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Report 1804

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HYDROMECHANICS

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ACOUSTICS AND VIBRATION

ANALYSIS OF WAKE SURVEY OF SHIP MODELS COMPUTER PROGRAM AML PROBLEM NO. 840-219F

by

Henry M. Cheng

HYDROMECHANICS LABORATORY

RESEARCH AND DEVELOPMENT REPORT

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ANALYSIS OF WAKE SURVEY OF SHIP MODELS
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LIST OF SYMBOLS

A_j, B_j	j^{th} harmonic coefficients of a sine and cosine series
C_j	j^{th} harmonic amplitude of a sine series
D	Propeller diameter, ft
J_a	Apparent advance coefficient, V/nD
k_x, k_θ	Orders of interpolation
n	Propeller revolutions, rps
P	Pressure factor, $(V_b{}^2)_{max}/\bar{V}_b{}^2 - 1$
r	Radial coordinate, ft
R	Radius of propeller, ft
$\underline{V}$	Resultant wake velocity vector, fps
V_b	Resultant inflow velocity to blade
$\bar{V}_b$	Mean resultant inflow velocity to blade
V	Model or ship velocity, fps
V_r	Radial component of velocity vector
$\bar{V}_r$	Mean radial component of velocity vector
V_t	Tangential component of velocity vector
$\bar{V}_t$	Mean tangential component of velocity vector
V_{tr}	Transverse component of velocity vector
$\bar{V}_v$	Volumetric velocity
V_x	Longitudinal component of velocity vector
$\bar{V}_x$	Mean longitudinal component of velocity vector
$V_{x_{corr}}$	Corrected longitudinal velocity

$\bar{V}_{x_{corr}}$	Mean corrected longitudinal component of velocity
W_x	Wake coefficient
x	Nondimensional radius r/R (radial coordinate)
x_h	Nondimensional radius at hub
X,Y,Z	Cartesian coordinates
α_h	Projected angle of velocity vector on X-Y plane
α_v	Projected angle of velocity vector on X-Z plane
β	Advance angle
$\bar{\beta}$	Mean advance angle
$\Delta\beta$	Variation of advance angle from its mean
ϕ_j	Phase angle of j^{th} harmonic in degrees
θ	Position angle (angular coordinate) in degrees

ABSTRACT

This report presents a brief discussion of the computer program written for the purpose of analyzing experimental wake survey data. The method used in computation is briefly discussed and a detailed instruction for preparation of input data is provided. Samples of computer input and output are included in Appendix A.

INTRODUCTION

The phenomena of propeller cavitation, propeller radiated noise, and vibration due to alternating forces developed by a propeller have been matters of great concern to naval architects. It is understood that to a large extent these phenomena are affected by the nonuniform character of the wake field in which a propeller operates. In order to gain a better understanding of the flow pattern behind a ship, experiments to measure the steady three-dimensional velocities at a number of points in the plane of a propeller using pitot tubes have been carried out for a large number of models by naval researchers for many years. This procedure of measuring velocities in way of a wake is commonly known as a Wake Survey.

In the past, experimental data obtained from wake surveys could only be analyzed to a limited extent using time consuming hand computation and curve fairing techniques. From these analyses information on the magnitude and direction of wake velocity at test points and a map of equal velocity contours may be obtained.

With the aid of modern electronic digital computers, it is believed that additional information could be gained from some more detailed analyses of the experimental data requiring very little effort as demonstrated in many other areas of study. With this in view, a computer program was initiated in 1961 to interpolate test data and provide a complete map of a wake velocity field, and thus give insight into the characteristics of the flow pattern behind a ship.

This report presents a brief discussion of the mathematical methods used in the computations, and a detailed instruction for preparation of input data for the convenience of the users of the program.

NOTES ON COMPUTER PROGRAM

The computer program entitled "Wake Analysis" was designated AML Problem No. 840-219 for the initial purpose of interpolating test wake velocity data in the plane of propeller using the IBM-7090 digital computer. As the work of programming progressed, a number of features were added resulting in various versions of the program. Each of the versions was designated by adding a letter alphabetically to the problem number. To date, there are six versions, 219A through 219F. The latest version, i.e., 219F, incorporates all the features that are in the versions preceding it. A brief discussion of this program is given below.

Input

Two pitot tubes of different design have been used in wake survey work at the David Taylor Model Basin. These are the so-called 5-hole and 13-hole pitot tubes. Each of these instruments provides a different set of input information in regard to the magnitude and direction of a velocity vector. Accordingly, the computer program is written to accommodate both of these cases.

For a 5-hole pitot tube which is being used currently, the input data is in the form of three nondimensional components (tangential, longitudinal, and radial) of the resultant velocity vector at various points in the plane of a propeller. This information is obtained with the aid of the computer program XF10, which converts directly the test data into these components.

Test data obtained with a 13-hole pitot tube is first converted into the following three quantities by hand computation and curve fairing:

Resultant velocity vector, $\underline{V}$

Projected angle of resultant velocity vector on X-Z vertical plane, α_v

Projected angle of resultant velocity vector on X-Y horizontal plane, α_h .

These three quantities are then used as input data to the computer. The computer converts this input data first into the three nondimensional velocity components at each of the test data points, and then handles them as in the case of a 5-hole pitot tube.

Usually, the data entered is "complete" in the sense that for each input radial coordinate, data points are on all of the input angular coordinates, or vice versa. But in some cases due to physical limitations or other considerations, measurements at some points may not have been made; in these cases, the data entered are "incomplete" in that for each input radial coordinate, test points may not necessarily be on all the input angular coordinates. Accordingly, the computer program is written such that data at the missing points may be supplied first by interpolation, and from there on, the problem is treated the same as if it were "complete."

Computation

The main purpose of the computer program is to interpolate or extrapolate input data for points other than the test points. The method used for this is a double interpolating procedure based on Aitken's formula.* Briefly, for given values of the two independent variables x and θ, the computer employs a subroutine which will perform k_x th and k_θ th order interpolations in the x and θ directions, respectively, on a table of (x, V, θ) values for the corresponding dependent argument V. The functional form which the table of (x, V, θ) values must satisfy is

either $V_{i,j} = f(x_{i,j}, \theta_i)$ (for incomplete case)

or $V_{i,j} = f(x_j, \theta_i)$ (for complete case)

$i = 1, 2, \ldots, m; \qquad j = 1, 2, \ldots, n$

The independent variables x and θ need not be equally spaced.

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* See e.g. "Numerical Calculus" by W. E. Milne, Princeton University Press, 1949.

In order to obtain the interpolation or extrapoated value of V at a given point $(\bar{x}, \bar{\theta})$, i.e., $V(\bar{x}, \bar{\theta})$ the subroutine performs double interpolation or extrapolation in the radial and angular directions in accordance with the following procedure:

1. Selection of data points in the input for interpolation

The subroutine first selects a set of $k_\theta + 1$ values of θ. In choosing these points the following rules are observed:

Let the table consist of $(\theta_1, \theta_2, \cdots, \theta_m)$ Then if

a. $\bar{\theta} < \theta_1$; use $\theta_1, \theta_2, \cdots, \theta_{k_\theta+1}$

b. $\bar{\theta} > \theta_m$; use $\theta_{m-k_\theta}, \theta_{m-k_\theta+1}, \cdots, \theta_m$

c. k_θ is odd, $\theta_i < \bar{\theta} < \theta_{i+1}$; use

$$\theta_{i - \frac{k_\theta - 1}{2}}, \quad \theta_{i - \frac{k_\theta - 3}{2}}, \quad \ldots, \quad \theta_{i + \frac{k_\theta + 1}{2}}$$

d. k_θ is even, $\theta_i < \bar{\theta} < \theta_{i+1}$, and $|\bar{\theta} - \theta_i| < |\theta_{i+1} - \bar{\theta}|$; use

$$\theta_{i - \frac{k_\theta}{2}}; \quad \theta_{i - \frac{k_\theta}{2} + 1}, \quad \ldots, \quad \theta_{i + \frac{k_\theta}{2}}$$

e. k_θ is even, $\theta_i < \bar{\theta} < \theta_{i+1}$, and $|\bar{\theta} - \theta_i| \geqslant |\theta_{i+1} - \bar{\theta}|$; use

$$\theta_{i - \frac{k_\theta}{2} + 1}, \quad \theta_{i - \frac{k_\theta}{2} + 2}, \quad \ldots, \quad \theta_{i + \frac{k_\theta}{2} + 1}$$

Next, for any value of θ_i a selection of $k_x + 1$ points is made. In choosing the points over which k_x^{th} order interpolation or extrapolation is desired to obtain $V(\bar{x}, \theta_i)$ a similar set of rules are observed:

Let the table consist of $(x_{i,1}, V_{i,1}), (x_{i,2}, V_{i,2}), \ldots, (x_{i,n}, V_{i,n})$ for θ_i. Then if

a. $\bar{x} < x_{i,1}$; extrapolation of $V(\bar{x}, \theta_i)$ will occur using

$$(x_{i,1}, V_{i,1}), (x_{i,2}, V_{i,2}), \ldots, (x_{i,k_x+1}, V_{i,k_x+1})$$

b. $\bar{x} > x_{i,n}$; extrapolation will occur using

$$(x_{i,n-k_x}, V_{i,n-k_x}), (x_{i,n-k_x+1}, V_{i,n-k_x+1}), \ldots, (x_{i,n}, V_{i,n})$$

c. k_x is odd and $x_{i,j} < \bar{x} < x_{i,j+1}$; interpolation will occur using

$$(x_{i,j-\frac{k_x-1}{2}}, V_{i,j-\frac{k_x-1}{2}}), (x_{i,j-\frac{k_x-3}{2}}, V_{i,j-\frac{k_x-3}{2}}), \ldots,$$

$$(x_{i,j+\frac{k_x+1}{2}}, V_{i,j+\frac{k_x+1}{2}})$$

d. k_x is even and $x_{i,j} < \bar{x} < x_{i,j+1}$ and $|\bar{x}-x_{i,j}| < |x_{i,j+1}-\bar{x}|$ interpolation will occur using

$$(x_{i,j-\frac{k_x}{2}}, V_{i,j-\frac{k_x}{2}}), (x_{i,j-\frac{k_x}{2}+1}, V_{i,j-\frac{k_x}{2}+1}), \ldots,$$

$$(x_{i,j+\frac{k_x}{2}}, V_{i,j+\frac{k_x}{2}})$$

e. k_x is even and $x_{i,j} < \bar{x} < x_{i,j+1}$ and $|\bar{x}-x_{i,j}| > |x_{i,j+1}-\bar{x}|$ interpolation will occur using

$$(x_{i,j-\frac{k_x}{2}+1}, V_{i,j-\frac{k_x}{2}+1}), (x_{i,j-\frac{k_x}{2}+2}, V_{i,j-\frac{k_x}{2}+2}), \ldots,$$

$$(x_{i,j+\frac{k_x}{2}+1}, V_{i,j+\frac{k_x}{2}+1})$$

2. Interpolation in radial direction

Single interpolations of order k_x are then performed on the $k_\theta +1$ set of tables

$$\theta_i: (x_{i,1}, V_{i,1}), (x_{1,2}, V_{i,2}), \ldots, (x_{i,n}, V_{i,n})$$

$$\theta_{I+1}: (x_{i+1,1}, V_{i+1,1}), (x_{I+1,2}, V_{i+1,2}), \ldots, (x_{i+1,n}, V_{i+1,n})$$

$$\ldots$$

$$\theta_{i+k}: (x_{i+k,1}, V_{i+k,1}), (x_{i+k,2}, V_{i+k,2}), \ldots, (x_{i+k,n}, V_{i+k,n})$$

3. Final interpolation in angular direction

With the newly acquired V values from Step 2, a final interpolation of order k_θ is performed on the tables

$$(\theta_i, V_i), (\theta_{i+1}, V_{i+1}), \ldots, (\theta_{i+k_\theta}, V_{i+k_\theta})$$

Additional rules should be observed:

a. k_x and k_θ should not exceed 5.

b. The independent arguments must be strictly monotonic, i.e.,

$$x_{i,j+1} > x_{i,j}$$

or $$x_{i,j+1} < x_{i,j} \qquad \text{for all } j,$$

and $$\theta_{i+1} > \theta_i$$

or $$\theta_{i+1} < \theta_i \qquad \text{for all } i.$$

It should be mentioned that the above rules are applicable to the case where x, θ are monotonically increasing. For the case where

$$x_{i,j+1} < x_{i,j} \quad \text{and} \quad \theta_{i+1} < \theta_i$$

appropriate changes of inequality signs in the above rules should be made.

Using the above interpolation procedure values of nondimensional tangential, longitudinal, and radial components are interpolated or extrapolated at specified output radial and angular coordinates (x, θ).

From the interpolated values of velocity components at each of the specified output points (x, θ) the values of nondimensional resultant inflow velocity to the blade squared $(V_b/V)^2$ (neglecting the radial component), and advance angle, β, are computed in accordance with the following formulas: (see Figure 2)

$$(V_b/V)^2 = (V_x/V)^2 + (\pi x/J_a + V_t/V)^2$$

$$\beta = \tan^{-1} (V_x/V) / (\pi x/J_a + V_t/V) \quad ,$$

where $J_a = V/nD$ is apparent advance coefficient.

Also computed is the corrected longitudinal velocity which is a fictitious, or pseudo longitudinal velocity. This corrected velocity, when used in conjunction with an assumed zero tangential velocity, gives the same advance angle, β , as would be obtained when both the longitudinal and tangential velocities are present, and it is defined as follows:

$$V_{x_{corr}}(x,\theta) = V_x(x,\theta) - V_t(x,\theta) \tan\beta(x,\theta)$$

The computer program also employs a harmonic analysis subroutine for the purpose of analyzing the harmonic contents of any of the velocity curves at each output radius. Briefly, this subroutine computes the A_j, B_j, C_j, and ϕ_j terms of the following series for a given set of V_i values ($i = 0, 1, 2, \ldots, k-1$) which correspond to a set of equally spaced θ_i points:

$$V = A_o + \sum_{j=1}^{H} A_j \cos j\theta + \sum_{j=1}^{H} B_j \sin j\theta$$

or

$$V = A_o + \sum_{j=1}^{H} C_j \sin (j\theta + \phi_j)$$

where H represents the number of harmonics desired, ($H \leq \frac{k}{2}$ if k is even, $H \leq \frac{k-1}{2}$ if k is odd), C_j is the amplitude and ϕ_j is the phase angle in degrees of the j^{th} harmonic. The function $V(\theta)$ is assumed periodic with $V_o = V_k$, i.e., $V(0^o) = V(360^o)$.

The coefficients A_j, B_j, C_j, and ϕ_j are calculated using the following equations:

k Even	k Odd
$A_o = \frac{1}{k} \sum_{i=0}^{k-1} V_i$	Same
$A_j = \frac{2}{k} \sum_{i=0}^{k-1} V_i \cos(ij\alpha_o)$	Same
$B_j = \frac{2}{k} \sum_{i=0}^{k-1} V_i \sin(ij\alpha_o)$	Same
$A_{k/2} = \frac{1}{k} \sum_{i=0}^{k-1} (-1)^i V_i$	No $A_{k/2}$
$C_j = (A_j^2 + B_j^2)^{1/2}$	Same
$\phi_j = \tan^{-1} \frac{A_j}{B_j}$ (degrees)	Same
where $j = 1, 2, 3, \ldots, k/2 - 1$	$j = 1, 2, 3, \ldots, (k-1)/2$

$\alpha_o = 2\pi/k$

It should be noted that a higher number of harmonics supposedly provide a better representation of the curve analyzed; however, the accuracy for the higher harmonics is not as good as that for the lower harmonics.

From harmonic analysis of the velocity components one obtains mean values of each velocity component at specified output radii. At each radius the mean values of nondimensional tangential, $\bar{V}_t/V$, and longitudinal components, $\bar{V}_x/V$, are used to compute a mean advance angle, $\bar{\beta}$:

$$\bar{\beta} = \tan^{-1} \quad (\bar{V}_x/V) \;/\; (\pi x/J_a + \bar{V}_t/V)$$

Also computed are the maximum variations in advance angle from its mean $\Delta\beta$, defined as follows:

$$+\Delta\beta = \beta_{max} - \bar{\beta} \qquad\qquad -\Delta\beta = \beta_{min} - \bar{\beta} ,$$

and a pressure factor of ratios of square of the inflow velocity defined as:

$$P = (V_b{}^2)_{max}/\bar{V}_b{}^2 - 1.$$

In order to obtain an "effective" wake coefficient an area integration is first performed using the following formula:

$$\bar{V}_v\ (x) = 2\pi \int_{x_h}^{x} x\ \bar{V}_{x_{corr}}\ (x)dx$$

where x_h is the hub radius which is assumed to be 0.2 in the computation. From this an "effective" wake coefficient is computed as follows:

$$W_x(x) = 1 - \bar{V}_v(x) / \pi V(x^2 - x_h{}^2)$$

The second term of the above equation may be considered as a mean effective wake velocity when x = 1. This is also known as a volumetric mean velocity.

The computer program also employs the Stromberg-Carlson (SC-4020) Microfilm Recorder System for curve plotting. The two subroutines used are ENPLOT and CURVE. The calculated data are plotted automatically on graphs when desired.

Output

The following information is available from the output:

1. At each specified output radial coordinate, x, and angular

coordinate, θ:

Nondimensional tangential velocity component, V_t/V

Nondimensional longitudinal velocity component, V_x/V

Nondimensional radial velocity component, V_r/V

Nondimensional blade element inflow velocity squared, $(V_b/V)^2$

Advance angle, β

Nondimensional corrected longitudinal velocity component, $V_{x_{corr}}/V$

2. At each specified output radial coordinate, x:

   Maximum inflow velocity squared, $(V_b/V)^2_{max}$

   Maximum advance angle, β_{max}

   Minimum advance angle, β_{min}

3. At each specified output radial coordinate, x:

   Harmonic analysis of nondimensional tangential velocity V_t/V

   Harmonic analysis of nondimensional longitudinal velocity V_x/V

   Harmonic analysis of nondimensional radial velocity, V_r/V

   Harmonic analysis of inflow velocity squared $(V_b/V)^2$

   Harmonic analysis of advance angle β

   Maximum variations in β, $+\Delta\beta$, and $-\Delta\beta$

   Pressure factor, P

   Harmonic analysis of nondimensional corrected longitudinal velocity $V_{x_{corr}}/V$

4. At each specified output radial coordinate, x:

   Volumetric velocity, $\bar{V}_x/V$

   Effective wake velocity, $1-W_x$

   Wake coefficient, W_x

5. At each specified output radial coordinate, x, plots of

   Nondimensional tangential velocity V_t/V versus position angle θ

   Nondimensional longitudinal velocity V_x/V versus position angle θ

   Nondimensional radial velocity V_r/V versus position angle θ

   Nondimensional inflow velocity squared $(V_o/V)^2$ versus position angle θ

   Advance angle β versus position angle θ

Also plots of

Mean tangential velocity $\overline{V}_t/V$ versus radius x

Mean longitudinal velocity $\overline{V}_x/V$ versus radius x

Maximum variations in advance angle $+\Delta\beta$ and $-\Delta\beta$ versus radius x

Pressure factor P versus radius x

Effective wake velocity $1-W_x$ versus radius x

INPUT DATA PREPARATION

In view of the many features that have been incorporated in the program to accommodate a number of cases, the input data format will therefore vary depending on the case entered. It is the main objective of this report to provide a detailed instruction to users of the program for preparation of input data cards.

Essentially the input cards consist mainly of two parts: (1) program control and (2) wake data.

For convenience, the following instruction is outlined in the order of the input cards entered. (See tables in the Appendix.)

Set 1 (one card)

Card 1 (control card)

Column	Parameter	Format
1 - 4	Model number	I4
5 - 7	No. of radii in input	I3
8 - 10	No. of angles for which there is at least one entry in input	I3
11 - 15	Propeller diameter, D	F5.2
16 - 20	Test number	F5.1
21 - 22	Blank	
23	*Table control no.	I3
24 - 26	Blank	
27 - 31	Model velocity, V	F5.2 for 13-hole pitot tube only

*Table Control no.	Data in Input
For complete data:	
0	V_t/V, V_x/V
1	V_t/V
2	V_x/V
3	V_r/V
4	$\underline{V}$, α_v, α_h (for 13-hole pitot tube)

For incomplete data:

5	V_t/V, V_x/V
6	V_t/V
7	V_x/V
8	V_r/V
9	$\underline{V}$, α_v, α_h (for 13-hole pitot tube)

Set 2 (one card)

Card 1 Format 12F6.3

Values of input radii in increasing order of magnitude, 6 digits each up to 12 values

Set 3 (up to 15 cards)

Card 1 Format 12F6.2

Values of angles for which a velocity is entered for at least one radius, 6 digits each up to 180 values, 12 to a card,etc.

Card sets 1 through 3 are common to all of the possible cases that may be entered.

Card sets 4 through 8 are data cards, their format vary depending on the type of data entered, i.e., depending on the Table Control Number. They are designated by set number followed by the Table Control Number, e.g., set 4.2 is set 4 for Table Control Number 2.

For "complete" data:

Table Control Number 0

Set 4.0

Card 1 Format 18F4.3

Values of nondimensional tangential velocity V_t/V for each input radius and angle. All V_t/V for first (innermost) radius, all V_t/V for second radius, etc. 4 digits each up to 18 per card, etc.

Set 5.0

Card 1 Format 18F4.3

Same as Set 4.0 except V_x/V in lieu of V_t/V etc.

Sets 6.0 through 8.0 - None

Table Control Number 1

Set 4.1

Same as Set 4.0

Sets 5 through 8 - None

Table Control Number 2

Set 4.2

Same as Set 5.0

Sets 5 through 8 - None

Table Control Number 3

Set 4.3

Same as Set 4.0 except V_r/V in lieu of V_t/V

Sets 5 through 8 - None

Table Control Number 4 (for 13-hole pitot tube)

Set 4.4 (up to 180 cards)

Card 1 Format 12F6.2

Values of V for each input radius and angle. All V for first (innermost) radius, all V for second radius, etc. 6 digits each up to 12 per card, etc.

Set 5.4 (up to 180 cards)

Card 1 Format 12F6.2

Values of α_v for each input radius and angle corresponding to V in Set 4.4

Set 6.4 (up to 180 cards)

Card 1 Format 12F6.2

Values of angle α_h for each input radius and angle corresponding to V in Set 4.4

Sets 7 and 8 - None

For "incomplete" data

Table Control Numbers 5, 6, 7, 8, and 9

Set 4 (one card)

Column		Format
1 - 3	Blank	
4	Order of interpolation in radial direction to be used for supplying missing data	I1
5 - 7	Blank	
8	Order of interpolation in angular direction to be used for supplying missing data	I1
9 - 72	Blank	

Each of the sets 5 through 8 is associated with an input radius. Complete specifications of the sets for the first (innermost) radius are given below. Sets described for a given Table Control Number will be repeated for each input radius in increasing order.

Table Control Number 5

Set 5.5 (one card)

Card 1

Column		Format
1	Blank	I3
2-4	Number of angles for which nondimensional tangential velocity values are entered at the first (innermost) radius	
5 - 72	Blank	

Set 6.5 (up to 24 cards)

Card 1 Format 12F6.2

Column	
1 - 6	Value of angle for which non-dimensional tangential velocity value is given
7 - 12	Value of tangential velocity, V_t/V
13 - 18	6-digit pairs
19 - 24	6 pairs per card up to 144 pairs
etc.	

Set 7.5 (one card)

Same as Set 5.5 but referring to nondimensional longitudinal velocities instead of tangential velocities

Set 8.5 (up to 24 cards)

Same as Set 6.5 but referring to nondimensional longitudinal velocities.

Table Control Number 6

Set 5.6 (one card)
Set 6.6 (up to 24 cards) Same as Sets 5.5 and 6.5

(Sets 7.6 and 8.6 - None)

Table Control Number 7

Set 5.7 (one card)

Set 6.7 (up to 24 cards) — Same as Sets 7.5 and 8.5

(Sets 7.7 and 8.7 - None)

Table Control Number 8

Set 5.8 (one card)

Set 6.8 (up to 24 cards) — Same as Sets 5.5 and 6.5 but referring to nondimensional radial velocities

(Sets 7.8 and 8.8 - None)

Table Control Number 9

Set 5.9 (one card) — Same as Set 5.5 but referring to velocity vector $\underline{V}$ and related projected angles

Set 6.9 (up to 48 cards)

Column	
1 - 6	Values of angle for which $\underline{V}$, α_v, α_h are entered.
7 - 12	$\underline{V}$
13 - 18	α_v
19 - 24	α_h
25 - 30	6-digit quadruples
31 - 36	3 quadruples per card up to 144 quadruples
37 - 42	
43 - 48	
etc.	

