MEASUREMENT IN A WIND TUNNEL OF THE MODIFICATION OF MEAN WIND AND TURBULENCE CHARACTERISTICS DUE TO INDUCTION EFFECTS NEAR WIND TURBINE ROTORS

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EXECUTIVE SUMMARY

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Objective: The objective of this study was to place a model wind turbine into a wind tunnel and measure the wind characteristics in the vicinity of the spinning rotor for a variety of different approach flow conditions.

Results: A 0.53 meter diameter model wind turbine was placed in the Meterological Wind Tunnel facility at Colorado State University. Four different approach flow conditions were studied. These were two different mean wind speeds (6 and 7.6 m/s) and two different turbulence conditions (0.1% and 1.5% intensity). For each of these test conditions the three dimensional wind field was measured between 3 rotor diameters upwind to 1/2 rotor diameter downwind. The rotor power coefficient vs. tip speed ratio was also obtained.

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1.0 INTRODUCTION

Aerodynamicists currently use wind field and turbulence information to calculate the character of dynamic loading that large wind-generator rotors receive (Hansen, 1979; Kareem, et al., 1981; Cliff and Fichtl, 1978; Fichtl, 1983). Unfortunately, these turbulence scales and intensities may be distorted by the pressure of the rotor flow field before they actually interact with the rotor blades. Indeed, wind-generator induction effects and streamline divergence caused by the hub and tower may significantly distort free wind field values.

In recent years, extensive model and field scale measurements have examined near- and far-field turbine rotor wakes (Riley, et al., 1980; Eberle, 1981; Barker and Walker, 1982). These wake measurements were made to evaluate the influence of upwind turbines on downwind installations, but little information appears in the literature concerning possible induction effects.

It is the purpose of this report to provide experimental model data on the wind field surrounding a single wind turbine rotor disk. These data should provide an improved physical insight into the induction effects of the air flow as it approaches the wind turbine. This insight should in turn improve an analytical model's predictive capabilities.

A scaled model of a horizontal axis wind turbine (a two bladed rotor of diameter 53 cm) was placed into the Meterological Wind Tunnel (MWT) facility at Colorado State University (cross-section width of 183 cm). Four different approach flow conditions were studied; low and moderate turbulence levels (0.1% and 1.5% intensity) at both 6 and

7.6 m/s freestream air velocities. For each of these flow conditions the rotor power coefficient vs. tip speed ratio was obtained, and the 3-dimensional velocity field from 3 rotor diameters upwind to 1/2 diameter downwind was tabulated.

The power output of the rotor was obtained via a simple prony brake friction device that imparts a torque (measured by the deflection of a spring) to the spinning shaft of the wind turbine. The rotor speed, measured by a strobe light, was observed to vary with load from 900 rpm up to 2100 rpm for the flow conditions described above.

The 3-dimensional velocity field was measured via a multiple hot film probe (TSI 1294) capable of measuring rapidly varying velocity vector direction and magnitude within a rectangular coordinate system octant. The transducer response was directed to an analog to digital converter connected to an HP-1000 mini-computer system for on-line data reduction. The statistical values computed from the u-v-w time series in axisymmetrical coordinates for each position are:

1) Mean, rms, skewness, and flatness of the axial velocity component,
2) Mean, rms, skewness, and flatness of the radial velocity component,
3) Mean, rms, skewness, and flatness of the angular velocity component,
4) Mean velocity vectors angles from the axial, radial and angular coordinate directions,
5) Reynolds stresses,
6) Mean, rms, skewness, and flatness of the angular deviations about the axial axis,
7) Mean, rms, skewness, and flatness of the angular deviations about the angular axis, and
8) Mean, rms, skewness, and flatness of the angular deviations about the angular axis.

Details of the measurement techniques are provided in Section

2.0. The test program and data results are given in Section 3.0. A short discussion of the implications of this data set are included in Section 4.0.

2.0 DATA ACQUISITION AND ANALYSIS

Laboratory measurement techniques are discussed in this section. Some of the methods used are conventional and need little elaboration.

2.1 WIND TUNNEL FACILITY

The experiments were performed in the Meterological Wind Tunnel (MWT) show in Figure 2.1 (Plate and Cermak, 1963). This wind tunnel has a wind speed range of 0.3 to 30 m/s. The approach flow turbulent intensity varies upward from 0.1% . The test section in which the model wind turbine was located had a cross-sectional area of 3.34 m^2 (1.83m x 1.83m). The model was located 7 meters downwind from the convergent entrance to the test section. For the grid turbulence tests (turb. intensity 1.5%) a dowel grid was mounted at the test section entrance. The dowels were 1.27 cm in diameter and spaced 12 cm apart. The wind turbine was placed in the spatially uniform velocity field downwind of the entrance.

2.2 WIND TURBINE MODEL

The wind turbine model (Figure 2.2-1) was built by Mr. Peter Bushnell of Cornell University (Bushnell, P., 1983; Bushnell, P., 1984). Figure 2.2-2 displays the mounting arrangement of this horizontal axis wind turbine. The rotor shaft is mounted on two support rods, each rod holds a low friction roller bearing to ensure rotor shaft rotational freedom. At the downwind end of the rotor shaft is mounted a small DC generator. A calibration of the generator's voltage variation versus rotational speed (obtained through the use of a strobe light) yielded the conversion equation

rpm = 744 x (volts).

The prony brake consisted of a spring mounted next to a ruler, a leather friction belt, an aluminum brake drum mounted on the rotor shaft, and a weight bucket. To start the wind turbine spinning one manually lifts the brake assembly away from the brake drum until the turbine reaches a rotational speed above its resonant frequency of around 1000 rpm. Once above this speed the prony brake is set back in place on the brake drum. The amount of weight placed in the bucket determines the rotor speed.

The rotor diameter was 53.4 cm. The rotor blades were made of balsa wood covered with epoxy. The blade shape was that of a NACA 4415 airfoil section. A steel pin at the base of each blade was connected to the hub with a set screw, and the hub was also connected to the rotor shaft with set screws. The blade chord was constant (4.76 cm) over the entire length, the tips were cut square. Table 2.2-1 displays the blade twist angle versus radial distance. The wind turbine was designed to operate at 1400 rpm, with a tip speed ratio of 5 and a lift coefficient of 1.0.

As stated in Section 2.1 the wind tunnel cross-sectional area was 3.34 m^2, whereas the rotor disk area was 0.268 m^2. A rough estimate of the mass flow through the spinning rotor disk indicates that approximately 1/2 half of the rotor disk acted as open area. Thus the effective wind tunnel blockage presented by a spinning rotor disk was 4%.

2.3 FLOW VISUALIZATION TECHNIQUES

Video movies (VHS) were taken of helium soap bubbles produced by a Sage Bubble Generator as they floated through or by the spinning rotor blades. Video movies were also taken of a smoke plume produced by titanium tetrachloride as it flowed past by the rotor blades.

2.4 VELOCITY MEASUREMENTS

Velocity measurements were made with pitot probes, single hot films, cross films and three dimensional hot film systems. Each of these instruments will be described in the following sections.

2.4.1 Pitot-Static Probe Measurements

Pitot-static probes were used as a velocity standard during the calibration of the different hot film systems and to provide the reference upwind velocity measurement. The principles of operation of pitot-static probes are described in any fundamental text on fluid mechanics and will not be discussed in detail here. The operational relationship for these probes is $U = (2g_c\Delta P/\rho)^{1/2}$, where U = velocity, g_c = gravitational conversion constant, ΔP = difference between static and stagnation pressures, and ρ is the air density. ρ was calculated from the ideal gas law and ΔP was measured using a Datametrics Electronic Manometer. The pitot-static probe measurements are accurate to within $\pm 2\%$ of the actual velocity.

2.4.2 Single-Hot-Film Probe Measurements

Single-hot-film (TSI 1210 Sensor) measurements were used to document the longitudinal turbulence levels for the four different approach flow conditions and as an error estimator for the cross film and 3-d film measurements. To calibrate the single film probe it was placed into the wind tunnel next to the pitot-static probe. The anemometer voltages were digitized for several velocities covering the range of interest. These voltage-velocity (E,U) pairs were then regressed to the equation $E^2 = A + BU^c$ via a least squares approach to assumed values of exponent c. Convergence to the minimum square was accelerated by using the secant method to find the best new estimate of c. To take measurements with this calibrated single film probe the anemometer voltage was digitized and stored on a disk file within an HP-1000 mini-computer system. This voltage time series was converted to a velocity time series using the inverse of the calibration equation;

$$U = [(E^2-A)/B]^{1/c}$$

This velocity time series was then analyzed for pertinent statistical quantities, such as mean, mean square, etc. and tabulated at the terminal.

The calibration curve yielded hot film anemometer velocities that were always within $\pm 1\%$ of the velocities calculated from the pitot-static probe. The accuracy of a single-hot-film during the measurement of turbulent flow quantities is dependent upon the flow regime being measured. During the present study the single-film probe was used only in conditions of no mean wind shear and low turbulent intensity. (less than 1.5%). For these conditions the velocity time series should be accurate to within $\pm 2\%$.

2.4.3 Cross-Film Probe Measurements

Cross-film (TSI 1241) measurements were used to document the lateral and vertical turbulent level for one approach flow condition and as an error estimator for the 3-d hot film measurements. To calibrate the cross-film probe it was placed next to the pitot-static probe. Each of the two films were yawed 45 degrees from the direction of the mean velocity vector. The anemometer voltages were digitized for several velocities covering the range of interest. These voltage-velocity pairs (E_1, U; E_2, U) were fit to the equation

$$(E_{i,j})^2 = A_i + B_i\,(U_j \cos(45^o))^{c_i}$$

via a least squares approach with the secant method used to find the best new estimate of exponent, c_i. Strict cosine dependence of the heat flux from the film versus yaw angle was assumed; and thus, no yaw angle calibration was necessary. During measurements made with this calibrated cross film probe it was placed so that the mean velocity vector was at 45^o to each film, while both films were located in the x-y plane. The voltage output from each anemometer was digitized, and the resulting voltage time series were converted to velocity time series via the equations

$$u = (U_{N1} + U_{N2})/1.414 \qquad v = (U_{N1} - U_{N2})/1.414$$

where $U_{Ni} = [(E_i^2 - A_i)/B_i]^{c_i}$

$= u \sin \emptyset_i + v \cos \emptyset_i; \quad \emptyset_1 = 45^o,\ \emptyset_2 = 135^o$

U_{Ni} = velocity component normal to film i

u = longitudinal velocity component

v = lateral velocity component

To measure vertical velocity components the probe was rotated 90^o so that both films were in the x-z plane. The reduction equations are similar to those above.

The calibration curve yielded hot film anemometer velocities that were always within $\pm1\%$ of the velocities calculated from the pitot-static probe. Since no yaw calibrations were performed no estimate can be made of inaccuracies introduced by the cosine law assumption. From past experiences it is felt that this cross film reduction method should be accurate to within $\pm10\%$ for a low intensity, nearly isotropic flow.

2.4.4 3-Dimensional Hot-Film Probe Measurements

A Thermo-System Incorporated (TSI) model 1294-20 probe was used for all measurements behind and to the side of the wind turbine. A specially made probe, similar to the TSI 1294-20 but with a 90° bend in the probe shaft 3.8 cm back from the sensors, was used for all measurements upwind of the wind turbine. The data reduction scheme use was similar to that described in TSI Technical Bulletin 8. The TSI model 1294-20 probe has three orthogonally-mounted, cylindrical hot films, (Dia. = 0.051 mm) each doubly supported (Figure 2.4.4-1). The probe can measure total vector velocities that are contained within the single octant defined by the three film positions.

To calibrate the 1294 3-D probe it was placed in the wind tunnel (the probe support axis parallel to air flow) next to the pitot-static probe. In this position the angle between each sensor and the flow vector is 54.74°; thus, the yaw angles for each sensor are 35.26° (Figure 2.4.4-1). The voltage from each anemometer channel (3 total) were digitized for several velocities covering the range of interest. These voltage-velocity pairs (E_i, U;= 1,3), at a fixed angle, were fit to the equation

$$E^2_{i,j} = A_i + B'_i(U_j)^{c_i} \quad ; \quad i = 1,3 \quad ; \quad j = 1,n$$

where $$B'_i = B_i(\cos^2\phi_i + k^2\sin^2\phi_i)^{c_i/2}$$

ϕ_i = yaw angle between velocity vector and film i.

k = yaw factor

n = no. of calibration points

via a least squares fit with the secant method to find the best new estimate of exponent, c_i. Note that if the yaw factor, k, equals zero than a simple cosine law dependence of heat flux exists. To determine the yaw factor, k, the air velocity was set at a constant value, and the probe was rotated about its y axis and then its x axis so that voltage samples could be taken for a wide range of yaw angle variation on all three films. Table 2.4.4-1 lists the yaw angles on the different films for the y - x axis rotations that were used. These voltage-yaw angle, $(E_i, \phi_i; i = 1,3)$ were regressed to the equation

$$B'_i = (E^2_{i,j} - A_i)/U^{c_i} = B_i(\cos^2\phi_{i,j} + k^2_i\sin^2\phi_{i,j})^{c_i/2}$$

where $i = 1,3$ and $j = 1,n$

via a least squares approach with the secant method to find the best new estimate for the yaw factor, k_i. A_i, B_i, c_i and k_i for all three films are thus obtained, but for the reduction algorithm used k_i must be equal for all films and not a function of velocity. Providing that all three films have a similar aspect ratio then all three k_i values should be of similar magnitude and forcing them equal does not introduce large errors. Once a value for k is specified then a least squares fit will determine the optimal values for B_i. Once the value of k was determined for a specific probe, it was no longer necessary to do angle calibrations.

Given the calibration constants A_i, B_i, c_i and the equations

$$E_i^2 = A_i + B_i(V_{eff,i})^{c_i} \quad ; \quad i = 1,3$$

where $V_{eff,i} = V\ (\cos^2\phi_i + k^2 \sin^2 \phi_i)^{1/2}; \quad i = 1,3$

$V_{eff,i}$ = effective cooling velocity for film i

V = total velocity vector approaching sensor array

are defined. Using the trigonometric relationships that exist between the three yaw angles

$$\sum_{i=1}^{3} \sin^2 \phi_i = 1 \text{ and } \sum_{i=1}^{3} \cos^2 \phi_i = 2$$

one finds that the total velocity approaching the sensor array, V is calulated from

$$V = [\sum_{i=1}^{3} V^2_{eff,i}/(2 + k^2)]^{1/2};$$

the yaw angles, ϕ_i, are

$$\phi_i = \arcsin\ [(1 - V^2_{eff,i}/V^2)/(1-k^2)]^{1/2};$$

the angles, θ_i, between a sensor coordinate axis and the velocity vector are

$$\theta_i = 90^\circ - \phi_i;$$

and the u_i velocity components (in the sensor coordinate system of x_i respectively) of the total velocity, V, are

$$u_i = V\sin\phi_i = [(V^2 - V^2_{eff,i})/(1-k^2)]^{1/2}$$

In the above equations $V_{eff,\ i}$ is given by

$$V_{eff,i} = [(E_i^2 - A_i)/B_i]^{1/c_i}$$

The algorithm finds the velocity components, u_i, that are along the sensor coordinate directions. Thus it is necessary to transform the u_i values from sensor coordinates to u_i values in wind tunnel coordinates. The details of this transformation are given in Appendix A.

The computer programs (listed in Appendix B) used to calibrate and take data with the 3-D probes were

1) CAL3D - This program finds the calibration constants, A_i, B_i, c_i, k (i = 1,3) and writes them to a disk file for later retrieval by a reduction program.

2) DAT3D - This program creates a digital voltage time series for each of the 3 channels, converts the voltage values into U_x, U_r, U_θ velocity time series files (in tunnel coordinates) and calculates each time series minimum, maximum, mean, rms, skewness and flatness.

3) DAT1 - This program creates a digital voltage time series for each of the 3 channels and stores it on the computer's disk. It was used to acquire data in a rapid sequence, as opposed to waiting for files to be reduced into velocity values.

4) DAT2 - This program picks up the digital voltage time series created by DAT1 and converts them into U_x, U_r, U_θ velocity time series. Then it calculates each time series mininum, maximum, mean, rms, skewness and flatness.

5) ANGTM - This program creates the time series of the angular

deviations about the tunnels x, r, θ coordinates and computes the mininum, maximum, mean, rms, skewness, and flatness. It is scheduled from inside DAT2.

6) PRT3 - This program prints out the reduced data that was calculated in program DAT2 in the format seen later in this report.

The accuracy of 3-D velocity measurements and associated reduction algorithms can be estimated by directing different known mean velocity vectors at the probe. Table 2.4.4-2 summarizes such tests. Table 2.4.4-2 shows that the mean velocity magnitude is generally within $\pm 3\%$ of the actual value. The error in angle calculations is seen to be approximately $\pm 2^{o}$ for angular deviations of 15^{o} or less and somewhat larger than this for greater deviations.

Another test of the accuracy of the 3-D probe is to compare the measure of different turbulent statistics measured to those obtained from more conventional probes, such as, single-film and cross-film probes. Table 2.4.4-3 displays the mean and rms turbulence magnitudes calculated from a single film, cross film, TSI 1294-60 3-D probe[1], and TSI 1294-20 probe for two different turbulence conditions. The mean and rms velocity comparisons between the single film and the cross film are within the bounds specified earlier in section 2.4.3, that is ~2% and ~10% respectively. The 3-D probes compare to these u and u' measurements within ~3.5% and ~10% respectively. v' and w' magnitude

[1]The 1294-60 probe has larger diameter sensors, and the sensors are separated by greater distances than the 1294-20 probe.

comparisons to the cross film results suggest errors of ~15% (except for v' in grid turb where 29% error was observed). Figure 2.4.4-3 displays the spectral responses of these four different probes. The single film, cross-film, and TSI 1294-20 3D probes all provide equivalent frequence response out to 800 Hz. The TSI 1294-60 3-D probe has a large sensing volume; hence, its response rolls off rapidly above 100 Hz. The large-sensor-volume TSI 1294-60 3-D probe was not used for any data acquisition during the remainder of the study.

2.5 POWER MEASUREMENTS

The power output from the wind turbine was calculated in the following manner (see figure 2.5-1):

1) The spring force constant was calculated to be 54.2 newtons/meter by measuring the deflection of the spring for loads varying between 0 and 453 grams.

2) Z_o, the spring zero deflection point as mounted in the prony brake system was calculated from the equation (see upper part of Figure 2.5-1)

$$W = (Z_s - Z_o)\ K \text{ or } Z_o = Z_s - W/K$$

for several different weights up to 453 gms. The average of these Z_o values was used as the spring zero deflection point.

3) The rotor was started for the specific approach flow conditions being tested. Over a range of weights placed in the bucket the rotor speed, Ω, and the spring deflection under dynamic conditions were recorded.

4) The frictional force, F, applied by the prony brake against the brake drum is $F = W - T_d$. The torque, τ, applied to the rotor

shaft is then $\tau = F \times R$ and the power is $P = \tau \times \Omega$.

5) The power coefficient, C_p, is $C_p = P/(1/2\rho AU^3)$ where $\rho = 1.0\ kg/m^3$ is the density of air in the tunnel, A is the rotor disk area, and U is the approach flow mean wind speed. The tip speed ratio, X, is given by $\Omega R/U$.

A calculation of the drag force on the wire connecting the weight to the prony brake assembly was determined to be small (equivalent deflection in spring of 0.3 mm) compared to the hysteresis errors accompanied with the estimate of the springs zero deflection point ($\pm$5mm). This error in the estimation of Z_o overshadow all other errors in the procedure to calculate the power, P. This error in P varies from $\pm$1.1 watts for the highest tip speed ratios down to $\pm$0.5 watts for the lowest tip speed ratios.

3.0 TEST PROGRAM AND DATA

The test program consisted of documenting the different approach flow characteristics, measurement of the performance (power coefficient vs. tip speed ratio) of the model wind turbine, and the tabulation of the flow field near the spinning rotor. These topics are discussed in the following sections.

3.1 APPROACH WIND CHARACTERISTICS

Four different approach flow characteristics were studied; two different mean wind speeds and two different turbulent intensities. They were:

1) Low turbulence (~ 0.1%) and mean wind speed = 6.0 m/s,
2) Low turbulence (~ 0.1%) and mean wind speed = 7.6 m/s,
3) Moderate turbulence (~ 1.5%) and mean wind speed = 6.0 m/s,
4) Moderate turbulence (~ 1.5%) and mean wind speed = 7.6 m/s.

The approach flow was uniform and steady (within ±2%) over the center portion of the wind tunnel. The moderate turbulence cases were produced by the placement of a grid, described in section 2.1, at the entrance of the test section. Measurements of the approach flow character were made by a single film probe and the TSI 1294-20 3-d hot-film probe. The turbulent statistics describing these approach flows are summarized in Table 3.1-1. The longitudinal and vertical velocity component power spectrums for Flows 3 and 4 are shown in Figure 3.1-1.

3.2 POWER COEFFICIENT RESULTS

The power output of the model wind turbine was measured for three different conditions:

Approach Flow's	CASE		
	I	II	III
mean velocity	6.0	7.6	7.6
turbulent intensity	0.1%	0.1%	1.5%

Tables 3.2-1 to 3.2-3 list the numerical values obtained from the cases I, II, and III respectively. Figure 3.2-1 displays the power coefficient versus tip speed ratio.

3.3 WIND CHARACTERISTIC NEAR THE ROTOR

Figure 3.3-1 indicates the 58 spatial grid points at which velocity measurements were taken with a TSI 1294-20 three dimensional hot film probe. Table 3.3-1 lists the coordinates of each spatial location. Note that the right most digit of the three digit position number always represents the radial distance in 1/8 rotor diameters and the left two digits represent the axial distance. Four different approach flow conditions were tested, as described in Section 3.1. These were:

Case No.	Mean Velocity (m/s)	Turb. Intensity (%)
1	6.0	0.1
2	7.6	0.1
3	6.0	1.5
4	7.6	1.5

The nomenclature used for test designations was case number followed by position number. Thus run number 3062 would be for approach flow case number 3 (U=6.0 m/s, T.I. = 1.5%) at position 62 which from Table 3.3-1 was at $x = -0.134$ m, $r = 0.134$ m, $\theta = 180^{o}$.

