01    0.488824E-01
 -0.600000E+01   -0.697565E+01    0.189013E-01    0.456026E-01

       CL              CDI             EFF
  0.163907E+00    0.510387E-02    0.111700E+01

       YL              ZL             XIL             PSIL
       YR              ZR             XIR             PSIR           DELCDI
  0.600000E+01   -0.697565E+01   -0.508191E-13    0.406260E+00
  0.921050E+01   -0.697565E+01    0.753518E-13    0.502860E+00    0.881745E-17
       YL              ZL             XIL             PSIL
       YR              ZR             XIR             PSIR           DELCDI
  0.921050E+01   -0.697565E+01   -0.202392E-01    0.502860E+00
  0.200000E+02   -0.697565E+01    0.290295E-01    0.124628E+01    0.310027E-04
  0.200000E+02   -0.697565E+01    0.145301E-01    0.124628E+01
  0.300000E+02   -0.697565E+01    0.694727E+00    0.185795E+01    0.243790E-02
       YL              ZL             XIL             PSIL
       YR              ZR             XIR             PSIR           DELCDI
  0.000000E+00   -0.129610E+02    0.319459E-01    0.559552E-13
  0.424270E+01   -0.112080E+02    0.527337E-01    0.305325E+00    0.133751E-04
  0.424270E+01   -0.112080E+02    0.526428E-01    0.305325E+00
  0.600000E+01   -0.697565E+01    0.251831E-01    0.406260E+00    0.259952E-04
       YL              ZL             XIL             PSIL
       YR              ZR             XIR             PSIR           DELCDI
  0.600000E+01   -0.697565E+01    0.493646E-01    0.406260E+00
  0.424270E+01   -0.274328E+01    0.529149E-01    0.301521E+00    0.344978E-04
  0.424270E+01   -0.274328E+01    0.530062E-01    0.301521E+00
  0.000000E+00   -0.990263E+00   -0.106828E-01    0.324185E-13    0.916332E-05
       YL              ZL             XIL             PSIL
       YR              ZR             XIR             PSIR           DELCDI
 -0.921050E+01   -0.697565E+01   -0.753518E-13   -0.502860E+00
 -0.600000E+01   -0.697565E+01    0.508191E-13   -0.406260E+00    0.881745E-17
       YL              ZL             XIL             PSIL
       YR              ZR             XIR             PSIR           DELCDI
 -0.300000E+02   -0.697565E+01   -0.694727E+00   -0.185795E+01
 -0.200000E+02   -0.697565E+01   -0.145301E-01   -0.124628E+01    0.243790E-02
 -0.200000E+02   -0.697565E+01   -0.290295E-01   -0.124628E+01
 -0.921050E+01   -0.697565E+01    0.202392E-01   -0.502860E+00    0.310027E-04
       YL              ZL             XIL             PSIL
       YR              ZR             XIR             PSIR           DELCDI
 -0.600000E+01   -0.697565E+01   -0.251831E-01   -0.406260E+00
 -0.424270E+01   -0.112080E+02   -0.526428E-01   -0.305325E+00    0.259952E-04
 -0.424270E+01   -0.112080E+02   -0.527337E-01   -0.305325E+00
  0.000000E+00   -0.129610E+02   -0.319459E-01    0.559552E-13    0.133751E-04
       YL              ZL             XIL             PSIL
       YR              ZR             XIR             PSIR           DELCDI
  0.000000E+00   -0.990263E+00    0.106828E-01    0.324185E-13
 -0.424270E+01   -0.274328E+01   -0.530062E-01   -0.301521E+00    0.916332E-05
 -0.424270E+01   -0.274328E+01   -0.529149E-01   -0.301521E+00
 -0.600000E+01   -0.697565E+01   -0.493646E-01   -0.406260E+00    0.344978E-04
1   NETWORK ID:winga      INDEX:   1   SOURCE TYPE =  1    DOUBLET TYPE = 12
    NUMBER ROWS =  10     NUMBER COLUMNS =   2


  JC  IP      X         Y         Z        WX        WY        WZ     CP2NDU   CPISNU   IMACHU   SOURCE   DOUBLET
  15   1   70.2006   14.7247    0.3889   0.9806   -0.0280   -0.1318   0.0545   0.0539   0.5848  -0.1989   3.8196
```

Header	Output Description
NP	Number of panels in each wake
Y, Z	Global coordinate Trefftz plane corner points.
DMDY, DMDZ	Gradient of the doublet strength in the Y and Z directions.
CL, CDI	Trefftz plane lift and induced drag coefficients. Values have the same reference quantites as the lift and drag coefficients from integration of the surface pressures. The lift coefficient contains the configuration and wake lift. Thus, you may need to use the lift coefficient from the integration of surface pressures.
EEF	Trefftz plane efficiency factor (2CL/CDπAR) is based on Trefftz plane coefficients. Currently not recommended value for efficiency factor, because the lift coefficient includes the wake lift.
YL,ZL	Global coordinate Trefftz plane corner points. Same as Y and Z.
XIL,XIR	Gradient of the doublet strength in the Y direction at the left and right hand sides of a wake panel (viewed from downstream looking upstream).
PSIL,PSIR	Trefftz plane stream function values at the left and right hand sides of a wake panel (viewed from downstream looking upstream).
DELCDI	Increment of induced drag coefficient over a wake panel column.

The third section of Trefftz plane analysis output summarizes the lift, induced drag, and the efficiency factor from the Trefftz plane analysis along with the values from the integration of the surface pressures. Note that these values may not always be comparable, because the integration of surface pressures may be over a different set of user specified surface networks.

The output is an additional line of output for each solution added to the full configuration induced drag and the lift. Some additional output is provided for reference.

```
************************************************************************************************************************

                          FULL CONFIGURATION FORCES AND MOMENTS SUMMARY

                          SYMMETRY CONDITIONS: MISYMM =   1   MJSYMM =   0

SOL-NO   ALPHA     BETA       CL        CDI         CY          FX         FY         FZ
                                                                MX         MY         MZ         AREA

  1     4.0000    0.0000    0.16279   0.00682    0.00000    -0.00455    0.00000    0.16287
                                                              0.00000    0.02731    0.00000   7907.50174

TREFFTZ PLANE ANALYSIS:   CL =  0.163907E+00  CDI =  0.510387E-02   EFF =  0.111700E+01

************************************************************************************************************************

CONFIGURATION IS COMPOSED OF THE FOLLOWING SELECTED NETWORKS

    1 winga          2 wingta          3 bodyl          4 bodyu

NOTE: THESE NETWORKS ARE ALL   KT=1   TYPES

REFERENCE CONDITIONS ARE:

SREF =         2400.00000 XREF =         46.00000 YREF =          0.00000 ZREF =          0.00000
                          CREF =         40.00000 BREF =         60.00000 DREF =         90.00000

************************************************************************************************************************
0*B*OFF-BODY
```