(Sets 7.9 and 8.9 - None)

Set 9 (one card)

Card 1 (control card)

Column		Format
1 - 4	No. of runs	I4
5 - 72	Blank	

Set 10 (one card)

Card 1 (control card)

Column		Format
1 - 3	No. of output radii, x	I3
4 - 6	No. of order of interpolation in radial direction for V_t/V	I3
7 - 9	No. of order of interpolation in angular direction for V_t/V	I3
10 - 12	No. of order of interpolation in radial direction for V_x/V	I3
13 - 15	No. of order of interpolation in angular direction for V_x/V	I3
16 - 20	No. of test	F5.1
21 - 24	Model No. of propeller	I4
25 - 30	Apparent coefficient of advance, J_a	F6.4
31 - 34	Control No. for plot 0 specifies plots desired 1 specifies plots not desired	I4

Set 11 (one card)

Card 1 Format 12F6.3

Values of output radii

Set 12 (one card)

Card 1 Format 12F6.2

Values of deviation angles at each of the output radii

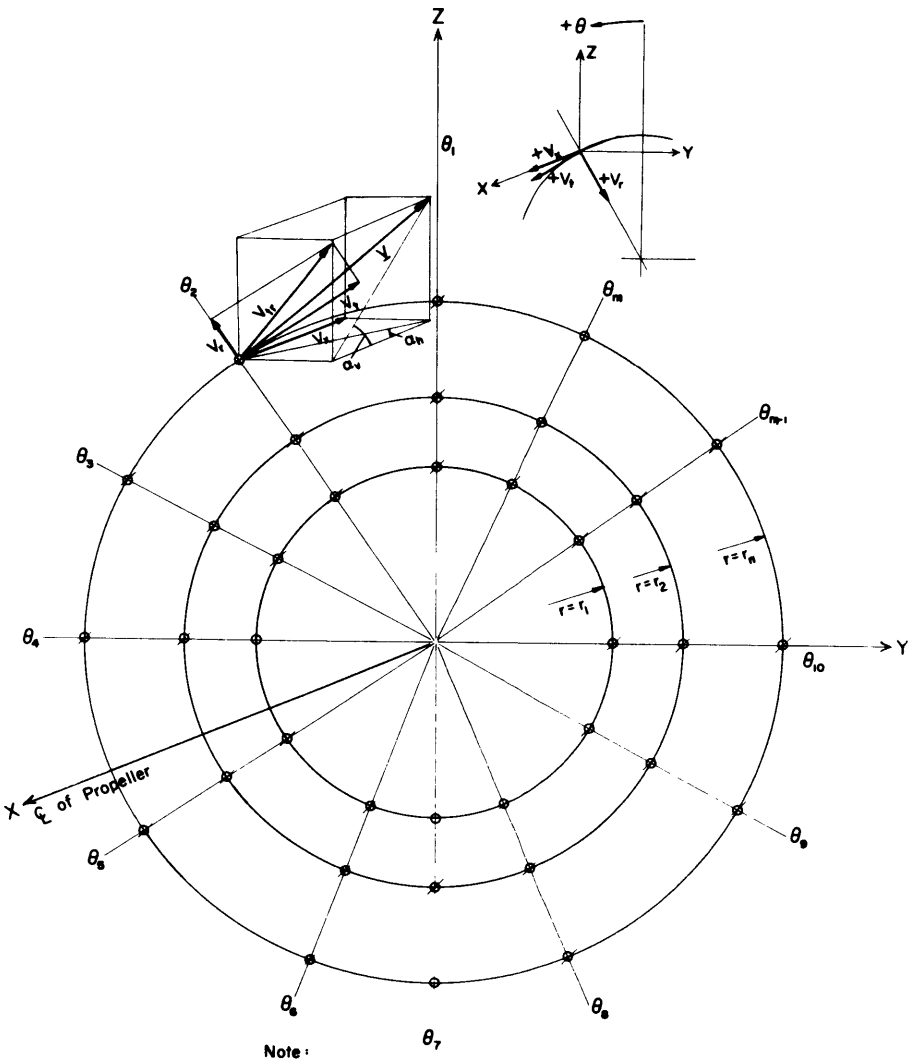
Set 13 (one card)

Card 1

Column		Format
1 - 4	No. of output angular coordinates (not to exceed 144)	I4
5 - 8	No. of harmonics, NHA, for velocity components	I4
	If 0 specified, NHA = 24	
	If negative specified, no harmonic analysis	
9 - 12	Control No. for harmonic analysis	I4
	0 or 1 specifies harmonic analysis desired at every output radius	
	2 specifies harmonic analysis desired at every other output radius	
13 - 16	No. of harmonics, NHV, for inflow velocity squared and beta angles	I4
	If 0 specified, NHV = NHA	

ACKNOWLEDGMENT

The computer program was programmed by Mr. Kenton L. Meals and Mrs. Juanita R. Mack of the Applied Mathematics Laboratory of the David Taylor Model Basin. The author wishes to express his many thanks to them for their effort and cooperation. Thanks are also due to Mr. George Smith for his reading of the draft.



Note:

O and Ø showing data points for a "complete" case.

Ø showing data points for an "incomplete" with no data on points O.

Looking Forward

Figure 1 - Coordinate System of Velocity Components

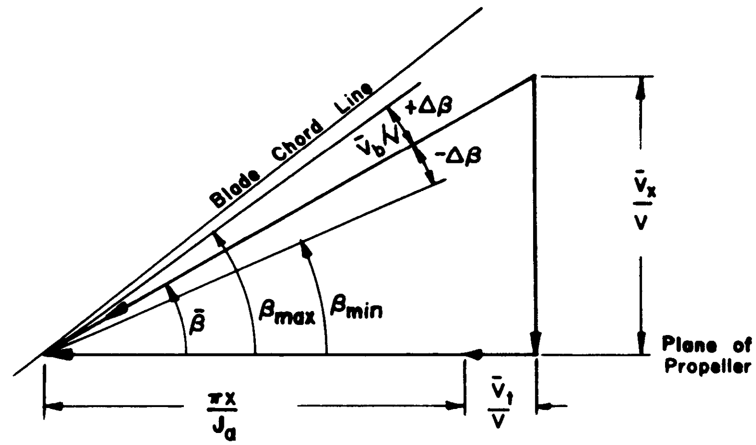


Figure 2 Velocity Diagram

APPENDIX A

Sample Input and Output

The input data coding form for four sample cases are presented in Tables 1, 2, 3, and 4 to illustrate the various types of input data discussed. These are:

1. "Complete" Case 1 with V_t/V and V_x/V as input
2. "Complete" Case 2 with $\underline{V}$, α_v, and α_h as input
3. "Incomplete" Case 1 with V_t/V and V_x/V as input
4. "Incomplete" Case 2 with $\underline{V}$, α_v, and α_h as input.

The output for the complete Case 1 is shown in Table 5. Also, for the "Complete" Case 1, output plots are shown in Figure 3.

CODING FORM FOR IBM TYPE 704 COMPUTER
PRNC-TMB-719

TITLE: WAKE ANALYSIS, INPUT DATA FOR MODEL 4521 — PROGRAMMER: — DATE: 11/1/63
PROBLEM NO: 840-219 E — PHASE: — LABEL: 73 / 76 — SHEET 1 OF 1

```
SYMBOL | OP | ADDRESS, TAG, DECREMENT  REMARKS                                     IDENT   SET NO
1       7    11      20        30        40        50        60                     70  72 77   80
4521   4 2121.50   .1                                                                     1
 .3000 .5500 .80001.0500                                                                  2
   0.0  15.0   30.0  45.0   60.0   90.0 120.0 135.0 150.0 165.0 180.0 195.0               3
 210.0 225.0 240.0 270.0 300.0 315.0 330.0 345.0 360.0
.000.005.051.057.033.000.008.127.082.039.000-039-082-127-008.000-033-057                 4.0
-051-005.000.000-025-051-106-168-180-132-092-016.103.000-103.016.092.132
.180.168.106.051.025.000.000.072-135-198-196-160-106-085-048-017.000.017
.048.085.106.160.196.198.135.072.000.000-124-164-191-192-150-093-071-043
-031.000.031.043.071.093.150.192.191.164.124.000
.500.510.530.530.490.480 530.520.450.400.420.400.450.520.530.480.490.530                 5.0
.530.510.500.530.580.590.620.700.890.900.890.840.600.340.600.840.890.900
.890.700.620.590.580.530.540.630.690.780.880.920.930.930.920.890.380.890
.920.930.930.920.880.780.690.630.540.540.690.750.820.890.920.930.930.930
.930.690.930.930.930.930.920.890.820.750.690.540
   1                                                                                      9
  9  2  3  2  3          .908                                                            10
  .3     .4     .5     .6     .7     .8     .9     .95  1.0                              11
  0.     0.     0.     0.     0.     0.     0.     0.     0.                             12
  72   12   2                                                                            13
```

Table 1 - Sample Input Coding Form for "Complete" Case 1 with V_t/V and V_x/V as Input

CODING FORM FOR IBM TYPE 704 COMPUTER
PRNC-TMB-719

TITLE: WAKE ANALYSIS, INPUT DATA FOR MODEL 4078 — PROGRAMMER: — DATE: 11/1/63
PROBLEM NO: 840-219 E — PHASE: — LABEL: 73 / 76 — SHEET 1 OF 1

```
SYMBOL | OP | ADDRESS, TAG, DECREMENT  REMARKS                                     IDENT   SET NO
1       7    11      20        30        40        50        60                     70  72 77   80
4078   3  1621.40011.2  4   5.63                                                          1
 .440   .740 1.0                                                                          2
   0.0  30.0   60.0   90.0 120.0 150.0 180.0 195.0 210.0 240.0 270.0 300.0               3
 315.0 330.0 345.0 360.0
  4.26   4.79   5.09   5.30   5.32   5.12   4.51   4.29   5.30   5.49   5.56   5.02       4.4
  4.02   3.15   3.93   4.26   4.28   5.00   5.33   5.50   5.56   5.55   5.09   4.10
  4.96   5.62   5.53   5.43   5.08   4.28   3.60   4.28   4.42   5.02   5.33   5.54
  5.59   5.56   5.56   5.59   5.59   5.56   5.55   5.49   5.30   4.65   3.52   4.42
 -1.75   0.00   1.50   1.75   1.70   1.00  -0.50   2.75  -1.75   6.00   6.00   8.00       5.4
  8.00  -0.50  -2.50  -1.75  -0.75   0.75   1.25   1.50   1.25   1.25   0.75   6.00
 -3.00   9.00   5.75   5.50   7.00   7.50  -2.00  -0.75   0.50   0.50   1.00   1.00
  1.00   1.00   1.25   3.00   7.25   6.50   5.75   5.25   6.00   7.00   1.75   0.50
 -8.50   9.00  -7.75   5.75   5.80   6.00   7.25  11.00   4.50  -0.75  -0.75   2.00       6.4
  5.50  -3.00  -9.50  -8.50  -8.00   8.50   6.25   5.25   4.25   4.75   8.75  -6.75
 -8.00  -1.25  -2.00  -1.75   0.75   1.25  -8.00  -8.00  -8.00   7.00   5.50   5.00
  4.00   3.50   5.00  -7.75  -8.50  -3.75  -2.75  -2.75  -2.00   2.00-10.00  -8.00
   1                                                                                      9
  9  2  3  2  3          .868   1                                                        10
  .3     .44    .5     .6     .74    .8     .9     .95  1.                               11
  0.     0.     0.     0.     0.     0.     0.     0.     0.                             12
 144 ,                                                                                   13
```

Table 2 - Sample Input Coding Form for "Complete" Case 2 with $\underline{V}$, α_v, and α_h as Input

CODING FORM FOR IBM TYPE 704 COMPUTER
PRNC-TMB-719

TITLE: WAKE ANALYSIS, INPUT DATA FOR MODEL 4536 PROGRAMMER: DATE: 11/1/63
PROBLEM NO.: 840 - 219 E PHASE: LABEL 73 76 SHEET 1 OF 2

SYMBOL (1–6)	OP (7–10)	ADDRESS, TAG, DECREMENT / REMARKS (11–69)	IDENT (70–72)	SET NO (77–80)
4536	3	1317.50 3.1 5		1
.520		.770 1.		2
0.	30.	60. 90. 120. 150. 180. 210. 240. 270. 300. 330.		3
360.				
2	3			4.5
11				5.5
30.		-.159 60. -.164 90. -.145120. -.103150. -.036210.	.082	6.5
240.		.094270. .125300. -.131330. -.141360. -.105		
11				7.5
30.		.909 60. .954 90. .973120. .976150. .799210.	.957	8.5
240.		.965270. .952300. .954330. .799360. .729		
13				
0.		-.120 30. -.141 60. -.154 90. -.129120. -.089150.	.033	
180.		.115210. .044240. .099270. .122300. .096330.	.164	
360.		-.120		
13				
0.		.706 30. .896 60. .950 90. .976120. .977150.	.976	
180.		1.017210. .978240. .960270. .956300. .952330.	.800	
360.		.706		
12				
0.		-.122 30. -.137 60. -.149 90. -.127120. -.084150.	-.034	
210.		.078240. .105270. .122300. .109330. .037300.	-.122	
12				
0.		.684 30. .864 60. .940 90. .981120. .980150.	.976	
210.		.971240. .955270. .961300. .920330. .744360.	.684	

CODING FORM FOR IBM TYPE 704 COMPUTER
PRNC-TMB-719

TITLE: WAKE ANALYSIS, INPUT DATA FOR MODEL 4536 PROGRAMMER: DATE: 11/1/63
PROBLEM NO.: 840 - 219 E PHASE: LABEL 73 76 SHEET 2 OF 2

SYMBOL (1–6)	OP (7–10)	ADDRESS, TAG, DECREMENT / REMARKS (11–69)	IDENT (70–72)	SET NO (77–80)
1				9
9	2 3	2 3 3.13645 .894 0		10
.3	.4	.5 .6 .7 .8 .9 .95 1.		11
0.	.0	0. 0. 0. 0. 0. 0. 0.		12
144				13

Table 3 - Sample Input Coding Form for "Incomplete" Case 1 with V_t/V and V_x/V as Input

CODING FORM FOR IBM TYPE 704 COMPUTER
PRNC-TMB-719

TITLE *WAKE ANALYSIS, INPUT DATA FOR MODEL 3862* PROGRAMMER ______ DATE *11/1/63*
PROBLEM NO *840 - 219 E* PHASE ______ LABEL 73 76 SHEET *1* OF *2*

```
SYMBOL   OP   ADDRESS, TAG, DECREMENT      REMARKS                                          IDENT   SET NO
1       7    11       20        30        40        50        60                          70  72 77   80
3862    3  1512.80  .1      9 5.58                                                                  1
  .490   .740   1.                                                                                  2
   0.0   22.5   45.0   90.0  135.0  157.5  180.0  202.5  225.0  247.5  270.0  292.5                 3
 315.0  337.5  360.0                                                                                4.9
     2   3                                                                                          5.9
     9                                                                                              6.9
   0.0   4.64   0.75-15.00   45.0   5.30  13.50  11.60   90.0   5.35  10.80   5.25
 135.0   5.38   3.50   2.30  180.0   4.91   5.00  -0.50  225.0   5.43   4.00   3.00
 270.0   5.33   5.00   0.00  315.0   4.55   8.00  10.00  360.0   4.64   0.75-15.00
    13
   0.0   4.27   4.00-13.25   22.5   4.84   7.00  10.50   45.0   5.24   8.50   8.25
  90.0   5.47   7.80   4.00  135.0   5.53   7.00   1.50  157.5   5.60   6.50   1.50
 180.0   5.55   5.50   0.50  202.5   5.50   6.00   0.50  225.0   5.44   4.50   0.50
 270.0   5.37   5.00  -0.50  315.0   4.99   6.50   3.00  337.5   3.28   3.50  -5.00
 360.0   4.27   4.00-13.25
    15
   0.0   3.77   6.25-10.25   22.5   4.73   7.00   8.75   45.0   5.17   7.80   6.75
  90.0   5.45   7.00   4.00  135.0   5.50   6.00   1.50  157.5   5.53   5.50   1.10
 180.0   5.47   4.50   0.75  202.5   5.41   5.00  -0.50  225.0   5.44   4.00  -0.50
 247.5   5.44   4.25  -0.50  270.0   5.37   4.50  -0.50  292.5   5.45   6.00  -0.50
 315.0   5.00   8.00   0.00  337.5   3.97   7.00  11.50  360.0   3.77   6.25-10.25
     1                                                                                              9
    9   2    3   2    3               .848      1                                                  10
   .3        .4       .49       .6       .74     .8      .9      .95     1.                         11
   0.        0.       0.        0.       0.      0.      0.      0.      0.                         12
```

CODING FORM FOR IBM TYPE 704 COMPUTER
PRNC-TMB-719

TITLE *WAKE ANALYSIS, INPUT DATA FOR MODEL 3862* PROGRAMMER ______ DATE *11/1/63*
PROBLEM NO *840 - 219 E* PHASE ______ LABEL 73 76 SHEET *2* OF *2*

```
SYMBOL   OP   ADDRESS, TAG, DECREMENT      REMARKS                                          IDENT   SET NO
1       7    11       20        30        40        50        60                          70  72 77   80
  144                                                                                               13
```

Table 4 - Sample Input Coding Form for "Incomplete" Case 2

APPLIED MATHEMATICS LABORATORY PROBLEM 840-219D
WAKE ANALYSIS

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET

TANGENTIAL VELOCITY COMPONENTS IN PROPELLER PLANE

RADIUS =	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500	1.0000
DEV.ANGLE=	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
POSITION ANGLE									
0.	0.	0.	0.	-0.	-0.	0.	0.	0.	0.
5.000	-0.0079	-0.0071	-0.0085	-0.0120	-0.0176	-0.0256	-0.0357	-0.0416	-0.0480
10.000	-0.0052	-0.0081	-0.0139	-0.0227	-0.0351	-0.0494	-0.0661	-0.0753	-0.0851
15.000	0.0050	-0.0050	-0.0176	-0.0330	-0.0526	-0.0720	-0.0922	-0.1026	-0.1132
20.000	0.0198	0.0001	-0.0210	-0.0437	-0.0704	-0.0936	-0.1148	-0.1247	-0.1342
25.000	0.0361	0.0052	-0.0254	-0.0555	-0.0888	-0.1144	-0.1348	-0.1431	-0.1500
30.000	0.0510	0.0080	-0.0320	-0.0692	-0.1080	-0.1350	-0.1532	-0.1590	-0.1626
35.000	0.0570	0.0034	-0.0449	-0.0882	-0.1315	-0.1592	-0.1747	-0.1779	-0.1780
40.000	0.0588	-0.0050	-0.0608	-0.1088	-0.1540	-0.1810	-0.1933	-0.1940	-0.1910
45.000	0.0570	-0.0167	-0.0791	-0.1301	-0.1731	-0.1980	-0.2071	-0.2057	-0.2003
50.000	0.0510	-0.0328	-0.1001	-0.1508	-0.1826	-0.2025	-0.2091	-0.2073	-0.2023
55.000	0.0427	-0.0504	-0.1214	-0.1702	-0.1875	-0.2014	-0.2056	-0.2042	-0.2003
60.000	0.0330	-0.0682	-0.1416	-0.1874	-0.1886	-0.1960	-0.1982	-0.1974	-0.1954
65.000	0.0257	-0.0789	-0.1531	-0.1967	-0.1892	-0.1925	-0.1930	-0.1921	-0.1906
70.000	0.0190	-0.0869	-0.1606	-0.2019	-0.1877	-0.1878	-0.1868	-0.1858	-0.1845
75.000	0.0129	-0.0924	-0.1645	-0.2036	-0.1845	-0.1821	-0.1797	-0.1785	-0.1773
80.000	0.0077	-0.0955	-0.1655	-0.2021	-0.1798	-0.1755	-0.1719	-0.1705	-0.1693
85.000	0.0033	-0.0967	-0.1638	-0.1981	-0.1738	-0.1680	-0.1636	-0.1619	-0.1605
90.000	0.	-0.0960	-0.1600	-0.1920	-0.1668	-0.1600	-0.1548	-0.1528	-0.1512
95.000	-0.0101	-0.0991	-0.1577	-0.1859	-0.1593	-0.1511	-0.1452	-0.1431	-0.1415
100.000	-0.0176	-0.1000	-0.1536	-0.1785	-0.1511	-0.1420	-0.1355	-0.1333	-0.1317
105.000	-0.0210	-0.0980	-0.1476	-0.1700	-0.1424	-0.1327	-0.1259	-0.1235	-0.1219
110.000	-0.0189	-0.0924	-0.1396	-0.1606	-0.1333	-0.1235	-0.1165	-0.1140	-0.1123
115.000	-0.0097	-0.0826	-0.1296	-0.1505	-0.1241	-0.1145	-0.1075	-0.1050	-0.1031
120.000	0.0080	-0.0679	-0.1173	-0.1401	-0.1148	-0.1060	-0.0992	-0.0966	-0.0946
125.000	0.0547	-0.0395	-0.1021	-0.1330	-0.1076	-0.0999	-0.0933	-0.0905	-0.0880
130.000	0.0966	-0.0118	-0.0850	-0.1230	-0.0991	-0.0930	-0.0872	-0.0843	-0.0814
135.000	0.1270	0.0123	-0.0663	-0.1087	-0.0886	-0.0850	-0.0802	-0.0774	-0.0744
140.000	0.1220	0.0219	-0.0477	-0.0867	-0.0742	-0.0734	-0.0702	-0.0678	-0.0648
145.000	0.1050	0.0284	-0.0265	-0.0596	-0.0576	-0.0608	-0.0600	-0.0582	-0.0554
150.000	0.0820	0.0349	-0.0017	-0.0277	-0.0396	-0.0480	-0.0504	-0.0494	-0.0470
155.000	0.0673	0.0572	0.0417	0.0209	-0.0171	-0.0366	-0.0455	-0.0460	-0.0438
160.000	0.0530	0.0765	0.0804	0.0645	0.0032	-0.0262	-0.0409	-0.0427	-0.0409
165.000	0.0390	0.0867	0.1049	0.0937	0.0183	-0.0170	-0.0353	-0.0381	-0.0367
170.000	0.0258	0.0663	0.0830	0.0758	0.0169	-0.0105	-0.0248	-0.0271	-0.0261
175.000	0.0128	0.0357	0.0454	0.0419	0.0099	-0.0050	-0.0128	-0.0140	-0.0135
180.000	-0.	-0.	-0.	0.	0.	-0.	-0.	-0.	-0.
185.000	-0.0128	-0.0357	-0.0454	-0.0419	-0.0099	0.0050	0.0128	0.0140	0.0135
190.000	-0.0258	-0.0663	-0.0830	-0.0758	-0.0169	0.0105	0.0248	0.0271	0.0261
195.000	-0.0390	-0.0867	-0.1049	-0.0937	-0.0183	0.0170	0.0353	0.0381	0.0367
200.000	-0.0530	-0.0765	-0.0804	-0.0645	-0.0032	0.0262	0.0409	0.0427	0.0409
205.000	-0.0673	-0.0572	-0.0417	-0.0209	0.0171	0.0366	0.0455	0.0460	0.0438
210.000	-0.0820	-0.0349	0.0017	0.0277	0.0396	0.0480	0.0504	0.0494	0.0470
215.000	-0.1050	-0.0284	0.0265	0.0596	0.0576	0.0608	0.0600	0.0582	0.0554
220.000	-0.1220	-0.0219	0.0477	0.0867	0.0742	0.0734	0.0702	0.0678	0.0648
225.000	-0.1270	-0.0123	0.0663	0.1087	0.0886	0.0850	0.0802	0.0774	0.0744
230.000	-0.0966	0.0118	0.0850	0.1230	0.0991	0.0930	0.0872	0.0843	0.0814
235.000	-0.0547	0.0395	0.1021	0.1330	0.1076	0.0999	0.0933	0.0905	0.0880
240.000	-0.0080	0.0679	0.1173	0.1401	0.1148	0.1060	0.0992	0.0966	0.0946
245.000	0.0097	0.0826	0.1296	0.1505	0.1241	0.1145	0.1075	0.1050	0.1031
250.000	0.0189	0.0924	0.1396	0.1606	0.1333	0.1235	0.1165	0.1140	0.1123
255.000	0.0210	0.0980	0.1476	0.1700	0.1424	0.1327	0.1259	0.1235	0.1219
260.000	0.0176	0.1000	0.1536	0.1785	0.1511	0.1420	0.1355	0.1333	0.1317
265.000	0.0101	0.0991	0.1577	0.1859	0.1593	0.1511	0.1452	0.1431	0.1415
270.000	0.	0.0960	0.1600	0.1920	0.1668	0.1600	0.1548	0.1528	0.1512
275.000	-0.0033	0.0967	0.1638	0.1981	0.1738	0.1680	0.1636	0.1619	0.1605
280.000	-0.0077	0.0955	0.1655	0.2021	0.1798	0.1755	0.1719	0.1705	0.1693
285.000	-0.0129	0.0924	0.1645	0.2036	0.1845	0.1821	0.1797	0.1785	0.1773
290.000	-0.0190	0.0869	0.1606	0.2019	0.1877	0.1878	0.1868	0.1858	0.1845
295.000	-0.0257	0.0789	0.1531	0.1967	0.1892	0.1925	0.1930	0.1921	0.1906
300.000	-0.0330	0.0682	0.1416	0.1874	0.1886	0.1960	0.1982	0.1974	0.1954
305.000	-0.0427	0.0504	0.1214	0.1702	0.1875	0.2014	0.2056	0.2042	0.2003
310.000	-0.0510	0.0328	0.1001	0.1508	0.1826	0.2025	0.2091	0.2073	0.2023
315.000	-0.0570	0.0167	0.0791	0.1301	0.1731	0.1980	0.2071	0.2057	0.2003
320.000	-0.0588	0.0050	0.0608	0.1088	0.1540	0.1810	0.1933	0.1940	0.1910
325.000	-0.0570	-0.0034	0.0449	0.0882	0.1315	0.1592	0.1747	0.1779	0.1780
330.000	-0.0510	-0.0080	0.0320	0.0692	0.1080	0.1350	0.1532	0.1590	0.1626
335.000	-0.0361	-0.0052	0.0254	0.0555	0.0888	0.1144	0.1348	0.1431	0.1500
340.000	-0.0198	-0.0001	0.0210	0.0437	0.0704	0.0936	0.1148	0.1247	0.1342
345.000	-0.0050	0.0050	0.0176	0.0330	0.0526	0.0720	0.0922	0.1026	0.1132
350.000	0.0052	0.0081	0.0139	0.0227	0.0351	0.0494	0.0661	0.0753	0.0851
355.000	0.0079	0.0071	0.0085	0.0120	0.0176	0.0256	0.0357	0.0416	0.0480