For cases 1 and 3 a mass of 454 grams was placed into the prony brake systems bucket. For cases 2 and 4 a mass of 906 grams was used. Unfortunately, the amount of friction between the prony brakes leather belt and the aluminum brake drum varied as the brake heated up and as aluminum oxide coated both belt and drum. Thus, the speed and power output of the wind turbine varied substantially during the test period. Table 3.3-2 documents the approximate rotor speed for each velocity measurement. The variation in rotor speed during the data acquisition period for a single case was as large as ± 150 rpm.

Table 3.3-3 summarize the pertinent turbulent statistics for all measurements of the 3-dimensional velocity field near the rotor. All measurements were made with a digital sampling rate of 1563 Hz for a total of 32384 samples. Thus, given a rotor speed of approximately 1400 rpm, the velocity time series includes 967 passes of a rotor blade (rotor has 2 blades). Again, considering a rotor speed of ~1400 rpm at a 1563 Hz sample rate, 67 samples were taken for every revolution of the rotor or a sample was taken every 5.37 degrees of blade rotation. These time series records were of sufficient length to insure an accuracy of $\pm 5\%$ in the computation of the mean, rms, and flatness.

The following is a description of the column headers that appear in Tables 3.3-3.

1) FILE NAME - The component velocity time series at each measurement location were saved on digital tape by these names. The last four characters are equivalent to the run number described above. The first two characters define the velocity component.
   - UU is for the axial component.
   - VV is for the radial component.
   - WW is for the angular component.
2) AXIS - 1 designates the axial coordinate.
   2 designates the radial coordinate
   3 designates the angular coordinate.
3) POSITION - Measurement position in meters for the axial and radial coordinates, and in degrees for the angular coordinate. See Figure 3.3-1 for further guidance.
4) LIMITS EXCEEDED - This was the number of times a velocity vector came within 10^{o} of leaving the measurement octant of

the sensor coordinate system. In many of these excursions the velocity vector will have left the measurement octant resulting in a calculational error. In this case the velocity component (in sensor coordinates) is set to zero before conversion to tunnel coordinates. In some cases the velocity vector many pass out of the measurement octant but not result in calculation errors; thus the approach places erroneous values into the time series. Records which have a significant number of these errors should not be trusted, and one that only has a few have dubious accuracy, particularly in the higher moments, such as skewness and flatness.

5) VELOCITY (MEAN) - Mean velocity component in meter/sec.
6) VELOCITY (ANGLE) - Angle (degrees) from the specified AXIS to the mean velocity vector.
7) VELOCITY (MIN) - Minimum velocity in meters/sec.
8) VELOCITY (MAX) - Maximum velocity in meters/sec.
9) VELOCITY RMS) - Root mean square of the velocity fluctuations in meters/sec.
10) VELOCITY (SKEWNESS) - Third moment of the velocity fluctuations normalized by the RMS. It is zero for a sine wave and a random signal.
11) VELOCITY (FLATNESS) - Fourth moment of the velocity fluctuations normalized by the RMS. It is 1.5 for a sine wave and 3.0 for a random signal.
12) VELOCITY (REYNOLDS STRESS) - This is not in the units of stress. It is simply the mean product of the indicated velocity components.
    U for the axial component.
    V for the radial component.
    W for the angular component.
    Units are $(m/s)^2$.
13) ANGLE (MEAN) - Mean value of the angular deviations about the indicated axis. The units are degrees.
14) ANGLE (MIN) - Minimum of the angular deviations (degrees).
15) ANGLE (MAX) - Maximum of the angular deviations (degrees).
16) ANGLE (RMS) - Root mean square of the angular deviation fluctuations (degrees).
17) ANGLE (SKEWNESS) - Third moment of the angular deviation fluctuations normalized by the RMS.
18) ANGLE (FLATNESS) - Fourth moment of the angular deviation fluctuations normalized by the RMS.

At the base of some of these Tables is a note stating the magnitude of calibration errors which consistently occurred in the data reduction of all velocity values on that page. In some cases this repeatable error is hypothesized and the word probably has been included, in others the error is definitely correctable. In any case the stated values are always within $\pm 3\%$ of the suggested values.

4.0 DISCUSSION

4.1 Visualization Results

When helium soap bubbles were introduced into flow upwind of the spinning rotor three different phenomena were observed. These were:

1) Most bubbles passed through the spinning rotor and were then caught up in the counterswirling flow downwind of the rotor. That is the rotor was spinning in a counterclockwise sense, the flow downwind of the rotor swirled in a clockwise sense. This result was expected due to the conservation of angular momentum for this system.
2) When the bubble source was placed at approximately 3/4 of a radius from the hub most bubbles seemed to have a straight line approach to the spinning rotor but roughly around 20% of them were deflected angularly upwind of the rotor. This deflection appeared to fairly abrupt and occurred around 1/4 to 1/2 a rotor radius upwind.
3) When bubbles were caught up into the tip vortices these vortices appear to be quite tight with a bubble making a full revolution in the equivalent distance of approximately one blade length.

The visual results from introducing a smoke source upwind of the rotor was not able to reproduce the detailed flow tagging of helium soap bubbles but it did display the curving of streamlines radially outward around the spinning rotor blades. This is a demonstration of the existence of axial induction effects.

4.2 Wind Field Results

Figure 4.2-1 displays the mean axial velocities for approach flow case I (U = 6.0 m/s, T.I. = 0.1%). The upwind data were obtained at a different time then the downwind data and thus the rotor speeds and calibration biasing may effect precise matching of these data sets. Figure 4.2-1 shows that the axial component of flow approaching the rotor disk was deaccelerated in core region defined by a tube containing the rotor disk and accelerated outside this region. This deacceleration was reasonably uniform with radial position up to the measurement location just upwind of the rotor (1/8 rotor diameter). Then it radically departs from this trend as the flow passes through the rotor. An axial induction factor based on mean velocity measurements at 1/8 rotor diameter upwind would be 0.125 but depending on how one extrapolates the data through the rotor section, a radially depended axial induction factor may vary from 0.125 to 0.42. The flow outside of the rotor tube accelerates as was expected from mass continuity. The ordering of velocity magnitudes with radial distance take an unexplained reversal as the flow passes outside of the rotor blades.

The estimitation of axial induction factors based on mean velocity values, as done above, may be in error due to the transient nature of velocity values as the rotor blade passes. The axial velocity just upwind of the rotor varies in a roughly sinusoidal form about its mean value (Figure 4.2-2). For approach flow Case I the periodic variation of axial flow velocity was as large as ±7.5% of the mean value at 1/8 rotor diameters upwind. If the minimum velocity value were used rather than the mean (File name UU1043, Table 3.3-3) the computed axial induction factor would be 0.2 instead of 0.133. Thus the transient nature of the flow has a significant influence on values important to the aerodynamic performance of the wind turbine.

Figures 4.2-3a to 4.2-3d display the normalized mean axial velocity change ($100 \times (u_x - (u_x)_\infty)/(u_x)_\infty$) versus axial distance in rotor diameters for each of the four approach flow conditions. Comparison between plots with similar approach velocities but different turbulence levels (figure 4.2-3a and 4.2-3c, figure 4.2-3b and 4.2-3d) do not show any major flow differences in this format.

Comparison between plots with similar turbulence levels but different approach velocities (figure 4.2-3a and 4.2-3b, figure 4.2-3c and 4.2-3d) display a difference in the magnitude of the range of mean axial velocities in the wake region of the turbine only. The range of axial velocity variation was greatest in the lower approach wind speed cases.

Figure 4.2-4 displays the normalized mean radial velocity ($100 \times \bar{u}_R/(\bar{u}_x)_\infty$) versus axial distance in rotor diameters for approach flow case II. It shows that the flow was divergent approaching the wind turbine and in the wake region out to at least one-half rotor diameters downwind. The maximum divergence is at the rotor disk where the mean velocity vector deviated by 10^o from that of the approach flow. The radial velocities are greatest (14-20% of the approach velocity value) near the tip region. The radial velocity transient variation just upwind of the disk and downwind outside of the rotor wake are nearly sinusoidal in form as observed by a flatness factor near to 1.5.

Figure 4.2-5 displays the normalized mean angular velocity ($100 \times \bar{u}_\theta/(\bar{u}_x)_\infty$) versus axial distance in rotor diameters. Within the wake region large negative angular velocities exist (the rotor was spinning in the positive sense). The magnitude of these angular velocities was greatest (≈25% of the approach flow velocity) at the innermost radial measurement position of one-eight rotor diameter. The flow immediately upwind of the rotor and the flow downwind of the rotor but outside of its wake have negative mean angular velocities but their magnitude (≈2-3% of the approach flow velocity) is much less than that in the wake region.

Classical vortex/strip theory assumes that the angular velocity at the rotor disk is one-half the angular velocity imparted to the slip stream (Wilson, et al., 1976). This assumption leads to the use of an angular induction factor, a', to correct blade section angle of attack for induced rotational motions. These corrections usually presume a rotating activator disk with an infinite number of blades.

To compute the instantaneous angular induction factor for the model wind turbine a correlation between the rotor blades position and the angular velocity components magnitude must be known, unfortunately, a blade position time series was not measured during this study. Examination of the axial and angular velocity time series (Run No. 1043) presented in Figures 4.2-2 and 4.2-6 can give a qualitative estimate as to the sign of the angular induction factor. The sharp drop seen in the axial velocity time series is undoubtably due to the pressure field surrounding a passing rotor blade. This fall in axial velocity occurs at the same time as a sharp maximum in the angular velocity time series. This would indicate that the rotor blade sees an angular velocity component that is in the opposite direction as the rotor blade travel.

Figures 4.2-2 and 4.2-6 also show that each rotor blade has a different periodic magnitude. This was due to slight misalignments of the rotor blades in their plane of motion. One rotor blade was 3 mm closer to the measurement probe than the other. Since the probe was 67 mm from the rotor plane the flow characteristics must be changing rapidly in the immediate region in front of the rotor disk.

Figures 4.2-7a and 4.2-7b display the axial turbulent intensity (100 x $(\bar{u}_x)$rms/$(\bar{u}_x)_\infty$ versus axial distance in rotor diameters for approach flow cases II and IV respectively. They show that the axial turbulent intensity increases dramatically in the region approaching the rotor disk and then initially decrease sharply in the rotor wake. The sharp increase in turbulent intensity for the spacial location of X = 1/2, R = 1/8 is due to the influence of the growing wake caused by the wind turbines hub and support mechanism. Figure 4.2-8 of the axial flatness factor versus axial distance shows that most of this turbulent intensity in the non-wake region is due to an organized periodic structure of slowly varying amplitudes, approaching that of a sine wave.

The velocity time series for the axial velocity component (Figure 4.2-2) and the angular velocity component (Figure 4.2-6) help estimate the angle of attack[1] during a rotor cycle. The rotor rotational velocity, 25.81 rps, was estimated by measuring the time period between blade passages on these figures. At a radius of 0.201 m the velocity of this rotor blade section, was 32.6 m/s. This information was used to plot the angle of attack time series shown in Figure 4.2-9. This figure shows that the periodic nature of axial induction is the primary cause for variations in the angle of attack for this approach flow and position. The actual variation of angle of attack that occurs at the rotor disk will be larger than that show here at 6.7 cm upwind of the rotor disk.

[1]No account has been made for rotor blade twist angle

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FIGURES

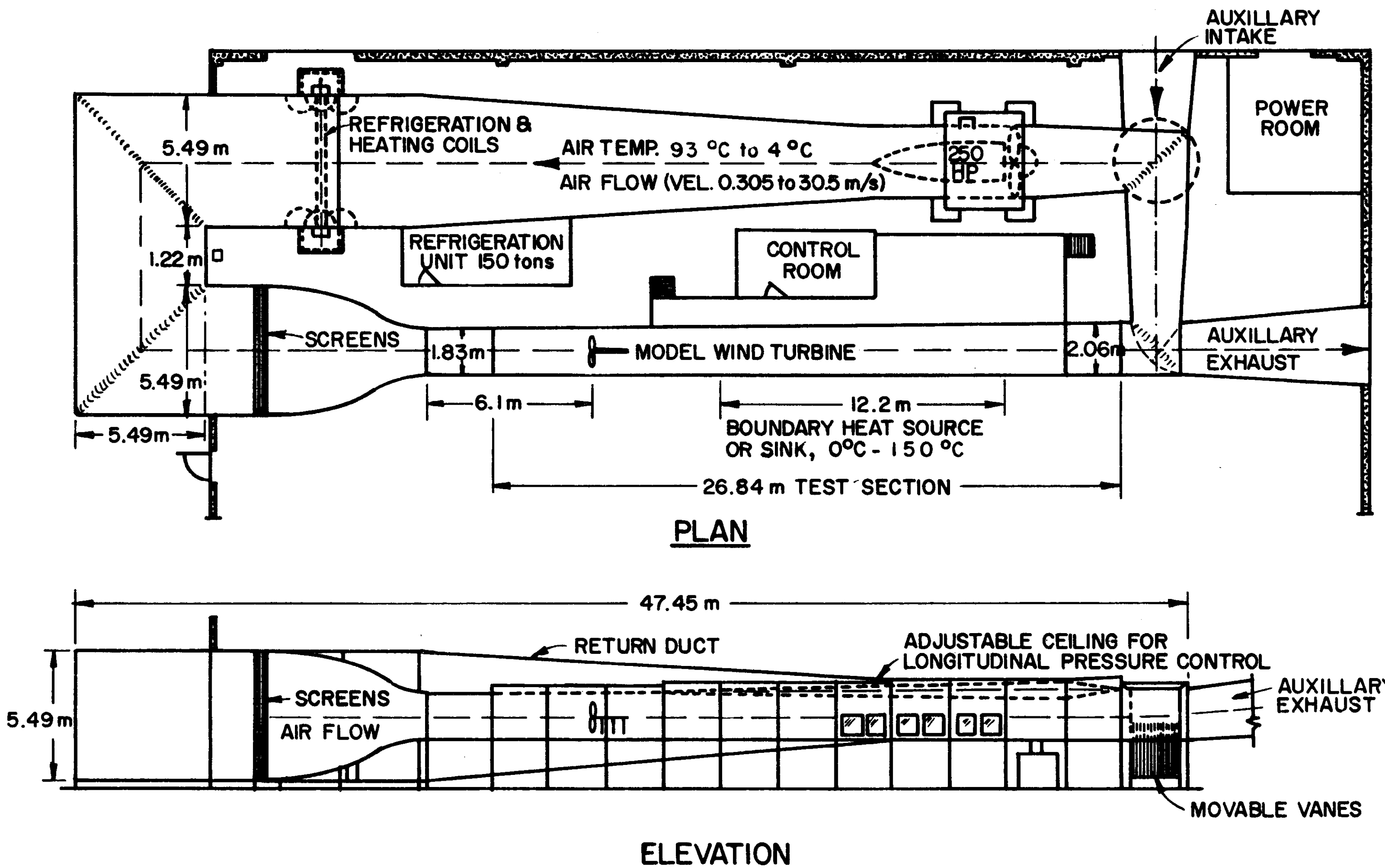


FIGURE 2.1-1 Meterological Wind Tunnel

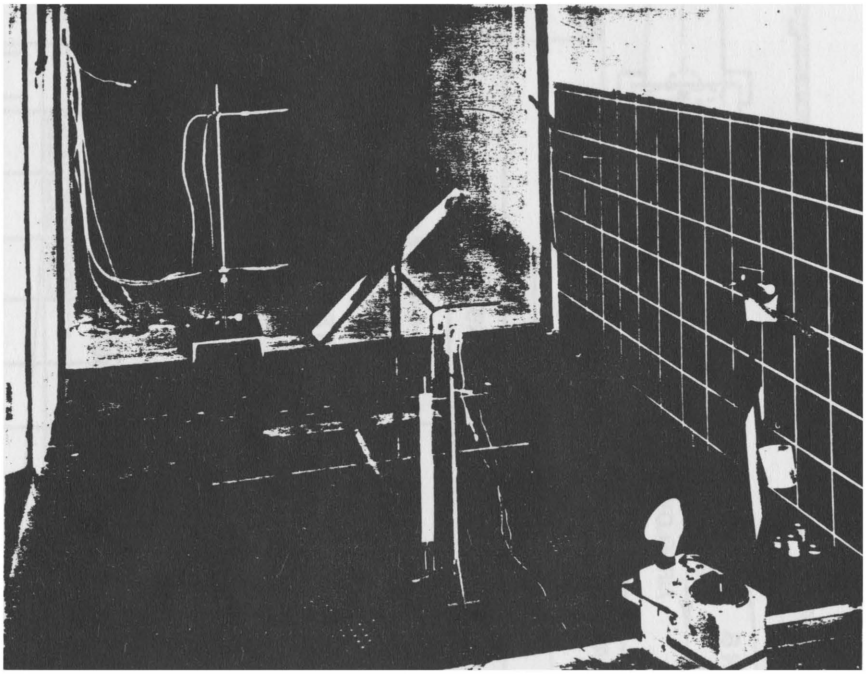


FIGURE 2.2-1 Wind Turbine Model

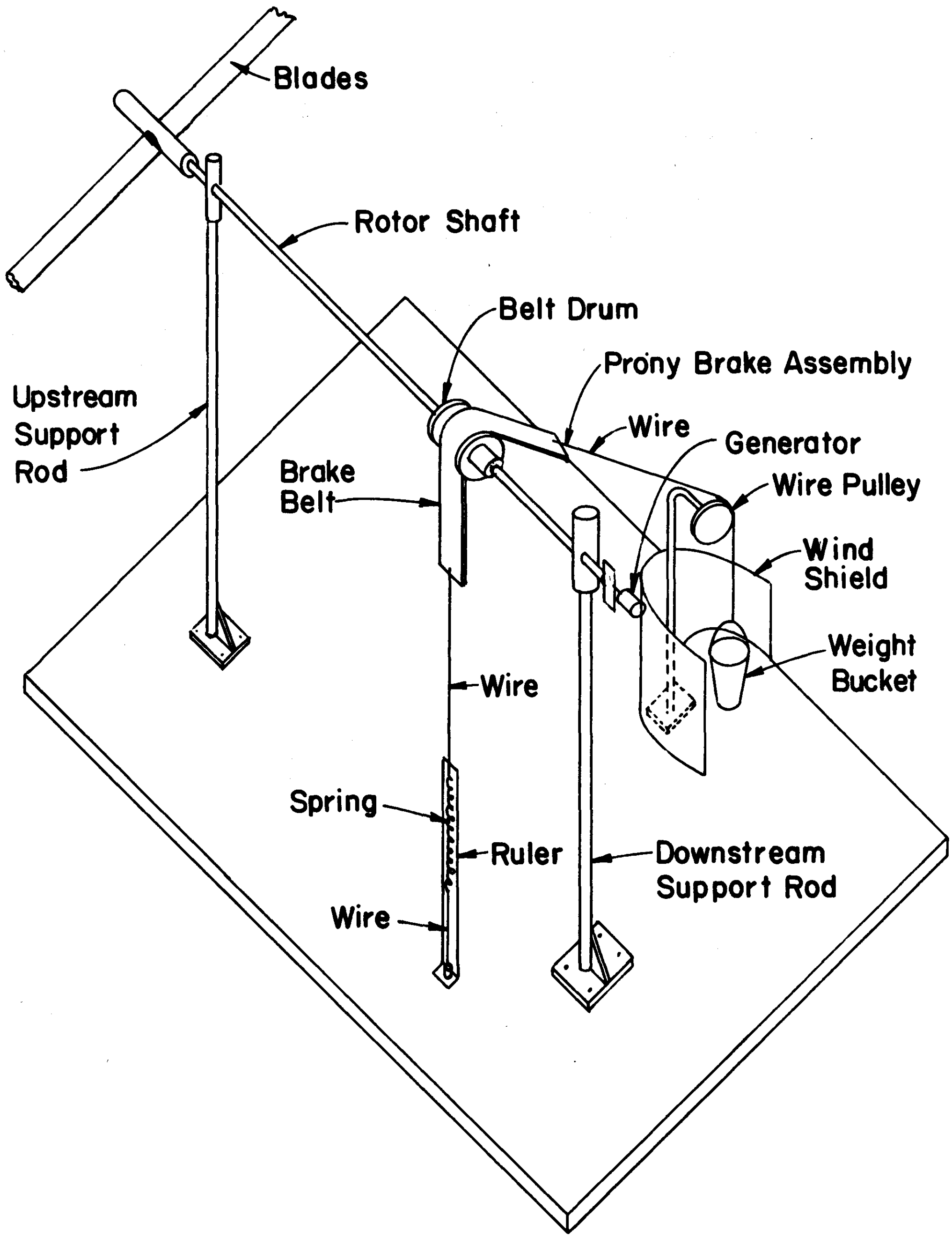


FIGURE 2.2-2 Wind Turbine Mounting Diagram

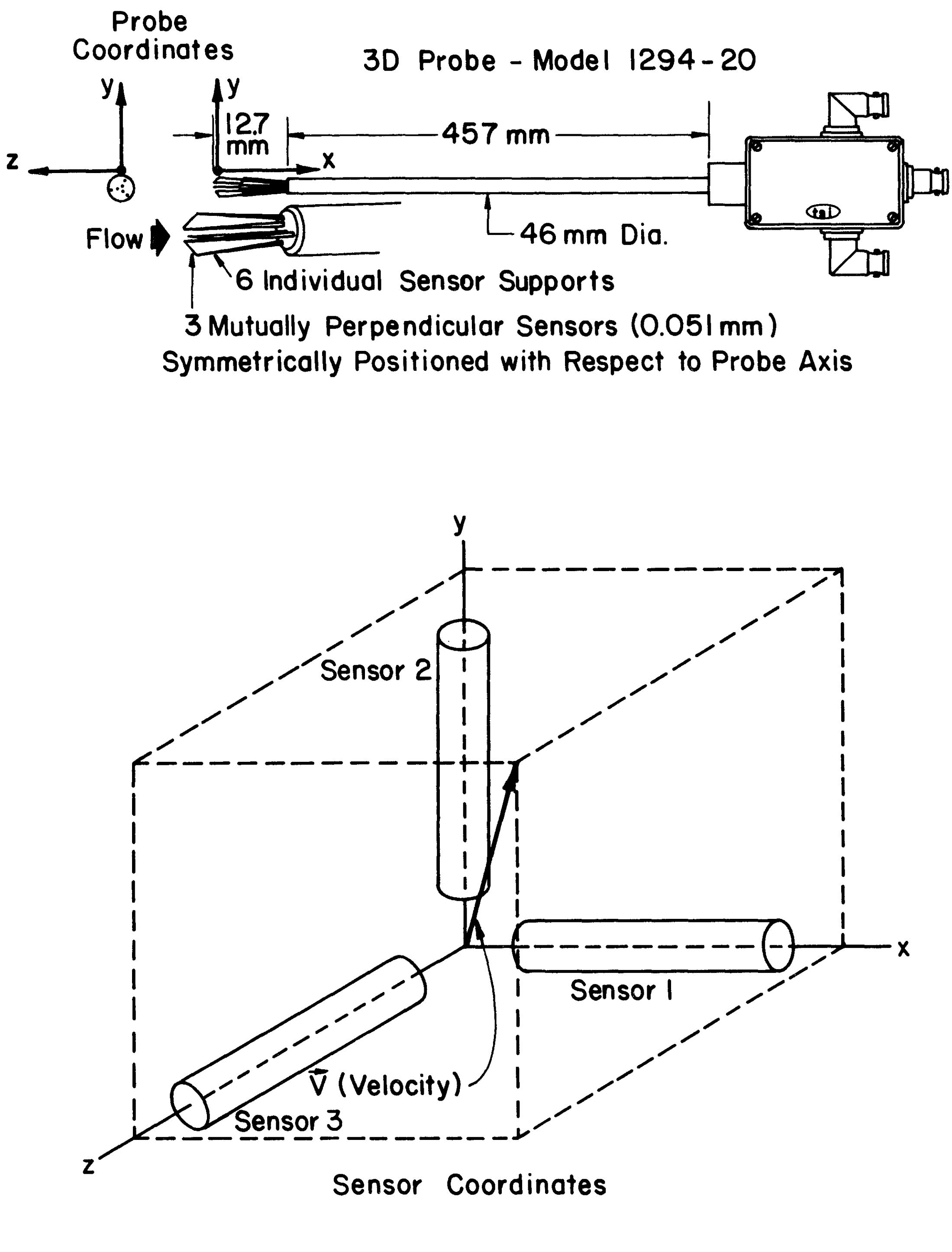


FIGURE 2.4.4-1 TSI Model 1294-20 3-D PROBE

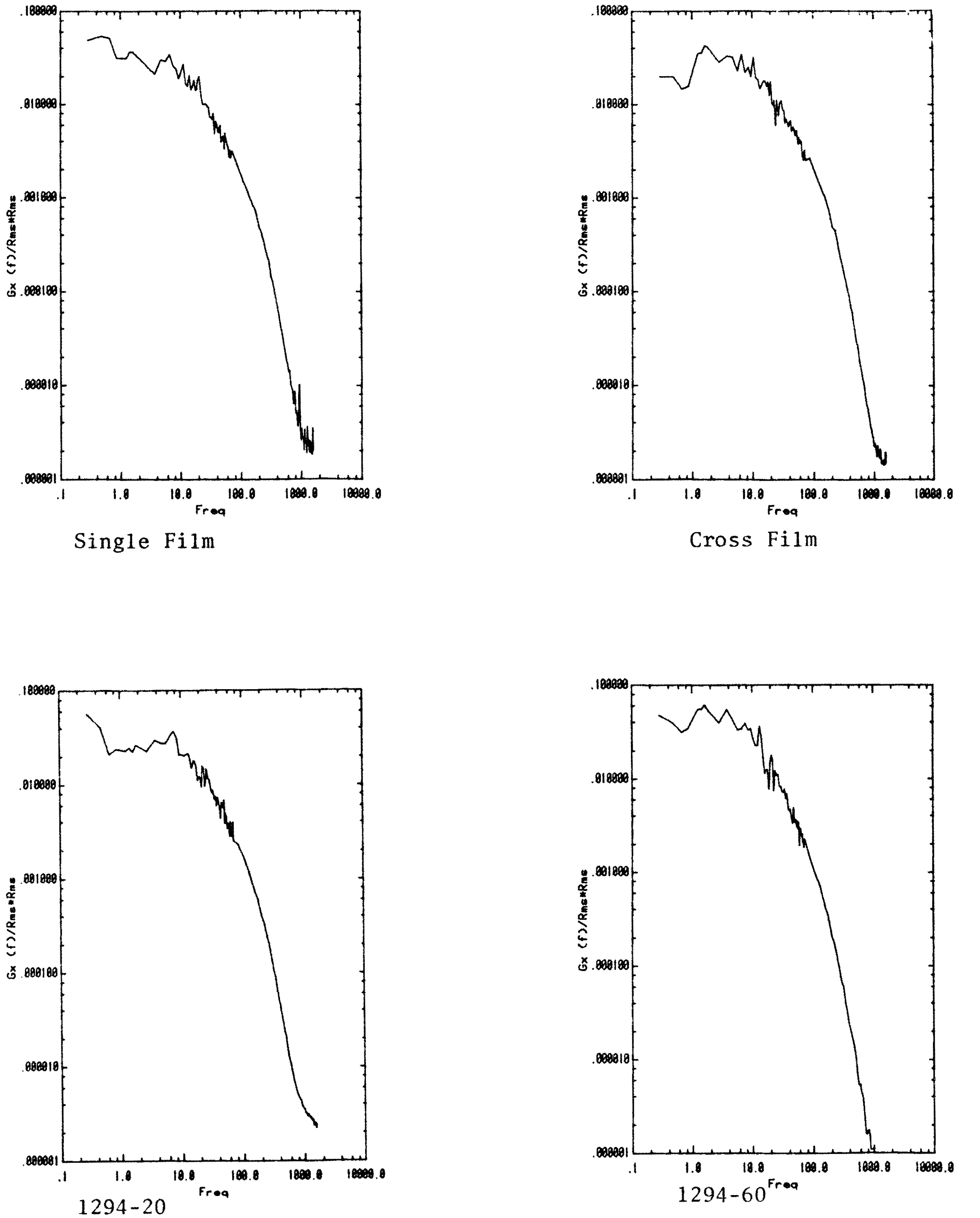


FIGURE 2.4.4-2 Spectral Response of Different Anemometer Probes

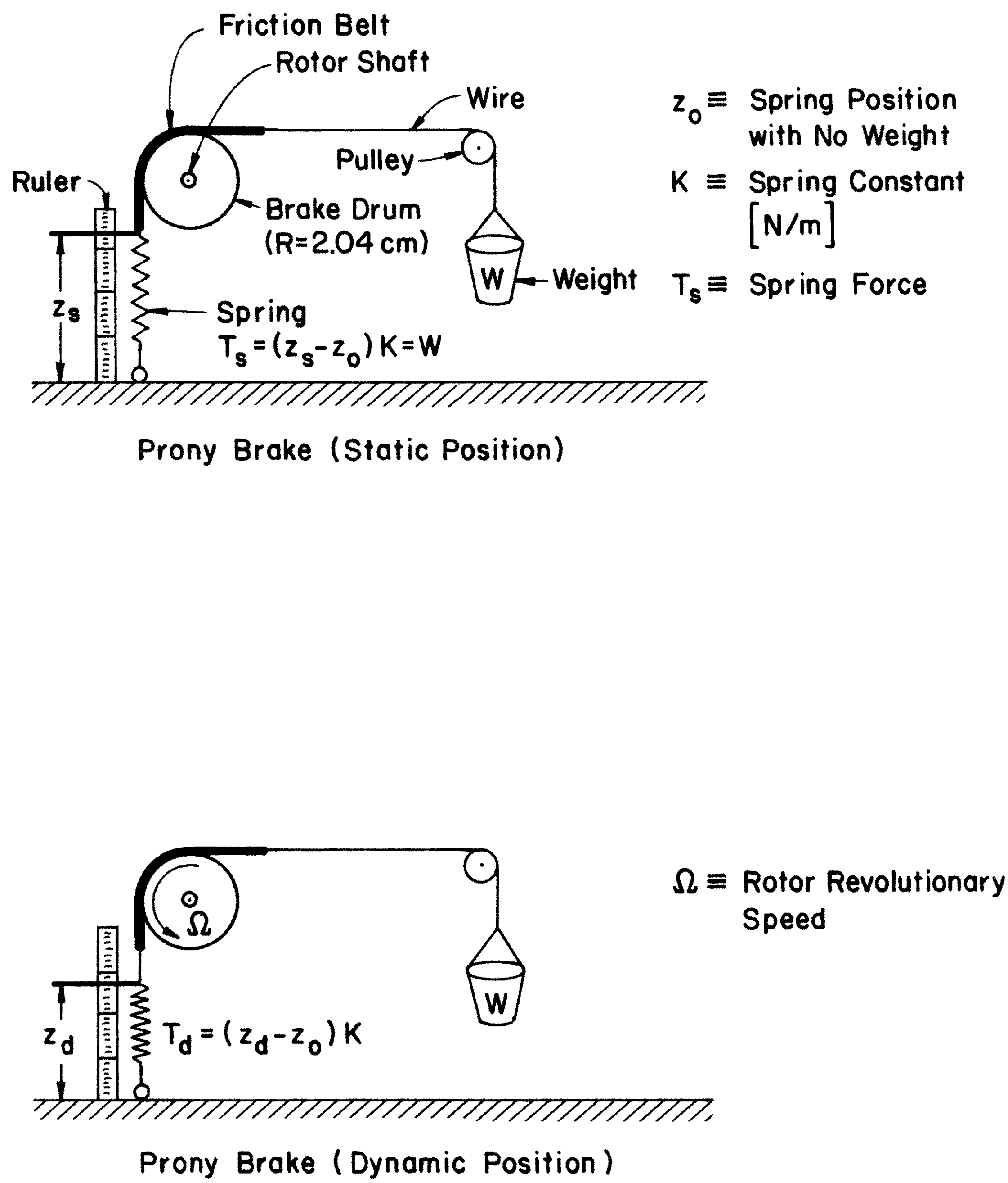
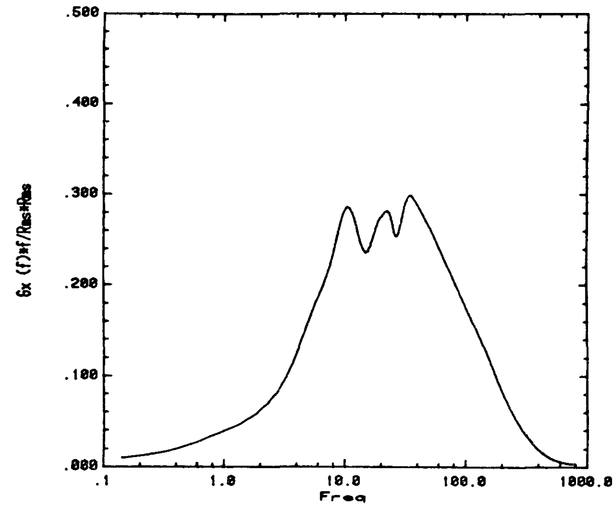
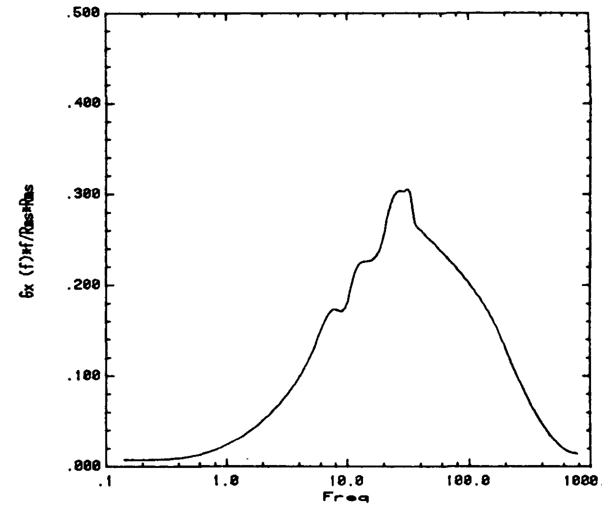