Table 5 - Sample Output for "Complete" Case 1

APPLIED MATHEMATICS LABORATORY PROBLEM 840-219D
WAKE ANALYSIS

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET

RADIUS =	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500	1.0000
DEV.ANGLE=	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
POSITION ANGLE	LONGITUDINAL VELOCITY COMPONENTS IN PROPELLER PLANE								
0.	0.5000	0.5144	0.5256	0.5336	0.5372	0.5400	0.5412	0.5412	0.5408
5.000	0.5004	0.5260	0.5465	0.5618	0.5673	0.5770	0.5879	0.5937	0.5998
10.000	0.5041	0.5345	0.5599	0.5803	0.5905	0.6063	0.6242	0.6339	0.6442
15.000	0.5100	0.5404	0.5676	0.5916	0.6088	0.6300	0.6528	0.6648	0.6772
20.000	0.5170	0.5444	0.5714	0.5981	0.6243	0.6504	0.6764	0.6893	0.7022
25.000	0.5241	0.5471	0.5732	0.6023	0.6389	0.6696	0.6975	0.7103	0.7224
30.000	0.5300	0.5492	0.5748	0.6068	0.6548	0.6900	0.7188	0.7308	0.7412
35.000	0.5332	0.5515	0.5790	0.6159	0.6771	0.7177	0.7476	0.7586	0.7670
40.000	0.5335	0.5541	0.5859	0.6288	0.7024	0.7479	0.7785	0.7881	0.7940
45.000	0.5300	0.5576	0.5964	0.6464	0.7304	0.7800	0.8104	0.8184	0.8216
50.000	0.5188	0.5625	0.6140	0.6731	0.7628	0.8146	0.8436	0.8497	0.8500
55.000	0.5048	0.5691	0.6355	0.7043	0.7960	0.8485	0.8755	0.8795	0.8771
60.000	0.4900	0.5776	0.6604	0.7384	0.8284	0.8800	0.9044	0.9064	0.9016
65.000	0.4825	0.5929	0.6897	0.7728	0.8513	0.8981	0.9192	0.9202	0.9147
70.000	0.4775	0.6109	0.7208	0.8074	0.8700	0.9102	0.9278	0.9281	0.9227
75.000	0.4750	0.6305	0.7526	0.8411	0.8849	0.9175	0.9313	0.9312	0.9265
80.000	0.4747	0.6509	0.7836	0.8728	0.8966	0.9209	0.9310	0.9308	0.9270
85.000	0.4764	0.6709	0.8126	0.9016	0.9053	0.9214	0.9280	0.9279	0.9253
90.000	0.4800	0.6896	0.8384	0.9264	0.9116	0.9200	0.9236	0.9236	0.9224
95.000	0.4891	0.6998	0.8485	0.9353	0.9167	0.9232	0.9259	0.9259	0.9248
100.000	0.4991	0.7077	0.8547	0.9400	0.9200	0.9257	0.9280	0.9279	0.9270
105.000	0.5090	0.7135	0.8576	0.9413	0.9218	0.9275	0.9298	0.9297	0.9288
110.000	0.5180	0.7172	0.8579	0.9401	0.9225	0.9288	0.9314	0.9313	0.9303
115.000	0.5253	0.7190	0.8562	0.9371	0.9223	0.9296	0.9326	0.9326	0.9315
120.000	0.5300	0.7188	0.8532	0.9332	0.9216	0.9300	0.9336	0.9336	0.9324
125.000	0.5316	0.7193	0.8531	0.9329	0.9222	0.9308	0.9344	0.9342	0.9328
130.000	0.5286	0.7159	0.8498	0.9302	0.9214	0.9309	0.9348	0.9346	0.9331
135.000	0.5200	0.7076	0.8424	0.9244	0.9188	0.9300	0.9348	0.9348	0.9332
140.000	0.4994	0.6948	0.8354	0.9212	0.9160	0.9283	0.9339	0.9343	0.9330
145.000	0.4751	0.6741	0.8186	0.9086	0.9092	0.9251	0.9330	0.9340	0.9330
150.000	0.4500	0.6432	0.7868	0.8808	0.8964	0.9200	0.9324	0.9344	0.9336
155.000	0.4286	0.5881	0.7184	0.8197	0.8887	0.9349	0.9563	0.9577	0.9529
160.000	0.4114	0.5278	0.6379	0.7418	0.8617	0.9306	0.9634	0.9662	0.9600
165.000	0.4000	0.4692	0.5528	0.6508	0.8040	0.8900	0.9360	0.9440	0.9420
170.000	0.4043	0.4231	0.4619	0.5209	0.6233	0.6993	0.7642	0.7926	0.8182
175.000	0.4123	0.3898	0.3884	0.4080	0.4495	0.5107	0.5922	0.6405	0.6938
180.000	0.4200	0.3736	0.3464	0.3384	0.3316	0.3800	0.4716	0.5336	0.6064
185.000	0.4123	0.3898	0.3884	0.4080	0.4495	0.5107	0.5922	0.6405	0.6938
190.000	0.4043	0.4231	0.4619	0.5209	0.6233	0.6993	0.7642	0.7926	0.8182
195.000	0.4000	0.4692	0.5528	0.6508	0.8040	0.8900	0.9360	0.9440	0.9420
200.000	0.4114	0.5278	0.6379	0.7418	0.8617	0.9306	0.9634	0.9662	0.9600
205.000	0.4286	0.5881	0.7184	0.8197	0.8887	0.9349	0.9563	0.9577	0.9529
210.000	0.4500	0.6432	0.7868	0.8808	0.8964	0.9200	0.9324	0.9344	0.9336
215.000	0.4751	0.6741	0.8186	0.9086	0.9092	0.9251	0.9330	0.9340	0.9330
220.000	0.4994	0.6948	0.8354	0.9212	0.9160	0.9283	0.9339	0.9343	0.9330
225.000	0.5200	0.7076	0.8424	0.9244	0.9188	0.9300	0.9348	0.9348	0.9332
230.000	0.5286	0.7159	0.8498	0.9302	0.9214	0.9309	0.9348	0.9346	0.9331
235.000	0.5316	0.7193	0.8531	0.9329	0.9222	0.9308	0.9344	0.9342	0.9328
240.000	0.5300	0.7188	0.8532	0.9332	0.9216	0.9300	0.9336	0.9336	0.9324
245.000	0.5253	0.7190	0.8562	0.9371	0.9223	0.9296	0.9326	0.9326	0.9315
250.000	0.5180	0.7172	0.8579	0.9401	0.9225	0.9288	0.9314	0.9313	0.9303
255.000	0.5090	0.7135	0.8576	0.9413	0.9218	0.9275	0.9298	0.9297	0.9288
260.000	0.4991	0.7077	0.8547	0.9400	0.9200	0.9257	0.9280	0.9279	0.9270
265.000	0.4891	0.6998	0.8485	0.9353	0.9167	0.9232	0.9259	0.9259	0.9248
270.000	0.4800	0.6896	0.8384	0.9264	0.9116	0.9200	0.9236	0.9236	0.9224
275.000	0.4764	0.6709	0.8126	0.9016	0.9053	0.9214	0.9280	0.9279	0.9253
280.000	0.4747	0.6509	0.7836	0.8728	0.8966	0.9209	0.9310	0.9308	0.9270
285.000	0.4750	0.6305	0.7526	0.8411	0.8849	0.9175	0.9313	0.9312	0.9265
290.000	0.4775	0.6109	0.7208	0.8074	0.8700	0.9102	0.9278	0.9281	0.9227
295.000	0.4825	0.5929	0.6897	0.7728	0.8513	0.8981	0.9192	0.9202	0.9147
300.000	0.4900	0.5776	0.6604	0.7384	0.8284	0.8800	0.9044	0.9064	0.9016
305.000	0.5048	0.5691	0.6355	0.7043	0.7960	0.8485	0.8755	0.8795	0.8771
310.000	0.5188	0.5625	0.6140	0.6731	0.7628	0.8146	0.8436	0.8497	0.8500
315.000	0.5300	0.5576	0.5964	0.6464	0.7304	0.7800	0.8104	0.8184	0.8216
320.000	0.5335	0.5541	0.5859	0.6288	0.7024	0.7479	0.7785	0.7881	0.7940
325.000	0.5332	0.5515	0.5790	0.6159	0.6771	0.7177	0.7476	0.7586	0.7670
330.000	0.5300	0.5492	0.5748	0.6068	0.6548	0.6900	0.7188	0.7308	0.7412
335.000	0.5241	0.5471	0.5732	0.6023	0.6389	0.6696	0.6975	0.7103	0.7224
340.000	0.5170	0.5444	0.5714	0.5981	0.6243	0.6504	0.6764	0.6893	0.7022
345.000	0.5100	0.5404	0.5676	0.5916	0.6088	0.6300	0.6528	0.6648	0.6772
350.000	0.5041	0.5345	0.5599	0.5803	0.5905	0.6063	0.6242	0.6339	0.6442
355.000	0.5004	0.5260	0.5465	0.5618	0.5673	0.5770	0.5879	0.5937	0.5998

Table 5 - Sample Output for "Complete" Case 1 (Cont'd.)

APPLIED MATHEMATICS LABORATORY PROBLEM 840-2190
WAKE ANALYSIS

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET

RADIUS =	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500	1.0000
DEV.ANGLE=	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

J SUB A =0.9080

SQUARE OF THE INFLOW VELOCITY

POSITION ANGLE	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500	1.0000
0.	1.3274	2.1800	3.2690	4.5943	6.1543	7.9530	9.9894	11.0967	12.2634
5.000	1.3114	2.1725	3.2622	4.5756	6.1024	7.8536	9.8211	10.8846	12.0006
10.000	1.3207	2.1788	3.2583	4.5524	6.0457	7.7577	9.6786	10.7160	11.8040
15.000	1.3479	2.1937	3.2542	4.5234	5.9844	7.6649	9.5569	10.5818	11.6590
20.000	1.3862	2.2121	3.2470	4.4878	5.9193	7.5752	9.4521	10.4745	11.5535
25.000	1.4283	2.2290	3.2341	4.4450	5.8517	7.4894	9.3613	10.3882	11.4773
30.000	1.4668	2.2393	3.2133	4.3951	5.7830	7.4084	9.2825	10.3179	11.4216
35.000	1.4832	2.2290	3.1745	4.3306	5.7043	7.3204	9.1980	10.2417	11.3592
40.000	1.4875	2.2087	3.1292	4.2650	5.6370	7.2515	9.1357	10.1873	11.3165
45.000	1.4799	2.1803	3.0811	4.2042	5.5908	7.2129	9.1064	10.1637	11.2999
50.000	1.4551	2.1420	3.0334	4.1592	5.5965	7.2447	9.1497	10.2056	11.3348
55.000	1.4227	2.1021	2.9913	4.1277	5.6264	7.3071	9.2245	10.2767	11.3943
60.000	1.3871	2.0650	2.9589	4.1117	5.6738	7.3892	9.3191	10.3664	11.4701
65.000	1.3642	2.0546	2.9622	4.1287	5.7100	7.4393	9.3769	10.4244	11.5253
70.000	1.3452	2.0555	2.9826	4.1638	5.7486	7.4854	9.4291	10.4784	11.5797
75.000	1.3301	2.0658	3.0168	4.2132	5.7891	7.5283	9.4770	10.5293	11.6336
80.000	1.3187	2.0836	3.0616	4.2730	5.8309	7.5688	9.5220	10.5784	11.6876
85.000	1.3113	2.1072	3.1131	4.3392	5.8735	7.6082	9.5656	10.6267	11.7423
90.000	1.3078	2.1344	3.1677	4.4075	5.9166	7.6477	9.6094	10.6757	11.7983
95.000	1.2957	2.1405	3.1919	4.4470	5.9599	7.6998	9.6704	10.7408	11.8670
100.000	1.2902	2.1494	3.2153	4.4839	6.0031	7.7524	9.7320	10.8064	11.9363
105.000	1.2932	2.1628	3.2392	4.5188	6.0462	7.8047	9.7930	10.8714	12.0050
110.000	1.3069	2.1825	3.2651	4.5524	6.0888	7.8557	9.8521	10.9344	12.0719
115.000	1.3333	2.2104	3.2944	4.5854	6.1308	7.9047	9.9081	10.9942	12.1356
120.000	1.3750	2.2486	3.3287	4.6184	6.1720	7.9507	9.9599	11.0494	12.1949
125.000	1.4767	2.3250	3.3777	4.6453	6.2066	7.9850	9.9969	11.0896	12.2396
130.000	1.5668	2.3953	3.4279	4.6795	6.2446	8.0215	10.0350	11.1304	12.2847
135.000	1.6276	2.4502	3.4774	4.7246	6.2884	8.0630	10.0770	11.1745	12.3328
140.000	1.5950	2.4593	3.5281	4.8056	6.3511	8.1224	10.1361	11.2354	12.3970
145.000	1.5320	2.4491	3.5719	4.8910	6.4164	8.1845	10.1969	11.2970	12.4612
150.000	1.4568	2.4268	3.6060	4.9712	6.4789	8.2444	10.2542	11.3543	12.5198
155.000	1.4055	2.4228	3.6549	5.0687	6.5729	8.3342	10.3298	11.4210	12.5779
160.000	1.3594	2.4115	3.6842	5.1319	6.6240	8.3832	10.3716	11.4583	12.6113
165.000	1.3199	2.3829	3.6723	5.1310	6.6011	8.3597	10.3538	11.4458	12.6058
170.000	1.2950	2.2823	3.5002	4.9012	6.3364	8.0925	10.1267	11.2548	12.4606
175.000	1.2742	2.1675	3.3028	4.6516	6.1157	7.8947	9.9678	11.1219	12.3589
180.000	1.2538	2.0549	3.1127	4.4241	5.9757	7.8058	9.9189	11.0885	12.3387
185.000	1.2210	1.9697	2.9885	4.3040	6.0202	7.9498	10.1268	11.3064	12.5461
190.000	1.1881	1.9151	2.9258	4.2721	6.1728	8.2084	10.4355	11.6106	12.8216
195.000	1.1579	1.9031	2.9463	4.3527	6.4240	8.5479	10.7938	11.9470	13.1135
200.000	1.1394	1.9879	3.1280	4.5960	6.5926	8.6730	10.8809	12.0201	13.1772
205.000	1.1258	2.1062	3.3663	4.8951	6.7387	8.7395	10.8964	12.0253	13.1838
210.000	1.1164	2.2337	3.6176	5.2010	6.8629	8.7758	10.8825	12.0043	13.1697
215.000	1.0962	2.2919	3.7551	5.3861	6.9749	8.8571	10.9442	12.0620	13.2278
220.000	1.0883	2.3379	3.8579	5.5258	7.0695	8.9346	11.0111	12.1271	13.2941
225.000	1.1003	2.3822	3.9361	5.6271	7.1472	9.0041	11.0765	12.1927	13.3619
230.000	1.1656	2.4607	4.0162	5.7004	7.2044	9.0516	11.1206	12.2384	13.4116
235.000	1.2494	2.5436	4.0840	5.7497	7.2489	9.0905	11.1595	12.2799	13.4581
240.000	1.3417	2.6246	4.1402	5.7816	7.2846	9.1243	11.1960	12.3200	13.5036
245.000	1.3736	2.6678	4.1909	5.8352	7.3329	9.1726	11.2475	12.3748	13.5629
250.000	1.3853	2.6941	4.2314	5.8856	7.3804	9.2228	11.3028	12.4337	13.6261
255.000	1.3806	2.7053	4.2608	5.9301	7.4254	9.2739	11.3608	12.4954	13.6918
260.000	1.3634	2.7030	4.2783	5.9660	7.4667	9.3244	11.4200	12.5587	13.7588
265.000	1.3378	2.6892	4.2832	5.9908	7.5029	9.3733	11.4794	12.6222	13.8256
270.000	1.3078	2.6658	4.2748	6.0018	7.5326	9.4191	11.5375	12.6846	13.8909
275.000	1.2975	2.6424	4.2467	5.9841	7.5577	9.4688	11.6034	12.7551	13.9636
280.000	1.2868	2.6126	4.2067	5.9513	7.5730	9.5115	11.6636	12.8201	14.0303
285.000	1.2763	2.5772	4.1555	5.9035	7.5767	9.5444	11.7153	12.8763	14.0878
290.000	1.2663	2.5367	4.0937	5.8406	7.5671	9.5650	11.7552	12.9208	14.1329
295.000	1.2574	2.4916	4.0215	5.7623	7.5425	9.5707	11.7805	12.9504	14.1626
300.000	1.2501	2.4423	3.9390	5.6681	7.5013	9.5592	11.7883	12.9622	14.1738
305.000	1.2454	2.3814	3.8315	5.5414	7.4427	9.5367	11.7860	12.9612	14.1665
310.000	1.2432	2.3237	3.7261	5.4116	7.3654	9.4872	11.7541	12.9318	14.1339
315.000	1.2432	2.2728	3.6283	5.2844	7.2676	9.4051	11.6857	12.8680	14.0723
320.000	1.2433	2.2361	3.5501	5.1684	7.1286	9.2556	11.5439	12.7378	13.9593
325.000	1.2467	2.2100	3.4855	5.0627	6.9786	9.0831	11.3739	12.5802	13.8227
330.000	1.2550	2.1948	3.4350	4.9700	6.8293	8.9031	11.1907	12.4084	13.6719
335.000	1.2784	2.2005	3.4098	4.9058	6.7120	8.7564	11.0409	12.2694	13.5533
340.000	1.3040	2.2114	3.3925	4.8506	6.6015	8.6110	10.8821	12.1144	13.4105
345.000	1.3271	2.2211	3.3762	4.7978	6.4939	8.4621	10.7053	11.9307	13.2257
350.000	1.3423	2.2234	3.3545	4.7412	6.3857	8.3052	10.5022	11.7065	12.9822
355.000	1.3442	2.2117	3.3207	4.6751	6.2734	8.1365	10.2656	11.4313	12.6654
MAXIMA	1.6276	2.7053	4.2832	6.0018	7.5767	9.5707	11.7883	12.9622	14.1738

Table 5 - Sample Output for "Complete" Case 1 (Cont'd.)

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET

RADIUS =	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500	1.0000
DEV.ANGLE=	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

J SUB A =0.9080

POSITION ANGLE	BETA IN DEGREES								
0.	25.7205	20.3894	16.9000	14.4152	12.5061	11.0393	9.8596	9.3500	8.8837
5.000	25.9085	20.9086	17.6125	15.2277	13.2767	11.8826	10.8118	10.3669	9.9705
10.000	26.0165	21.2288	18.0699	15.7830	13.8960	12.5728	11.5740	11.1657	10.8064
15.000	26.0581	21.3991	18.3394	16.1504	14.4104	13.1532	12.1906	11.7925	11.4392
20.000	26.0498	21.4716	18.4891	16.3995	14.8673	13.6682	12.7086	12.2969	11.9223
25.000	26.0090	21.4984	18.5873	16.6005	15.3144	14.1634	13.1770	12.7315	12.3125
30.000	25.9521	21.5312	18.7027	16.8246	15.8005	14.6850	13.6462	13.1506	12.6689
35.000	25.9654	21.6765	18.9641	17.2155	16.4683	15.3815	14.2714	13.7130	13.1544
40.000	25.9372	21.8909	19.3414	17.7255	17.2070	16.1251	14.9247	14.2954	13.6525
45.000	25.8284	22.1870	19.8629	18.3761	17.9932	16.8836	15.5780	14.8748	14.1471
50.000	25.4715	22.6033	20.6417	19.2726	18.8107	17.6159	16.1948	15.4244	14.6240
55.000	25.0398	23.1100	21.5596	20.2825	19.6084	18.2936	16.7541	15.9233	15.0607
60.000	24.5855	23.7001	22.5769	21.3554	20.3514	18.8887	17.2331	16.3508	15.4391
65.000	24.3981	24.4336	23.6237	22.3546	20.8701	19.2244	17.4690	16.5590	15.6309
70.000	24.3131	25.2198	24.6699	23.3079	21.2754	19.4326	17.5869	16.6610	15.7325
75.000	24.3222	26.0213	25.6757	24.1893	21.5798	19.5357	17.6098	16.6776	15.7610
80.000	24.4163	26.8017	26.6044	24.9757	21.7955	19.5555	17.5605	16.6295	15.7334
85.000	24.5851	27.5269	27.4233	25.6469	21.9349	19.5136	17.4612	16.5369	15.6666
90.000	24.8177	28.1655	28.1035	26.1850	22.0102	19.4314	17.3342	16.4199	15.5774
95.000	25.4490	28.5738	28.3541	26.3289	22.0539	19.4331	17.3228	16.4099	15.5731
100.000	26.0650	28.8629	28.4660	26.3535	22.0537	19.4183	17.3060	16.3957	15.5633
105.000	26.5894	29.0229	28.4571	26.2831	22.0177	19.3902	17.2851	16.3781	15.5488
110.000	26.9456	29.0446	28.3449	26.1414	21.9539	19.3520	17.2610	16.3577	15.5306
115.000	27.0612	28.9199	28.1472	25.9516	21.8704	19.3069	17.2346	16.3353	15.5093
120.000	26.8716	28.6426	27.8815	25.7368	21.7749	19.2580	17.2070	16.3116	15.4859
125.000	25.9441	28.1475	27.6562	25.6478	21.7254	19.2322	17.1883	16.2923	15.4641
130.000	24.9819	27.5532	27.3208	25.4686	21.6360	19.1880	17.1624	16.2686	15.4391
135.000	24.0542	26.8754	26.8554	25.1684	21.4934	19.1182	17.1262	16.2389	15.4105
140.000	23.2921	26.2999	26.4094	24.8493	21.3135	19.0087	17.0582	16.1843	15.3655
145.000	22.5700	25.5133	25.6653	24.2564	21.0336	18.8657	16.9885	16.1339	15.3254
150.000	21.8901	24.3861	24.4775	23.2688	20.6201	18.6878	16.9282	16.0992	15.2988
155.000	21.1963	22.1991	22.0737	21.3516	20.2815	18.8962	17.3108	16.4628	15.5859
160.000	20.6595	19.8683	19.4110	19.1132	19.5612	18.7485	17.4062	16.5854	15.6844
165.000	20.3756	17.6950	16.7662	16.6969	18.2360	17.9278	16.9111	16.2023	15.3858
170.000	20.8118	16.2620	14.2939	13.6087	14.3372	14.2296	13.8955	13.6656	13.4027
175.000	21.4261	15.3529	12.3389	10.9055	10.4728	10.4731	10.8108	11.0724	11.3826
180.000	22.0300	15.1069	11.3230	9.2584	7.7962	7.8171	8.6120	9.2210	9.9410
185.000	21.9111	16.1253	12.9823	11.3429	10.5565	10.4364	10.7245	10.9805	11.2962
190.000	21.7738	17.8003	15.6669	14.5970	14.5301	14.1267	13.6843	13.4506	13.2092
195.000	21.8218	19.8840	18.7872	18.1760	18.4946	17.7227	16.5527	15.8496	15.0778
200.000	22.6668	21.9824	21.1419	20.2428	19.6096	18.4211	16.9813	16.1823	15.3355
205.000	23.8269	23.9053	23.0526	21.7461	20.0196	18.4367	16.8409	16.0324	15.2147
210.000	25.2076	25.4904	24.4356	22.7194	20.0095	18.0929	16.4180	15.6458	14.9076
215.000	26.9842	26.4389	24.9872	23.0469	20.1358	18.1093	16.3813	15.6005	14.8641
220.000	28.5996	27.0280	25.1726	23.0722	20.1518	18.0927	16.3466	15.5622	14.8257
225.000	29.7186	27.2875	25.1257	22.9351	20.1012	18.0550	16.3126	15.5282	14.7910
230.000	29.3182	27.1538	25.0890	22.9301	20.0764	18.0232	16.2786	15.4953	14.7608
235.000	28.4004	26.8087	24.9686	22.8957	20.0301	17.9820	16.2421	15.4618	14.7308
240.000	27.2293	26.3392	24.7913	22.8367	19.9659	17.9316	16.2015	15.4254	14.6985
245.000	26.6292	26.1157	24.7241	22.8254	19.9140	17.8742	16.1459	15.3732	14.6512
250.000	26.1117	25.9106	24.6492	22.7982	19.8510	17.8078	16.0829	15.3140	14.5971
255.000	25.6705	25.7090	24.5490	22.7396	19.7726	17.7321	16.0135	15.2489	14.5370
260.000	25.3047	25.4966	24.4063	22.6339	19.6742	17.6465	15.9389	15.1792	14.4717
265.000	25.0180	25.2595	24.2035	22.4656	19.5512	17.5505	15.8601	15.1058	14.4021
270.000	24.8177	24.9835	23.9225	22.2188	19.3993	17.4435	15.7780	15.0300	14.3289
275.000	24.7247	24.3757	23.2242	21.6272	19.2270	17.4227	15.8096	15.0583	14.3374
280.000	24.7374	23.7458	22.4603	20.9638	19.0141	17.3728	15.8195	15.0676	14.3290
285.000	24.8632	23.1271	21.6646	20.2524	18.7533	17.2765	15.7894	15.0414	14.2903
290.000	25.1097	22.5541	20.8714	19.5167	18.4370	17.1166	15.7006	14.9628	14.2075
295.000	25.4839	22.0627	20.1162	18.7805	18.0573	16.8759	15.5346	14.8151	14.0673
300.000	25.9928	21.6908	19.4356	18.0683	17.6055	16.5364	15.2726	14.5814	13.8559
305.000	26.8964	21.6397	18.9465	17.4084	16.9647	15.9475	14.7750	14.1400	13.4758
310.000	27.7279	21.6551	18.5464	16.8197	16.3240	15.3348	14.2452	13.6668	13.0674
315.000	28.3815	21.7071	18.2463	16.3314	15.7199	14.7344	13.7135	13.1879	12.6513
320.000	28.5824	21.7494	18.1160	16.0556	15.2518	14.2311	13.2451	12.7572	12.2700
325.000	28.5252	21.7743	18.0677	15.8863	14.8505	13.7757	12.8080	12.3505	11.9057
330.000	28.2356	21.7594	18.0674	15.7944	14.5109	13.3706	12.4080	11.9737	11.5637
335.000	27.6141	21.6442	18.0852	15.7802	14.2770	13.0789	12.1168	11.6999	11.3168
340.000	26.9214	21.4752	18.0742	15.7576	14.0614	12.8049	11.8312	11.4223	11.0549
345.000	26.2765	21.2600	17.9933	15.6696	13.8218	12.5078	11.5087	11.0968	10.7318
350.000	25.7900	21.0046	17.8003	15.4575	13.5137	12.1448	11.1049	10.6771	10.2988
355.000	25.5678	20.7137	17.4516	15.0609	13.0913	11.6712	10.5724	10.1132	9.7027
MAXIMA	29.7186	29.0446	28.4660	26.3535	22.0539	19.5555	17.6098	16.6776	15.7610
MINIMA	20.3756	15.1069	11.3230	9.2584	7.7962	7.8171	8.6120	9.2210	8.8837

Table 5 - Sample Output for "Complete" Case 1 (Cont'd.)