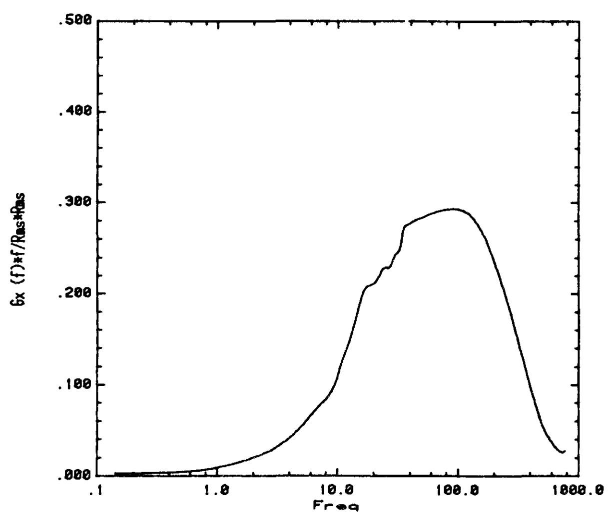
FIGURE 2.5-1 Prony Brake System



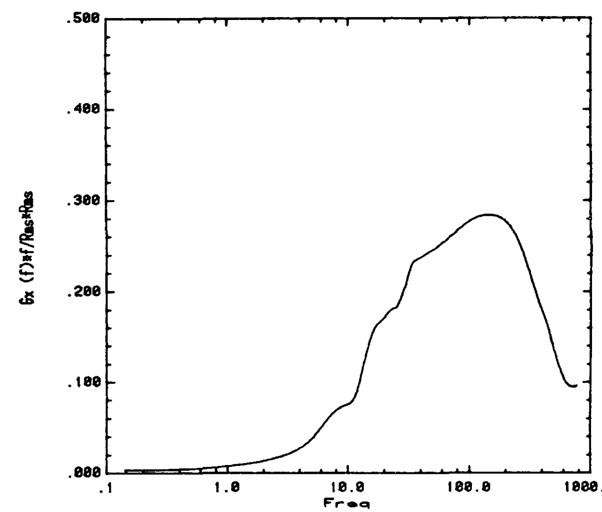
U Component
Flow No. 3



U Component
Flow No. 4



W Component
Flow No. 3



W Component
Flow No. 4

FIGURE 3.1-1 Velocity Fluctuation Power Spectrums For Approach Flows 3 & 4

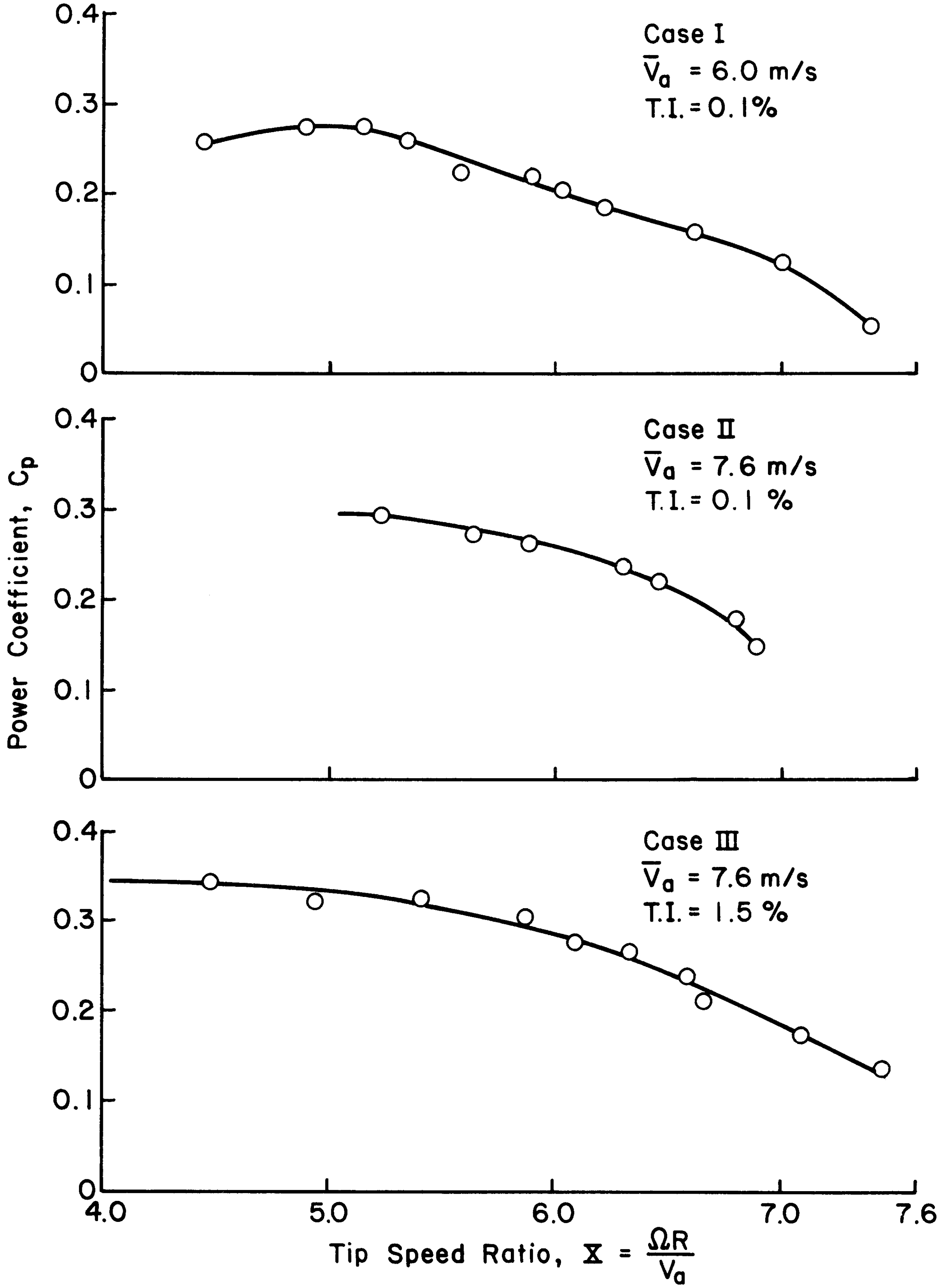


FIGURE 3.2-1 Power Coefficient versus Tip Speed Ratio

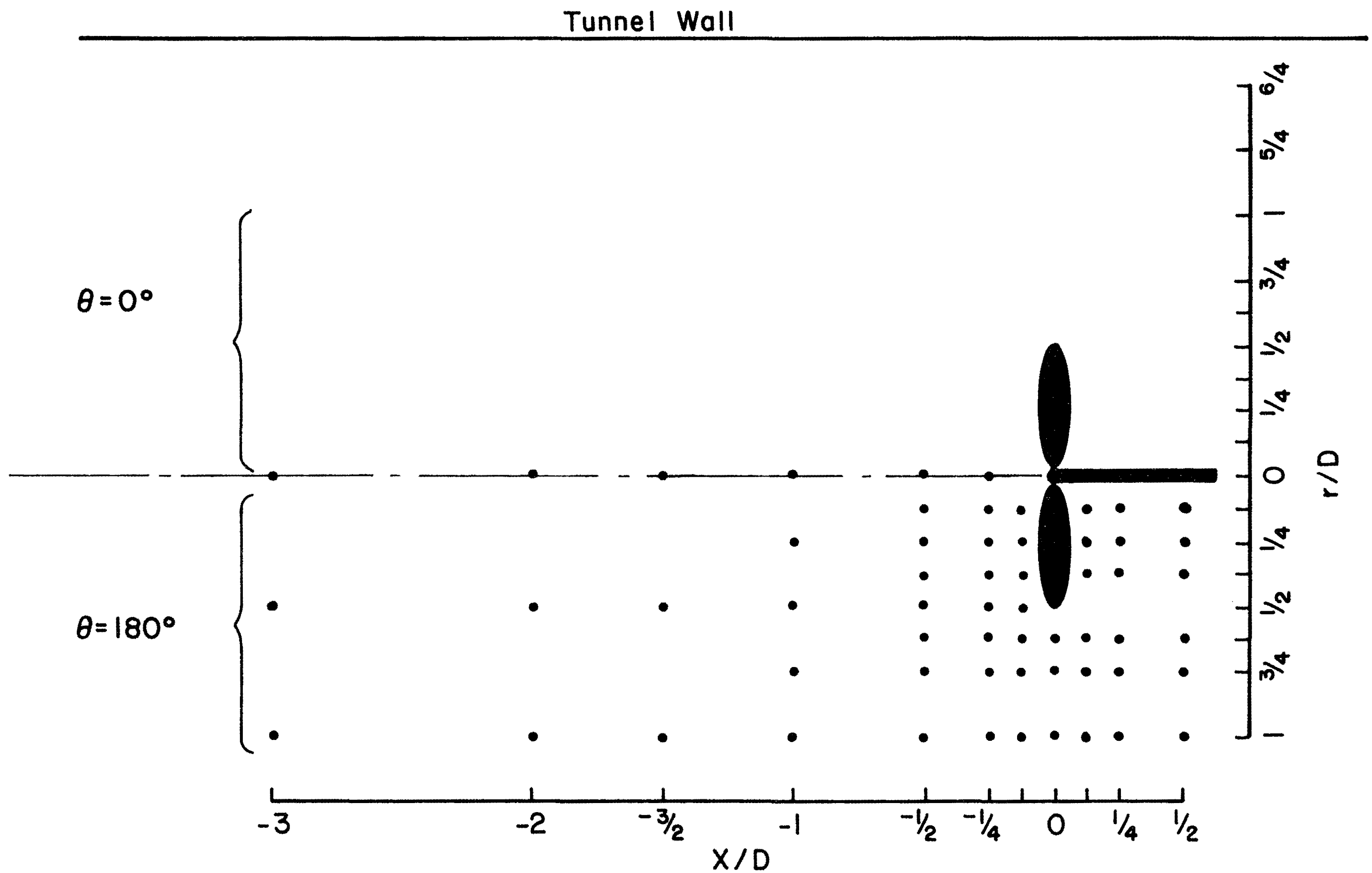


FIGURE 3.3-1 Measurement Locations

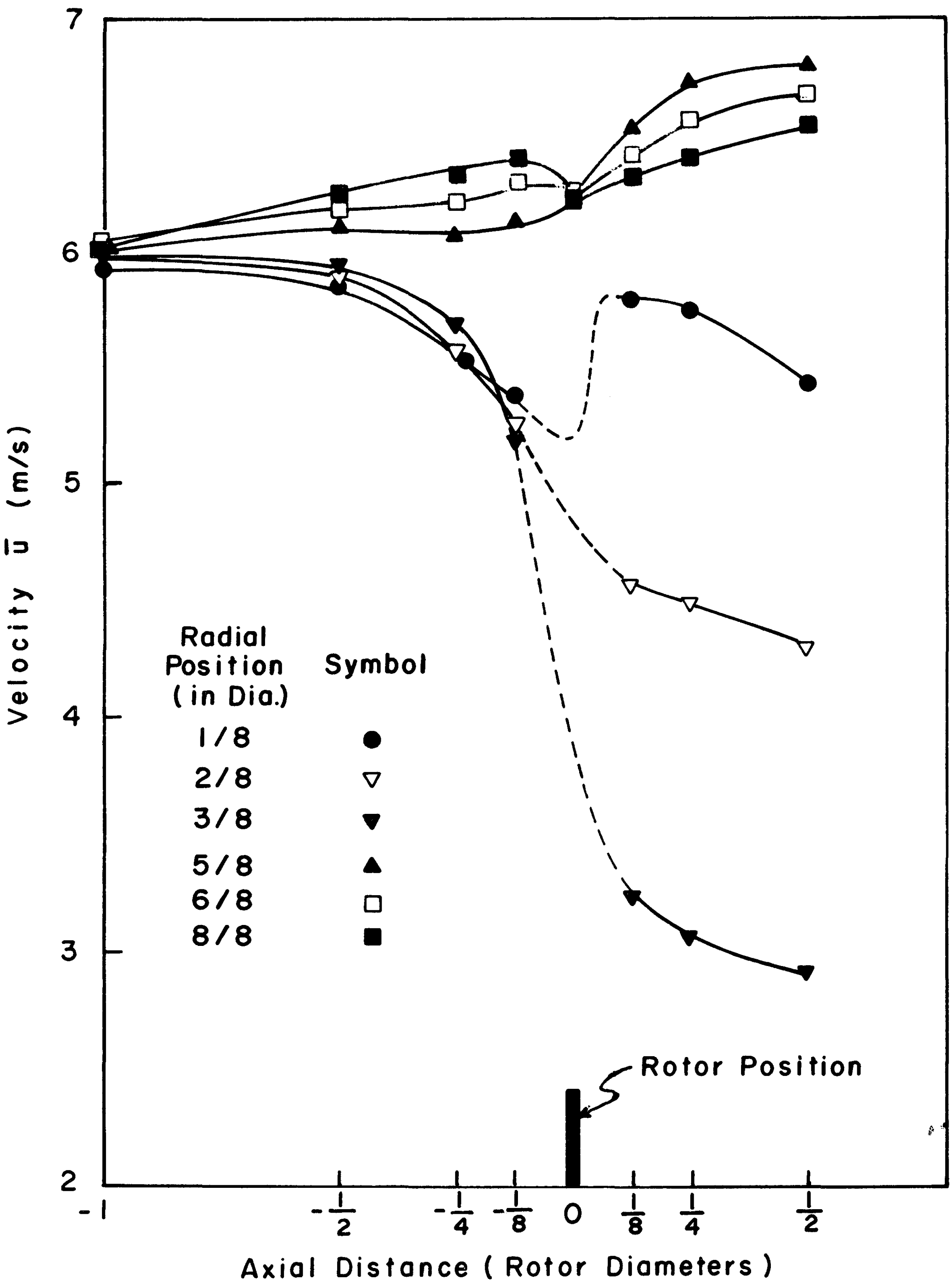


FIGURE 4.2-1 Mean Axial Velocities for Approach Flow Case I

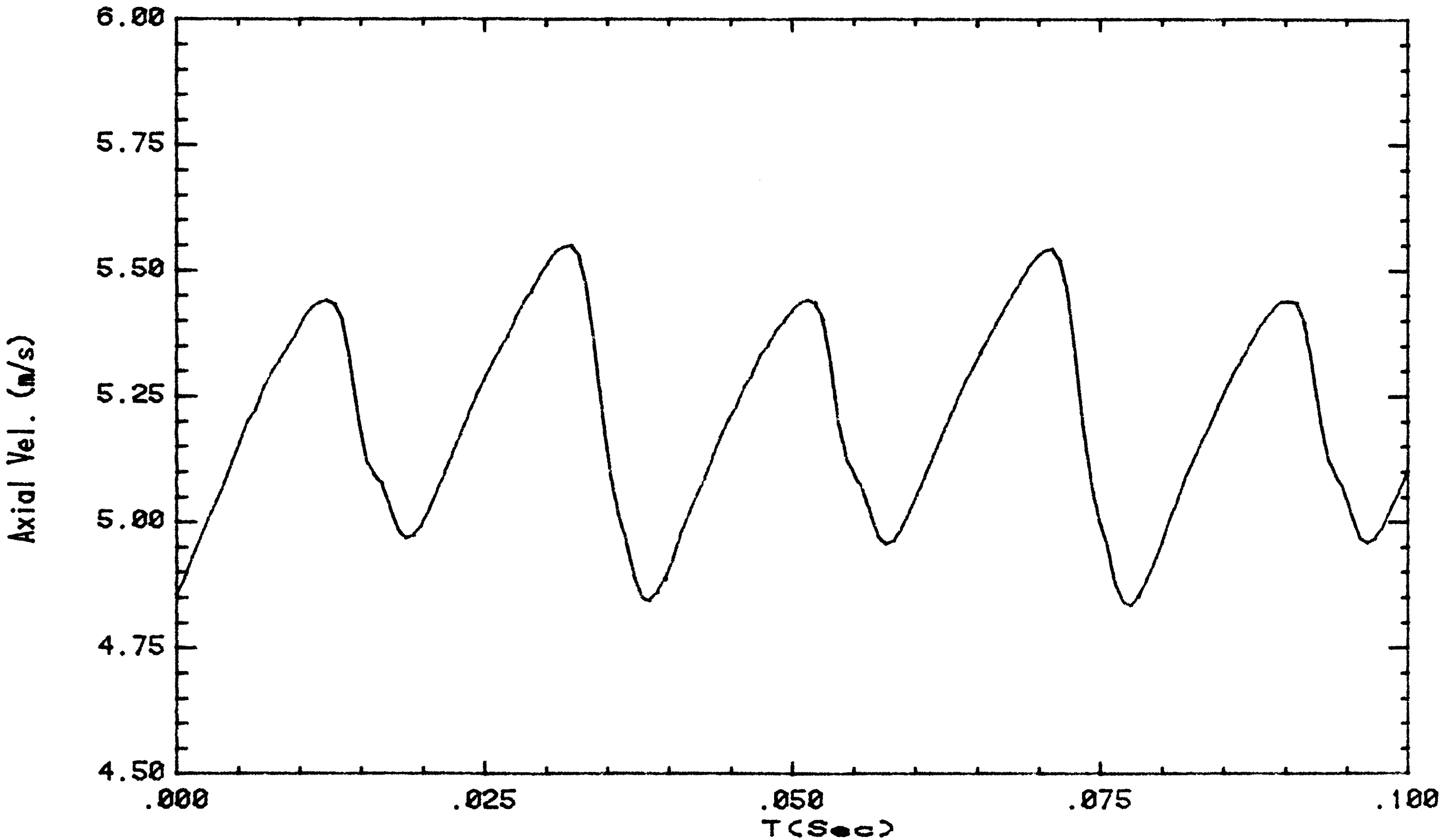


FIGURE 4.2-2 Axial Velocity Time Series for Run No. 1043

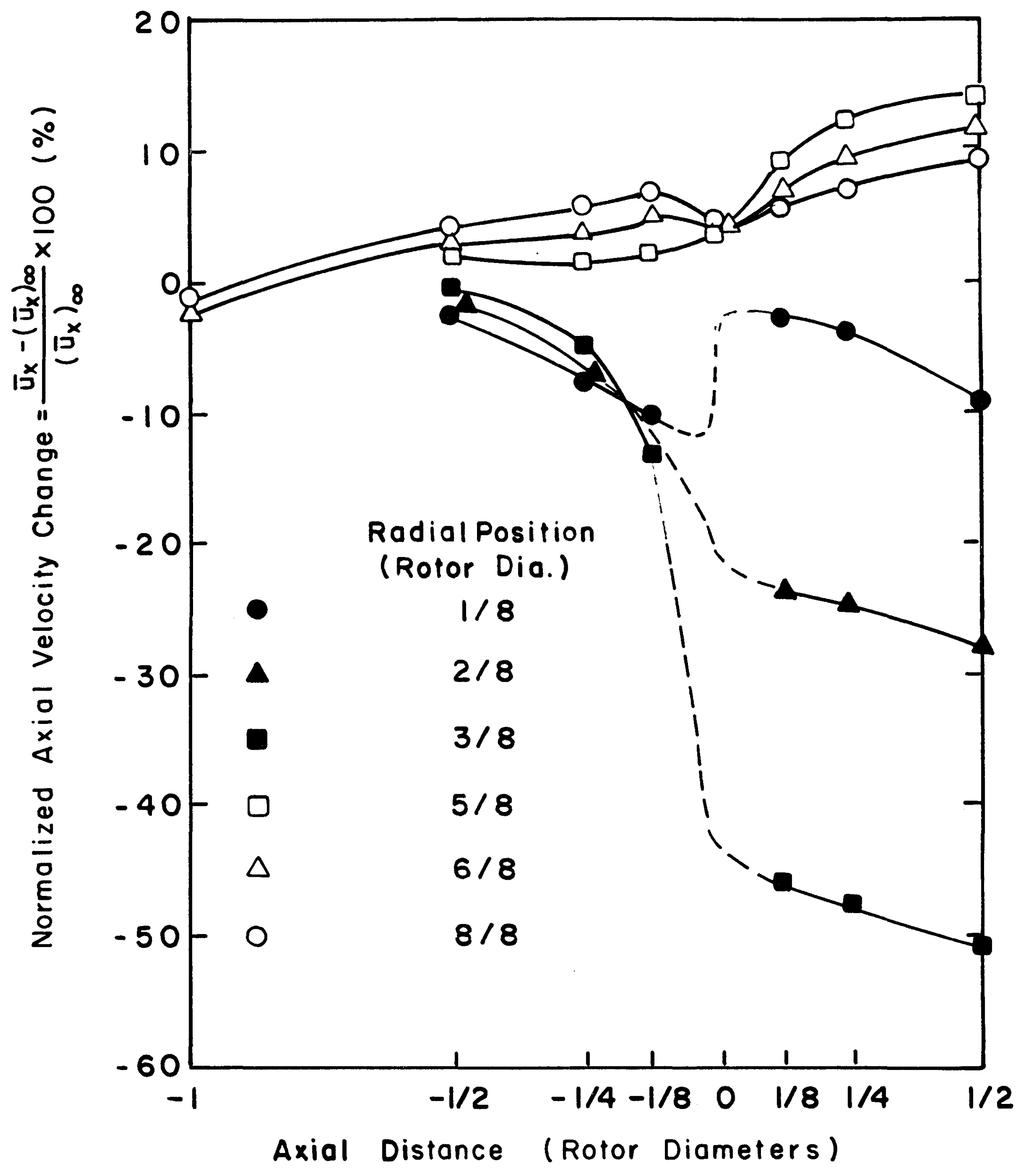


Figure 4.2-3a Normalized Mean Axial Velocity Change vs. Axial Distance for Approach Flow Case I.

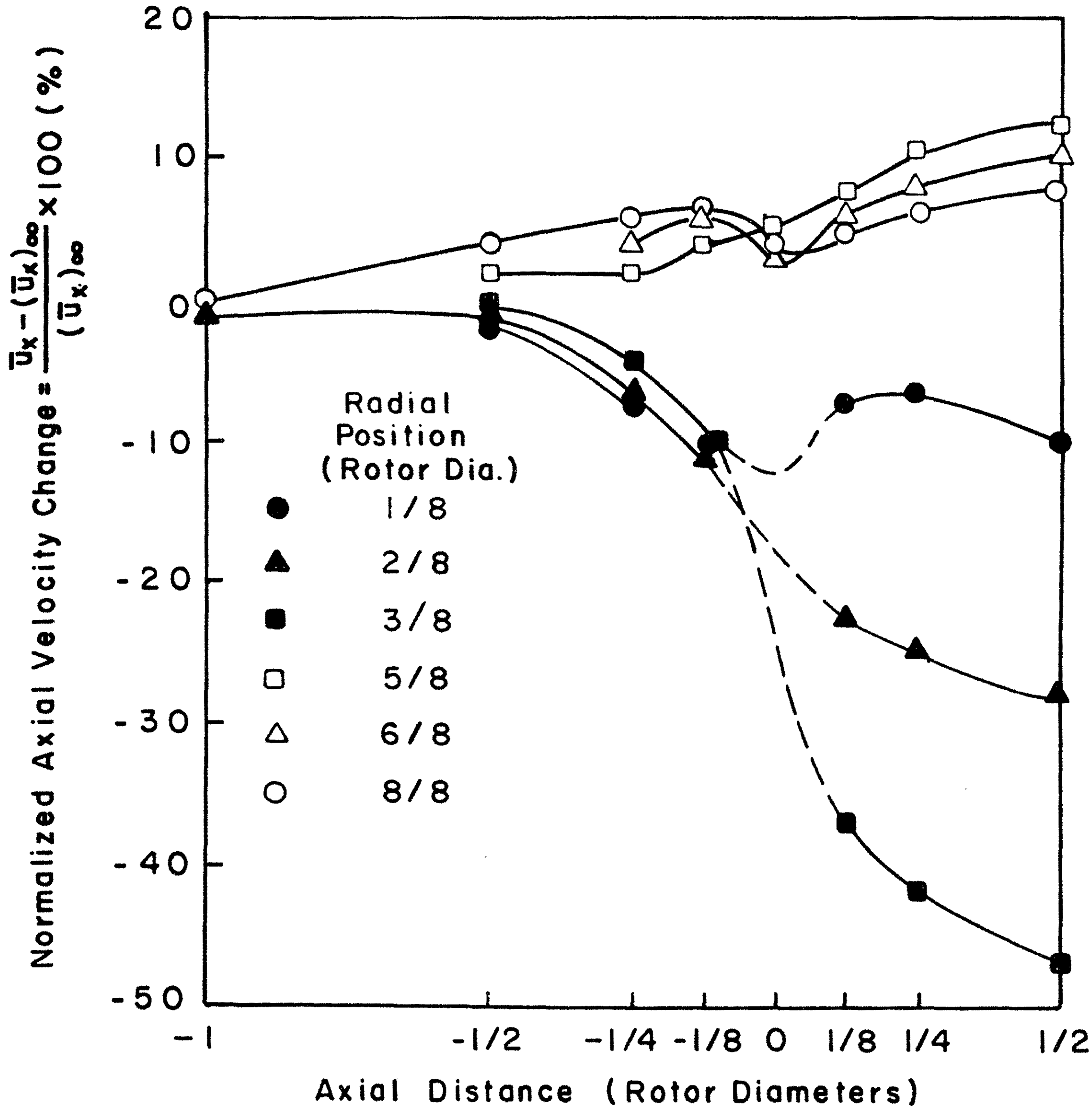


Figure 4.2-3b Normalized Mean Axial Velocity Change vs. Axial Distance for Approach Flow Case II.

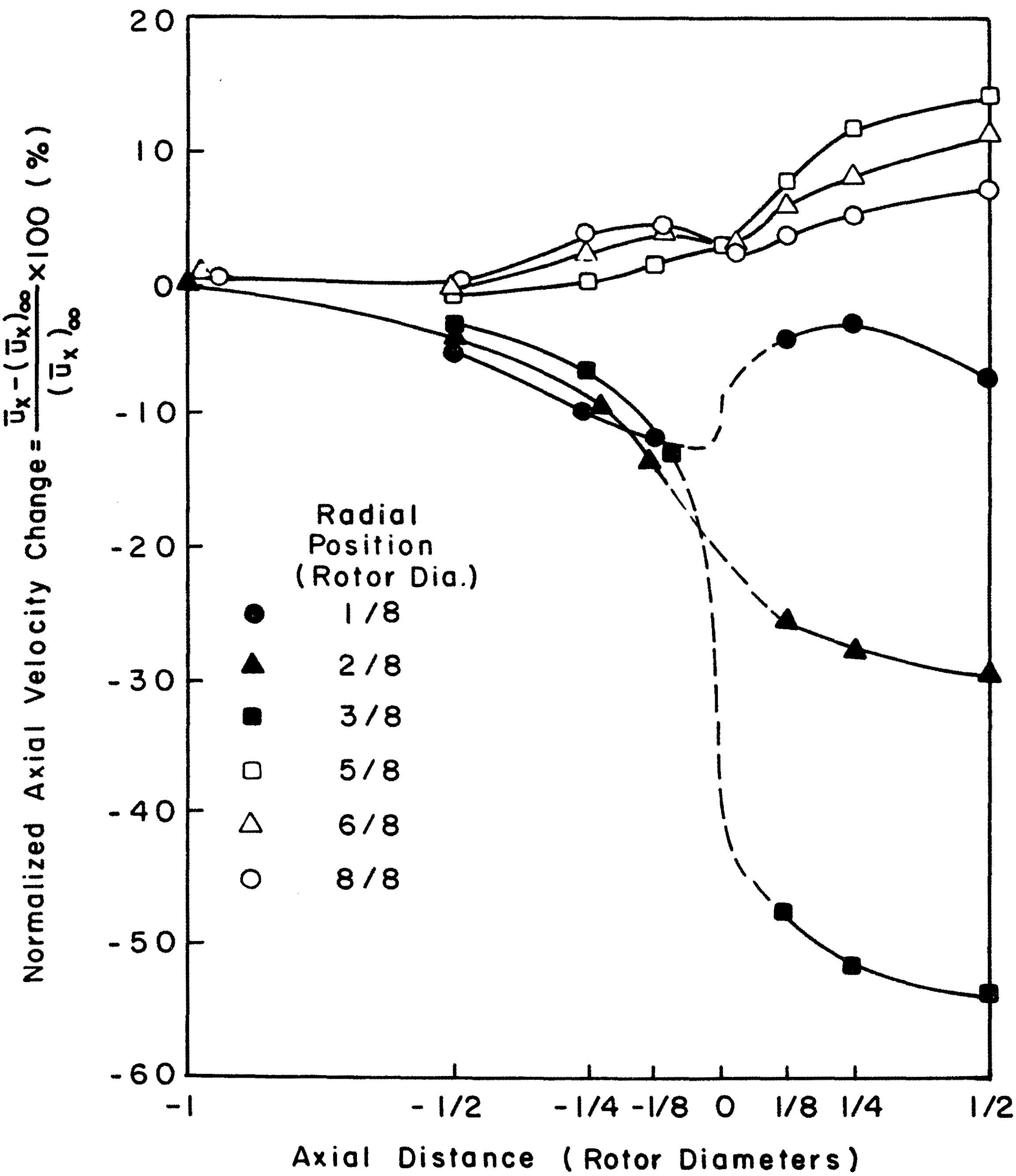


Figure 4.2-3c Normalized Mean Axial Velocity Change vs. Axial Distance for Approach Flow Case III.

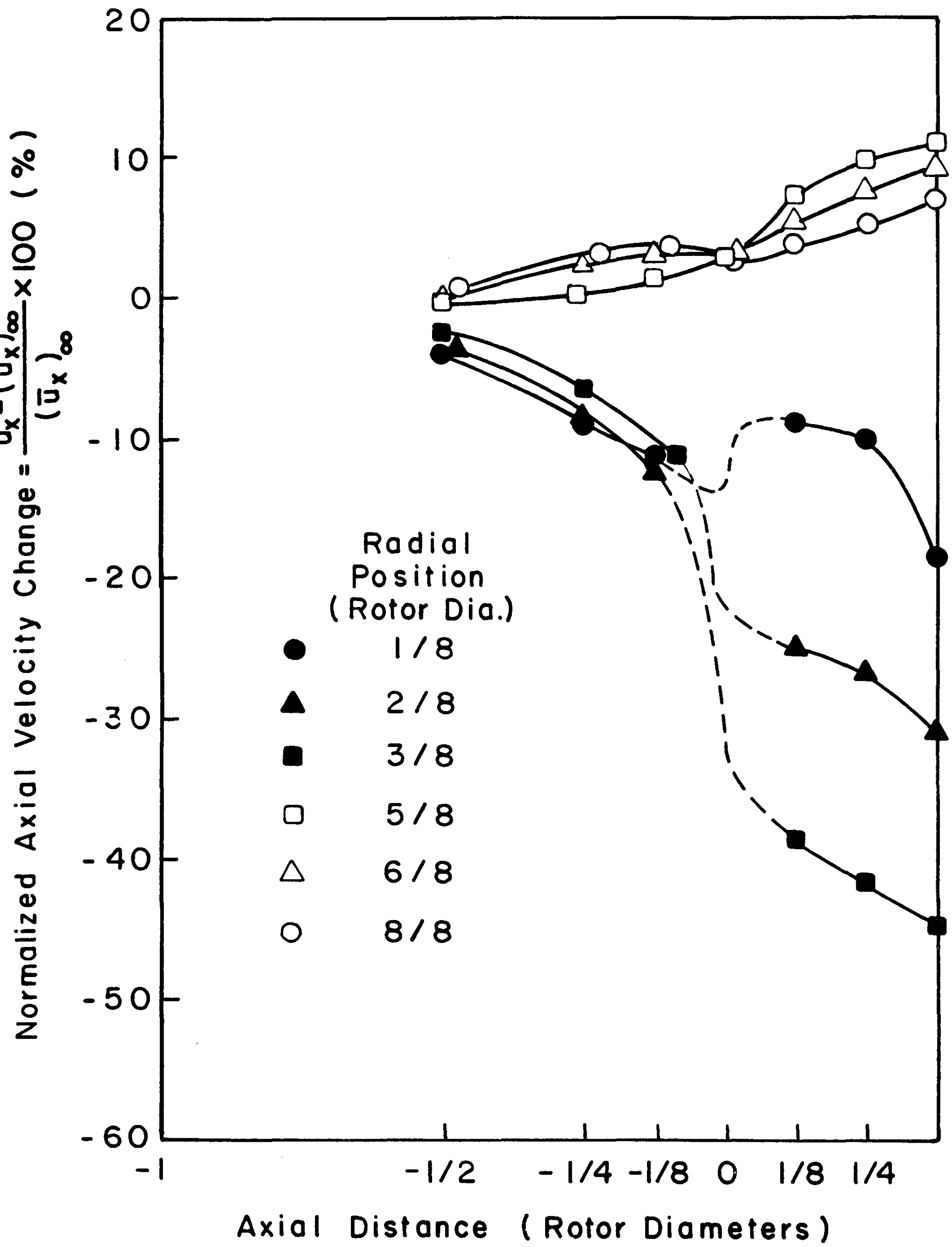


Figure 4.2-3d Normalized Mean Axial Velocity Change vs. Axial Distance for Approach Flow Case IV.

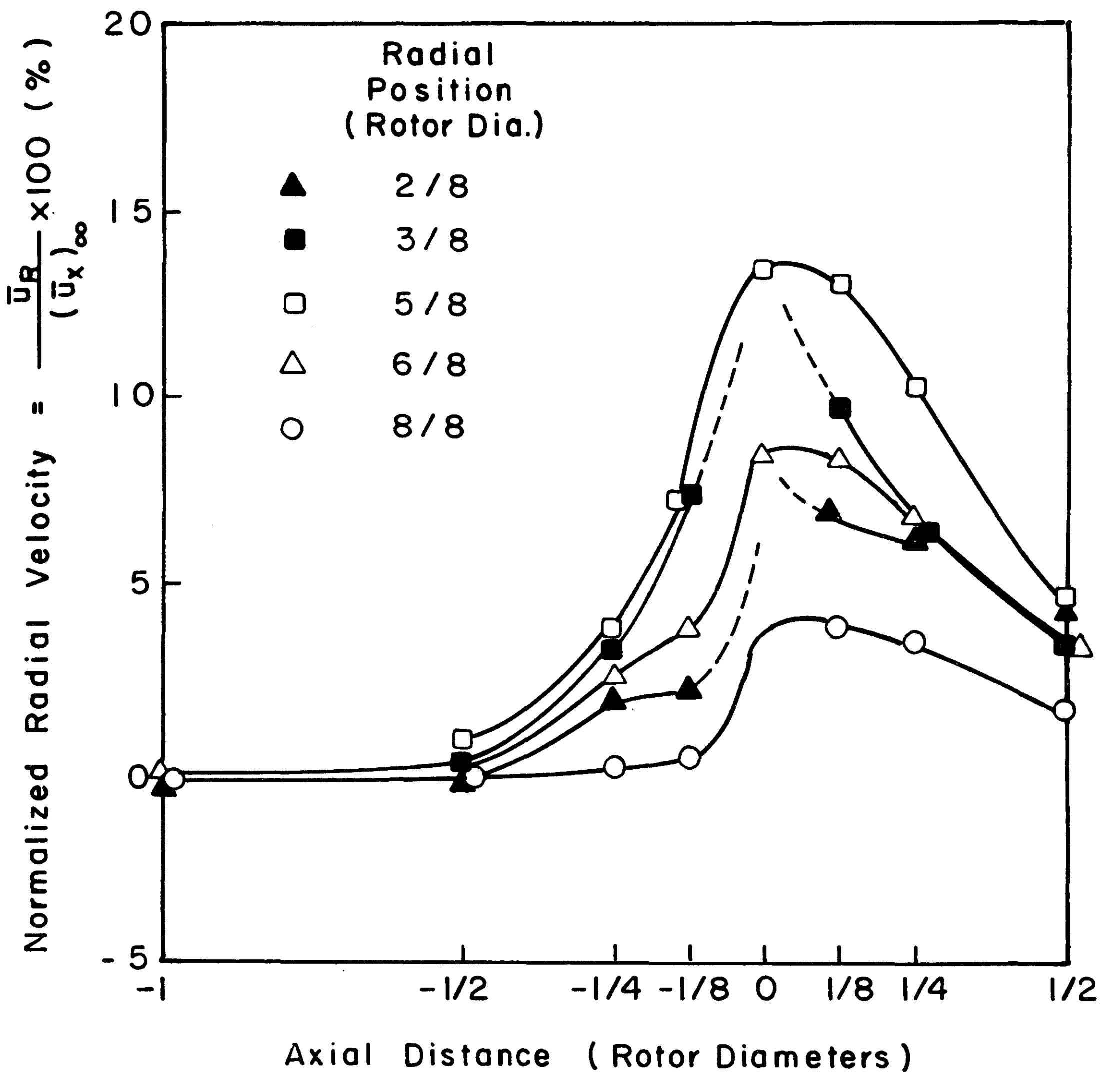


Figure 4.2-4 Normalized Mean Radial Velocity Change vs. Axial Distance for Approach Flow Case II.

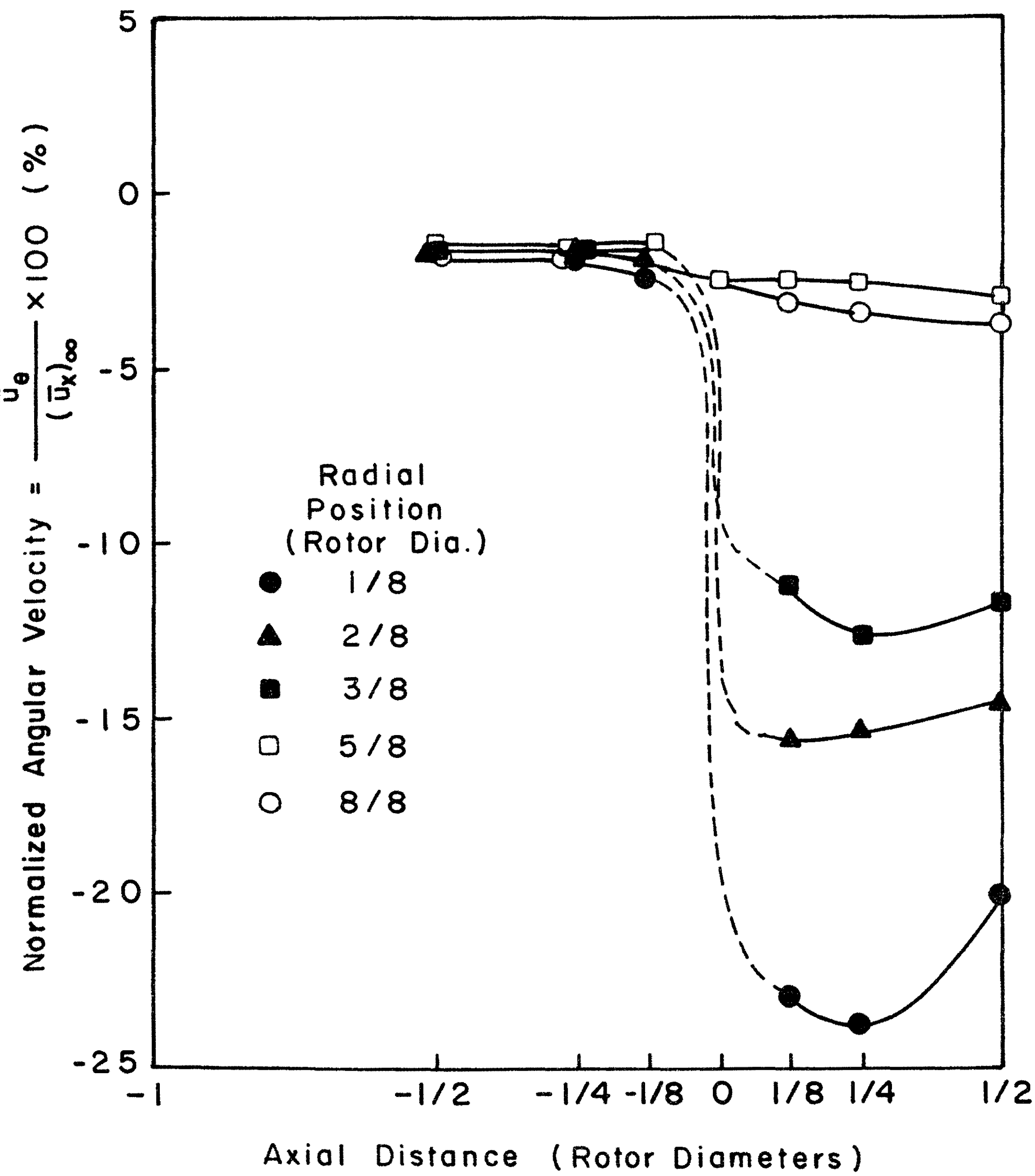


Figure 4.2-5 Normalized Mean Angular Velocity Change vs. Axial Distance for Approach Flow Case II

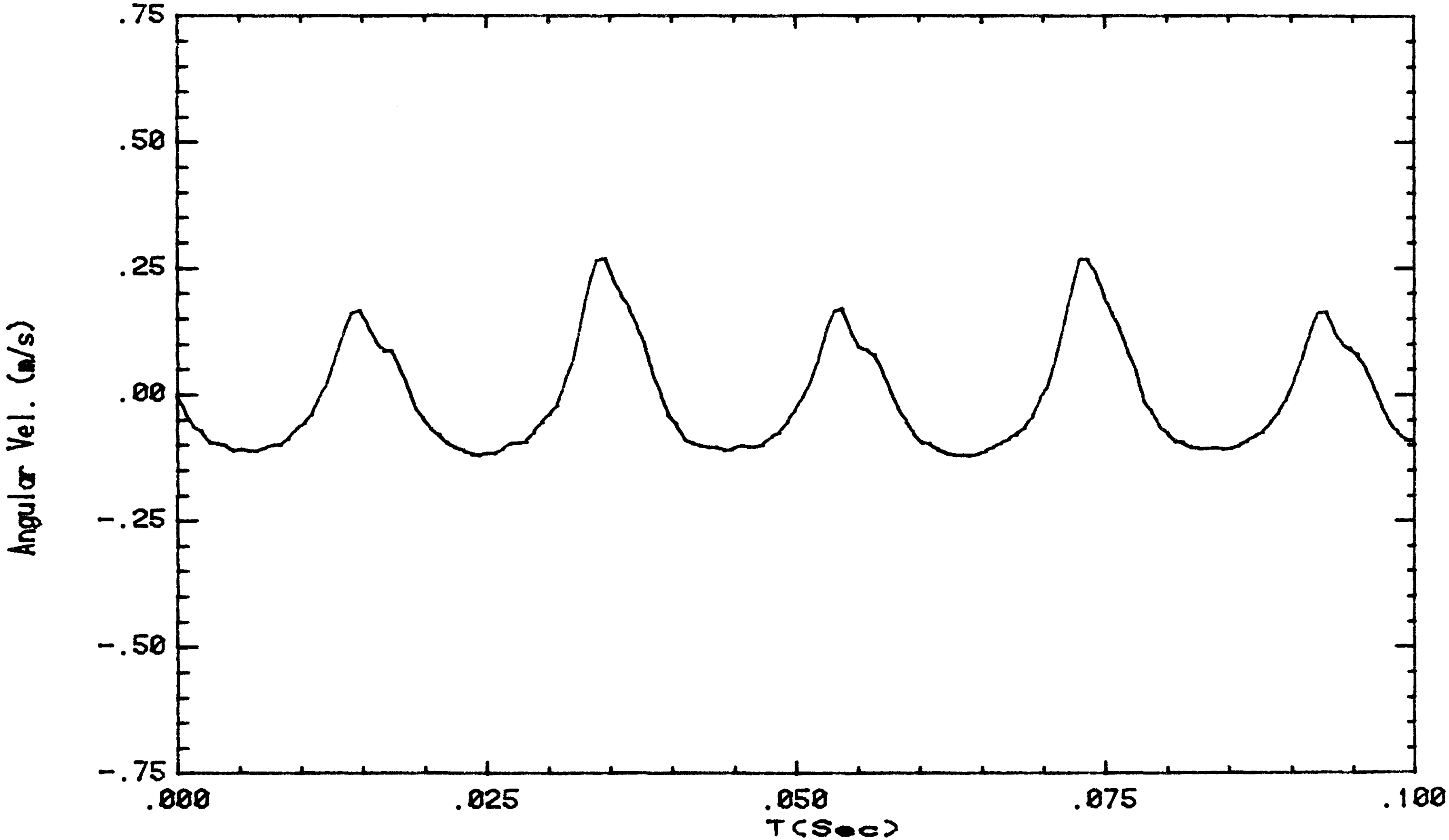


FIGURE 4.2-6 Angular Velocity Time Series for Run No. 1043

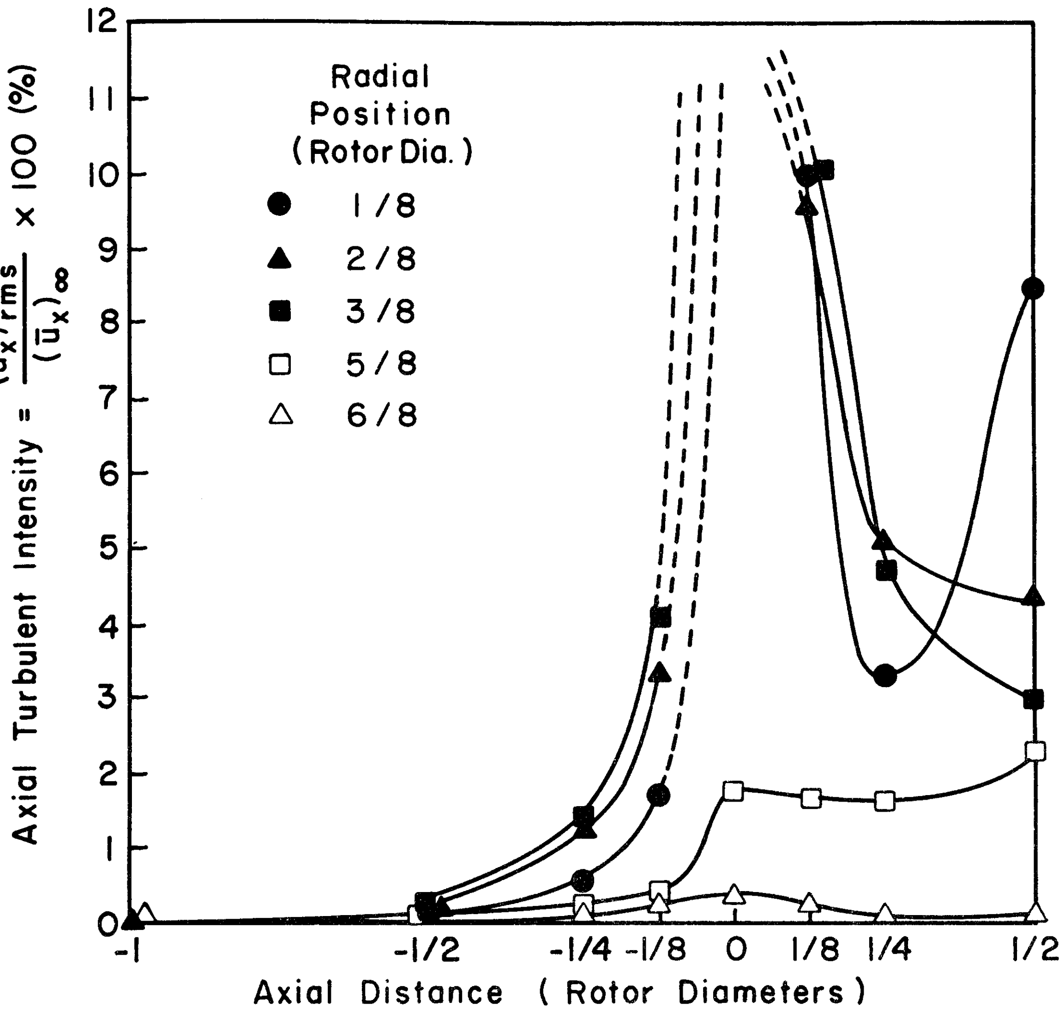


Figure 4.2-7a Axial Turbulent Intensity vs. Axial Distance for Approach Flow Case II

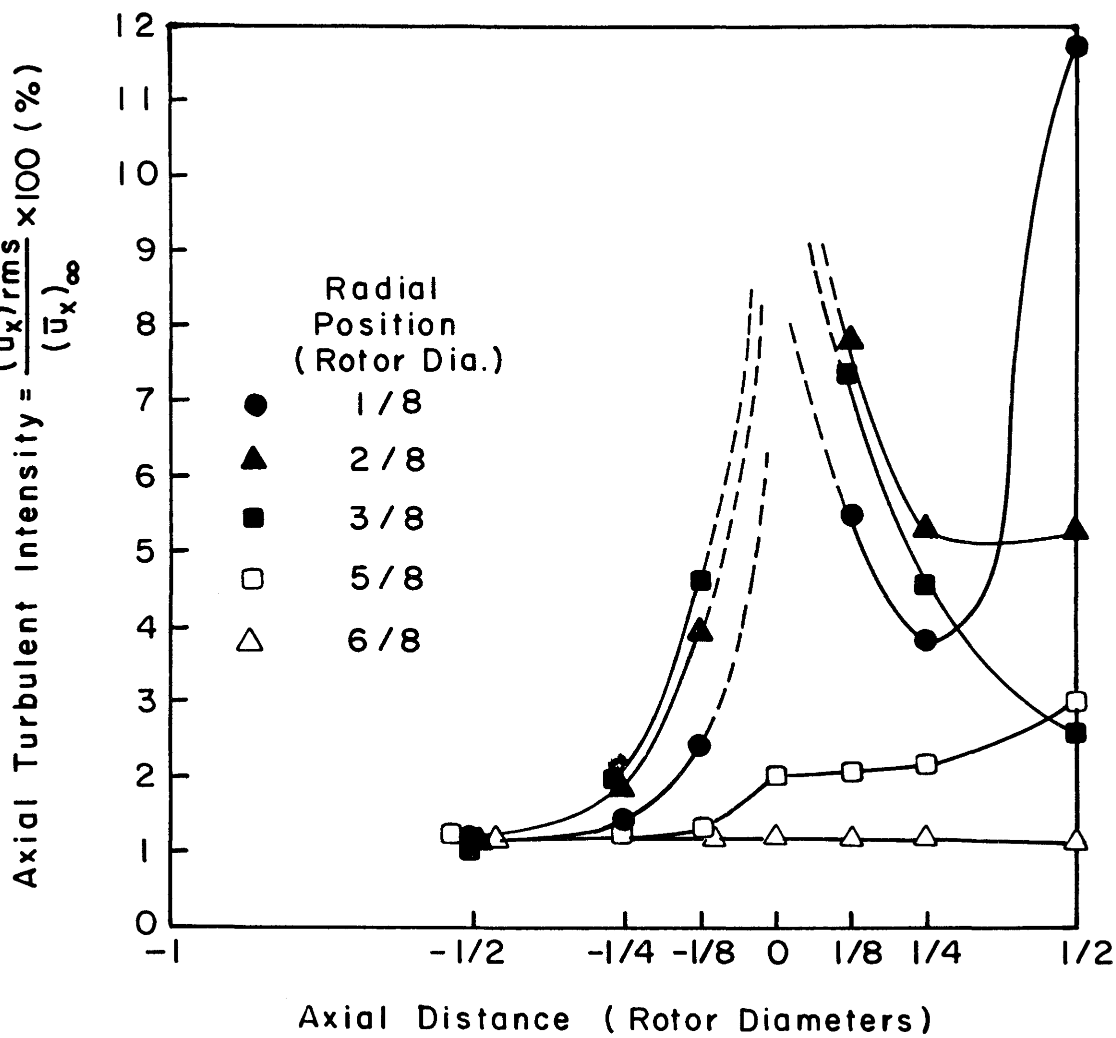


Figure 4.2-7b Axial Turbulent Intesity vs. Axial Distance for Approach Flow Case IV

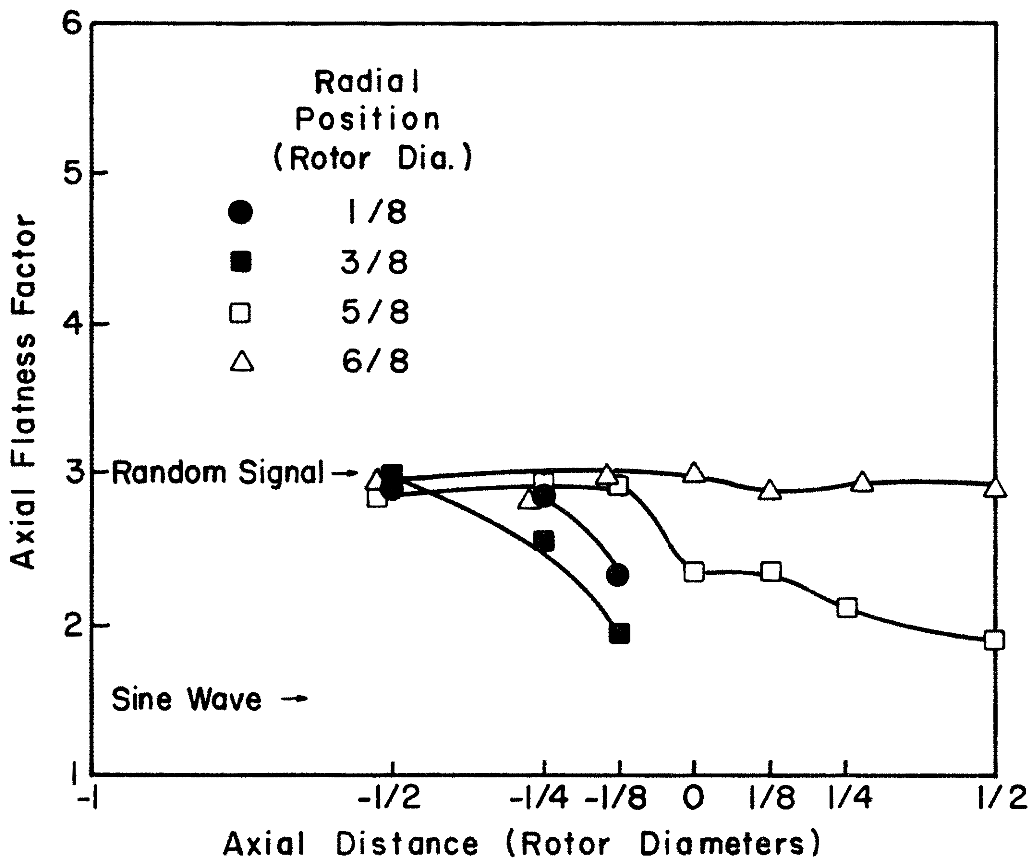


Figure 4.2-8 Axial Flatness Factor vs. Axial Distance for Approach Flow Case IV.