APPLIED MATHEMATICS LABORATORY PROBLEM 840-219D
WAKE ANALYSIS

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET

RADIUS =	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500	1.0000
DEV.ANGLE=	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

J SUB A =0.9080

CORRECTED LONGITUDINAL VELOCITY COMPONENTS

POSITION ANGLE									
0.	0.5000	0.5144	0.5256	0.5336	0.5372	0.5400	0.5412	0.5412	0.5408
5.000	0.5042	0.5287	0.5492	0.5651	0.5715	0.5824	0.5947	0.6013	0.6082
10.000	0.5066	0.5376	0.5644	0.5868	0.5992	0.6173	0.6377	0.6488	0.6604
15.000	0.5076	0.5423	0.5734	0.6012	0.6223	0.6468	0.6727	0.6862	0.7001
20.000	0.5074	0.5444	0.5785	0.6110	0.6429	0.6731	0.7022	0.7165	0.7305
25.000	0.5065	0.5451	0.5818	0.6189	0.6632	0.6985	0.7290	0.7426	0.7552
30.000	0.5052	0.5460	0.5856	0.6277	0.6854	0.7254	0.7560	0.7679	0.7778
35.000	0.5055	0.5501	0.5945	0.6432	0.7160	0.7615	0.7921	0.8021	0.8086
40.000	0.5048	0.5561	0.6072	0.6635	0.7500	0.8002	0.8300	0.8375	0.8404
45.000	0.5024	0.5644	0.6250	0.6896	0.7866	0.8401	0.8681	0.8730	0.8721
50.000	0.4945	0.5762	0.6517	0.7259	0.8250	0.8789	0.9044	0.9069	0.9028
55.000	0.4849	0.5906	0.6835	0.7672	0.8628	0.9151	0.9374	0.9377	0.9310
60.000	0.4749	0.6075	0.7193	0.8117	0.8984	0.9471	0.9659	0.9643	0.9556
65.000	0.4708	0.6288	0.7566	0.8537	0.9234	0.9652	0.9800	0.9773	0.9680
70.000	0.4689	0.6518	0.7946	0.8944	0.9431	0.9765	0.9870	0.9837	0.9747
75.000	0.4691	0.6756	0.8317	0.9325	0.9579	0.9821	0.9884	0.9847	0.9765
80.000	0.4712	0.6991	0.8665	0.9670	0.9685	0.9832	0.9854	0.9817	0.9747
85.000	0.4749	0.7213	0.8976	0.9967	0.9753	0.9809	0.9795	0.9759	0.9704
90.000	0.4800	0.7410	0.9238	1.0208	0.9790	0.9764	0.9719	0.9686	0.9646
95.000	0.4940	0.7537	0.9336	1.0273	0.9812	0.9765	0.9712	0.9680	0.9643
100.000	0.5077	0.7628	0.9380	1.0284	0.9812	0.9757	0.9702	0.9671	0.9636
105.000	0.5195	0.7679	0.9376	1.0252	0.9794	0.9742	0.9690	0.9660	0.9627
110.000	0.5276	0.7686	0.9332	1.0189	0.9763	0.9721	0.9675	0.9648	0.9615
115.000	0.5303	0.7646	0.9255	1.0103	0.9722	0.9697	0.9660	0.9634	0.9601
120.000	0.5259	0.7559	0.9152	1.0007	0.9675	0.9670	0.9643	0.9619	0.9586
125.000	0.5050	0.7404	0.9066	0.9968	0.9650	0.9656	0.9632	0.9607	0.9572
130.000	0.4836	0.7221	0.8937	0.9888	0.9607	0.9632	0.9617	0.9592	0.9556
135.000	0.4633	0.7014	0.8760	0.9755	0.9537	0.9595	0.9595	0.9574	0.9537
140.000	0.4469	0.6840	0.8591	0.9614	0.9449	0.9535	0.9555	0.9540	0.9508
145.000	0.4314	0.6605	0.8313	0.9354	0.9313	0.9458	0.9513	0.9508	0.9482
150.000	0.4171	0.6274	0.7876	0.8927	0.9113	0.9362	0.9478	0.9487	0.9464
155.000	0.4025	0.5648	0.7015	0.8115	0.8950	0.9475	0.9705	0.9713	0.9651
160.000	0.3914	0.5001	0.6096	0.7194	0.8606	0.9395	0.9762	0.9790	0.9715
165.000	0.3855	0.4415	0.5212	0.6227	0.7980	0.8955	0.9467	0.9551	0.9521
170.000	0.3945	0.4037	0.4408	0.5026	0.6190	0.7019	0.7704	0.7992	0.8244
175.000	0.4073	0.3800	0.3784	0.4000	0.4477	0.5117	0.5946	0.6432	0.6965
180.000	0.4200	0.3736	0.3464	0.3384	0.3316	0.3800	0.4716	0.5336	0.6064
185.000	0.4175	0.4001	0.3988	0.4164	0.4513	0.5098	0.5898	0.6378	0.6911
190.000	0.4146	0.4444	0.4852	0.5406	0.6277	0.6966	0.7582	0.7861	0.8121
195.000	0.4156	0.5006	0.5885	0.6816	0.8101	0.8846	0.9255	0.9332	0.9321
200.000	0.4335	0.5587	0.6690	0.7656	0.8629	0.9219	0.9509	0.9538	0.9488
205.000	0.4584	0.6134	0.7362	0.8281	0.8824	0.9227	0.9426	0.9445	0.9410
210.000	0.4886	0.6598	0.7860	0.8692	0.8820	0.9043	0.9175	0.9206	0.9211
215.000	0.5285	0.6882	0.8062	0.8832	0.8880	0.9052	0.9154	0.9178	0.9183
220.000	0.5659	0.7060	0.8130	0.8843	0.8888	0.9043	0.9133	0.9154	0.9158
225.000	0.5925	0.7139	0.8113	0.8784	0.8864	0.9023	0.9113	0.9133	0.9136
230.000	0.5829	0.7098	0.8100	0.8782	0.8852	0.9006	0.9093	0.9112	0.9116
235.000	0.5612	0.6994	0.8055	0.8767	0.8830	0.8984	0.9072	0.9092	0.9097
240.000	0.5341	0.6852	0.7990	0.8742	0.8799	0.8957	0.9048	0.9069	0.9076
245.000	0.5204	0.6785	0.7966	0.8737	0.8774	0.8926	0.9015	0.9037	0.9045
250.000	0.5088	0.6723	0.7938	0.8726	0.8744	0.8891	0.8978	0.9001	0.9011
255.000	0.4989	0.6663	0.7902	0.8701	0.8706	0.8851	0.8937	0.8960	0.8972
260.000	0.4907	0.6600	0.7850	0.8656	0.8659	0.8805	0.8893	0.8917	0.8930
265.000	0.4844	0.6530	0.7776	0.8584	0.8601	0.8754	0.8847	0.8872	0.8885
270.000	0.4800	0.6449	0.7674	0.8480	0.8529	0.8697	0.8799	0.8826	0.8838
275.000	0.4780	0.6271	0.7423	0.8231	0.8447	0.8686	0.8817	0.8843	0.8843
280.000	0.4782	0.6088	0.7152	0.7954	0.8346	0.8660	0.8823	0.8849	0.8838
285.000	0.4810	0.5911	0.6872	0.7660	0.8223	0.8609	0.8805	0.8833	0.8813
290.000	0.4864	0.5748	0.6596	0.7358	0.8074	0.8524	0.8753	0.8784	0.8760
295.000	0.4947	0.5609	0.6336	0.7059	0.7896	0.8397	0.8656	0.8694	0.8670
300.000	0.5061	0.5505	0.6104	0.6773	0.7685	0.8218	0.8503	0.8550	0.8534
305.000	0.5265	0.5491	0.5939	0.6509	0.7388	0.7909	0.8213	0.8281	0.8291
310.000	0.5456	0.5495	0.5804	0.6275	0.7093	0.7590	0.7906	0.7992	0.8031
315.000	0.5608	0.5509	0.5703	0.6083	0.6817	0.7279	0.7599	0.7702	0.7766
320.000	0.5655	0.5521	0.5660	0.5974	0.6604	0.7020	0.7329	0.7442	0.7525
325.000	0.5642	0.5528	0.5644	0.5908	0.6422	0.6786	0.7079	0.7197	0.7295
330.000	0.5574	0.5524	0.5643	0.5872	0.6268	0.6579	0.6851	0.6971	0.7079
335.000	0.5430	0.5492	0.5649	0.5867	0.6163	0.6430	0.6685	0.6807	0.6924
340.000	0.5271	0.5445	0.5646	0.5858	0.6066	0.6291	0.6523	0.6641	0.6760
345.000	0.5125	0.5385	0.5619	0.5823	0.5959	0.6140	0.6340	0.6447	0.6557
350.000	0.5016	0.5314	0.5554	0.5741	0.5821	0.5957	0.6112	0.6197	0.6287
355.000	0.4966	0.5233	0.5438	0.5586	0.5632	0.5718	0.5812	0.5863	0.5916

Table 5 - Sample Output for "Complete" Case 1 (Cont'd.)

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET
HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENTS IN A PROPELLER PLANE

RADIUS =0.3000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	-0.000000	0.	0.	0.	-0.
1	0.000000	0.039357	0.039357	0.000004	-18810756.000000
2	-0.000000	-0.013097	0.013097	180.000006	-6259670.250000
3	0.000000	0.049861	0.049861	0.000007	-23831534.000000
4	0.000000	-0.017783	0.017783	179.999994	-8499363.000000
5	-0.000000	-0.010547	0.010547	180.000000	-5041117.437500
6	0.000000	0.010661	0.010661	0.000009	-5095610.625000
7	-0.000000	-0.018173	0.018173	180.000002	-8686071.250000
8	-0.000000	-0.002364	0.002364	180.000017	-1129866.156250
9	0.000000	0.003926	0.003926	0.000004	-1876516.312500
10	-0.000000	-0.007832	0.007832	180.000002	-3743219.125000
11	0.000000	0.002049	0.002049	0.000002	-979405.734375
12	-0.000000	-0.000301	0.000301	180.000008	-143722.933594

RADIUS =0.5000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.000000	0.	0.	0.	0.
1	-0.000000	-0.130489	0.130489	180.000002	18135724.250000
2	-0.000000	-0.021608	0.021608	180.000023	3003204.093750
3	0.000000	0.050780	0.050780	0.000003	7057587.500000
4	-0.000000	-0.016033	0.016033	180.000000	2228274.125000
5	0.000000	0.024404	0.024404	0.000007	3391737.468750
6	-0.000000	-0.019930	0.019930	180.000002	2769992.093750
7	0.000000	0.008604	0.008604	0.000001	1195799.843750
8	-0.000000	-0.011969	0.011969	180.000002	1663506.203125
9	0.000000	0.006508	0.006508	0.000006	904505.015625
10	-0.000000	-0.004046	0.004046	180.000008	562311.070312
11	-0.000000	0.001545	0.001545	359.999989	214732.916016
12	-0.000000	-0.000286	0.000286	180.000044	39765.806152

RADIUS =0.7000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.000000	0.	0.	0.	0.
1	-0.000000	-0.168924	0.168924	180.000000	18182218.000000
2	-0.000000	-0.043967	0.043967	180.000011	4732380.625000
3	-0.000000	0.006766	0.006766	359.999969	728283.750000
4	-0.000000	-0.003327	0.003327	180.000040	358102.472656
5	0.000000	0.014461	0.014461	0.000002	1556565.171875
6	-0.000000	-0.004470	0.004470	180.000004	481157.718750
7	-0.000000	0.006640	0.006640	359.999992	714728.507812
8	-0.000000	-0.004078	0.004078	180.000000	438953.968750
9	-0.000000	0.000238	0.000238	359.999985	25608.903564
10	-0.000000	-0.001976	0.001976	180.000019	212735.888672
11	-0.000000	-0.000558	0.000558	180.000051	60099.554687
12	-0.000000	-0.000028	0.000028	180.000404	3036.967926

RADIUS =0.9000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.000000	0.	0.	0.	0.
1	-0.000000	-0.174372	0.174372	180.000000	15070557.875000
2	-0.000000	-0.059551	0.059551	180.000008	5146838.750000
3	-0.000000	-0.021091	0.021091	180.000015	1822883.921875
4	-0.000000	-0.001110	0.001110	180.000149	95930.872070
5	-0.000000	0.000231	0.000231	359.999722	19933.517334
6	-0.000000	0.002310	0.002310	359.999985	199626.220703
7	-0.000000	-0.000292	0.000292	180.000153	25208.322998
8	-0.000000	-0.000220	0.000220	180.000141	19000.371582
9	-0.000000	-0.003914	0.003914	180.000002	338308.078125
10	-0.000000	-0.001121	0.001121	180.000013	96865.073242
11	-0.000000	-0.001831	0.001831	180.000025	158239.644531
12	-0.000000	-0.000261	0.000261	180.000069	22546.025391

RADIUS =1.0000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.000000	0.	0.	0.	0.
1	-0.000000	-0.171647	0.171647	179.999998	15002762.625000
2	-0.000000	-0.063353	0.063353	180.000008	5537347.312500
3	-0.000000	-0.024666	0.024666	180.000011	2155955.687500
4	-0.000000	-0.005443	0.005443	180.000027	475700.285156
5	-0.000000	-0.005638	0.005638	180.000021	492766.949219
6	-0.000000	-0.001404	0.001404	180.000055	122686.555664
7	-0.000000	-0.003949	0.003949	180.000023	345179.035156
8	-0.000000	-0.001317	0.001317	180.000057	115084.852539
9	-0.000000	-0.004425	0.004425	180.000008	386765.503906
10	-0.000000	-0.001113	0.001113	180.000000	97260.037109
11	-0.000000	-0.001985	0.001985	180.000015	173474.154297
12	-0.000000	-0.000613	0.000613	180.000023	53557.257324

Table 5 - Sample Output for "Complete" Case 1 (Cont'd.)

APPLIED MATHEMATICS LABORATORY PROBLEM 84C-219
WAKE ANALYSIS

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET
HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENTS IN A PROPELLER PLANE

RADIUS =0.3000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.490386	0.	0.	0.	0.
1	0.032236	-0.000000	0.032236	90.000114	0.065736
2	-0.017588	-0.000000	0.017588	269.999916	0.035865
3	0.028777	-0.000000	0.028777	90.000034	0.058682
4	-0.026871	-0.000000	0.026871	269.999985	0.054796
5	-0.009881	-0.000000	0.009881	269.999954	0.020149
6	0.003029	-0.000000	0.003029	90.000036	0.006177
7	-0.005574	-0.000000	0.005574	269.999954	0.011366
8	0.005951	0.000000	0.005951	89.999907	0.012136
9	-0.001924	0.000000	0.001924	270.000099	0.003923
10	0.002471	-0.000000	0.002471	90.000078	0.005039
11	-0.001512	-0.000000	0.001512	269.999943	0.003082
12	-0.000301	0.000000	0.000301	270.002117	0.000615

RADIUS =0.5000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.693664	0.	0.	0.	0.
1	-0.061874	-0.000000	0.061874	269.999916	0.089199
2	-0.148996	-0.000000	0.148996	269.999992	0.214796
3	0.090743	-0.000000	0.090743	90.000013	0.130816
4	-0.038345	-0.000000	0.038345	269.999992	0.055279
5	0.041560	-0.000000	0.041560	90.000010	0.059914
6	-0.037924	-0.000000	0.037924	269.999992	0.054672
7	0.015426	-0.000000	0.015426	90.000010	0.022239
8	-0.011906	0.000000	0.011906	270.000072	0.017163
9	0.003381	0.000000	0.003381	89.999910	0.004874
10	-0.005673	-0.000000	0.005673	269.999943	0.008178
11	-0.000123	0.000000	0.000123	270.000141	0.000178
12	-0.001472	0.000000	0.001472	270.000610	0.002121

RADIUS =0.7000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.793660	0.	0.	0.	0.
1	-0.079442	-0.000000	0.079442	269.999935	0.100096
2	-0.151477	-0.000000	0.151477	269.999989	0.190858
3	0.037450	-0.000000	0.037450	90.000034	0.047186
4	-0.055204	0.000000	0.055204	270.000000	0.069556
5	0.051402	-0.000000	0.051402	90.000011	0.064765
6	-0.042415	0.000000	0.042415	270.000000	0.053442
7	0.032960	-0.000000	0.032960	90.000010	0.041530
8	-0.035750	0.000000	0.035750	270.000027	0.045045
9	0.022356	0.000000	0.022356	89.999982	0.028169
10	-0.025361	-0.000000	0.025361	269.999992	0.031954
11	0.016997	-0.000000	0.016997	90.000006	0.021416
12	-0.016946	0.000000	0.016946	270.000069	0.021352

RADIUS =0.9000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.843935	0.	0.	0.	0.
1	-0.085661	-0.000000	0.085661	269.999928	0.101502
2	-0.122414	-0.000000	0.122414	269.999981	0.145051
3	-0.006107	-0.000000	0.006107	269.999844	0.007236
4	-0.052857	0.000000	0.052857	270.000000	0.062632
5	0.037291	-0.000000	0.037291	90.000020	0.044187
6	-0.034623	0.000000	0.034623	270.000004	0.041025
7	0.029061	-0.000000	0.029061	90.000014	0.034435
8	-0.039346	0.000000	0.039346	270.000027	0.046622
9	0.022967	0.000000	0.022967	89.999978	0.027214
10	-0.029451	-0.000000	0.029451	269.999992	0.034897
11	0.018807	-0.000000	0.018807	90.000008	0.022285
12	-0.021080	0.000000	0.021080	270.000057	0.024978

RADIUS =1.0000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.854193	0.	0.	0.	0.
1	-0.089098	-0.000000	0.089098	269.999928	0.104306
2	-0.102901	-0.000000	0.102901	269.999973	0.120466
3	-0.015445	-0.000000	0.015445	269.999943	0.018081
4	-0.042752	0.000000	0.042752	269.999996	0.050050
5	0.022495	-0.000000	0.022495	90.000025	0.026335
6	-0.027820	0.000000	0.027820	270.000004	0.032569
7	0.017809	-0.000000	0.017809	90.000016	0.020849
8	-0.031705	0.000000	0.031705	270.000027	0.037117
9	0.014133	0.000000	0.014133	89.999957	0.016545
10	-0.023738	-0.000000	0.023738	269.999992	0.027790
11	0.011787	-0.000000	0.011787	90.000008	0.013799
12	-0.017090	0.000000	0.017090	270.000069	0.020008

Table 5 - Sample Output for "Complete" Case 1 (Cont'd.)

APPLIED MATHEMATICS LABORATORY PROBLEM 840-219
WAKE ANALYSIS

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET
HARMONIC ANALYSES OF INFLOW VELOCITY SQUARED IN A PROPELLER PLANE

RADIUS =0.3000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	1.321998	0.	0.	0.	0.
1	0.027736	0.081702	0.086282	18.751384	0.065266
2	-0.014769	-0.027188	0.030940	208.511229	0.023404
3	0.028154	0.103509	0.107270	15.216149	0.081142
4	-0.029590	-0.036916	0.047311	218.714113	0.035788
5	-0.008724	-0.021895	0.023570	201.724434	0.017829
6	0.001777	0.022132	0.022203	4.591668	0.016795
7	-0.005963	-0.037727	0.038195	188.981384	0.028892
8	0.007236	-0.004907	0.008743	124.145053	0.006614
9	-0.002338	0.008150	0.008479	343.992584	0.006414
10	0.002719	-0.016258	0.016484	170.504381	0.012469
11	-0.000578	0.004254	0.004293	352.260536	0.003247
12	-0.001494	-0.000624	0.001619	247.326061	0.001225

RADIUS =0.5000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	3.504385	0.	0.	0.	0.
1	-0.097990	-0.451478	0.461990	192.245714	0.131832
2	-0.210889	-0.074763	0.223749	250.479856	0.063848
3	0.123659	0.175694	0.214849	35.139121	0.061309
4	-0.037865	-0.055472	0.067163	214.317560	0.019165
5	0.045697	0.084435	0.096008	28.422505	0.027396
6	-0.042835	-0.068957	0.081178	211.847731	0.023165
7	0.013697	0.029769	0.032769	24.708483	0.009351
8	-0.007953	-0.041412	0.042169	190.871704	0.012033
9	-0.001202	0.022517	0.022549	356.943188	0.006435
10	-0.002984	-0.013998	0.014313	192.031790	0.004084
11	-0.002768	0.005346	0.006020	332.626324	0.001718
12	0.000805	-0.000990	0.001276	140.878616	0.000364

RADIUS =0.7000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	6.532352	0.	0.	0.	0.
1	-0.124982	-0.818244	0.827734	188.684452	0.126713
2	-0.236442	-0.212969	0.318214	227.989897	0.048714
3	0.051760	0.032774	0.061264	57.658078	0.009379
4	-0.071390	-0.016116	0.073187	257.279350	0.011204
5	0.072709	0.070049	0.100963	46.067499	0.015456
6	-0.053244	-0.021653	0.057479	247.869486	0.008799
7	0.041832	0.032164	0.052768	52.443484	0.008078
8	-0.043415	-0.019754	0.047698	245.534336	0.007302
9	0.026014	0.001153	0.026039	87.463229	0.003986
10	-0.028947	-0.009574	0.030489	251.699291	0.004667
11	0.018554	-0.002705	0.018750	98.293880	0.002870
12	-0.017737	-0.000137	0.017738	269.558998	0.002715

RADIUS =0.9000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	10.442276	0.	0.	0.	0.
1	-0.129835	-1.085961	1.093695	186.817791	0.104737
2	-0.199771	-0.370873	0.421255	208.309177	0.040341
3	-0.016617	-0.131354	0.132401	187.209791	0.012679
4	-0.079636	-0.006913	0.079935	265.038948	0.007655
5	0.061343	0.001436	0.061359	88.658777	0.005876
6	-0.048761	0.014385	0.050839	286.436253	0.004869
7	0.046176	-0.001817	0.046212	92.252867	0.004425
8	-0.058492	-0.001369	0.058508	268.659298	0.005603
9	0.035860	-0.024378	0.043362	124.208104	0.004152
10	-0.042655	-0.006980	0.043222	260.706654	0.004139
11	0.028218	-0.011403	0.030435	112.002752	0.002915
12	-0.029420	-0.001624	0.029464	266.839592	0.002822

RADIUS =1.0000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	12.729996	0.	0.	0.	0.
1	-0.132312	-1.187767	1.195114	186.356285	0.093882
2	-0.171894	-0.438391	0.470887	201.410288	0.036990
3	-0.028086	-0.170687	0.172982	189.343969	0.013589
4	-0.067180	-0.037661	0.077016	240.724964	0.006050
5	0.040743	-0.039012	0.056409	133.757172	0.004431
6	-0.041787	-0.009713	0.042901	256.914345	0.003370
7	0.031349	-0.027328	0.041588	131.079699	0.003267
8	-0.049810	-0.009111	0.050637	259.634369	0.003978
9	0.024830	-0.030620	0.039422	140.961220	0.003097
10	-0.036530	-0.007700	0.037333	258.096943	0.002933
11	0.020173	-0.013734	0.024404	124.247775	0.001917
12	-0.025607	-0.004240	0.025956	260.598728	0.002039

Table 5 - Sample Output for "Complete" Case 1 (Cont'd.)

APPLIED MATHEMATICS LABORATORY PROBLEM 840-219
WAKE ANALYSIS

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET
HARMONIC ANALYSES OF BETA IN DEGREES IN A PROPELLERPLANE

RADIUS =0.3000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	25.306231	0.	0.	0.	0.
1	1.445847	-0.851406	1.677905	120.492278	0.066304
2	-0.807629	0.259543	0.848308	287.815529	0.033522
3	1.335094	-1.066482	1.708760	128.618116	0.067523
4	-1.281891	0.341755	1.326666	284.927975	0.052424
5	-0.396555	0.267170	0.478159	303.969299	0.018895
6	0.110627	-0.253656	0.276730	156.436550	0.010935
7	-0.254799	0.417824	0.489387	328.624176	0.019339
8	0.302328	0.058953	0.308022	78.966016	0.012172
9	-0.119731	-0.099333	0.155571	230.319803	0.006148
10	0.131627	0.182322	0.224871	35.827264	0.008886
11	-0.067450	-0.053988	0.086396	231.325647	0.003414
12	-0.023445	0.004662	0.023904	281.246834	0.000945

RADIUS =0.5000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	21.802952	0.	0.	0.	0.
1	-1.703890	1.624337	2.354084	313.630753	0.107971
2	-4.369049	0.140354	4.371303	271.839973	0.200491
3	2.565708	-0.658899	2.648963	104.402882	0.121496
4	-1.122275	0.203021	1.140491	280.253979	0.052309
5	1.256530	-0.223185	1.276197	100.071839	0.058533
6	-1.122326	0.202537	1.140454	280.229622	0.052307
7	0.479568	-0.072827	0.485067	98.634956	0.022248
8	-0.401279	0.093444	0.412015	283.108589	0.018897
9	0.134442	-0.043064	0.141170	107.760972	0.006475
10	-0.195583	0.015497	0.196196	274.530251	0.008999
11	0.020559	0.006744	0.021637	71.838748	0.000992
12	-0.064612	-0.017030	0.066818	255.234400	0.003065

RADIUS =0.7000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	18.132394	0.	0.	0.	0.
1	-1.667082	1.257525	2.088188	307.028233	0.115163
2	-3.322075	0.248477	3.331355	274.277500	0.183724
3	0.777506	-0.121436	0.786932	98.877148	0.043399
4	-1.225066	-0.000424	1.225066	269.980141	0.067562
5	1.120163	-0.107530	1.125312	95.483286	0.062061
6	-0.930937	0.041649	0.931868	272.561657	0.051392
7	0.730908	-0.040443	0.732026	93.167078	0.040371
8	-0.790426	0.029011	0.790958	272.101986	0.043621
9	0.499182	-0.000037	0.499182	90.004283	0.027530
10	-0.568917	0.007238	0.568963	270.728893	0.031378
11	0.381267	0.005384	0.381305	89.190948	0.021029
12	-0.384769	-0.003908	0.384789	269.418056	0.021221

RADIUS =0.9000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	15.166650	0.	0.	0.	0.
1	-1.456830	0.846152	1.684734	300.148750	0.111081
2	-2.139319	0.245679	2.153380	276.551140	0.141981
3	-0.124875	0.052656	0.135523	292.863884	0.008936
4	-0.932323	-0.031358	0.932850	268.073589	0.061507
5	0.637231	-0.019224	0.637521	91.727998	0.042034
6	-0.604746	-0.012309	0.604871	268.833992	0.039882
7	0.503864	0.002879	0.503873	89.672681	0.033222
8	-0.681626	0.002813	0.681631	270.236454	0.044943
9	0.397857	0.014367	0.398116	87.931896	0.026249
10	-0.514499	0.004070	0.514515	270.453232	0.033924
11	0.325526	0.003969	0.325551	89.301404	0.021465
12	-0.370451	0.002043	0.370457	270.316010	0.024426

RADIUS =1.0000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	13.873693	0.	0.	0.	0.
1	-1.385077	0.684261	1.544879	296.290455	0.111353
2	-1.631435	0.218157	1.645956	277.616447	0.118639
3	-0.259067	0.058992	0.265699	282.828167	0.019151
4	-0.682629	-0.008852	0.682686	269.257084	0.049207
5	0.345790	0.005899	0.345841	89.022722	0.024928
6	-0.440451	0.000310	0.440451	270.040318	0.031747
7	0.277122	0.013597	0.277455	87.191122	0.019999
8	-0.498847	0.003460	0.498859	270.397354	0.035957
9	0.219587	0.012706	0.219954	86.688366	0.015854
10	-0.375405	0.001884	0.375410	270.287556	0.027059
11	0.183213	0.003630	0.183249	88.864915	0.013208
12	-0.271223	0.001894	0.271229	270.400204	0.019550

Table 5 - Sample Output for "Complete" Case 1 (Cont'd.)