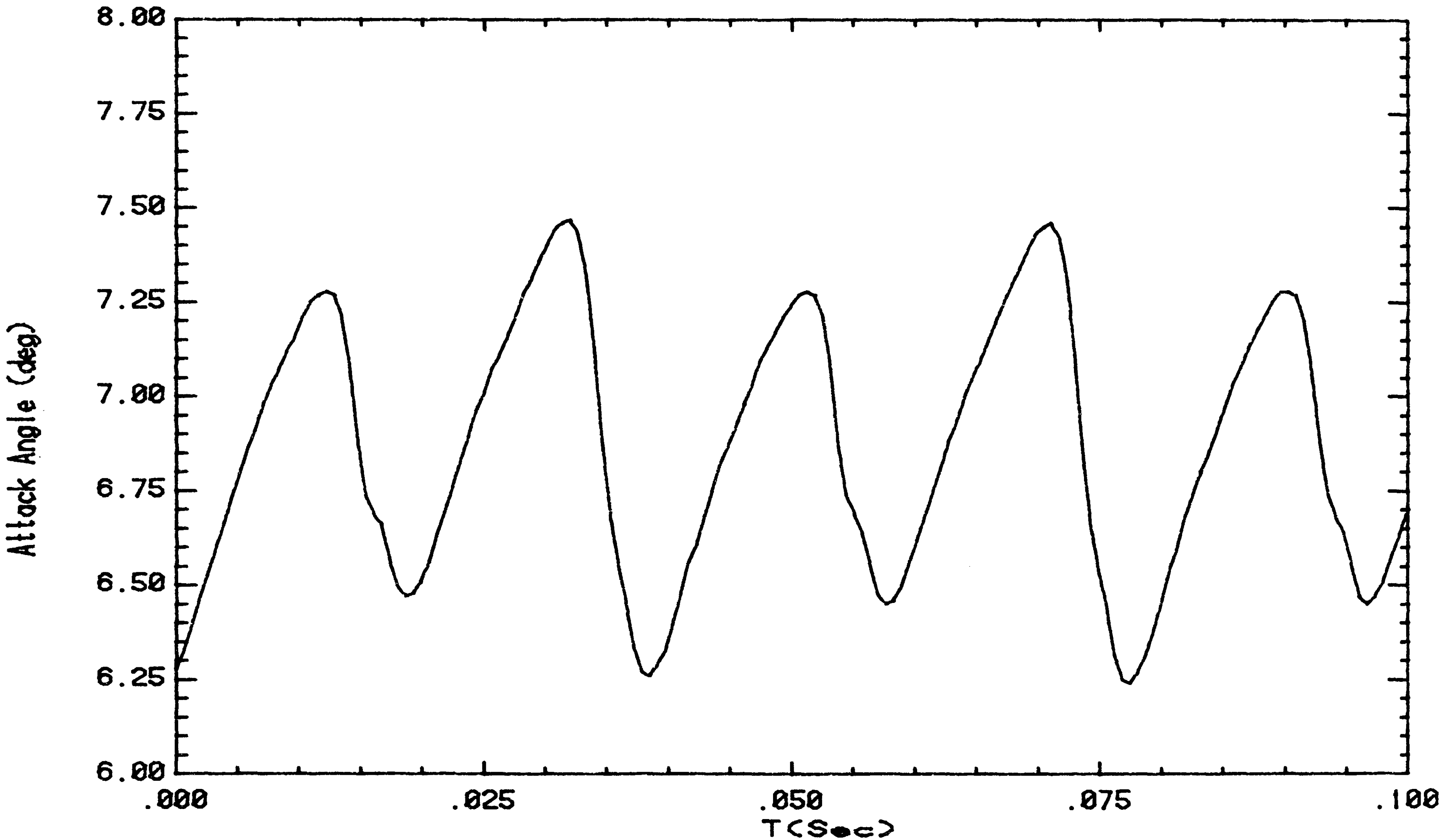


Figure 4.2-9 Angle of Attack Time Series for Run No. 1043

TABLES

TABLE 2.2-1 BLADE TWIST ANGLES VERSUS ROTOR RADIUS

r (m)	r/R	Twist Angle (degree)
0.021	0.08	37.9
0.031	0.12	31.8
0.052	0.20	22.5
0.062	0.24	19.0
0.094	0.36	11.8
0.125	0.48	7.5
0.156	0.60	4.7
0.187	0.72	2.8
0.219	0.84	1.4
0.250	0.96	0.3
0.260	1.00	0.0

note - Blade Begins at r = 0.016 m (r/R = 0.061)

TABLE 2.4.4-1 YAW ANGLE CALIBRATION POINTS

1st rotation* about y axis	2nd rotation* about x axis	Yaw Angles* $\emptyset_1$	$\emptyset_1$	$\emptyset_3$
0	-30	17.2	17.2	65.3
	-15	26.9	26.9	50.3
	0	35.3	35.3	35.3
	10	39.8	39.8	25.3
	20	43.0	43.0	15.3
-120	-30	17.2	65.3	17.2
	-15	26.9	50.3	26.9
	0	35.3	35.3	35.3
120	-30	65.3	17.2	17.2
	-15	50.3	26.9	26.9
	0	35.3	35.3	35.3

*All angles in degrees, positive rotations about probe coordinate system are clockwise (looking from positive axis to negative axis)

Table 2.4.4-2 Comparison of Actual and Calculated Velocity Vectors for 3-D Probe

Actual				Calculated*			
Velocity	Angle From Axis (Deg.)			Velocity	Angle From Axis (Deg.)		
m/s	X	Y	Z	m/s	X	Y	Z
4.0	40	90	50	4.2	41.2	88.0	48.9
	30	90	60	4.1	31.9	89.1	58.2
	15	90	75	4.0	16.9	89.9	73.1
	0	90	90	4.0	0.3	90.0	89.7
	30	120	90	4.1	26.4	116.3	93.1
	15	105	90	4.0	15.0	105.0	90.5
	15	75	90	4.0	15.4	74.6	90.1
	30	60	90	4.1	26.2	63.9	92.5
	15	90	105	4.0	14.5	89.9	104.5
	30	90	120	4.0	22.8	89.4	112.8
6.0	40	90	50	6.2	43.4	88.0	46.7
	30	90	60	6.2	32.8	89.7	57.2
	15	90	75	6.1	17.1	90.1	72.5
	0	90	90	6.0	0.5	90.2	89.5
	30	120	90	6.1	27.0	116.9	92.9
	15	105	90	6.0	15.4	105.4	90.4
	15	75	90	6.0	15.3	74.7	90.0
	30	60	90	6.2	26.8	63.3	92.3
	15	90	105	6.0	14.6	89.7	104.6
	30	90	120	6.0	23.9	89.0	113.8
8.0	40	90	50	8.2	44.8	87.3	45.4
	30	90	60	8.1	33.0	89.4	57.0
	15	90	75	8.0	16.9	90.1	73.1
	0	90	90	8.0	0.4	89.7	89.7
	30	120	90	8.1	27.0	116.8	93.2
	15	105	90	8.0	15.0	105.0	90.6
	15	75	90	8.1	15.2	74.8	90.1
	30	60	90	8.3	26.7	63.5	92.5
	15	90	105	8.0	14.8	89.9	104.8
	30	90	120	8.1	24.3	89.4	114.3

*Velocity Calibration on $\theta_x = 0^o$, $\theta_y = 90^o$, $\theta_z = 90^o$

Angle Calibration Performed at 6.0 m/s

Table 2.4.4-3 COMPARATIVE RESPONSE OF ANEMOMETER PROBES

PROBE	GRID TURBULENCE				CYLINDER WAKE TURBULENCE			
	$\bar{u}$	u'	v'	w'	$\bar{u}$	u'	v'	w'
Single Wire	5.99m/s	0.106			5.7	0.407		
Crosswire	5.982	0.106	0.0763		5.827	0.374		0.368
	5.983	0.109		0.0813	5.776	0.411	0.383	
3-d Probe (1294-60)	5.86	0.097	0.108	0.099	5.51	0.386	0.433	0.418
3-d Probe (1294-20)	5.90	0.096	0.100	0.096				

Table 3.1-1 APPROACH FLOW CHARACTERISTICS

Approach Flow No.	Measurement Probe	Velocity Component	Minimum (M/S)	Mean (M/S)	Maximum (M/S)	RMS (M/S)	Skewness	Flatness	Integral Scale (m)
1	single film	u	5.878	5.900	5.924	0.007	0.162	2.934	
2	single film	u	7.500	7.538	7.588	0.009	0.188	3.106	
3	single film	u	5.491	5.928	6.330	0.107	-0.045	2.952	0.0463
4	single film	u	6.980	7.516	8.033	0.131	0.0414	2.900	0.0425
1	3-D Probe	u	5.877	5.90	5.918	0.007	-0.0346	2.441	
2	3-D Probe	u	7.581	7.60	7.622	0.007	1.092	2.858	
3	3-D Probe	u	5.580	5.96	6.325	0.100	-0.120	2.963	0.0517
4	3-D Probe	u	7.060	7.59	8.057	0.120	-0.039	2.912	0.0504
1	3-D Probe	v	-0.014	0.01	0.045	0.008	0.072	3.167	
2	3-D Probe	v	-0.142	-0.08	-0.028	0.016	0.086	2.671	
3	3-D Probe	v	-0.581	-0.08	0.392	0.106	-0.003	3.006	0.0147
4	3-D Probe	v	-0.758	-0.11	0.478	0.139	-0.039	3.177	0.0152
1	3-D Probe	w	-0.004	0.02	0.052	0.008	-0.018	2.966	
2	3-D Probe	w	0.036	0.08	0.116	0.011	-0.116	2.744	
3	3-D Probe	w	-0.429	0.07	0.482	0.101	-0.090	3.104	0.0171
4	3-D Probe	w	-0.618	0.12	0.622	0.128	-0.040	3.156	0.0164

Table 3.2-1 Power Measurement Test for U = 6.0 m/s, T.I. = 0.1%

Mass (Kg)	Spring Deflection Z_d* (cm)	Ω rpm	Tip Speed Ratio	Power (watts)	Power Coefficient
0.091	8.5	1640	7.4	1.13	0.050
0.227	10.0	1545	7.01	2.79	0.124
0.318	11.1	1460	6.62	3.57	0.158
0.408	12.2	1370	6.22	4.19	0.186
0.454	12.7	1330	6.03	4.58	0.203
0.499	13.2	1300	5.90	4.95	0.219
0.545	13.8	1230	5.58	5.01	0.222
0.635	14.7	1180	5.35	5.8	0.757
0.681	15.1	1135	5.15	6.16	0.273
0.726	15.7	1080	4.9	6.13	0.272
0.771	16.3	980	4.45	5.8	0.257

*Z_d = 7.45 cm

Table 3.2-2 Power Measurement Test for U = 7.6 m/s, T.I. = 0.1%

Mass (Kg)	Spring Deflection Z_d* (cm)	Ω rpm	Tip Speed Ratio	Power (watts)	Power Coefficient
.453	12.6	1925	6.89	6.81	0.148
.544	13.6	1900	6.80	8.15	0.178
.680	15	1805	6.46	9.97	0.217
.770	16.1	1760	6.3	10.80	0.235
.906	17.6	1645	5.89	11.93	0.26
.997	18.7	1575	5.64	12.4	0.271
1.088	19.2	1460	5.23	13.46	0.293

*Z_d = 7.45 cm

Table 3.2-3 Power Measurement Test for U = 7.6 m/s, T.I. = 1.5%

Mass (Kg)	Spring Deflection Z_d* (cm)	Ω rpm	Tip Speed Ratio	Power (watts)	Power Coefficient
.453	13	2080	7.45	6.39	0.139
.544	13.8	1980	7.09	8.03	0.175
.680	15.2	1860	6.66	9.83	0.214
.771	16.2	1840	6.59	11.11	0.242
.861	17.1	1770	6.34	12.19	0.266
.906	17.4	1700	6.09	12.72	0.277
.996	18.1	1640	5.87	14.0	0.306
1.087	18.6	1510	5.41	14.9	0.326
1.132	18.7	1380	4.94	14.7	0.322
1.222	18.6	1240	4.44	15.8	0.344
1.313	18.7	1080	3.87	15.68	0.342

*Z_d = 7.45 cm

Table 3.3-1 Measurement Locations

Position	x/D	r/D	x (m)	r (m)	θ (deg.)
001	1/2	1/8	0.267	0.067	180
002	1/2	2/8	0.267	0.134	180
003	1/2	3/8	0.267	0.201	180
005	1/2	5/8	0.267	0.334	180
006	1/2	6/8	0.267	0.401	180
008	1/2	8/8	0.267	0.535	180
011	1/4	1/8	0.134	0.067	180
012	1	2/8	0.134	0.134	180
013	1/4	3/8	0.134	0.201	180
015	1/4	5/8	0.134	0.334	180
016	1/4	6/8	0.134	0.401	180
018	1/4	8/8	0.134	0.535	180
021	1/8	1/8	0.067	0.067	180
022	1/8	2/8	0.067	0.134	180
023	1/8	3/8	0.067	0.201	180
025	1/8	5/8	0.067	0.334	180
026	1/8	6/8	0.067	0.401	180
028	1/8	8/8	0.067	0.535	180
035	0	5/8	0	0.334	180
036	1	6/8	0	0.401	180
038	0	8/8	0	0.535	180
041	-1/8	1/8	-0.067	0.067	180
042	-1/8	2/8	-0.067	0.134	180
043	-1/8	3/8	-0.067	0.201	180
044	-1/8	4/8	-0.067	0.267	180
045	-1/8	5/8	-0.067	0.334	180
046	-1/8	6/8	-0.067	0.401	180
048	-1/8	8/8	-0.067	0.535	180
060	-1/4	0	-0.134	0	0
061	-1/4	1/8	-0.134	0.067	180
062	-1/4	2/8	-0.134	0.134	180
063	-1/4	3/8	-0.134	0.201	180
064	-1/4	4/8	-0.134	0.267	180
065	-1/4	5/8	-0.134	0.334	180
066	-1/4	6/8	-0.134	0.401	180
068	-1/4	8/8	-0.134	0.535	180
070	-1/2	0	-0.267	0	0
071	-1/2	1.8	-0.267	0.067	180
072	-1/2	2/8	-0.267	0.134	180
073	-1/2	3/8	-0.267	0.201	180
074	-1/2	4/8	-0.267	0.267	180
075	-1/2	5/8	-0.267	0.334	180
076	-1/2	6/8	-0.267	0.401	180
078	-1/2	8/8	-0.267	0.535	180

Table 3.3-1 continued

Position	x/D	r/D	x (m)	r (m)	θ (deg.)
080	1	0	-0.535	0	0
082	1	1/4	-0.535	0.134	180
084	1	2/4	-0.535	0.267	180
086	1	3/4	-0.535	0.401	180
088	1	4/4	-0.535	0.535	180
090	3/2	0	-0.802	0	0
094	3/2	1/2	-0.802	0.267	180
098	3/2	2/2	-0.802	0.535	180
100	2	0	-1.070	0	0
104	2	1/2	-1.070	0.267	180
108	2	2/2	-1.070	0.535	180
110	3	0	-1.605	0	0
114	3	1/2	-1.605	0.267	180
118	3	2/2	-1.605	0.535	180

Table 3.3-2 Rotor Speed During Data Aquisition

Position No.	Case No. 1	2	3	4
	(Data Obtained with TSI 1294-20 Probe)			
001	1340	1600	1470	1360
002	1340	1600	1470	1370
003	1340	1580	1440	1350
005	1340	1560	1440	1340
006	1300	1525	1440	1330
008	1340	1525	1440	1320
011	1360	1500	1420	1320
012	1360	1500	1420	1330
013	1360	1500	1420	1350
015	1360	1500	1420	1370
016	1360	1510	1440	1360
018	1340	1510	1440	1350
021	1380	1500	1400	1350
022	1380	1400	1420	1370
023	1380	1450	1420	1370
025	1380	1450	1420	1370
026	1430	1465	1420	1500
028	1430	1465	1420	1560
035	1430	1390	1380	1550
036	1430	1390	1400	1520
038	1430	1390	1400	1520
045	1420	1400	1400	1580
046	1406	1400	1400	1580
048	1490	1420	1400	1600
(Data Obtained with Modified TSI 1294-20 Probe, 90° bend)				
041	1550	1540	1354	1360
042	1550	1540	1354	1360
043	1550	1530	1354	1360
044	1550	1420	1354	1360
045	1550	1380	1354	1360
046	1550	1420	1354	1320
048	1540	1380	1354	1320
060	1500	1380	1300	1370
061	1500	1400	1320	1370
062	1520	1430	1320	1370
063	1530	1400	1320	1430
064	1530	1340	1320	1430
065	1530	1340	1320	1430
066	1530	1460	1320	1350
068	1540	1460	1320	1350

Table 3.3-2 continued

Position No.	Case No. 1	2	3	4
	(Data Obtained with TSI 1294-20 Probe, 90°)			
070	1490	1450	1310	1430
071	1465	1410	1310	1430
072	1465	1420	1310	1430
073	1465	1460	1330	1430
074	1465	1340	1330	1430
075	1465	1370	1330	1430
076	1465	1370	1330	1390
078	1440	1430	1330	1310
080	1320	1413	1330	1310
082	1320	1450	1330	1310
084	1320	1465	1330	1310
086	1320	1413	1330	1310
088	1300	1450	1330	1310
090	1350	1460	1350	1310
094	1350	1420	1350	1310
098	1350	1420	1350	1310
100	1420	1550	1400	1310
104	1400	1465	1400	1310
108	1400	1525	1400	1310
110	1500	1600	1465	1310
114	1500	1600	1443	1310
118	1465	1600	1400	1310

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW NESS	FLAT NESS		REYNOLDS STRESS	ANGLE INFORMATION MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU1001	1	.267	1.692	5.44	11.8	1.57	7.88	.518	-2.43	10.78	VW	.0253	14.0	.3	51.8	6.9	2.33	8.87
VV1001	2	.067	2.709	.02	87.8	-4.16	4.02	.717	.44	8.25	UW	-.0403	87.8	48.4	131.6	7.8	-.40	8.72
WW1001	3	180.000	.590	-1.14	101.8	-4.46	3.83	.548	1.06	14.68	UV	.0902	101.7	59.7	140.6	6.2	-.98	15.98
UU1002	1	.267	0.000	4.31	11.6	2.95	5.27	.330	.01	2.42	VW	.0292	12.5	.1	40.4	4.0	.74	9.36
VV1002	2	.134	.469	.26	86.6	1.58	2.69	.304	1.15	9.18	UW	.0420	86.5	55.3	110.2	4.0	-1.17	9.20
WW1002	3	180.000	.009	-.84	101.0	-2.49	2.02	.324	1.93	8.81	UV	-.0187	101.1	59.7	120.5	4.5	-1.65	7.84
UU1003	1	.267	.006	2.93	13.3	1.98	3.73	.237	.13	2.75	VW	.0060	14.3	.1	40.9	4.7	.75	7.74
VV1003	2	.201	1.059	.23	85.6	-1.10	1.93	.254	1.17	6.99	UW	-.0155	85.6	54.2	110.7	5.0	-1.22	7.30
WW1003	3	180.000	.019	-.66	102.6	-1.60	1.43	.247	1.66	7.27	UV	-.0084	102.5	59.7	121.9	4.8	-1.49	7.27
UU1005	1	.267	0.000	6.81	3.0	6.58	7.06	.136	.08	1.54	VW	.0015	3.1	1.1	5.4	1.1	.08	1.54
VV1005	2	.334	0.000	.31	87.4	.05	.61	.150	.04	1.55	UW	.0057	87.4	84.9	89.6	1.2	-.03	1.55
WW1005	3	180.000	0.000	-.19	91.6	-.31	.06	.030	.09	2.23	UV	-.0027	91.6	90.5	92.5	.3	-.06	2.17
UU1006	1	.267	0.000	6.68	2.8	6.64	6.72	.015	.37	2.55	VW	.0000	2.8	2.4	3.2	.1	-.16	3.11
VV1006	2	.401	0.000	.24	87.9	.19	.30	.015	.01	3.00	UW	.0001	87.9	87.4	88.4	.1	.14	2.99
WW1006	3	180.000	0.000	-.23	91.9	-.26	.19	.010	.06	2.88	UV	.0000	91.9	91.6	92.2	.1	.27	2.89
UU1008	1	.267	0.000	6.55	2.4	6.52	6.60	.013	.27	2.44	VW	.0000	2.4	2.1	2.7	.1	.14	2.91
VV1008	2	.535	0.000	.13	88.8	.09	.18	.011	.02	2.88	UW	.0000	88.8	88.4	89.2	.1	.27	2.88
WW1008	3	180.000	0.000	-.24	92.1	-.27	-.21	.008	.16	2.98	UV	.0000	92.1	91.8	92.4	.1	-1.19	3.04
UU1011	1	.134	.025	5.76	11.1	4.11	6.72	.184	1.28	8.71	VW	.0190	12.1	.4	40.9	3.2	1.48	12.77
VV1011	2	.067	.244	.18	88.3	-2.95	3.46	.492	.31	4.46	UW	-.0468	88.2	57.4	122.2	4.8	-.34	4.84
WW1011	3	180.000	.009	-1.12	101.0	-3.04	2.82	.209	1.70	13.92	UV	-.0694	101.0	59.7	122.0	2.9	-1.49	13.62
UU1012	1	.134	.015	4.50	10.2	2.96	5.73	.332	.58	3.12	VW	.0131	13.3	.1	41.7	5.6	1.76	8.52
VV1012	2	.134	2.307	.35	85.6	-2.68	3.45	.560	1.31	6.30	UW	-.1070	85.5	50.3	127.1	7.1	-1.25	5.94
WW1012	3	180.000	.828	-.73	99.2	-3.23	2.63	.553	2.26	10.14	UV	-.0228	99.1	59.7	123.9	7.1	-2.25	10.22
UU1013	1	.134	.065	3.07	13.3	1.80	4.22	.264	.60	4.52	VW	.0146	15.8	.3	43.9	5.5	1.28	7.70
VV1013	2	.201	2.900	.35	83.6	-2.02	2.23	.301	.63	5.58	UW	-.0506	83.4	51.4	124.5	7.0	-.68	5.45
WW1013	3	180.000	.750	-.63	101.6	1.80	1.98	.309	2.53	11.92	UV	-.0074	101.5	59.7	128.4	7.1	-2.50	11.78
UU1015	1	.134	0.000	6.73	5.9	6.61	6.89	.076	.24	1.61	VW	.0014	6.0	4.0	7.7	.9	-.21	1.68
VV1015	2	.334	0.000	.68	84.2	.44	.89	.116	.22	1.67	UW	.0008	84.2	82.5	86.3	1.0	.20	1.66
WW1015	3	180.000	0.000	-.17	91.4	-.25	-.10	.025	.52	2.69	UV	.0004	91.4	90.8	92.2	.2	.51	2.61
UU1016	1	.134	0.000	6.56	4.5	6.51	6.59	.012	.35	2.76	VW	.0000	4.5	3.8	5.0	.2	-.16	2.26
VV1016	2	.401	0.000	.47	85.9	.40	.53	.024	-.19	2.20	UW	.0001	85.9	85.3	86.5	.2	.14	2.20
WW1016	3	180.000	0.000	-.20	91.8	-.25	-.15	.013	-.42	2.79	UV	.0000	91.8	91.3	92.2	.1	.33	2.73
UU1018	1	.134	0.000	6.41	2.8	6.37	6.44	.013	.27	2.22	VW	-.0000	2.8	2.4	3.2	.1	-.02	2.93
VV1018	2	.535	0.000	.24	87.8	.20	.29	.011	.09	3.02	UW	.0000	87.8	87.4	88.2	.1	.54	3.04
WW1018	3	180.000	0.000	-.21	91.8	-.24	-.17	.008	.01	2.93	UV	.0000	91.8	91.5	92.1	.1	1.06	2.94
UU1021	1	.067	.083	5.80	11.7	3.83	7.14	.264	.34	5.18	VW	.0185	13.7	.2	40.4	3.6	1.31	12.83
VV1021	2	.067	.513	.42	85.9	-3.11	3.79	.678	.10	3.12	UW	-.1087	85.8	54.5	125.1	6.6	.10	3.40
WW1021	3	180.000	.157	-1.13	101.0	-3.18	3.46	.448	2.57	17.63	UV	.0086	100.9	59.7	122.3	4.4	-2.53	17.85
UU1022	1	.067	.179	4.57	10.4	2.89	6.41	.440	.79	3.25	VW	-.0041	15.4	.1	42.7	6.0	1.79	7.47
VV1022	2	.134	3.147	.41	85.0	2.94	4.08	.725	.73	5.51	UW	-.1449	84.8	48.8	127.3	8.6	-.58	5.18
WW1022	3	180.000	3.045	-.73	99.1	-3.01	3.63	.795	2.20	9.30	UV	.0592	99.0	59.7	120.2	9.5	-2.22	9.08
UU1023	1	.067	.324	3.24	14.3	1.46	5.09	.330	.98	7.26	VW	.0471	17.5	.2	48.1	6.7	1.35	5.14
VV1023	2	.201	5.219	.53	80.9	2.31	2.92	.545	.58	4.53	UW	.0013	81.2	48.7	125.4	8.3	-.30	4.10
WW1023	3	180.000	1.794	-.63	100.9	-2.52	2.59	.531	2.32	13.08	UV	.0093	100.9	59.7	137.0	8.4	-2.20	11.82