APPLIED MATHEMATICS LABORATORY PROBLEM 840-219
WAKE ANALYSIS

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET
HARMONIC ANALYSES OF CORRECTED LONGITUDINAL VELOCITY COMPONENTS

RADIUS =0.3000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.491592	0.	0.	0.	0.
1	0.031265	-0.019102	0.036638	121.424544	0.074530
2	-0.017246	0.005555	0.018118	287.854935	0.036857
3	0.029308	-0.023801	0.037755	129.080324	0.076802
4	-0.028629	0.007155	0.029510	284.031693	0.060029
5	-0.009001	0.006417	0.011055	305.485577	0.022488
6	0.002428	-0.005906	0.006386	157.654037	0.012989
7	-0.005804	0.009632	0.011246	328.927788	0.022877
8	0.006815	0.001476	0.006973	77.776686	0.014184
9	-0.002503	-0.002436	0.003492	225.780266	0.007104
10	0.002818	0.004251	0.005100	33.537989	0.010374
11	-0.001255	-0.001326	0.001826	223.430307	0.003713
12	-0.000754	0.000040	0.000755	273.059681	0.001536

RADIUS =0.5000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.696436	0.	0.	0.	0.
1	-0.062050	0.059522	0.085983	313.808483	0.123461
2	-0.152532	0.003249	0.152566	271.220356	0.219067
3	0.090415	-0.024560	0.093692	105.196646	0.134530
4	-0.037029	0.007919	0.037867	282.071442	0.054372
5	0.041612	-0.007161	0.042224	99.765003	0.060628
6	-0.037810	0.006771	0.038412	280.152267	0.055155
7	0.015417	-0.002456	0.015612	99.052995	0.022417
8	-0.012219	0.002905	0.012559	283.371796	0.018033
9	0.003543	-0.001193	0.003738	108.610813	0.005368
10	-0.005843	0.000305	0.005851	272.988625	0.008402
11	0.000093	0.000384	0.000395	13.578110	0.000567
12	-0.001625	-0.000711	0.001774	246.359673	0.002548

RADIUS =0.7000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.795883	0.	0.	0.	0.
1	-0.078616	0.060032	0.098916	307.365833	0.124285
2	-0.153832	0.010956	0.154221	274.073662	0.193774
3	0.036461	-0.006538	0.037043	100.165417	0.046543
4	-0.055304	-0.000145	0.055304	269.849487	0.069488
5	0.051528	-0.005027	0.051773	95.572558	0.065051
6	-0.042203	0.002127	0.042256	272.884914	0.053093
7	0.033010	-0.001846	0.033061	93.201547	0.041540
8	-0.035658	0.001356	0.035684	272.178238	0.044835
9	0.022344	0.000001	0.022344	89.998381	0.028074
10	-0.025395	0.000273	0.025396	270.615116	0.031909
11	0.016980	0.000270	0.016982	89.090118	0.021338
12	-0.016997	-0.000210	0.016998	269.293690	0.021358

RADIUS =0.9000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.845474	0.	0.	0.	0.
1	-0.084723	0.049808	0.098279	300.451225	0.116241
2	-0.123585	0.014084	0.124385	276.501663	0.147119
3	-0.007044	0.002695	0.007542	290.939419	0.008920
4	-0.053284	-0.002119	0.053326	267.722561	0.063073
5	0.037233	-0.001224	0.037253	91.883372	0.044061
6	-0.034564	-0.000680	0.034571	268.873390	0.040889
7	0.029142	0.000219	0.029142	89.568737	0.034469
8	-0.039278	0.000188	0.039278	270.274284	0.046457
9	0.022983	0.000805	0.022997	87.993799	0.027200
10	-0.029488	0.000228	0.029489	270.443222	0.034879
11	0.018774	0.000199	0.018775	89.392965	0.022207
12	-0.021129	0.000136	0.021129	270.369362	0.024991

RADIUS =1.0000 DEV. ANGLE =-0.

N	A(N)	B(N)	C(N)	PHI(N)	C(N)/A(0)
0	0.855426	0.	0.	0.	0.
1	-0.088270	0.044091	0.098669	296.541985	0.115345
2	-0.103740	0.013789	0.104653	277.571262	0.122340
3	-0.016160	0.003515	0.016537	282.270660	0.019332
4	-0.043070	-0.000775	0.043077	268.969166	0.050358
5	0.022426	0.000294	0.022428	89.247661	0.026218
6	-0.027823	0.000017	0.027823	270.034935	0.032526
7	0.017817	0.000887	0.017839	87.150104	0.020854
8	-0.031706	0.000222	0.031707	270.400612	0.037066
9	0.014119	0.000786	0.014141	86.812001	0.016531
10	-0.023777	0.000109	0.023777	270.263229	0.027795
11	0.011764	0.000209	0.011766	88.982309	0.013754
12	-0.017126	0.000128	0.017127	270.429104	0.020021

NON-DIMENSIONAL VOLUMETRIC VELOCITY AND EFFECTIVE WAKE AT J SUBA= 0.90800

X=	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.9500	1.0000
VXVOL=	0.0772	0.1948	0.3805	0.6339	0.9538	1.3357	1.7826	2.0293	2.2908
1-WX=	0.4916	0.5168	0.5767	0.6305	0.6747	0.7086	0.7369	0.7489	0.7596
WX=	0.5084	0.4832	0.4233	0.3695	0.3253	0.2914	0.2631	0.2511	0.2404

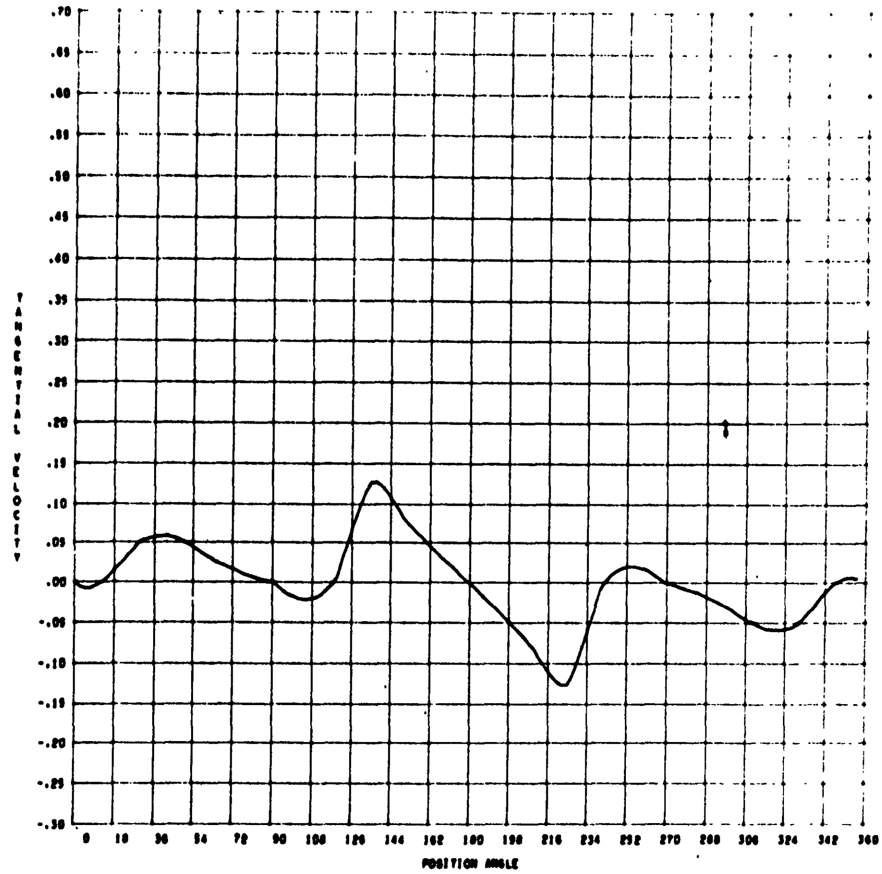
Table 5 - Sample Output for "Complete" Case 1 (cont'd)

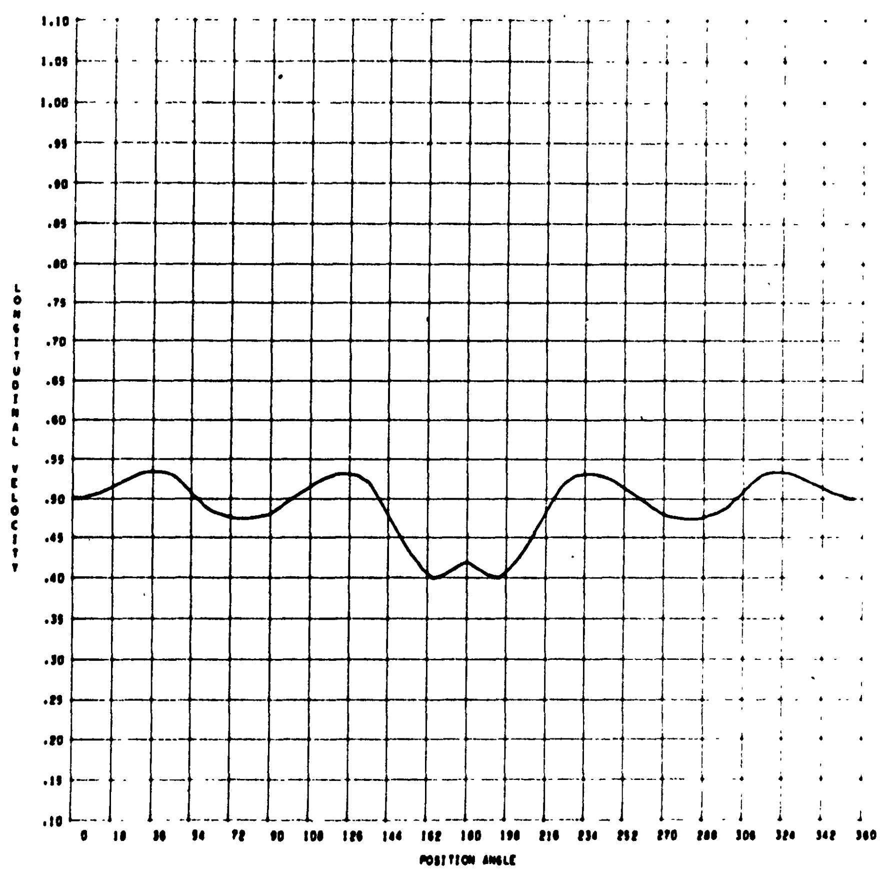
APPLIED MATHEMATICS LABORATORY PROBLEM 840-219
WAKE ANALYSIS

TEST 0.1 WITH MODEL 4521 PROPELLER NO. -0 DIAMETER 21.50 FEET

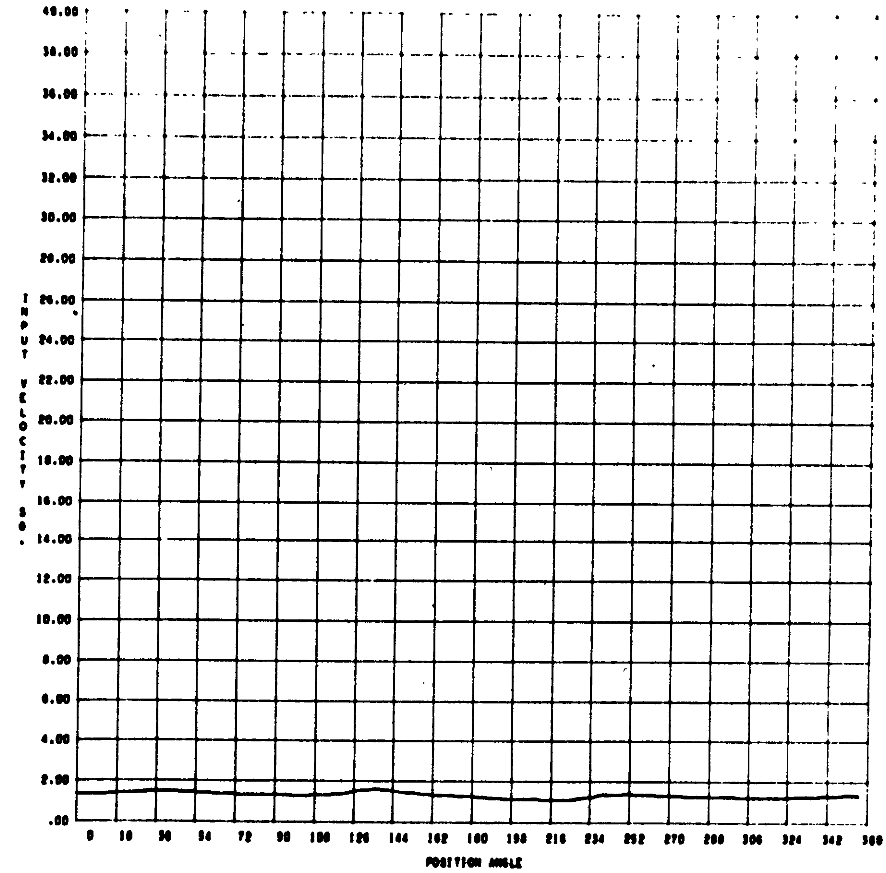
RADIUS	P	DELTA BETA PLUS	DELTA BETA MINUS
0.300	0.2350	4.4303	-4.9126
0.500	0.2330	6.6165	-10.5265
0.700	0.1664	3.9101	-10.3476
0.900	0.1325	2.4457	-6.5521
1.000	0.1160	1.8929	-4.9843

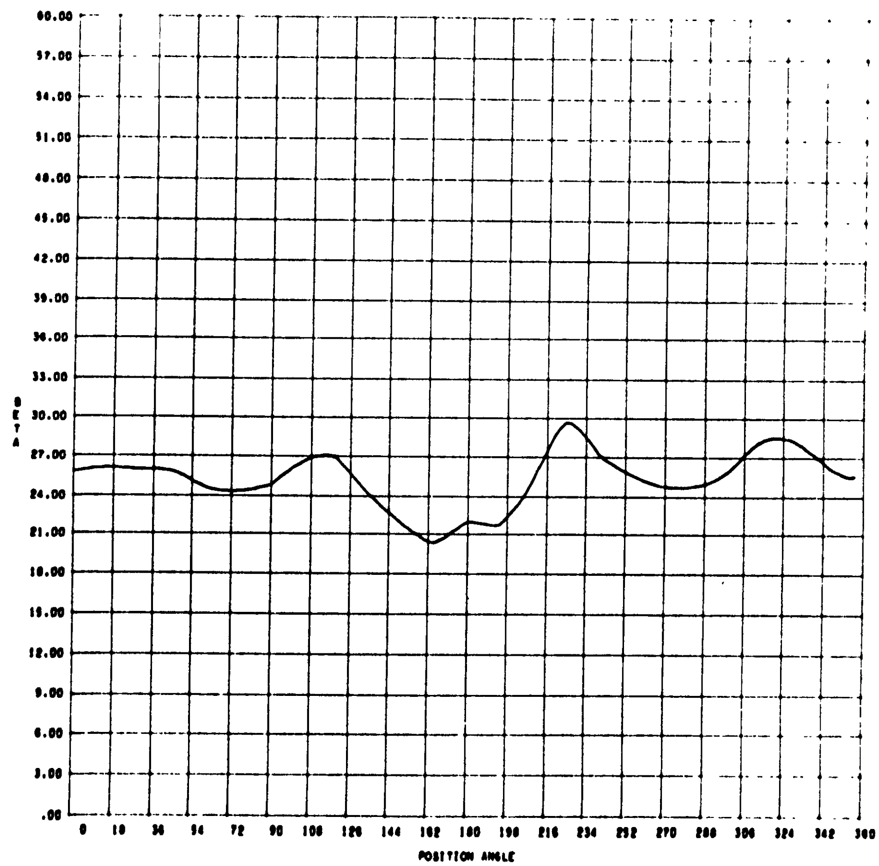
Table 5 - Sample Output for "Complete" Case 1 (Cont'd.)





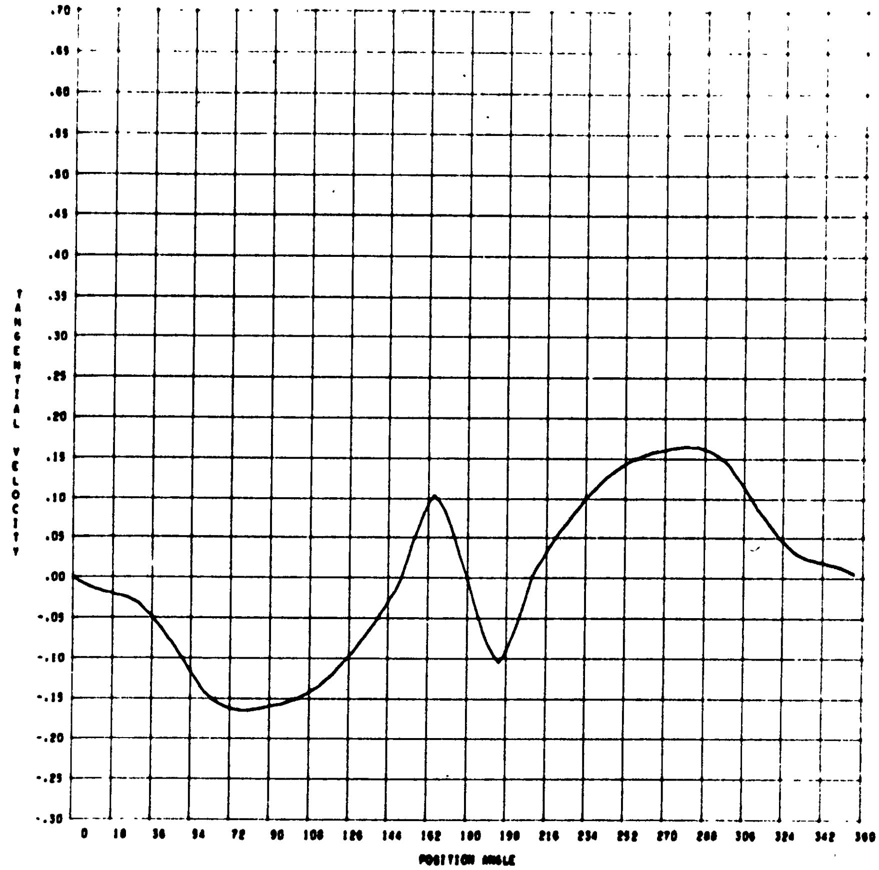
MODEL 4521 TEST 0.1 WAKE ANALYSIS RADIUS - 0.300

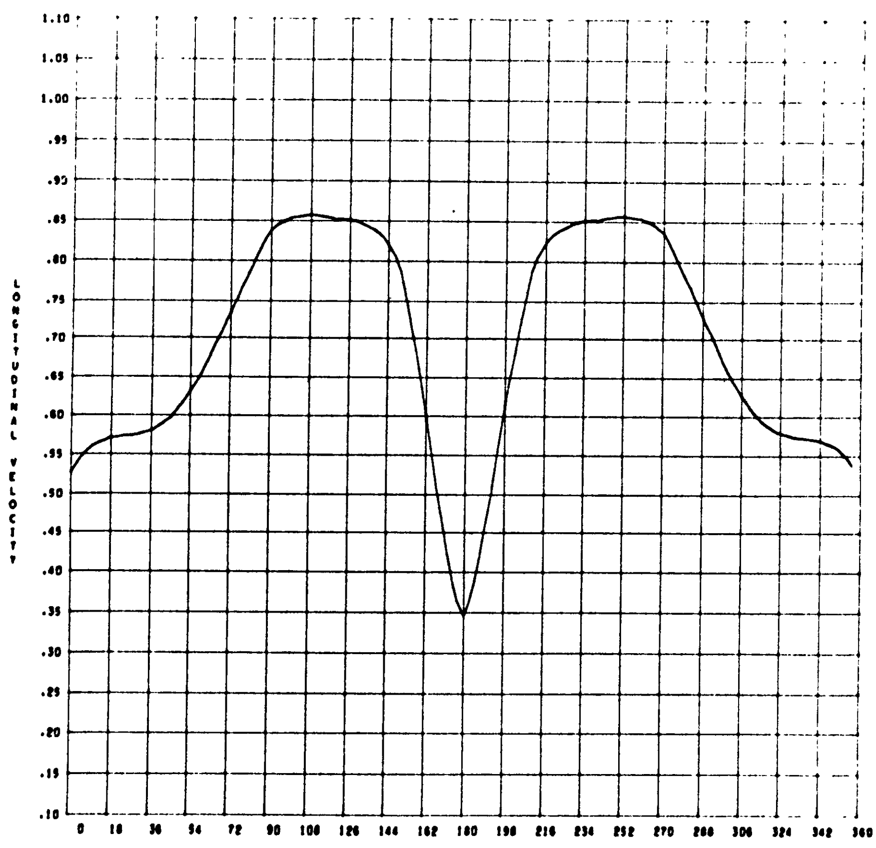




MODEL 4921 TEST 0.1 VANE ANALYSIS RADIUS - 0.300

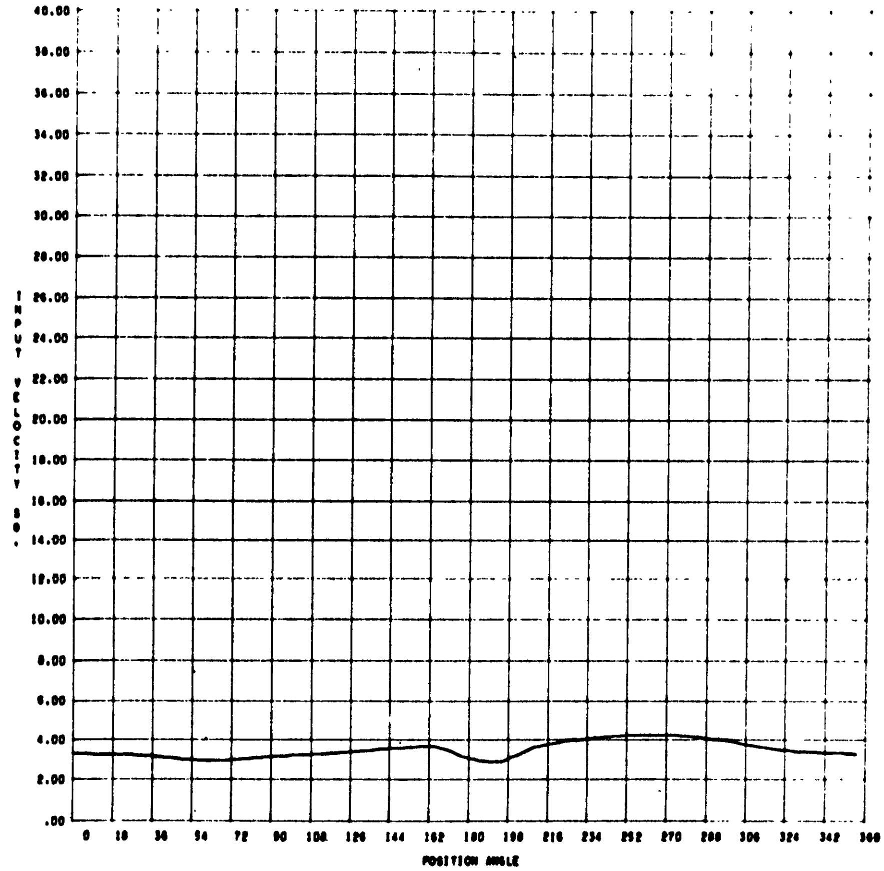
Figure 3 - Sample Computer Plots for "Complete" Case 1 (Cont'd.)





MODEL 4521 TEST 0.1 WAKE ANALYSIS RADIUS - 0.500

Figure 3 - Sample Computer Plots for "Complete" Case 1 (Cont'd.)