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEWNESS	FLATNESS		REYNOLDS STRESS	ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEWNESS	FLATNESS
UU1025	1	.067	0.000	6.54	8.3	6.44	6.65	.054	-.06	1.58	VW	.0002	8.3	7.0	10.3	.9	.67	2.03
VV1025	2	.334	0.000	.94	81.8	.80	1.18	.102	.67	2.01	UW	.0035	81.8	79.9	83.0	.8	-.69	2.06
WW1025	3	180.000	0.000	-.15	91.3	-.28	-.09	.040	1.41	4.00	UV	.0022	91.3	90.8	92.4	.3	1.40	3.99
UU1026	1	.067	0.000	6.42	5.6	6.38	6.47	.013	.25	2.72	VW	.0000	5.6	5.0	6.3	.2	.06	2.12
VV1026	2	.401	0.000	.60	84.6	.53	.68	.026	-.03	2.13	UW	-.0001	84.6	83.9	85.3	.2	-.03	2.10
WW1026	3	180.000	0.000	-.18	91.6	.23	-.14	.014	-.61	3.00	UV	-.0001	91.6	91.3	92.1	.1	.70	3.07
UU1028	1	.067	0.000	6.33	3.1	6.30	6.36	.010	-.14	2.45	VW	.0000	3.1	2.7	3.5	.1	-.10	2.92
VV1028	2	.535	0.000	.28	87.4	.23	.33	.011	-.18	2.92	UW	-.0000	87.4	87.0	87.9	.1	.51	2.98
WW1028	3	180.000	0.000	-.20	91.8	-.22	-.17	.008	.01	2.91	UV	.0000	91.8	91.5	92.0	.1	-.10	2.90
UU1035	1	0.000	0.000	6.21	9.8	6.06	6.37	.009	-.01	1.56	VW	.0003	9.8	8.3	10.7	.5	-1.21	3.44
VV1035	2	.334	0.000	1.07	80.2	.90	1.16	.053	1.20	3.73	UW	.0016	80.2	79.4	81.9	.5	1.23	3.48
WW1035	3	180.000	0.000	-.14	91.3	-.25	-.09	.024	-1.90	6.73	UV	.0002	91.3	90.8	92.3	.2	1.65	6.10
UU1036	1	0.000	0.000	6.25	6.1	6.20	6.31	.022	-.03	2.00	VW	.0001	6.1	5.5	6.6	.2	-.37	2.61
VV1036	2	.401	0.000	.65	84.1	.59	.70	.016	-.49	2.78	UW	-.0002	84.1	83.6	84.7	.2	.31	2.56
WW1036	3	180.000	0.000	-.16	91.5	-.21	-.12	.012	-.22	3.04	UV	.0000	91.5	91.1	91.9	.1	.46	3.09
UU1038	1	0.000	0.000	6.26	3.2	6.21	6.29	.010	-.16	3.42	VW	-.0000	3.2	2.8	3.7	.1	-.22	3.45
VV1038	2	.535	0.000	.30	87.2	.26	.36	.011	-.19	3.09	UW	-.0000	87.2	86.7	87.6	.1	-.54	2.95
WW1038	3	180.000	0.000	-.18	91.7	-.21	-.15	.007	.06	3.06	UV	.0000	91.7	91.4	91.9	.1	-1.15	2.95
UU1045	1	-.067	0.000	5.92	7.9	5.88	6.01	.026	.70	2.40	VW	.0001	7.9	6.9	8.9	.4	-.15	1.94
VV1045	2	.334	0.000	.82	82.2	.71	.93	.045	.10	1.87	UW	.0008	82.2	81.1	83.2	.4	.12	1.93
WW1045	3	180.000	0.000	-.12	91.2	-.16	-.07	.012	.33	2.74	UV	.0001	91.2	90.7	91.5	.1	-.60	2.82
UU1046	1	-.067	0.000	6.10	5.5	6.02	6.15	.017	.25	2.53	VW	-.0000	5.5	4.8	6.0	.1	.09	2.97
VV1046	2	.401	0.000	.57	84.7	.48	.62	.014	.04	2.93	UW	.0001	84.7	84.2	85.5	.1	.07	2.95
WW1046	3	180.000	0.000	-.15	91.4	-.18	.11	.010	-.01	2.61	UV	-.0000	91.3	91.0	91.7	.1	.40	2.65
UU1048	1	-.067	0.000	6.18	3.2	6.15	6.22	.012	.16	2.33	VW	-.0000	3.2	2.8	3.6	.1	.07	2.98
VV1048	2	.535	0.000	.30	87.2	.26	.35	.012	.03	2.93	UW	-.0000	87.2	86.7	87.6	.1	-.42	2.94
WW1048	3	180.000	0.000	-.16	91.5	-.19	-.13	.007	.00	2.99	UV	.0000	91.5	91.2	91.8	.1	1.06	3.04

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS		REYNOLDS STRESS	MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
				---VELOCITY INFORMATION---									------ANGLE INFORMATION------					
UU1041	1	-.067	0.000	5.39	1.1	5.26	5.54	.081	.26	1.72	VW	.0011	1.7	.4	3.4	.4	-.64	3.14
VV1041	2	.067	0.000	.07	87.3	.12	.25	.005	.19	2.35	UW	.0054	87.3	87.4	91.3	.9	.23	2.35
WW1041	3	180.000	0.000	-.08	90.9	-.31	.15	.090	1.01	2.78	UV	.0013	90.9	88.4	93.3	1.0	-1.03	2.81
UU1042	1	-.067	0.000	5.25	2.0	4.96	5.53	.147	.15	2.31	VW	-.0007	2.4	.2	4.1	.8	-.62	2.32
VV1042	2	.134	0.000	.17	88.1	.01	.33	.089	.01	1.63	UW	.0078	88.1	86.4	89.9	.9	.04	1.63
WW1042	3	180.000	0.000	-.06	90.7	-.23	.25	.121	.91	2.90	UV	.0023	90.7	87.2	92.5	1.3	-.91	2.89
UU1043	1	-.067	0.000	5.20	6.0	4.81	5.56	.206	.06	1.81	VW	.0013	6.1	4.9	7.4	.6	.22	1.81
VV1043	2	.201	0.000	.55	84.0	.45	.64	.043	-.16	1.57	UW	-.0021	84.0	82.6	85.1	.6	-.30	2.11
WW1043	3	180.000	0.000	-.01	90.2	-.15	.29	.114	.86	2.54	UV	.0015	90.1	86.9	91.6	1.2	-.86	2.51
UU1044	1	-.067	0.000	5.64	9.0	5.51	5.80	.075	.28	1.85	VW	-.0007	9.1	6.9	11.5	1.2	.11	1.68
VV1044	2	.267	0.000	.90	81.0	.69	1.13	.113	.13	1.69	UW	-.0078	81.0	78.5	83.1	1.2	-.11	1.68
WW1044	3	180.000	0.000	.03	89.7	-.06	.18	.054	.62	2.08	UV	.0024	89.7	88.2	90.6	.5	-.63	2.08
UU1045	1	-.067	0.000	6.13	6.8	6.08	6.20	.026	.66	2.40	VW	.0001	6.8	5.8	7.7	.4	-.12	1.93
VV1045	2	.334	0.000	.73	83.2	.62	.83	.044	-.11	1.88	UW	.0008	83.2	82.3	84.2	.4	.11	1.93
WW1045	3	180.000	0.000	.01	89.9	-.03	.06	.013	.25	2.67	UV	.0002	89.9	89.5	90.3	.1	-.32	2.69
UU1046	1	-.067	0.000	6.31	4.4	6.27	6.36	.015	.21	2.19	VW	.0000	4.4	4.0	4.9	.1	-.02	2.93
VV1046	2	.401	0.000	.49	85.6	.44	.54	.014	.04	2.87	UW	.0001	85.6	85.1	86.0	.1	.21	2.92
WW1046	3	180.000	0.000	-.03	90.3	-.06	.01	.009	.23	2.86	UV	.0000	90.3	89.9	90.5	.1	-.98	3.04
UU1048	1	-.067	0.000	6.41	2.0	6.36	6.45	.012	.24	2.91	VW	.0000	2.0	1.5	2.3	.1	-.02	3.10
VV1048	2	.535	0.000	.21	88.1	.16	.26	.012	-.09	3.03	UW	-.0000	88.1	87.7	88.5	.1	-.31	2.99
WW1048	3	180.000	0.000	-.06	90.5	-.09	-.03	.007	.09	2.97	UV	.0000	90.5	90.2	90.8	.1	1.14	2.87
UU1060	1	-.134	0.000	5.54	2.6	5.51	5.58	.009	.17	2.76	VW	-.0000	2.6	1.7	3.4	.3	-.06	1.80
VV1060	2	0.000	0.000	.19	88.1	.10	.26	.033	.02	1.80	UW	.0001	88.0	87.3	88.9	.3	-.03	1.80
WW1060	3	0.000	0.000	.16	88.3	.09	.22	.029	-.03	1.72	UV	.0001	88.3	87.7	89.0	.3	.03	1.72
UU1061	1	-.134	0.000	5.54	1.8	5.42	5.62	.033	.10	2.22	VW	.0000	1.8	.6	6.4	.4	-.60	3.26
VV1061	2	.067	0.000	-.08	90.8	-.19	.14	.038	-.08	2.41	UW	.0011	90.8	88.6	91.9	.4	.12	2.41
WW1061	3	180.000	0.000	-.15	91.6	.61	-.04	.038	.70	3.23	UV	.0002	91.6	90.4	96.2	.4	-.69	3.19
UU1062	1	-.134	0.000	5.57	1.4	5.44	5.70	.062	.16	2.26	VW	-.0001	1.5	.3	2.3	.4	-.62	2.45
VV1062	2	.134	0.000	.07	89.3	-.01	.15	.032	-.00	1.85	UW	.0016	89.3	88.5	90.1	.3	.03	1.86
WW1062	3	180.000	0.000	-.12	91.2	-.21	.01	.048	.63	2.38	UV	.0003	91.2	87.9	92.1	.5	-.62	2.37
UU1063	1	-.134	0.000	5.70	2.2	5.55	5.84	.072	.05	1.93	VW	-.0004	2.3	1.4	2.9	.3	-.48	3.03
VV1063	2	.201	0.000	.18	88.2	.08	.27	.036	-.45	2.12	UW	-.0006	88.2	87.3	89.2	.4	.39	2.13
WW1063	3	180.000	0.000	-.12	91.2	-.23	-.00	.045	.44	2.38	UV	.0008	91.2	90.0	92.3	.5	-.44	2.38
UU1064	1	-.134	0.000	5.85	4.4	5.77	5.94	.039	.08	1.79	VW	-.0001	4.4	3.6	5.3	.3	.11	2.08
VV1064	2	.267	0.000	.45	85.6	.37	.54	.031	.11	2.12	UW	-.0011	85.6	84.7	86.4	.3	-.16	2.08
WW1064	3	180.000	0.000	-.02	90.1	-.07	.06	.025	.44	2.13	UV	.0002	90.1	89.4	90.7	.2	-.53	2.18
UU1065	1	-.134	0.000	6.08	4.1	6.04	6.12	.011	.04	2.74	VW	-.0000	4.1	3.4	4.7	.2	-.01	2.10
VV1065	2	.334	0.000	.43	85.9	.36	.50	.025	-.01	2.09	UW	-.0002	85.9	85.3	86.6	.2	.04	2.10
WW1065	3	180.000	0.000	-.02	90.2	-.06	.02	.012	.17	2.71	UV	.0001	90.2	89.8	90.6	.1	-.47	2.77
UU1066	1	-.134	0.000	6.23	3.2	6.20	6.26	.008	.24	2.87	VW	.0000	3.2	2.6	3.7	.1	-.10	2.92
VV1066	2	.401	0.000	.35	86.8	.29	.40	.015	.14	2.90	UW	.0000	86.8	86.3	87.4	.1	.05	2.91
WW1066	3	180.000	0.000	-.04	90.3	-.07	-.01	.008	.03	3.06	UV	.0000	90.4	90.1	90.6	.1	-.97	2.97
UU1068	1	-.134	0.000	6.34	1.7	6.31	6.38	.008	-.04	2.89	VW	.0000	1.7	1.3	2.1	.1	.07	2.99
VV1068	2	.535	0.000	.18	88.4	.13	.23	.013	-.00	2.78	UW	-.0000	88.4	87.9	88.8	.1	.13	2.98
WW1068	3	180.000	0.000	-.04	90.4	-.07	.02	.008	.14	3.09	UV	.0000	90.4	90.1	90.6	.1	-.28	3.11

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS		REYNOLDS STRESS	ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU1070	1	-.267	0.000	5.83	2.3	5.80	5.85	.009	-1.05	3.27	VW	.0000	2.3	1.8	2.9	.1	.08	2.92
VV1070	2	0.000	0.000	.20	88.1	.14	.25	.014	.08	2.74	UW	.0000	88.1	87.5	88.6	.1	-.43	2.99
WW1070	3	0.000	0.000	.13	88.7	.09	.17	.010	.10	2.76	UV	.0000	88.7	88.3	89.1	.1	.47	2.80
UU1071	1	-.267	0.000	5.85	1.8	5.81	5.88	.011	.03	2.49	VW	.0000	1.8	1.3	2.3	.1	-.04	2.89
VV1071	2	.067	0.000	-.13	91.3	-.17	-.07	.013	.04	3.01	UW	.0000	91.3	90.7	91.7	.1	-.31	3.00
WW1071	3	180.000	0.000	-.13	91.3	-.17	-.09	.011	.26	2.84	UV	.0000	91.3	90.9	91.6	.1	-.28	2.84
UU1072	1	-.267	0.000	5.88	1.1	5.83	5.92	.015	-.11	2.57	VW	-.0000	1.1	.7	1.5	.1	-.13	2.85
VV1072	2	.134	0.000	-.03	90.3	-.07	.01	.012	-.01	2.97	UW	.0000	90.3	89.9	90.7	.1	-.32	2.95
WW1072	3	180.000	0.000	-.11	91.0	-.14	-.07	.011	.23	2.81	UV	.0000	91.0	90.7	91.4	.1	.20	2.70
UU1073	1	-.267	0.000	5.94	1.0	5.90	5.99	.014	.01	2.60	VW	-.0000	1.0	.7	1.4	.1	-.05	2.77
VV1073	2	.201	0.000	.02	89.8	-.03	.06	.010	.20	3.13	UW	.0000	89.8	89.5	90.3	.1	-.35	3.01
WW1073	3	180.000	0.000	-.10	91.0	-.15	-.07	.011	.10	2.80	UV	.0000	91.0	90.7	91.4	.1	.38	2.77
UU1074	1	-.267	0.000	6.03	.9	5.99	6.07	.013	.19	2.65	VW	-.0000	.9	.7	1.3	.1	.10	3.01
VV1074	2	.267	0.000	.05	89.5	.01	.10	.011	.05	3.13	UW	-.0000	89.5	89.0	89.9	.1	-.09	3.12
WW1074	3	180.000	0.000	-.08	90.8	-.11	-.04	.009	.08	2.83	UV	.0000	90.8	90.4	91.1	.1	-.87	2.89
UU1075	1	-.267	0.000	6.11	1.0	6.07	6.14	.009	.13	2.78	VW	-.0000	1.0	.7	1.3	.1	-.10	2.84
VV1075	2	.334	0.000	.06	89.5	.00	.10	.012	.16	3.03	UW	.0000	89.5	89.0	90.0	.1	-.39	2.94
WW1075	3	180.000	0.000	-.09	90.8	-.13	-.06	.009	.02	3.00	UV	.0000	90.8	90.5	91.2	.1	-.32	2.99
UU1076	1	-.267	0.000	6.18	1.0	6.15	6.20	.008	-.54	2.79	VW	-.0000	1.0	.7	1.3	.1	.27	3.47
VV1076	2	.401	0.000	.04	89.6	-.01	.09	.012	-.11	3.13	UW	.0000	89.6	89.2	90.1	.1	.50	3.16
WW1076	3	180.000	0.000	-.09	90.9	.14	.06	.009	.08	3.20	UV	.0000	90.9	90.5	91.3	.1	.19	3.21
UU1078	1	-.267	0.000	6.26	.9	6.23	6.29	.008	.36	2.52	VW	-.0000	.9	.5	1.2	.1	.04	3.16
VV1078	2	.535	0.000	-.03	90.2	-.07	.02	.012	.01	3.23	UW	.0000	90.2	89.8	90.7	.1	-.57	3.17
WW1078	3	180.000	0.000	-.09	90.8	-.12	-.06	.008	.25	3.24	UV	.0000	90.8	90.5	91.1	.1	-.78	3.34