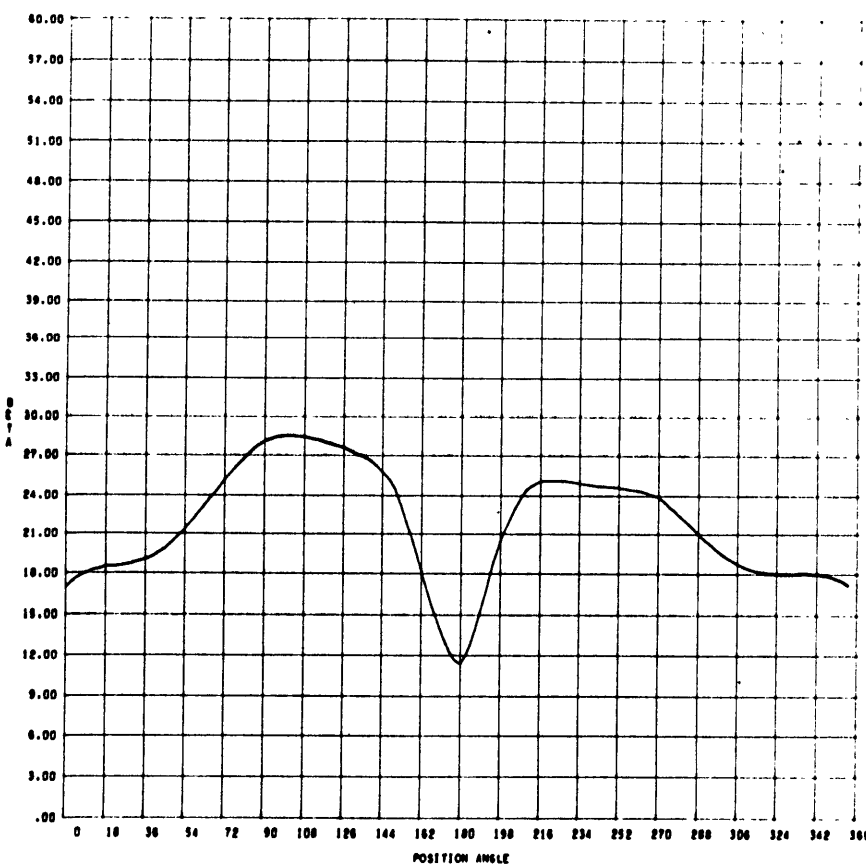
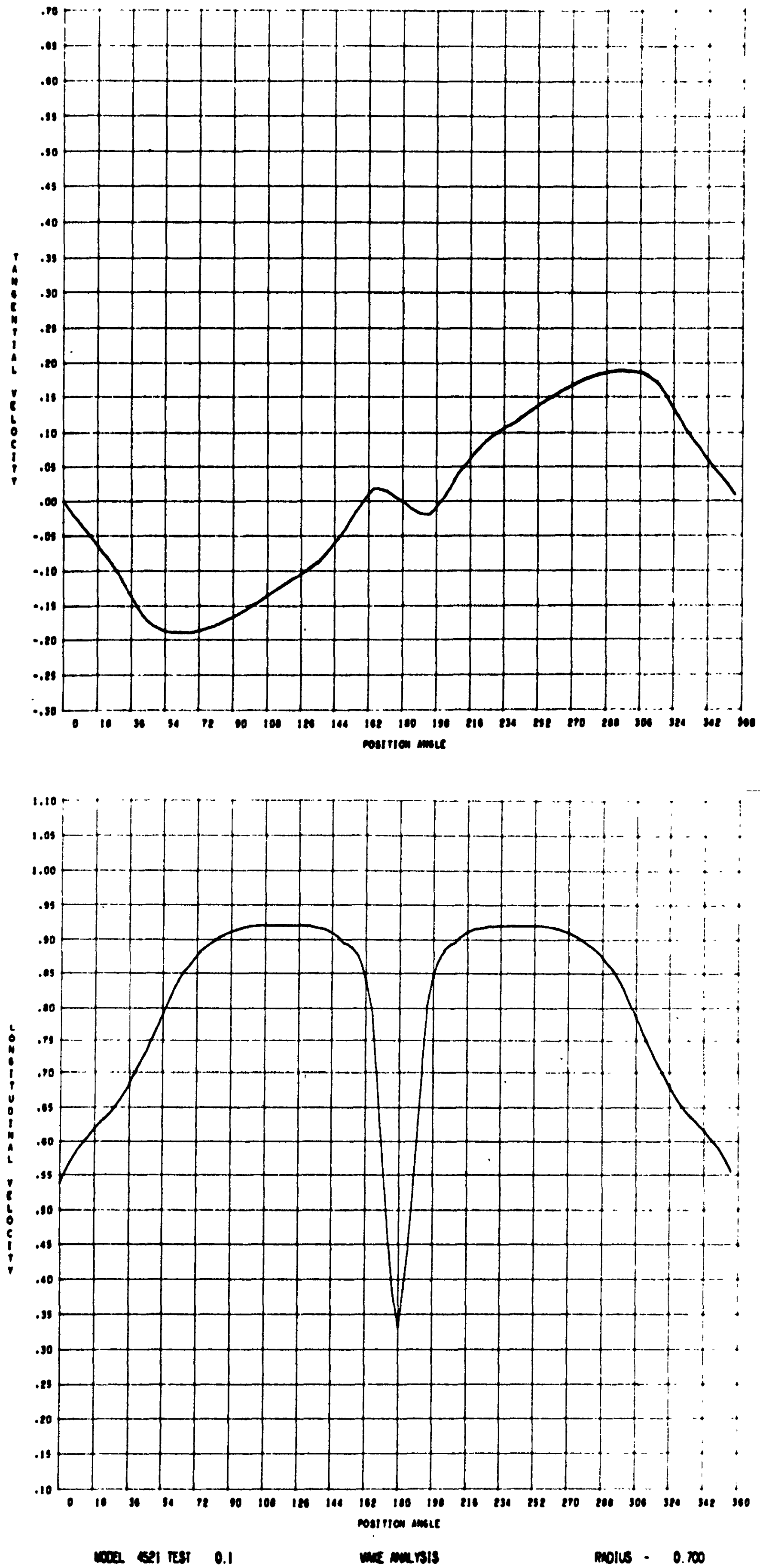
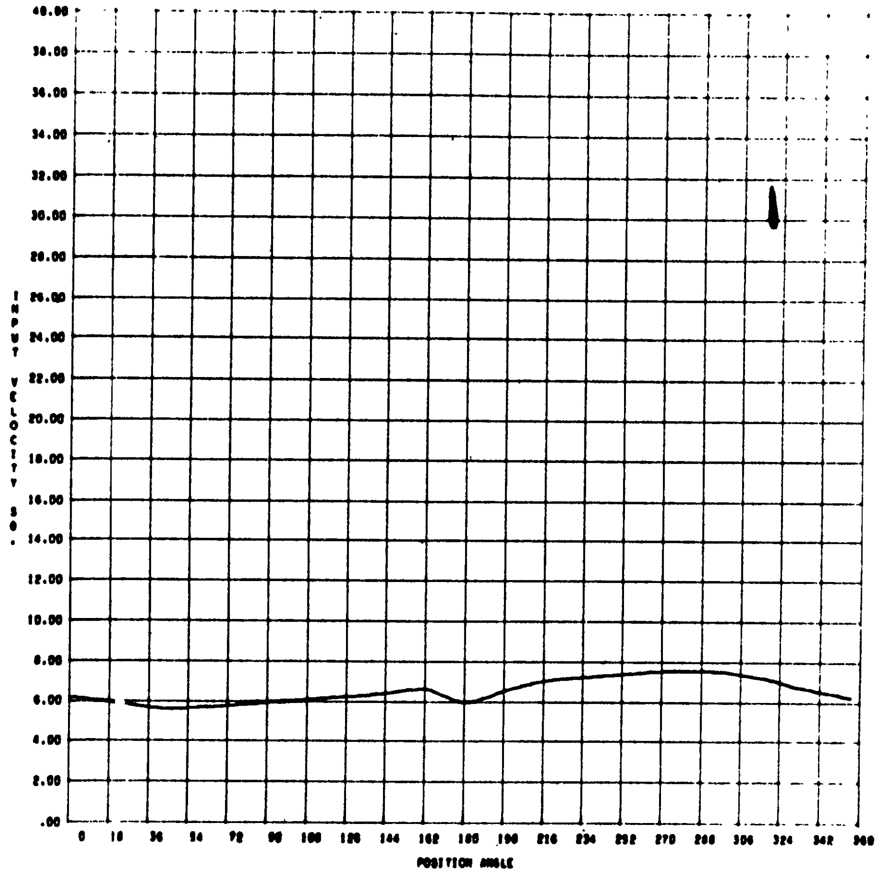


Figure 3 - Sample Computer Plots for "Complete" Case 1 (Cont'd.)


TANGENTIAL VELOCITY
POSITION ANGLE
0 18 36 54 72 90 108 126 144 162 180 198 216 234 252 270 288 306 324 342 360
LONGITUDINAL VELOCITY
POSITION ANGLE
MODEL 4521 TEST 0.1
WAKE ANALYSIS
RADIUS - 0.700



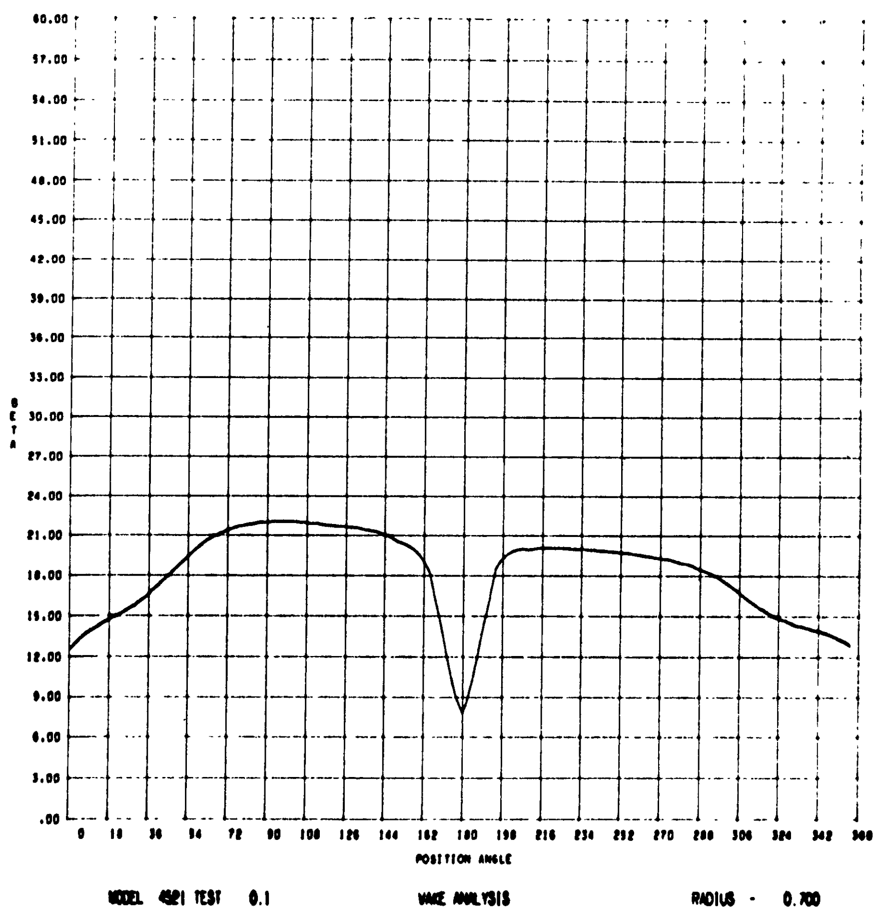
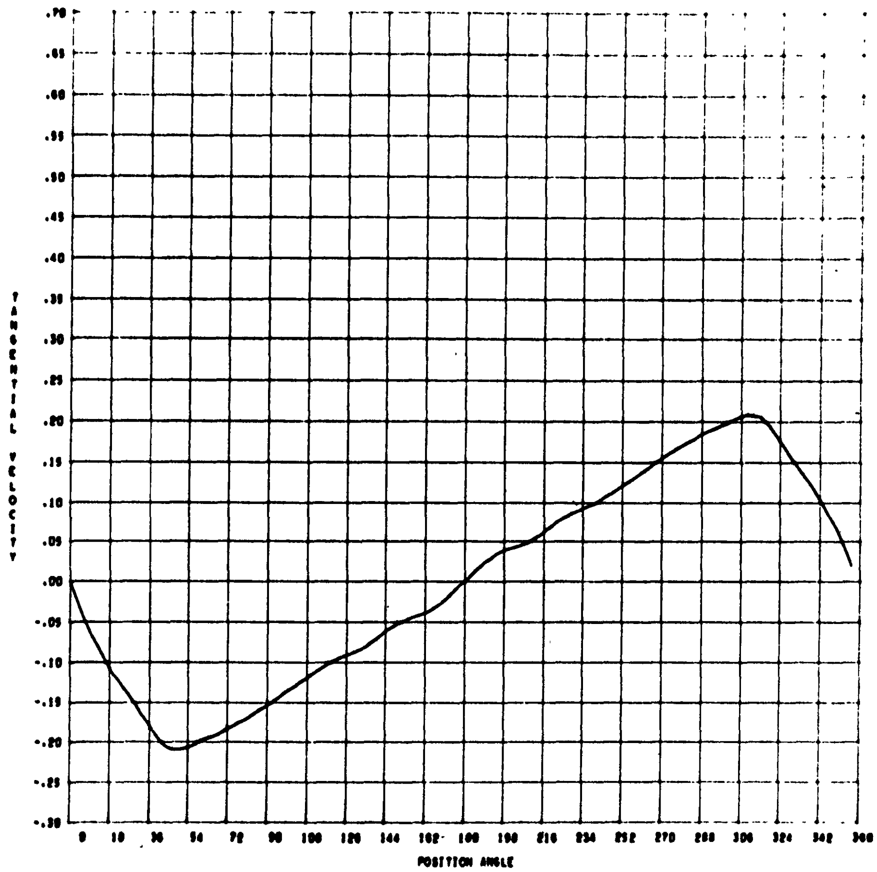
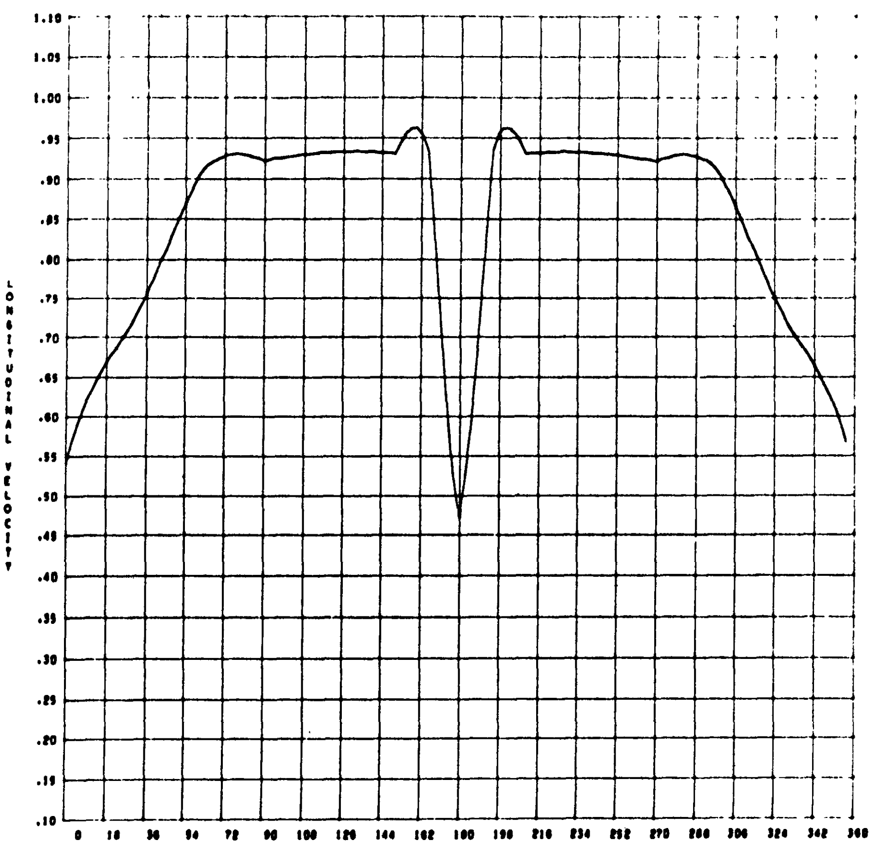


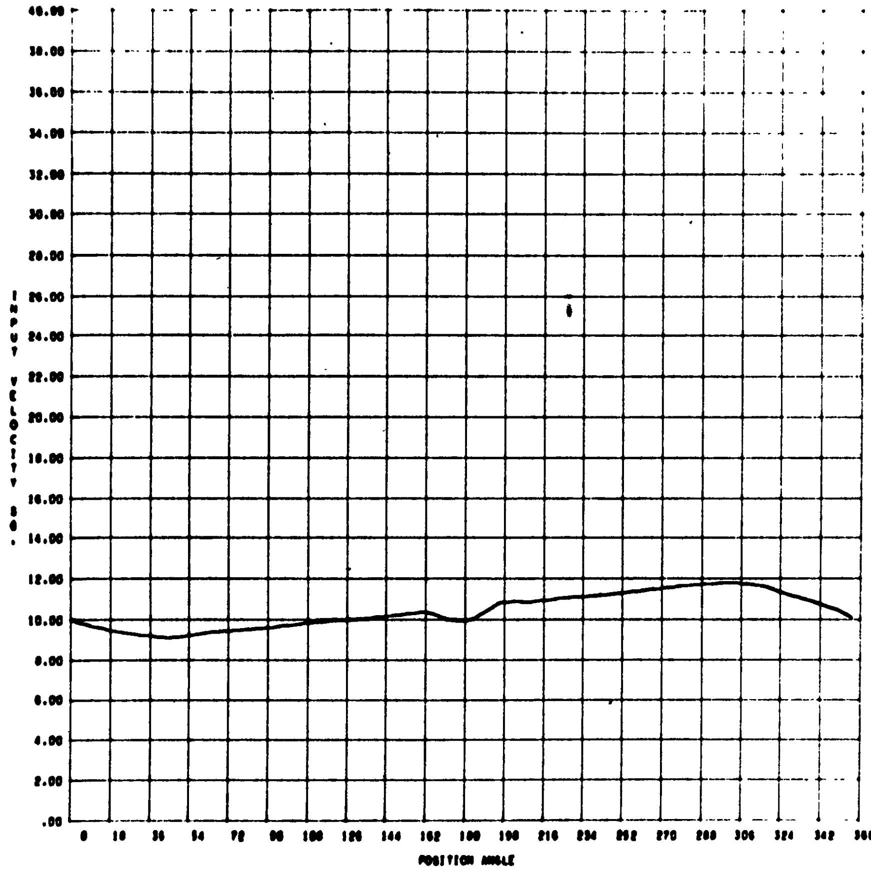
Figure 2. Sample Computer Plots for "Complete" Case 1 (Cont'd.)

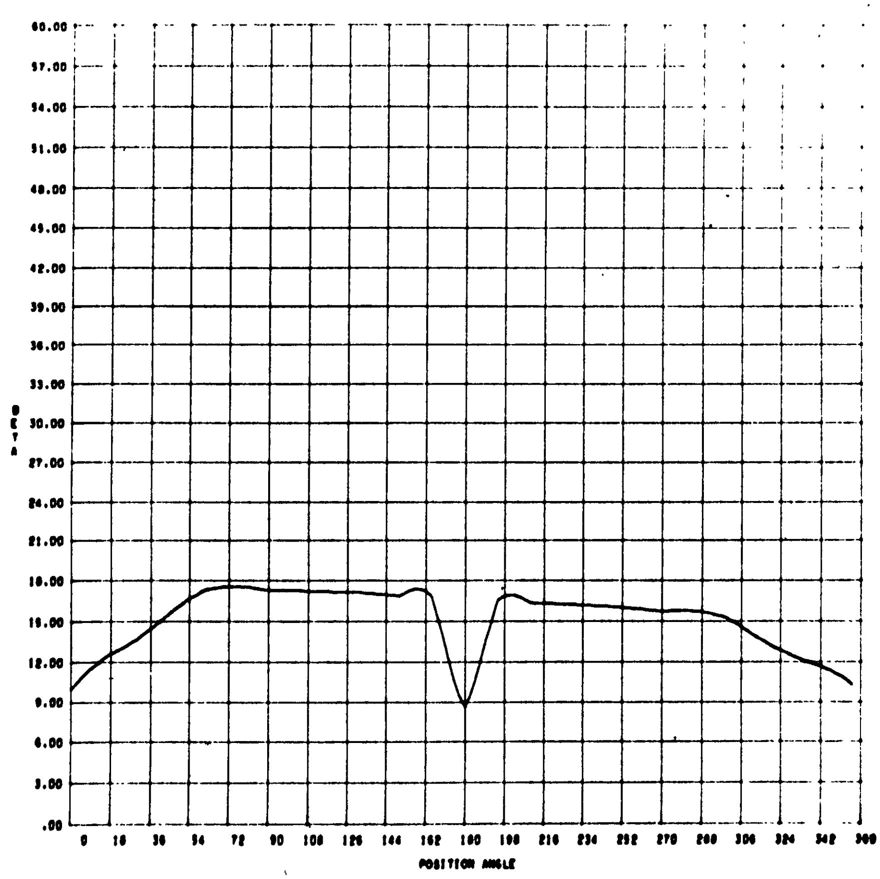




MODEL 4521 TEST 0.1   VANE ANALYSIS   RADIUS - 0.900

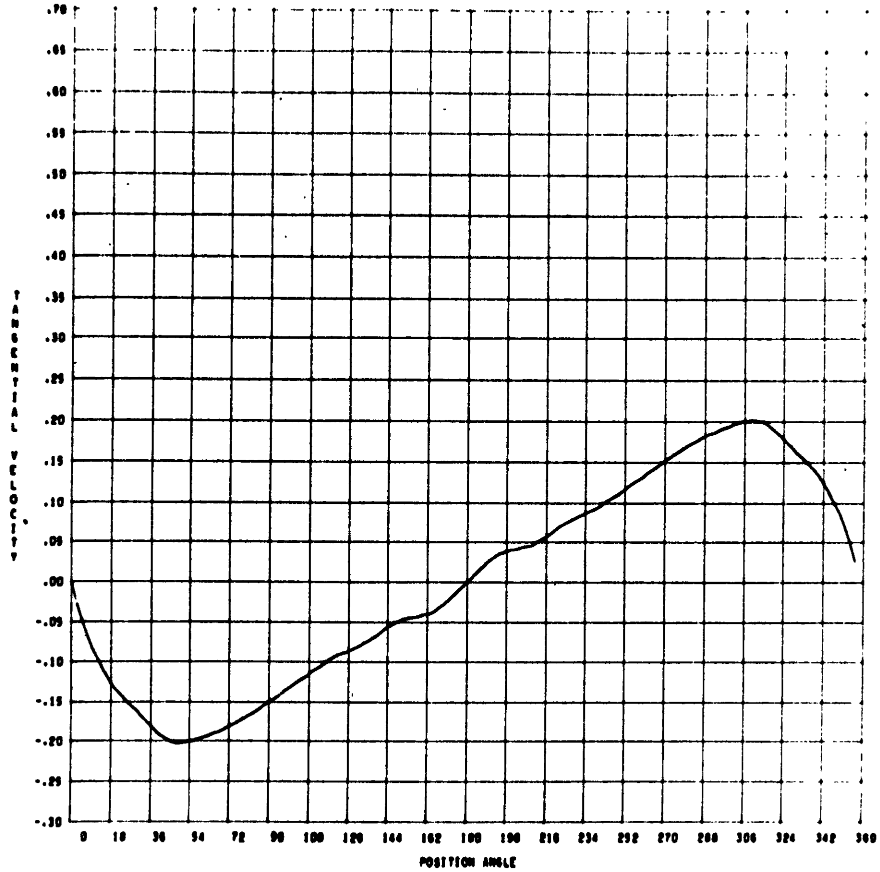
Figure 3 - Sample Computer Plots for "Complete" Case 1 (Cont'd.)





MODEL 4521 TEST 0.1 WAKE ANALYSIS RADIUS - 0.800

Figure 3 - Sample Computer Plots for "Complete" Case 1 (Cont'd.)



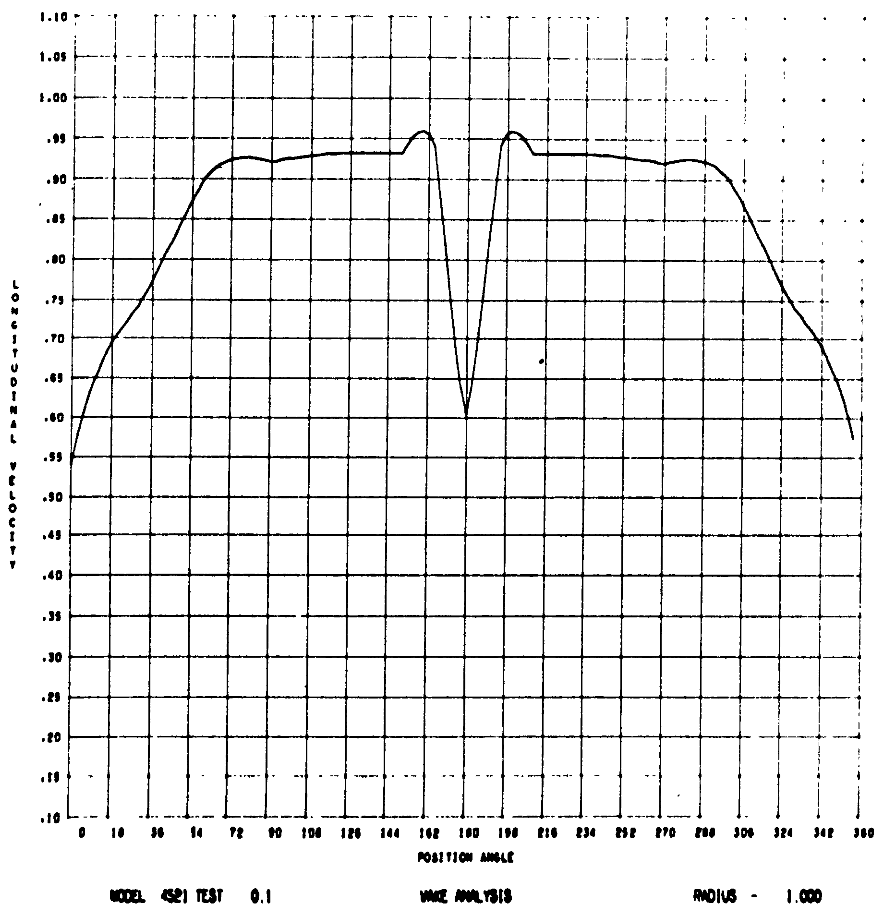
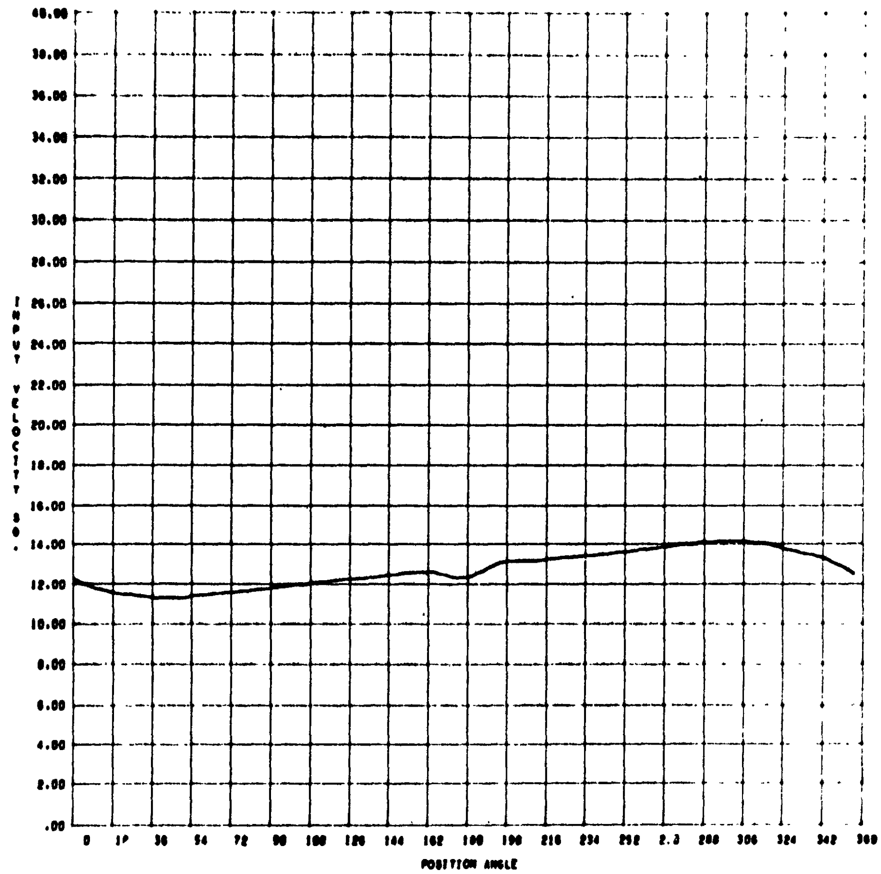
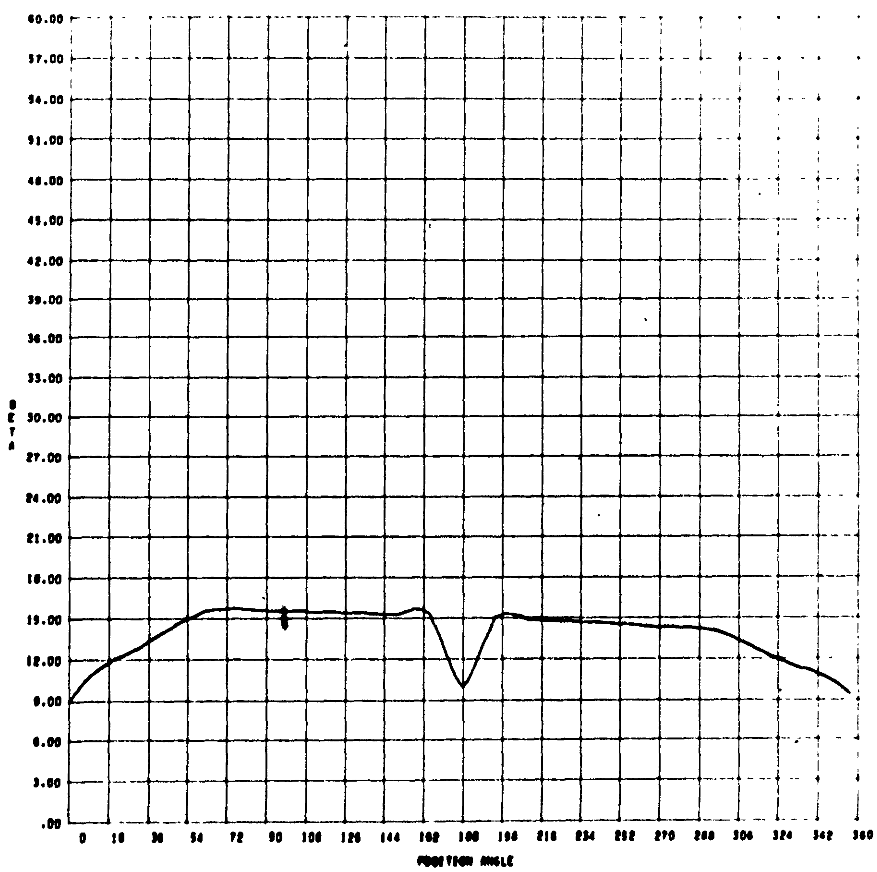


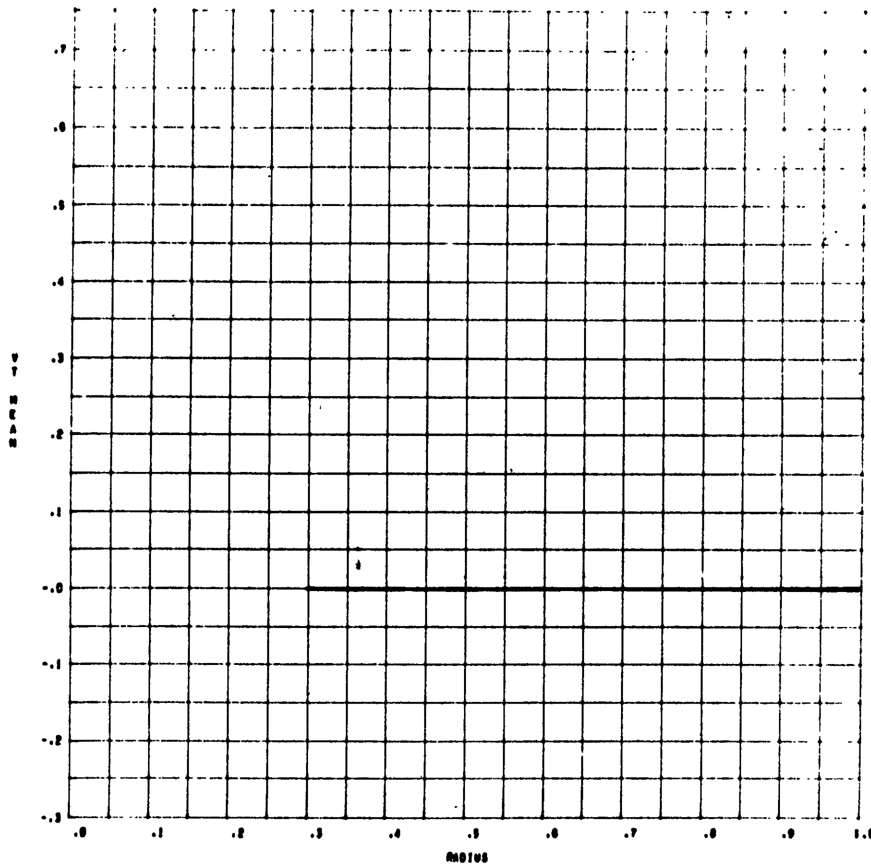
Figure 3 - Sample Computer Plots for "Complete" Case 1 (Cont'd.)





MODEL 4521 TEST 0.1 VANE ANALYSIS RADIUS - 1.000

Figure 3. Sample Computer Plots for "Complete" Case 1 (Cont'd.)



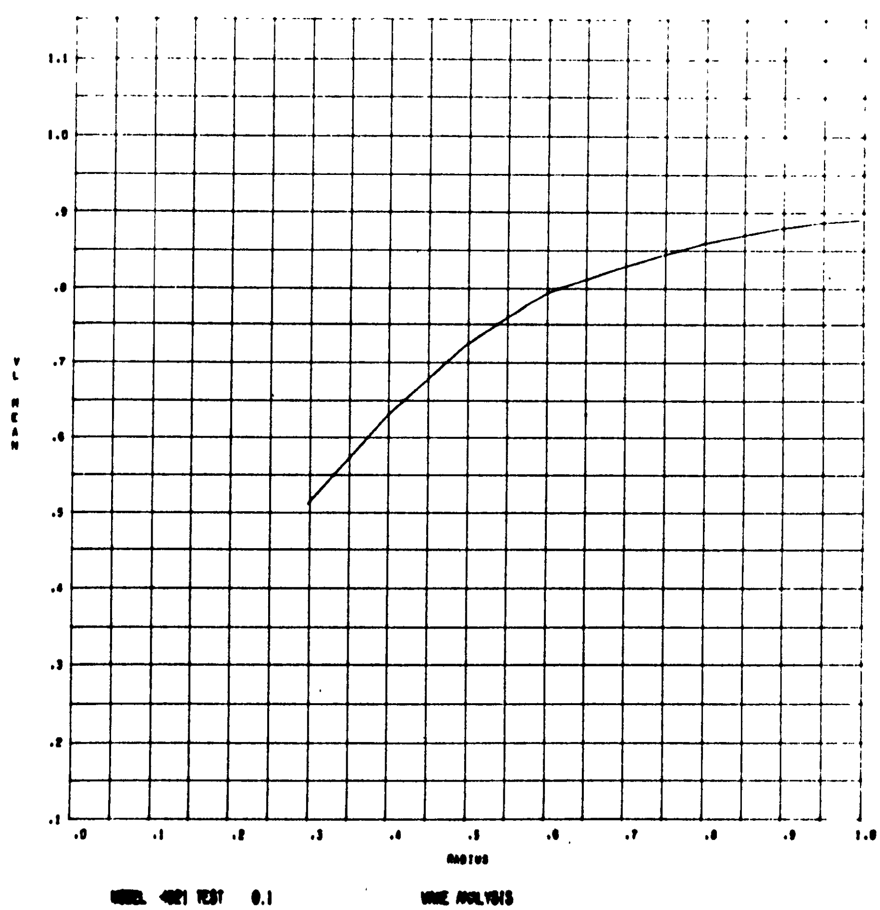
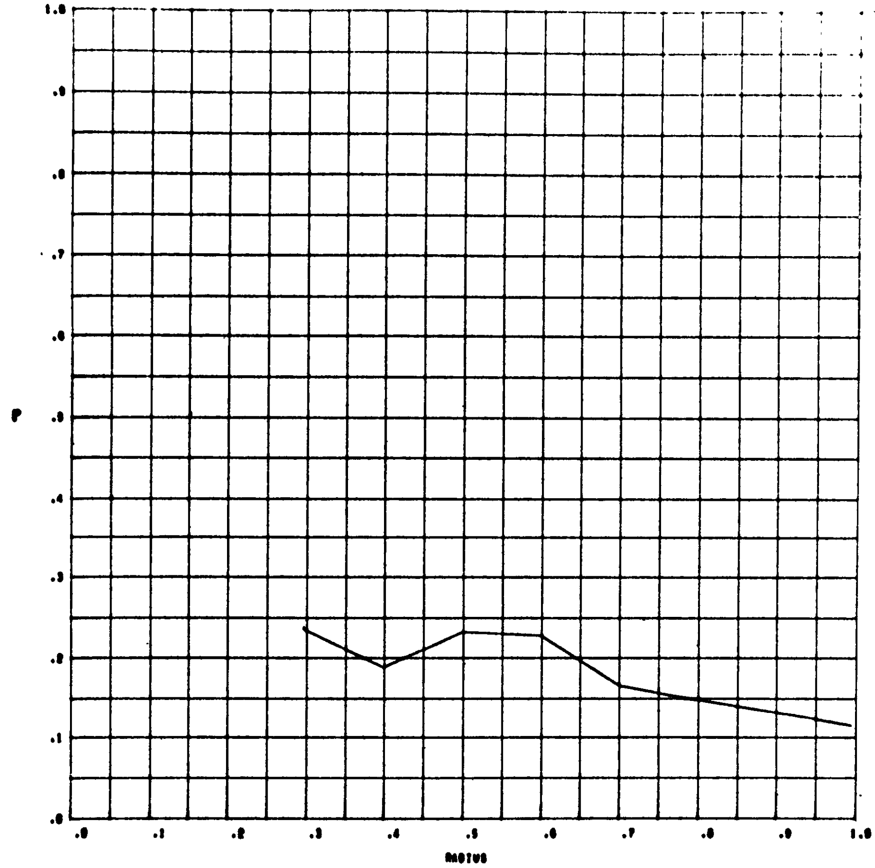


Figure 3 - Sample Computer Plots for "Complete" Case 1 (Cont'd.)



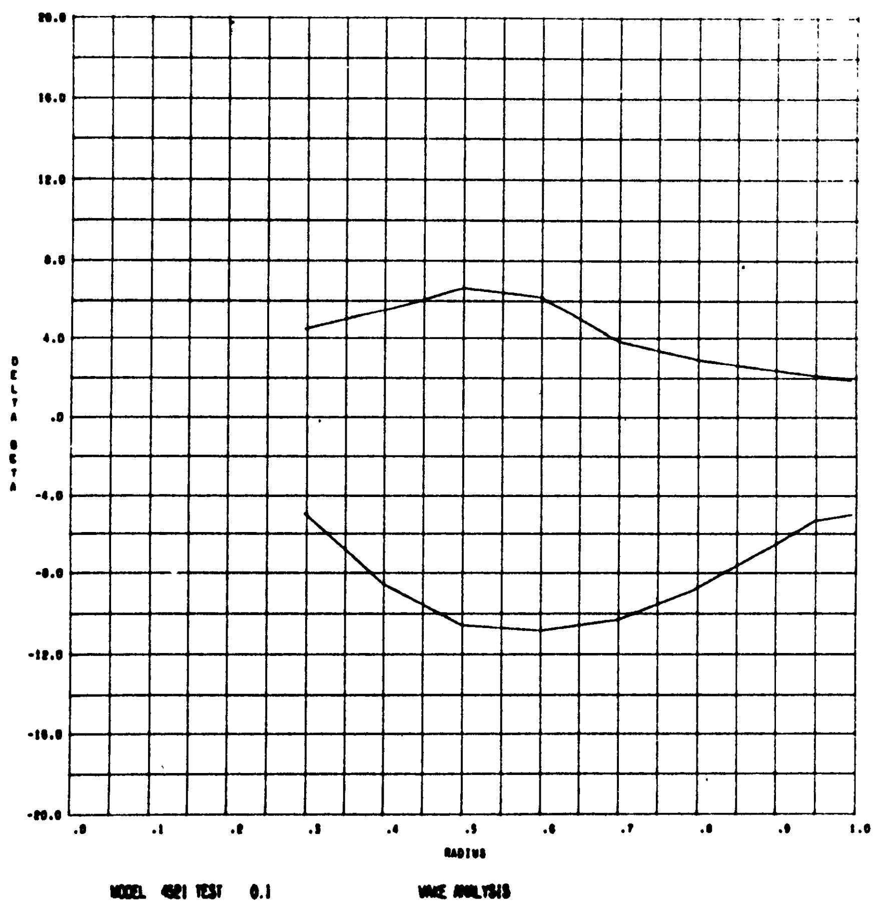


Figure 3 - Sample Computer Plots for "Complete" Case 1 (Cont'd.)

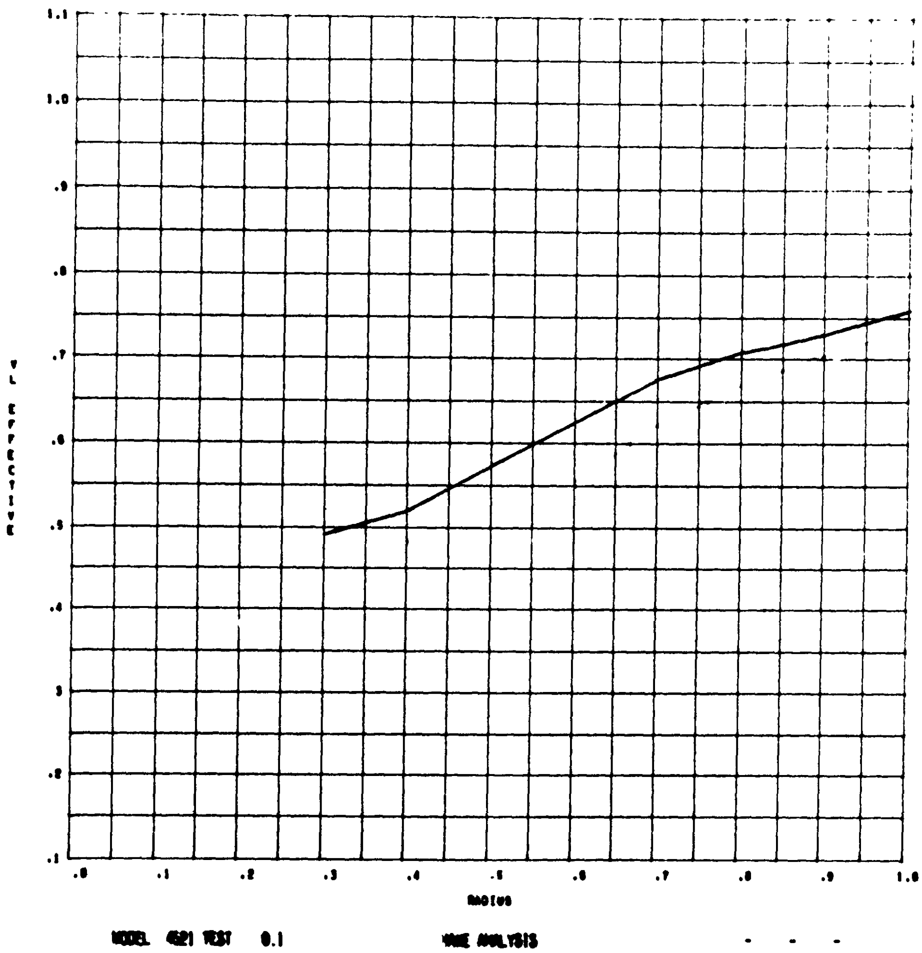


Figure 3 - Sample Computer Plots for "Complete" Case 1 (Cont'd.)

APPENDIX B

Program Listing

```
      FOR
      WAKE ANALYSIS, AML PROBLEM 840-219F
      TABULAR OUTPUT ON TAPE A3 AND GRAPHICAL OUTPUT ON TAPE A8
      DIMENSION DIFV(12),TABFE1(12),TABR(12),TABFE(180),TABVT(12,144),TA
     XBVL(12,144),L(15),R(12),FE1(12),VL(12,144),VT(12,144),RADFE(144),F
     XE(144),HAR(370),VV(12),BETA(12),VVMAX(12),BMAX(12),BMIN(12),VTBAR(
     X12),VLBAR(12),P(12),BBAR(12),BPOS(12),BNEG(12),VV2(12,144),BETA2(1
     X2,144),TABVR(12,144),VR(12,144)
      DIMENSION TITLE(12)
      DIMENSION  VXE(12)
      DIMENSION VLC(12,144),VLCBAR(12)
      EQUIVALENCE (VV2,VLC)
  101 READ 2,IDTAB,NTR,NTFE,DIAM,PPTEST,MTAB,MDIF,VS
      IF (IDTAB-9999) 112,921,921
  112 READ 3,(TABR(I),I=1,NTR)
  113 READ 5,(TABFE(I),I=1,NTFE)
      IDPLOT=1
      IF (MTAB-5)1114,5500,5500
 5500 NN=MTAB-4
      PRINT 57
      READ 1,KR,KFE
      L(1)=XLOCF(L(1))
      L(2)=XLOCF(TABR(1))
      L(3)=1
      L(4)=NTR
      L(5)=KR
      L(6)=KFE
      L(7)=XTABF(0)
      L(8)=0
      L(9)=XLOCF(BETA2(1,1))
      L(11)=12
      L(12)=12
      GO TO (5510,5510,5520,5530,5540),NN
 5510 PRINT 58
      NTHR=1
 5511 DO 5512 J=1,NTR
      READ 1,NFE
      READ 5,(BETA2(J,I),TABVT(J,I),I=1,NFE)
      PRINT 52,TABR(J)
      PRINT 53,(BETA2(J,I),I=1,NFE)
 5512 PRINT 54,(TABVT(J,I),I=1,NFE)
      GO TO (5520,137),NN
 5520 PRINT 59
      DO 5522 J=1,NTR
      READ 1, NFE
      READ 5,(VV2(J,I),TABVL(J,I),I=1,NFE)
      PRINT 52,TABR(J)
      PRINT 53,(VV2(J,I),I=1,NFE)
 5522 PRINT 54,(TABVL(J,I),I=1,NFE)
      GO TO 137
 5530 PRINT 60
      DO 5532 J=1,NTR
      READ 1, NFE
      READ 5,(BETA2(J,I),TABVR(J,I),I=1,NFE)
      PRINT 52, TABR(J)
```

```
      PRINT 53, (BETA2(J,I),I=1,NFE)
 5532 PRINT 54,(TABVR(J,I),I=1,NFE)
      GO TO 137
 5540 PRINT 61
      DO 5545 J=1,NTR
      READ 1, NFE
      READ 5,(BETA2(J,I),VL(J,I),VT(J,I),VR(J,I),I=1,NFE)
      PRINT 52,TABR(J)
      PRINT 53,(BETA2(J,I),I=1,NFE)
      PRINT 54,(VL(J,I),I=1,NFE)
      PRINT 55,(VT(J,I).I=1,NFE)
      PRINT 56,(VR(J,I),I=1,NFE)
      DO 5545 I=1,NFE
      VV2(J,I)=BETA2(J,I)
      VL(J,I)=VL(J,I)/VS
      VH=VL(J,I)*COSDF(VT(J,I))*SINDF(VR(J,I))
      VV=VL(J,I)*SINDF(VT(J,I))
      TABVL(J,I)=VL(J,I)*COSDF(VT(J,I))*COSDF(VR(J,I))
      SINFE=SINDF(BETA2(J,I))
      COSFE=COSDF(BETA2(J,I))
      IF (BETA2(J,I)) 5541,5542,5641
 5641 IF (BETA2(J,I)-180.) 5541,5541,5542
 5541 TABVT(J,I)=-VV*SINFE-VH*COSFE
      TABVR(J,I)=-VV*COSFE+VH*SINFE
      GO TO 5545
 5542 TABVT(J,I)=-VV*SINFE+VH*COSFE
      TABVR(J,I)=-VV*COSFE-VH*SINFE
 5545 CONTINUE
      GO TO 137
   52 FORMAT(6H  R/R=,4X,11F10.4)
   53 FORMAT(6H  PHI=,4X,11F10.4)
   54 FORMAT(6H    V =,4X,11F10.4)
   55 FORMAT(6H L H =,4X,11F10.4)
   56 FORMAT(6H L V =,4X,11F10.4)
   57 FORMAT(36X,47HAPPLIED MATHEMATICS LABORATORY PROBLEM 840-219D/53X,
     X13HWAKE ANALYSIS)
   58 FORMAT(/57X,5HINPUT/45X,30HTANGENTIAL VELOCITY COMPONENTS)
   59 FORMAT(/57X,5HINPUT/44X,32HLONGITUDINAL VELOCITY COMPONENTS)
   60 FORMAT(/57X,5HINPUT/47X,26HRADIAL VELOCITY COMPONENTS)
   61 FORMAT(/57X,5HINPUT/41X,37HDATA MEASURED WITH 13-HOLE PITOT TUBE)
   62 FORMAT(34H1ERROR IN INPUT INTERPOLATION R/R= F10.4,4HPHI= F10.4)
 1114 NN=MTAB+1
      GO TO (115,115,116,116,5001),NN
C  ----------*   WAKE SURVEY FOR 13 HOLE PITOT TUBE--------------- -
C------------READ VELOCITY INTO VL, VANG INTO VT, AND HANG INTO VR-----
 5001 READ 5,((VL(J,I),I=1,NTFE),J=1,NTR)
      READ 5,((VT(J,I),I=1,NTFE),J=1,NTR)
      READ 5,((VR(J,I),I=1,NTFE),J=1,NTR)
      IF (VS) 5002,5004,5002
 5004 WRITE OUTPUT TAPE 99,36
      PRINT 36
      GO TO 921
 5002 DO 5003 I=1,NTFE
      DO 5003 J=1,NTR
 5003 VL(J,I)=VL(J,I)/VS
```

```
      PRINT 14, PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
 5005 PRINT 48
      DO 5007 I=1,NTFE
 5007 PRINT 17,TABFE(I),(VL(J,I),J=1,NTR)
      PRINT 14, PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
      PRINT 49
      DO 5010 I=1,NTFE
 5010 PRINT 17,TABFE(I),(VT(J,I),J=1,NTR)
      PRINT 14, PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
      PRINT 47
      DO 5015 I=1,NTFE
 5015 PRINT 17,TABFE(I),(VR(J,I),J=1,NTR)
      DO 5040 I=1,NTFE
      DO 5040 J=1,NTR
      TABVL(J,I)=VL(J,I)*COSDF(VT(J,I))*COSDF(VR(J,I))
      VH=VL(J,I)*COSDF(VT(J,I))*SINDF(VR(J,I))
      VV=VL(J,I)*SINDF(VT(J,I))
      SINFE=SINDF(TABFE(I))
      COSFE=COSDF(TABFE(I))
      IF (TABFE(I)) 5020,5030,5019
 5019 IF (TABFE(I)-180.) 5020,5020,5030
 5020 TABVT(I,J)=-VV*SINFE-VH*COSFE
      TABVR(J,I)=-VV*COSFE+VH*SINFE
      GO TO 5040
 5030 TABVT(J,I)=-VV*SINFE+VH*COSFE
      TABVR(J,I)=-VV*COSFE-VH*SINFE
 5040 CONTINUE
 5041 PRINT 14,PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
      PRINT 15
      DO 5300 I=1,NTFE
 5300 PRINT 17,TABFE(I),(TABVT(J,I),J=1,NTR)
      PRINT 14,PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
      PRINT 16
      DO 5305 I=1,NTFE
 5305 PRINT 17,TABFE(I),(TABVL(J,I),J=1,NTR)
      PRINT 14,PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
      PRINT 26
      DO 5310 I=1,NTFE
 5310 PRINT 17,TABFE(I),(TABVR(J,I),J=1,NTR)
      GO TO 137
C----------WAKE SURVEY WHEN VELOCITY COMPONENTS ARE GIVEN-------------
  115 READ 8,((TABVT(J,I),I=1,NTFE),J=1,NTR)
      GO TO (116,117,116),NN
  116 READ 8,((TABVL(J,I),I=1,NTFE),J=1,NTR)
  117 PRINT 14, PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
      GO TO (118,118,120,1208),NN
 1208 PRINT 26
      GO TO 1120
  118 PRINT 15
      DO 1118  I = 1,NTFE
 1118 PRINT 17,TABFE(I),(TABVT(J,I),J=1,NTR)
      GO TO (119,121,119),NN
  119 PRINT 14, PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
  120 PRINT 16
 1120 DO 1119  I = 1,NTFE
```

```
1119 PRINT 17, TABFE(I),(TABVL(J,I),J=1,NTR)
 121 IF(MDIF) 122,137,122
 122 PRINT 14, PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
     NDTR=NTR-1
     GO TO (123,123,134,1133),NN
1133 PRINT 14,PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
     PRINT 26
     GO TO 1134
 123 PRINT 15
     PRINT 18
     DO 132 I=1,NTFE
     DO 131 J=1,NDTR
     DIFV(J)=TABVT(J,I+1)-TABVT(J,I)
 131 CONTINUE
 132 CONTINUE
     PRINT 17, TABFE(I),(DIFV(J),J=1,NDTR)
     GO TO (133,137,134,1133),NN
 133 PRINT 14, PPTEST,IDTAB,DIAM,(TABR(I),I=1,NTR)
 134 PRINT 16
1134 PRINT 18
     DO 136 I=1,NTFE
     DO 135 J=1,NDTR
     DIFV(J)=TABVL(J,I+1)-TABVL(J,I)
 135 CONTINUE
     PRINT 17, TABFE(I),(DIFV(J),J=1,NDTR)
 136 CONTINUE
 137 READ 1, NRUNS
     DO 146  NTIMES = 1,NRUNS
C----------                      READ CONTROL DATA------------
 104 READ 4,NR,KRT,KFET,KRL,KFEL,PTEST,NPROP,AJ,MPLOT
      MPLOT=MPLOT+1
     IF(PTEST) 105,106,105
 105 PPTEST=PTEST
 106 READ 3,(R(I),I=1,NR)
     GO TO (5050,5055),MPLOT
5050 GO TO (5051,5052),IDPLOT
5051 CALL LGCHAR(8,6H  219 )
B    TITLE(18)=740100023060
B    TITLE(17)=604446242543
B    TITLE(15)=606325626360
B    TITLE(13)=606060606060
B    TITLE(12)=606060606060
B    TITLE(11)=606060606060
B    TITLE(10)=606060602142
B    TITLE(9) =256021452143
B    TITLE(8) =706231626060
B    TITLE(7) =606060606060
B    TITLE(6) =606060606060
B    TITLE(5) =606060606060
B    TITLE(4) =606060606060
B    TITLE(3)=512124316462
B    TITLE(2)=606040606060
     IDPLOT=2
     REWIND 4
     WRITE OUTPUT TAPE 4,8051,PPTEST,IDTAB
```

```
      REWIND 4
      READ INPUT TAPE 4,8050,TITLE(14),TITLE(16)
 5052 REWIND 4
      DO 8060 I=1,NR
      WRITE OUTPUT TAPE 4,3,R(I)
 8060 CONTINUE
      REWIND 4
 5055 READ 5,(FE1(I),I=1,NR)
      READ 1, NBLD,NHA,NRH,NHV
      PRINT 50,NR,KRT,KFET,KRL,KFEL,AJ,MPLOT,VS,NBLD,NHA,NRH,NHV
      MAXH=NBLD/2
      DELFE=360.0/FLOATF(NBLD)
      RADFE(1)=0.0
      DO 138 I=2,NBLD
  138 RADFE(I)=RADFE(I-1)+DELFE
  139 DO 143 K=1,NBLD
      DO 143 I=1,NR
      FE(K)=RADFE(K)+FE1(I)
      IF(FE(K)-0.0) 2130,2140,2131
 2130 FE(K) = 360.0 + FE(K)
      GO TO 2140
 2131 IF(FE(K) - 360.0) 2140,2140,2132
 2132 FE(K) = FE(K) - 360.0
 2140 IF (MTAB-5) 2141,2141,6000
 2141 GO TO (140,140,142,142,140),NN
 6000 GO TO (6140,6140,6142,6142,6140),NN
 6140 L(9)=XLOCF(BETA2(1,1))
  200 CONTINUE
      L(13)=NTFE
      L(10)=XLOCF(TABVT(1,1))
      VT(I,K)=DTABF(FE(K),R(I),L(1))
      NXT=L(8)
      GO TO (6141,301),NXT
 6141 GO TO (6142,143,6142,6142,6142,6142),NN
 6142 L(9)=XLOCF(VV2(1,1))
      L(10)=XLOCF(TABVL(1,1))
      VL(I,K)=DTABF(FE(K),R(I),L(1))
      GO TO (6143,302),NXT
 6143 GO TO (143,143,143,143,6144),NN
 6144 L(9)=XLOCF(BETA2(1,1))
      L(10)=XLOCF(TABVR(1,1))
      VR(I,K)=DTABF(FE(K),R(I),L(1))
      GO TO (143,304),NXT
  140 L(1)=XLOCF(L(1))
      L(2)=XLOCF(TABR(1))
      L(3)=1
      L(4)=NTR
      L(5)=KRT
      L(6)=KFET
      L(7)=XTABF(0)
      L(8)=0
      L(9)=XLOCF(TABFE(1))
      L(10)=XLOCF(TABVT(1))
      L(11)=1
      L(12)=12
```

```
      L(13)=NTFE
      VT(I,K)=DTABF(FE(K),R(I),L(1))
      NXT=L(8)
      GO TO (141,301),NXT
  141 GO TO (142,143,142,142,142),NN
  142 L(1)=XLOCF(L(1))
      L(2)=XLOCF(TABR(1))
      L(3)=1
      L(4)=NTR
      L(5)=KRT
      L(6)=KFET
      L(7)=XTABF(0)
      L(8)=0
      L(9)=XLOCF(TABFE(1))
      L(10)=XLOCF(TABVL(1))
      L(11)=1
      L(12)=12
      L(13)=NTFE
      VL(I,K)=DTABF(FE(K),R(I),L(1))
      NXL=L(8)
      GO TO (5100,302),NXL
 5100 GO TO (143,143,143,143,5105),NN
 5105 L(1)=XLOCF(L(1))
      L(2)=XLOCF(TABR(1))
      L(3)=1
      L(4)=NTR
      L(5)=KRT
      L(6)=KFET
      L(7)=XTABF(0)
      L(8)=0
      L(9)=XLOCF(TABFE(1))
      L(10)=XLOCF(TABVR(1))
      L(11)=1
      L(12)=12
      L(13)=NTFE
      VR(I,K)=DTABF(FE(K),R(I),L(1))
      NXL=L(8)
      GO TO (143,304),NYL
  143 CONTINUE
      GO TO (144,144,145,1244,144),NN
 1244 PRINT 114,PPTEST,IDTAB,NPROP,DIAM,(R(I),I=1,NR)
      PRINT 19,(FE1(I),I=1,NR)
      PRINT 26
      GO TO 1245
  144 PRINT 114,PPTEST,IDTAB,NPROP,DIAM,(R(I),I=1,NR)
      PRINT 19,(FE1(I),I=1,NR)
      PRINT 15
      DO 1144 I = 1,NBLD
 1144 PRINT 17, RADFE(I),(VT(J,I), J=1,NR)
      GO TO (145,2700,145,1245,145),NN
  145 PRINT 114,PPTEST,IDTAB,NPROP,DIAM,(R(I),I=1,NR)
      PRINT 19,(FE1(I),I=1,NR)
      PRINT 16
 1245 DO 1145 I = 1,NBLD
 1145 PRINT 17, RADFE(I),(VL(J,I), J=1,NR)
```

```
      GO TO (3100,3100,3100,3100,5150),NN
 5150 PRINT 114,PPTEST,IDTAB,NPROP,DIAM,(R(I),I=1,NR)
      PRINT 19,(FE1(I),I=1,NR)
      PRINT 26
      DO 5155 I=1,NBLD
 5155 PRINT 17,RADFE(I),(VR(J,I),J=1,NR)
      GO TO 3100
 3100 IF(AJ) 3110,2700,3110
 3110 PIJ=3.14159269/AJ
      PRINT 114,PPTEST,IDTAB,NPROP,DIAM,(R(I),I=1,NR)
      PRINT 19,(FE1(I),I=1,NR)
      PRINT 8052,AJ
      PRINT 28
      ERASE VVMAX
 3112 DO 3150 K=1,NBLD
      DO 3140 I=1,NR
      VV(I)=VL(I,K)**2+(VT(I,K)+PIJ*R(I))**2
      VV2(I,K)=VV(I)
      IF(VV(I)-VVMAX(I))3140,3140,3120
 3120 VVMAX(I)=VV(I)
 3140 CONTINUE
      PRINT 17, RADFE(K),(VV(I),I=1,NR)
 3150 CONTINUE
 3155 PRINT 40,(VVMAX(I),I=1,NR)
      PRINT 114,PPTEST,IDTAB,NPROP,DIAM,(R(I),I=1,NR)
      PRINT 19,(FE1(I),I=1,NR)
      PRINT 8052,AJ
      PRINT 29
      DO 3159 I=1,NR
      BMAX(I)=0.
 3159 BMIN(I)=360.
 4100 DO 4150 K=1,NBLD
      DO 4140 I=1,NR
      BETA(I)=ATANDF(VL(I,K)/(PIJ*R(I)+VT(I,K)))
      BETA2(I,K)=BETA(I)
      IF (BETA(I)-BMAX(I)) 4111,4111,4110
 4110 BMAX(I)=BETA(I)
 4111 IF (BETA(I)-BMIN(I)) 4120,4140,4140
 4120 BMIN(I)=BETA(I)
 4140 CONTINUE
      PRINT 17, RADFE(K),(BETA(I),I=1,NR)
 4150 CONTINUE
 4155 PRINT 40,(BMAX(I),I=1,NR)
      PRINT 41,(BMIN(I),I=1,NR)
 2700 IF(NHA-MAXH) 2800,2800,303
 2800 IF(NRH) 2900,2900,901
 2900 NRH = 1
  901 IF(NHA)  924,904,905
  904 NHA=24
  905 GO TO (906,906,911,1905,906),NN
 1905 PRINT 21,PPTEST,IDTAB,NPROP,DIAM
      PRINT 27
      GO TO 912
  906 PRINT 21, PPTEST,IDTAB,NPROP,DIAM
      PRINT 22
```

```
      DO 910  I=1,NR,NRH
      DO 7001 JI=1,NBLD
 7001 TABFE(JI)=VT(I,JI)
      PRINT 24, R(I),FE1(I)
-     CALL GMHAS(NBLD,NHA,TABFE(1),HAR(370))
      VTBAR(I)=HAR(370)
      NHAT=NHA+1
      DO 910  J=1,NHAT
      JJ=J-1
      K=370-5*JJ
      HAR(K-4)=HAR(K-2)/HAR(370)
      PRINT 25,JJ,HAR(K),HAR(K-1),HAR(K-2),HAR(K-3),HAR(K-4)
  910 CONTINUE
      GO TO (911,902,911,1905,911),NN
  911 PRINT 21, PPTEST,IDTAB,NPROP,DIAM
      PRINT 23
  912 DO 920  I=1,NR,NRH
      DO 7002 JI=1,NBLD
 7002 TABFE(JI)=VL(I,JI)
      PRINT 24, R(I),FE1(I)
-     CALL GMHAS(NBLD,NHA,TABFE(1),HAR(370))
      VLBAR(I)=HAR(370)
      NHAT=NHA+1
      DO 920  J=1,NHAT
      JJ=J-1
      K=370-5*JJ
      HAR(K-4)=HAR(K-2)/HAR(370)
      PRINT 25,JJ,HAR(K),HAR(K-1),HAR(K-2),HAR(K-3),HAR(K-4)
  920 CONTINUE
      PRINT 21, PPTEST,IDTAB,NPROP,DIAM
      PRINT 5800
      DO 5801 I=1,NR,NRH
      DO 5802 JI=1,NBLD
 5802 TABFE(JI)=VV2(I,JI)
      PRINT 24, R(I),FE1(I)
-     CALL GMHAS(NBLD,NHA,TABFE(1),HAR(370))
      NHAT=NHA+1
      DO 5801 J=1,NHAT
      JJ=J-1
      K=370-5*JJ
      HAR(K-4)=HAR(K-2)/HAR(370)
      PRINT 25,JJ,HAR(K),HAR(K-1),HAR(K-2),HAR(K-3),HAR(K-4)
 5801 CONTINUE
      PRINT 21, PPTEST,IDTAB,NPROP,DIAM
      PRINT 5805
      DO 5803 I=1,NR,NRH
      DO 5804 JI=1,NBLD
 5804 TABFE(JI)=BETA2(I,JI)
      PRINT 24, R(I),FE1(I)
-     CALL GMHAS(NBLD,NHA,TABFE(1),HAR(370))
      NHAT=NHA+1
      DO 5803 J=1,NHAT
      JJ=J-1
      K=370-5*JJ
      HAR(K-4)=HAR(K-2)/HAR(370)
```

```
      PRINT 25,JJ,HAR(K),HAR(K-1),HAR(K-2),HAR(K-3),HAR(K-4)
 5803 CONTINUE
      IF(AJ) 4200,922,4200
 4200 IF (NHV) 4201,4208,4202
 4201 NHV=NHA
 4202 PRINT 21,PPTEST,IDTAB,NPROP,DIAM
      PRINT 45
      DO 4205 I=1,NR,NRH
      PRINT 24,R(I),FE1(I)
      CALL GMHAS(NBLD,NHV,VV2(1,I),HAR(370))
      NHAT=NHV+1
      DO 4205 J=1,NHAT
      JJ=J-1
      K=370-5*JJ
      HAR(K-4)=HAR(K-2)/HAR(370)
      PRINT 25, JJ,HAR(K),HAR(K-1),HAR(K-2),HAR(K-3),HAR(K-4)
 4205 CONTINUE
      PRINT 21,PPTEST,IDTAB,NPROP,DIAM
      PRINT 46
      DO 4207 I=1,NR,NRH
      PRINT 24,R(I),FE1(I)
      CALL GMHAS(NBLD,NHV,BETA2(I,1),HAR(370))
      NHAT=NHV+1
      DO 4207 J=1,NHAT
      JJ=J-1
      K=370-5*JJ
      HAR(K-4)=HAR(K-2)/HAR(370)
      PRINT 25,JJ,HAR(K),HAR(K-1),HAR(K-2),HAR(K-3),HAR(K-4)
 4207 CONTINUE
 4208 PRINT 42,PPTEST,IDTAB,NPROP,DIAM
      PRINT 43
 4210 DO 4220 I=1,NR,NRH
      P(I)=(VVMAX(I)/(VLBAR(I)**2+(PIJ*R(I)+VTBAR(I))**2))-1.0
      BBAR(I)=ATANDF(VLBAR(I)/(PIJ*R(I)+VTBAR(I)))
      BPOS(I)=BMAX(I)-BBAR(I)
      BNEG(I)=BMIN(I)-BBAR(I)
      PRINT 44, R(I),P(I),BPOS(I),BNEG(I)
 4220 CONTINUE
  922 WRITE OUTPUT TAPE 99,33,PPTEST,IDTAB
  924 GO TO (925,11461),MPLOT
  925 N=NBLD
      DO 8010 J=1,NR
      READ INPUT TAPE 4,8020,TITLE(1)
      GO TO (8003,8003,8002,8001,8003),NN
 8001 CALL FNPLOT(TITLE(18),21H(16H  POSITION ANGLE),26H(21H   RADIAL
     A VELOCITY),-0.,360.,-.25,.25,20,1,20,1,6H(F6.0),6H(F6.2))
      DO 6801 N=1,NBLD
 6801 FE(N)=VL(J,N)
      CALL CURVE(RADFE(N),FE(N),N,6H      )
      GO TO 8010
 8003 CALL FNPLOT(TITLE(18),21H(16H  POSITION ANGLE),26H(21H  TANGENTIAL
     A VELOCITY),-0.,360.,-.3,.7,20,1,20,1,6H(F6.0),6H(F6.2))
      DO 6800 N=1,NBLD
 6800 FE(N)=VT(J,N)
      CALL CURVE(RADFE(N),FE(N),N,6H      )
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      GO TO (8002,8010,8002,8010,8002),NN
 8002 CALL FNPLOT(TITLE(18),21H(16H  POSITION ANGLE),28H(23H  LONGITUDIN
     AAL VELOCITY),-0.,360.,.1,1.1,20,1,20,1,6H(F6.0),6H(F6.2))
      DO 6804 N=1,NBLD
 6804 FE(N)=VL(J,N)
      CALL CURVE(RADFE(N),FE(N),N,6H       )
      GO TO (8006,8010,8010,8010,8006),NN
 8006 IF(AJ)8076,8010,8076
 8076 CALL FNPLOT(TITLE(18),21H(16H  POSITION ANGLE),26H(21H  INPUT VELO
     ACITY SQ. ),-0.,360.,.0,40.,20,1,20,1,6H(F6.0),6H(F6.2))
      DO 6802 N=1,NBLD
 6802 FE(N)=VV2(J,N)
      CALL CURVE(RADFE(N),FE(N),N,6H       )
      CALL FNPLOT(TITLE(18),21H(16H  POSITION ANGLE),10H(6H  BETA),-0.,3
     A60.,.0,60.,20,1,20,1,6H(F6.0),6H(F6.2))
      DO 6803 N=1,NBLD
 6803 FE(N)=BETA2(J,N)
      CALL CURVE(RADFE(N),FE(N),N,6H       )
 8010 CONTINUE
      M=NR/NRH
B     TITLE(1)=606040606060
B     TITLE(2)=606040606060
B     TITLE(3)=606040606060
      CALL FNPLOT(TITLE(18),12H(8H  RADIUS),17H(12H  VT MEAN   ),0.,1.,-
     X.30,.70,20,2,21,2,6H(F6.1),6H(F6.1))
      CALL CURVE(R(M),VTBAR(M),M,6H       )
      CALL FNPLOT(TITLE(18),12H(8H  RADIUS),17H(12H  VL MEAN   ),0.,1.,.
     X100,1.1,20,2,21,2,6H(F6.1),6H(F6.1))
      CALL CURVE(R(M),VLBAR(M),M,6H       )
      CALL FNPLOT(TITLE(18),12H(8H  RADIUS),7H(3H  P),0.,1.,0.,1.,20,2,20,2
     X0,2,6H(F6.1),6H(F6.1))
      CALL CURVE(R(M),P(M),M,6H       )
      CALL FNPLOT(TITLE(18),12H(8H  RADIUS),17H(12H  DELTA BETA),0.,1.,-1
     X20.,20.,20,2,20,2,6H(F6.1),6H(F6.1))
       CALL CURVE(R(M),BPOS(M),M,6H       )
       CALL CURVE(R(M),BNEG(M),M,6H       )
      CALL FNPLOT(TITLE(18),12H(8H  RADIUS),19H(14H  VL EFFECTIVE),0.,1.
     X,
     X.100,1.1,20,2,20,2,6H(F6.1),6H(F6.1))
      CALL CURVE(R(M),VXE(M),M,6H       )
      IF(NN-4) 11461,11461,5201
 5201 DO 5205 K=1,NBLD
      DO 5205 I=1,NR
 5205 VL(I,K)=VR(I,K)
      NN=4
      REWIND 4
      GO TO 925
11461 PRINT 114,PPTEST,IDTAB,NPROP,DIAM,(R(I),I=1,NR)
      PRINT 19,(FE1(I),I=1,NR)
      PRINT 8052,AJ
      PRINT 291
  291 FORMAT(9H POSITION/7H  ANGLE,20X,42HCORRECTED LONGITUDINAL VELOCITY COM
     XY COMPONENTS     )
      DO 14155 K=1,NBLD
      DO 14155 I=1,NR
```

```
14155 VLC(I,K)=VL(I,K)-VT(I,K)*SINDF(BETA2(I,K))/COSDF(BETA2(I,K))
      DO 14156 I=1,NBLD
14156 PRINT 17,RADFE(I),(VLC(J,I),J=1,NR)
      PRINT 21, PPTEST,IDTAB,NPROP,DIAM
      PRINT 4611
 4611 FORMAT(26X,63HHARMONIC ANALYSES OF CORRECTED LONGITUDINAL VELOCITY
     X COMPONENTS    )
      DO 4612 I=1,NR,NRH
      DO 4613 JI=1,NBLD
 4613 TABFE(JI)=VLC(I,JI)
      PRINT 24,R(I),FE1(I)
      CALL GMHAS(NBLD,NHA,TABFE(1),HAR(370))
      VLCBAR(I)=HAR(370)
      NHAT=NHA+1
      DO 4612 J=1,NHAT
      JJ=J-1
      K=370-5*JJ
      HAR(K-4)=HAR(K-2)/HAR(370)
      PRINT 25,JJ,HAR(K),HAR(K-1),HAR(K-2),HAR(K-3),HAR(K-4)
 4612 CONTINUE
      CALL XPMW(VLCBAR,NRH,R,AJ,NR,VXE)
  146 CONTINUE
      REWIND 4
  902 GO TO 101
  921 PRINT 90,  PPTEST,IDTAB
      CALL ENDJOB
  301  PRINT 31,I,R(K),FE1(K),FE(I)
      WRITE OUTPUT TAPE 99,31,I,R(K),FE1(K),FE(I)
      GO TO 146
  302  PRINT 32,K,R(K),FE1(K),FE(I)
      WRITE OUTPUT TAPE 99,32,K,R(K),FE1(K),FE(I)
      GO TO 146
  303 PRINT 34,NHA
      WRITE OUTPUT TAPE 99,34,NHA
      GO TO 902
  304 PRINT 35,K,R(K),FE1(K),FE(I)
      WRITE OUTPUT TAPE 99,35,K,R(K),FE1(K),FE(I)
      GO TO 146
    1 FORMAT(4I4)
    2 FORMAT(I4,2I3,F5.2,F5.1,2I3,F5.2)
    3 FORMAT(12F6.3)
    4 FORMAT(5I3,F5.1,I4,F6.4,I4)
    5 FORMAT(12F6.2)
    8 FORMAT(18F4.3)
   14 FORMAT(1H1,36X,46HAPPLIED MATHEMATICS LABORATORY PROBLEM 840-219/3
     X4X,52H                       WAKE ANALYSIS                 //23X,5H
     XTEST F6.1,12H WITH MODEL I4,5X,19HPROPELLER DIAMETER F5.1,5H FEET/
     X/10H  RADIUS =12F9.4/11H DEV.ANGLE=12F9.4/9H POSITION)
   15 FORMAT( 9H POSITION / 7H  ANGLE,28X,49HTANGENTIAL VELOCITY COMPONE
     XNTS IN PROPELLER PLANE /)
   16 FORMAT ( 9H POSITION / 7H  ANGLE,27X,51HLONGITUDINAL VELOCITY COMP
     XONENTS IN PROPELLER PLANE /)
   17 FORMAT(F10.3,12F9.4)
   18 FORMAT(51X,17HFIRST DIFFERENCES)
   19 FORMAT( 11H DEV.ANGLE=12F9.4/9H POSITION)
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   20 FORMAT(//9H POSITION)
   21 FORMAT(1H1,36X,46HAPPLIED MATHEMATICS LABORATORY PROBLEM 840-219/3
     X4X,51H                        WAKE ANALYSIS                    //24X,5HT
     XEST F5.1,12H WITH MODEL I4,5X,13HPROPELLER NO.  I4,10H DIAMETER F5
     X.2,5H FEET )
   22 FORMAT(24X,72HHARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENTS
     XIN A PROPELLER PLANE /)
 5800 FORMAT(24X,72HHARMONIC ANALYSES OF INFLOW VELOCITY SQUARED IN A
     XPROPELLER PLANE        /)
   23 FORMAT(23X,74HHARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT
     XS IN A PROPELLER PLANE /)
   24 FORMAT(/36X,8HRADIUS = F6.4,18X12HDEV. ANGLE = F6.3/16X,1HN,15X,4H
     XA(N),13X,4HB(N),13X,4HC(N),12X,6HPHI(N),10X,9HC(N)/A(0))
   25 FORMAT (13X,I4,4X,5F18.6)
   26 FORMAT (9H POSITION / 7H  ANGLE,30X,46HRADIAL VELOCITY COMPONENTS
     XIN PROPELLER PLANE  /)
   27 FORMAT (26X,68HHARMONIC ANALYSES OF RADIAL VELOCITY COMPONENTS IN
     XA PROPELLER PLANE / )
 5805 FORMAT (31X,68HHARMONIC ANALYSES OF BETA IN DEGREES IN A PROPELLER
     XPLANE                / )
   28 FORMAT(9H POSITION/7H  ANGLE,28X,29HSQUARE OF THE INFLOW VELOCITY)
   29 FORMAT(9H POSITION/7H  ANGLE,28X,15HBETA IN DEGREES)
   31 FORMAT(51H1ERROR IN INTERPOLATING FOR TANGENTIAL VELOCITY  I=I4,3H
     X R=F5.3,4HFE1= F8.3, 3HFE=F8.3)
   32 FORMAT(53H1ERROR IN INTERPOLATING FOR LONGITUDINAL VELOCITY  I=I4,
     X3H R=F5.3,4HFE1=F8.3,3HFE=F8.3)
   34 FORMAT(3X,I4,21HIS TOO MANY HARMONICS)
   35 FORMAT(47H1ERROR IN INTERPOLATING FOR RADIAL VELOCITY  I=I4,3H R=F
     X5.3,4HFE1=F8.3,3HFE=F8.3)
   36 FORMAT (60H VALUE OF V SUB S NEEDED ON FIRST CARD COL 27-31 FORMAT
     X F5.2)
   40 FORMAT(//10H    MAXIMA,12F9.4)
   41 FORMAT(10H    MINIMA,12F9.4)
   42 FORMAT(1H1,36X,46HAPPLIED MATHEMATICS LABORATORY PROBLEM 840-219/3
     X4X,52H                        WAKE ANALYSIS                    //24X,5H
     XTEST F5.1,12H WITH MODEL I4,5X,13HPROPELLER NO.I4,10H DIAMETER F5.
     X2,5H FEET)
   43 FORMAT(//10H    RADIUS,24X,1HP,17X,15HDELTA BETA PLUS,17X,16HDELTA
     X BETA MINUS/)
   44 FORMAT(F10.3,18X,F8.4,18X,F8.4,18X,F8.4)
   45 FORMAT(34X,56HHARMONIC ANALYSIS OF THE SQUARES OF THE INPUT VELOCI
     XTIES /)
   46 FORMAT(46X,32HHARMONIC ANALYSES OF BETA VALUES /)
   47 FORMAT(9H POSITION/7H  ANGLE,23X,59H ANGLE FROM CL TO PROJECTION O
     XF VELOCITY VECTOR ON X-Y PLANE)
   48 FORMAT(9H POSITION/7H  ANGLE,41X,23H VELOCITY VECTOR VALUES )
   49 FORMAT(9H POSITION/7H  ANGLE,23X,59H ANGLE FROM CL TO PROJECTION O
     XF VELOCITY VECTOR ON X-Z PLANE)
   50 FORMAT(1H1,20X,18HCONTROL PARAMETERS///20X,8HNR      =I4/20X,8HKRT
     X    =I4/20X,8HKFET    =I4/20X,8HKRL     =I4/20X,8HKFEL    =I4/20X,8HJ
     XSUB A=F6.4/20X,8HMPLOT   =I4/20X,8HV SUB S=F6.2/20X,8HNBLD    =I4/20
     XX,8HNHA     =I4/20X,8HNRH     =I4/20X,8HNHV     =I4)
  114 FORMAT(1H1,36X,47HAPPLIED MATHEMATICS LABORATORY PROBLEM 840-219D/
     X35X,51H                       WAKE  ANALYSIS                   //24X,5H
     XTEST F5.1,12H WITH MODEL I4,5X,13HPROPELLER NO.I4,10H DIAMETER F5.
```

```
     X2,5H FEET//10H  RADIUS = 12F9.4)
  90 FORMAT(21H1 END OF RUN FOR TESTF6.1,12H WITH MODEL I4)
  33 FORMAT(13H END OF TEST F6.1,16H WITH MODEL NO. I4)
8020 FORMAT(A6)
8050 FORMAT(A6,A6)
8051 FORMAT(F6.1,I6)
8052 FORMAT (52X,9HJ SUB A = F6.4)
     END
```

```
      FOR
      SUBROUTINE XPMW(VLCBAR,NRH,R,AJ,NR,VXE)
C     CALCULATION OF EFFECTIVE WAKE FROM WAKE ANALYSIS
      DIMENSION XX(12),R(12),YY(12),VLCBAR(12),VXVOL(12),WX(12),VXE(12)
      XX(1)=0.2
      YY(1)=VLCBAR(1)*0.2
      J=1
      JJ=2
    1 XX(JJ)=R(J)
      YY(JJ)=VLCBAR(J)*R(J)
      J=J+NRH
      JJ=JJ+1
      IF(J-NR)1,1,2
    2 JJ=JJ-1
      KR=JJ
    3 AX=3.1416*((XX(KR))**2-(.2)**2)
      VXVOL(KR)=SIMPUN(XX,YY,KR)*6.2832
      VXE(KR)=VXVOL(KR)/AX
      WX(KR)=1.-VXE(KR)
      KR=KR-1
      IF(KR-2)6,3,3
    6 PRINT 105,AJ
      PRINT 106,(XX(J),J=2,JJ)
      PRINT 107,(VXVOL(J),J=2,JJ)
      PRINT 108,(VXE(J),J=2,JJ)
      PRINT 109,(WX(J),J=2,JJ)
  105 FORMAT(///66H NONDIMENSIONAL VOLUMETRIC VELOCITY AND EFFECTIVE WAK
     XE AT J SUBA= F8.5)
  106 FORMAT( 5X,12H      X=      ,9F10.4)
  107 FORMAT( 5X,12H VXVOL=       ,9F10.4)
  108 FORMAT( 5X,12H  1-WX=       ,9F10.4)
  109 FORMAT( 5X,12H    WX=       ,9F10.4)
      RETURN
      END
```

The program uses the following subroutines and functions:

GMHAS

FNPLOT

ENDJOB

DTAB

CURVE

XTAB

XLOC

SIND

COSD

ATAND

LGCHAR

SIMPUN

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2. Ship models--Wakes--Mathematical analysis
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