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS	REYNOLDS STRESS	MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
			---VELOCITY INFORMATION---									---ANGLE INFORMATION---					
UU1080	1	-.535	0.000	5.73	.4	5.71	5.75	.006	-.78	3.09	VW .0000	.4	.1	.7	.1	-.24	3.35
VV1080	2	0.000	0.000	-.00	90.0	-.04	.04	.010	.16	3.14	UW .0000	90.0	89.6	90.4	.1	.30	3.04
WW1080	3	0.000	0.000	-.04	90.4	-.07	-.00	.008	.36	3.42	UV .0000	90.4	90.0	90.7	.1	-.49	3.47
UU1082	1	-.535	0.000	5.77	.6	5.75	5.79	.007	.55	2.58	VW -.0000	.6	.2	.9	.1	-.03	2.89
VV1082	2	.134	0.000	.04	89.6	.00	.07	.009	-.16	3.01	UW .0000	89.6	89.3	90.0	.1	.77	3.09
WW1082	3	180.000	0.000	.04	89.6	.01	.07	.008	.02	3.09	UV .0000	89.5	89.3	89.9	.1	.91	2.94
UU1084	1	-.535	0.000	5.80	.8	5.77	5.82	.008	-.16	2.67	VW -.0000	.8	.4	1.2	.1	.05	3.08
VV1084	2	.267	0.000	.05	89.5	.01	.09	.010	-.15	3.04	UW .0000	89.5	89.1	89.9	.1	-.14	3.01
WW1084	3	180.000	0.000	.06	89.4	.03	.09	.007	.27	3.15	UV .0000	89.5	89.1	89.7	.1	-1.37	3.49
UU1086	1	-.535	0.000	5.84	.7	5.81	5.86	.008	-.75	3.34	VW -.0000	.7	.2	1.1	.1	.06	3.18
VV1086	2	.401	0.000	.05	89.5	.00	.09	.010	-.07	3.26	UW .0000	89.5	89.1	90.0	.1	-.38	3.21
WW1086	3	180.000	0.000	.04	89.6	.01	.08	.008	-.22	2.92	UV .0000	89.5	89.2	89.9	.1	.68	3.03
UU1088	1	-.535	0.000	5.87	.6	5.83	5.90	.009	-.40	3.22	VW .0000	.6	.3	1.1	.1	.12	3.18
VV1088	2	.535	0.000	.03	89.7	.01	.09	.012	.03	3.18	UW -.0000	89.6	89.1	90.1	.1	.19	3.15
WW1088	3	180.000	0.000	.05	89.5	.03	.09	.007	.02	2.97	UV .0000	89.5	89.2	89.7	.1	-.84	3.01
UU1090	1	-.802	0.000	5.84	.7	5.82	5.87	.008	1.18	4.00	VW .0000	.8	.5	1.0	.1	-.08	2.93
VV1090	2	0.000	0.000	.01	89.9	-.04	.05	.010	.06	3.11	UW .0000	89.9	89.5	90.4	.1	-.72	3.06
WW1090	3	0.000	0.000	-.08	90.7	-.10	-.05	.008	.12	2.87	UV .0000	90.8	90.5	91.0	.1	-1.09	2.94
UU1094	1	-.802	0.000	5.82	.9	5.79	5.84	.010	-.78	2.09	VW .0000	.9	.6	1.2	.1	.25	3.24
VV1094	2	.267	0.000	.00	90.0	-.05	.04	.011	-.17	3.40	UW -.0000	90.0	89.6	90.5	.1	.36	3.43
WW1094	3	180.000	0.000	.09	89.1	.06	.12	.007	.17	3.25	UV .0000	89.1	88.8	89.4	.1	.50	3.03
UU1098	1	-.802	0.000	5.84	.8	5.81	5.86	.009	-.22	2.41	VW .0000	.8	.5	1.2	.1	.10	2.99
VV1098	2	.535	0.000	-.00	90.0	-.05	.04	.011	.16	3.22	UW -.0000	90.0	89.6	90.5	.1	.61	3.71
WW1098	3	180.000	0.000	.08	89.2	.05	.12	.008	.02	3.02	UV .0000	89.1	88.8	89.5	.1	.37	2.90
UU1100	1	-1.070	0.000	5.81	1.0	5.79	5.84	.007	.01	2.74	VW .0000	1.0	.7	1.3	.1	.03	2.98
VV1100	2	0.000	0.000	-.00	90.0	.05	.04	.009	.04	3.17	UW .0000	90.0	89.6	90.5	.1	.45	3.15
WW1100	3	0.000	0.000	-.10	91.0	-.13	-.07	.008	.06	2.87	UV .0000	90.9	90.7	91.2	.1	1.01	2.86
UU1104	1	-1.070	0.000	5.82	1.0	5.80	5.85	.008	-.01	2.43	VW .0000	1.1	.8	1.4	.1	-.01	3.29
VV1104	2	.267	0.000	.00	90.0	-.05	.04	.011	.05	3.29	UW .0000	90.0	89.6	90.5	.1	.14	3.30
WW1104	3	180.000	0.000	.11	89.0	.08	.14	.007	-.09	3.28	UV .0000	89.0	88.6	89.2	.1	-.89	3.15
UU1108	1	-1.070	0.000	5.85	1.0	5.82	5.88	.008	.41	2.52	VW -.0000	1.0	.5	1.3	.1	.09	2.94
VV1108	2	.535	0.000	-.01	90.1	-.05	.03	.010	-.02	3.19	UW -.0000	90.1	89.7	90.5	.1	.51	3.21
WW1108	3	180.000	0.000	.10	89.0	.05	.13	.008	.03	3.02	UV .0000	89.0	88.7	89.5	.1	-.94	3.01
UU1110	1	-1.605	0.000	5.84	1.1	5.81	5.87	.011	.00	2.39	VW .0000	1.1	.8	1.4	.1	.11	2.91
VV1110	2	0.000	0.000	-.00	90.0	-.04	.04	.009	.08	3.28	UW .0000	90.0	89.6	90.4	.1	.17	3.25
WW1110	3	0.000	0.000	-.11	91.1	-.14	-.09	.007	.21	2.90	UV .0000	91.1	90.8	91.3	.1	.07	2.86
UU1114	1	-1.605	0.000	5.87	1.2	5.85	5.90	.008	.63	3.06	VW -.0000	1.2	.9	1.5	.1	.00	3.02
VV1114	2	.267	0.000	.00	90.0	-.04	.05	.010	-.04	3.31	UW -.0000	90.0	89.5	90.4	.1	.13	3.31
WW1114	3	180.000	0.000	.13	88.8	.09	.15	.008	-.10	3.02	UV .0000	88.7	88.5	89.1	.1	.95	3.04
UU1118	1	-1.605	0.000	5.86	1.2	5.84	5.89	.009	.73	2.63	VW .0000	1.2	1.0	1.5	.1	-.03	2.77
VV1118	2	.535	0.000	-.01	90.1	-.06	.04	.011	-.04	3.26	UW -.0000	90.1	89.6	90.6	.1	.47	3.29
WW1118	3	180.000	0.000	.13	88.8	.10	.16	.008	-.07	2.73	UV .0000	88.7	88.5	89.0	.1	.72	2.76

*Note ($\bar{U}$ values are 2.5% low)

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS	REYNOLDS STRESS	ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU2001	1	.267	1.927	6.84	12.5	2.13	9.44	.644	-2.30	10.49	VW .0967	14.6	.3	55.0	7.0	2.22	8.64
VV2001	2	.067	2.949	-.02	90.2	-5.00	5.01	.919	.40	7.51	UW -.0870	90.1	45.8	130.4	7.8	-.33	7.78
WW2001	3	180.000	.500	-1.52	102.5	-6.58	4.31	.715	.44	12.35	UV -.1499	102.4	59.7	144.5	6.4	-.22	13.26
UU2002	1	.267	0.000	5.47	11.9	3.82	6.63	.332	.00	2.61	VW .0294	12.7	.1	39.5	3.6	.23	8.72
VV2002	2	.134	.306	.30	87.0	-1.62	3.20	.373	.79	7.51	UW -.0677	86.9	57.4	107.6	3.9	-.84	7.63
WW2002	3	180.000	.006	-1.11	101.5	-2.75	2.67	.389	2.26	9.88	UV -.0292	101.5	59.7	117.9	4.2	-2.01	9.02
UU2003	1	.267	.015	4.00	13.0	2.78	4.97	.226	.30	4.01	VW .0038	13.7	.1	40.0	3.8	.19	8.73
VV2003	2	.201	.361	.26	86.4	-1.70	2.35	.206	.52	7.61	UW -.0134	86.4	57.4	116.5	4.1	-.58	8.14
WW2003	3	180.000	.015	-.88	102.4	-2.31	2.20	.208	2.01	9.22	UV .0159	102.4	59.8	119.3	4.1	-1.90	9.28
UU2005	1	.267	0.000	8.54	2.8	8.26	8.89	.175	.15	1.61	VW .0015	2.9	1.1	5.3	1.1	.20	1.59
VV2005	2	.334	0.000	.35	87.7	.00	.74	.205	.03	1.59	UW .0050	87.7	85.1	90.0	1.4	-.02	1.58
WW2005	3	180.000	0.000	-.24	91.6	-.33	-.12	.022	.32	3.35	UV -.0015	91.6	90.8	92.2	.2	-.50	3.19
UU2006	1	.267	0.000	8.37	2.6	8.32	8.41	.014	-.32	2.73	VW .0001	2.6	2.3	3.1	.1	.18	3.25
VV2006	2	.401	0.000	.26	88.2	.20	.33	.017	.09	2.89	UW .0000	88.2	87.7	88.6	.1	-.13	2.88
WW2006	3	180.000	0.000	-.28	91.9	-.34	-.23	.015	-.15	2.96	UV .0000	91.9	91.6	92.3	.1	.47	3.02
UU2008	1	.267	0.000	8.18	2.3	8.14	8.23	.012	.14	2.82	VW .0000	2.3	1.9	2.7	.1	.05	3.11
VV2008	2	.535	0.000	.13	89.1	.08	.19	.014	.07	3.09	UW -.0000	89.1	88.7	89.5	.1	.56	3.11
WW2008	3	180.000	0.000	-.30	92.1	-.35	-.23	.012	.26	3.63	UV .0000	92.2	91.6	92.5	.1	-1.01	3.76
UU2011	1	.134	.145	7.09	14.5	4.99	8.90	.254	-.73	8.46	VW .0315	15.4	.1	41.5	3.2	1.59	16.70
VV2011	2	.067	.442	.33	87.4	-3.91	4.68	.663	-.43	5.53	UW -.0633	87.4	57.2	122.2	5.2	.47	5.84
WW2011	3	180.000	.006	-1.81	104.3	-4.26	2.72	.338	1.80	17.37	UV .0721	104.2	67.5	123.3	2.8	-1.55	16.32
UU2012	1	.134	.019	5.71	12.3	3.55	8.41	.392	-.01	7.37	VW .0484	13.8	.1	42.3	5.1	2.27	11.16
VV2012	2	.134	2.365	.47	85.4	-2.70	5.10	.632	1.82	9.13	UW .0585	85.4	51.3	118.5	6.1	-1.69	8.29
WW2012	3	180.000	.161	-1.16	101.4	-4.06	3.81	.470	2.27	14.85	UV -.0532	101.4	59.7	125.1	4.9	-2.19	13.99
UU2013	1	.134	.034	4.40	13.7	2.74	5.39	.359	-.94	3.18	VW .0069	15.3	.2	41.0	5.3	1.29	7.09
VV2013	2	.201	2.097	.40	83.9	-2.54	3.05	.450	.66	6.10	UW -.0817	83.7	51.4	124.1	6.0	-.87	6.67
WW2013	3	180.000	.420	-.96	102.2	-2.45	2.53	.462	2.57	13.27	UV -.0480	102.0	59.7	122.1	6.1	-2.52	13.86
UU2015	1	.134	0.000	8.43	5.5	8.21	8.66	.125	.08	1.60	VW -.0027	5.5	4.2	6.8	.6	.00	1.75
VV2015	2	.334	0.000	.78	84.7	.60	.98	.093	.04	1.74	UW .0002	84.7	83.3	85.9	.6	-.10	1.73
WW2015	3	180.000	0.000	-.20	91.4	-.30	-.13	.030	-.07	3.13	UV -.0006	91.4	90.9	92.0	.2	.73	3.08
UU2016	1	.134	0.000	8.20	4.0	8.14	8.23	.013	-.74	4.06	VW .0000	4.0	3.5	4.6	.2	-.04	2.30
VV2016	2	.401	0.000	.52	86.3	.45	.60	.026	-.14	2.33	UW .0000	86.3	85.8	86.9	.2	.15	2.34
WW2016	3	180.000	0.000	-.25	91.7	-.31	.21	.017	.45	2.72	UV -.0000	91.7	91.4	92.1	.1	.23	2.59
UU2018	1	.134	0.000	8.05	2.6	8.01	8.09	.012	-.03	2.76	VW .0000	2.6	2.2	3.0	.1	.02	2.94
VV2018	2	.535	0.000	.26	88.2	.19	.31	.015	-.14	2.91	UW .0000	88.2	87.8	88.6	.1	-.07	2.87
WW2018	3	180.000	0.000	-.26	91.9	-.32	-.22	.012	.05	3.09	UV -.0000	91.8	91.5	92.3	.1	.92	3.03
UU2021	1	.067	.284	7.05	14.6	4.22	8.77	.461	.63	3.70	VW .0463	17.1	.3	42.3	5.2	.68	5.56
VV2021	2	.067	1.572	.54	85.7	-4.62	4.93	1.065	.16	2.82	UW -.3376	85.5	50.6	120.5	8.6	-.14	3.06
WW2021	3	180.000	.262	-1.75	103.9	-4.39	4.18	.731	2.03	12.38	UV -.0938	103.7	59.7	127.3	5.9	-2.02	12.81
UU2022	1	.067	.111	5.09	12.4	3.26	8.82	.733	-.02	1.83	VW .0009	16.4	.3	45.1	7.2	.77	3.54
VV2022	2	.134	2.866	.54	84.9	-3.69	6.27	.860	1.28	6.44	UW -.3718	84.5	47.0	127.6	8.3	-.94	4.77
WW2022	3	180.000	2.514	-1.18	101.3	-4.85	4.82	1.044	1.85	9.53	UV .0915	101.1	59.7	130.5	9.8	-1.76	8.62
UU2023	1	.067	.090	4.78	13.4	2.71	6.51	.793	.67	2.10	VW .0776	17.2	.5	44.1	7.3	1.05	3.74
VV2023	2	.201	3.841	.74	81.3	-2.89	3.99	.577	1.46	8.00	UW -.0623	81.3	47.6	124.5	7.1	-1.45	7.59
WW2023	3	180.000	3.693	-.86	100.1	3.23	3.48	.950	1.40	7.48	UV .0761	100.0	59.7	126.2	10.9	-1.58	7.45

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS		REYNOLDS STRESS	ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU2025	1	.067	0.000	8.20	7.0	7.98	8.42	.127	.04	1.53	VW	.0052	7.0	4.6	9.2	1.4	-.10	1.45
VV2025	2	.334	0.000	.99	83.1	.64	1.30	.208	-.15	1.46	UW	-.0020	83.1	80.9	85.5	1.4	.08	1.45
WW2025	3	180.000	0.000	-.19	91.3	-.37	-.10	.053	-1.31	3.90	UV	-.0022	91.3	90.7	92.6	.4	1.34	3.91
UU2026	1	.067	0.000	8.07	4.8	8.01	8.13	.022	.02	2.39	VW	.0002	4.8	4.1	5.5	.3	-.07	1.90
VV2026	2	.401	0.000	.64	85.5	.51	.74	.038	.13	1.92	UW	.0004	85.5	84.8	86.2	.3	.13	1.90
WW2026	3	180.000	0.000	-.22	91.6	-.29	-.17	.018	-.37	2.96	UV	-.0001	91.6	91.2	92.0	.1	.29	2.89
UU2028	1	.067	0.000	7.95	2.7	7.87	8.00	.016	-.83	3.40	VW	.0000	2.7	2.4	3.1	.1	-.01	2.91
VV2028	2	.535	0.000	.29	87.9	.24	.35	.014	-.21	3.06	UW	-.0000	87.9	87.5	88.3	.1	.84	3.22
WW2028	3	180.000	0.000	-.24	91.8	-.29	-.20	.012	.02	2.89	UV	.0000	91.7	91.4	92.1	.1	-.08	2.90
UU2035	1	0.000	0.000	7.90	7.5	7.70	8.14	.133	.16	1.53	VW	.0016	7.5	5.8	8.5	.6	-.71	2.68
VV2035	2	.334	0.000	1.02	82.7	.79	1.16	.083	-.50	2.36	UW	.0016	82.7	81.6	84.4	.6	.71	2.65
WW2035	3	180.000	0.000	-.19	91.4	-.30	-.12	.027	-.77	4.05	UV	.0007	91.4	90.9	92.2	.2	.63	3.58
UU2036	1	0.000	0.000	7.84	5.0	7.77	7.92	.031	.04	1.92	VW	.0001	5.0	4.4	5.5	.1	-.26	2.82
VV2036	2	.401	0.000	.65	85.3	.57	.72	.020	.23	2.73	UW	-.0001	85.3	84.7	85.8	.2	.43	2.83
WW2036	3	180.000	0.000	-.21	91.6	-.26	-.16	.013	.10	3.05	UV	.0000	91.6	91.2	91.9	.1	-.27	3.03
UU2045	1	-.067	0.000	7.61	6.3	7.55	7.71	.035	.57	2.25	VW	.0005	6.3	5.2	7.2	.5	-.13	1.73
VV2045	2	.334	0.000	.82	83.9	.67	.95	.067	-.08	1.69	UW	.0012	83.9	82.9	85.0	.5	.09	1.71
WW2045	3	180.000	0.000	-.17	91.3	-.23	-.10	.019	.20	2.47	UV	.0003	91.3	90.7	91.7	.1	-.13	2.41
UU2046	1	-.067	0.000	7.74	4.5	7.69	7.79	.021	.21	2.15	VW	.0001	4.5	4.1	5.1	.2	.12	2.71
VV2046	2	.401	0.000	.58	85.7	.51	.66	.022	.03	2.57	UW	.0002	85.7	85.1	86.2	.2	-.13	2.63
WW2046	3	180.000	0.000	-.20	91.5	-.25	-.14	.015	.10	2.61	UV	.0000	91.5	91.1	91.8	.1	.36	2.59
UU2048	1	-.067	0.000	7.80	2.7	7.75	7.85	.015	.66	3.18	VW	-.0000	2.7	2.3	3.2	.1	.14	3.33
VV2048	2	.535	0.000	.31	87.7	.25	.36	.015	.08	2.88	UW	-.0000	87.7	87.4	88.2	.1	-.02	2.86
WW2048	3	180.000	0.000	-.21	91.5	-.26	-.16	.012	.08	3.12	UV	-.0000	91.5	91.2	91.9	.1	.41	3.15

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEWNESS	FLATNESS		REYNOLDS STRESS	ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEWNESS	FLATNESS
UU2041	1	-.067	0.000	6.85	1.5	6.59	7.09	.131	-.04	2.09	VW	-.0018	2.2	.3	3.8	.8	-.44	2.17
VV2041	2	.067	0.000	-.01	90.1	-.31	.28	.146	-.04	1.88	UW	.0175	90.1	87.8	92.7	1.2	.10	1.89
WW2041	3	180.000	0.000	-.18	91.5	-.41	.18	.157	.62	2.29	UV	.0051	91.5	88.4	93.4	1.3	-.62	2.30
UU2042	1	-.067	0.000	6.76	1.9	6.27	7.21	.254	-.13	1.93	VW	-.0008	2.6	.0	3.8	.9	-1.28	3.59
VV2042	2	.134	0.000	.17	88.6	-.06	.40	.121	.02	1.66	UW	.0277	88.6	86.8	90.5	1.0	.05	1.66
WW2042	3	180.000	0.000	-.15	91.3	-.40	.36	.205	.76	2.36	UV	.0049	91.3	87.0	93.4	1.7	-.77	2.37
UU2043	1	-.067	0.000	6.83	4.7	6.27	7.33	.309	-.13	1.71	VW	-.0065	4.9	3.6	6.5	.6	.23	2.15
VV2043	2	.201	0.000	.56	85.4	.42	.69	.052	.15	2.19	UW	-.0096	85.3	83.7	86.7	.6	-.37	2.37
WW2043	3	180.000	0.000	-.09	90.7	-.40	.38	.178	.96	2.61	UV	.0040	90.7	86.7	93.2	1.5	-.98	2.63
UU2045	1	-.067	0.000	7.89	3.9	7.82	8.00	.037	.53	2.28	VW	.0007	4.0	2.9	5.0	.5	-.07	1.72
VV2045	2	.334	0.000	.54	86.1	.37	.70	.073	-.04	1.70	UW	.0014	86.1	85.0	87.3	.5	.05	1.71
WW2045	3	180.000	0.000	-.10	90.7	-.18	.03	.025	.14	2.32	UV	.0010	90.7	90.2	91.3	.2	-.05	2.29
UU2046	1	-.067	0.000	8.03	2.3	7.96	8.10	.023	.17	2.21	VW	.0001	2.3	1.8	2.8	.1	-.02	2.63
VV2046	2	.401	0.000	.29	87.9	.21	.37	.024	-.03	2.51	UW	.0002	87.9	87.4	88.5	.2	.04	2.54
WW2046	3	180.000	0.000	-.14	91.0	-.19	-.09	.013	.20	3.22	UV	.0001	91.0	90.6	91.3	.1	.47	3.06
UU2048	1	-.067	0.000	8.07	1.2	8.04	8.11	.011	.05	2.79	VW	-.0000	1.2	.9	1.6	.1	.28	3.48
VV2048	2	.535	0.000	.03	89.8	-.05	.09	.017	.01	2.86	UW	-.0000	89.8	89.3	90.3	.1	-.23	2.87
WW2048	3	180.000	0.000	-.17	91.2	-.22	-.12	.010	.05	3.20	UV	.0000	91.2	90.9	91.6	.1	-1.06	3.11
UU2060	1	-.134	0.000	7.00	1.7	6.97	7.15	.010	.46	3.03	VW	.0000	1.7	.1	2.4	.2	-.04	2.19
VV2060	2	0.000	0.000	.14	88.8	.00	.23	.029	.10	2.23	UW	-.0000	88.8	88.1	90.0	.2	-.10	2.23
WW2060	3	0.000	0.000	.15	88.8	-.01	.22	.024	.06	2.11	UV	.0000	88.8	88.2	90.1	.2	-.10	2.10
UU2061	1	-.134	0.000	7.04	1.2	6.94	7.15	.044	-.12	2.16	VW	-.0001	1.3	.1	2.2	.4	-.57	2.37
VV2061	2	.067	0.000	-.01	90.1	-.15	.13	.055	-.06	1.96	UW	.0022	90.1	88.9	91.2	.4	.06	1.96
WW2061	3	180.000	0.000	-.15	91.2	-.27	-.00	.056	.40	2.09	UV	.0002	91.2	90.0	92.2	.5	-.40	2.09
UU2062	1	-.134	0.000	7.10	1.6	6.90	7.28	.095	-.13	1.84	VW	.0004	1.7	.5	2.5	.4	-.55	2.05
VV2062	2	.134	0.000	.15	88.8	.04	.26	.048	-.02	1.75	UW	.0041	88.8	87.9	89.6	.4	.04	1.77
WW2062	3	180.000	0.000	-.12	91.0	-.25	.06	.076	.42	1.91	UV	.0003	91.0	89.5	92.0	.6	-.45	1.93
UU2063	1	-.134	0.000	7.25	2.5	7.03	7.44	.109	-.08	1.67	VW	-.0008	2.5	1.9	3.2	.2	.09	2.56
VV2063	2	.201	0.000	.29	87.7	.21	.36	.019	-.18	2.90	UW	-.0006	87.7	87.1	88.3	.2	.04	2.87
WW2063	3	180.000	0.000	-.11	90.9	-.23	.04	.066	.55	1.96	UV	.0006	90.9	89.6	91.8	.5	-.52	1.94
UU2064	1	-.134	0.000	7.56	2.6	7.44	7.73	.065	.04	1.68	VW	-.0004	2.7	1.5	3.6	.3	.12	1.91
VV2064	2	.267	0.000	.34	87.5	.04	.46	.048	.17	1.97	UW	-.0028	87.4	86.5	89.7	.4	-.17	1.94
WW2064	3	180.000	0.000	-.09	90.7	-.20	.02	.042	.52	2.07	UV	.0008	90.7	89.8	91.5	.3	-.46	2.03
UU2065	1	-.134	0.000	7.77	2.3	7.72	7.82	.019	.19	2.33	VW	.0000	2.3	1.6	3.1	.3	.00	2.04
VV2065	2	.334	0.000	.29	87.9	.17	.40	.039	.01	2.02	UW	-.0005	87.9	87.1	88.8	.3	-.00	2.01
WW2065	3	180.000	0.000	-.12	90.9	-.20	-.05	.022	.09	2.60	UV	.0003	90.9	90.3	91.4	.2	-.04	2.59
UU2066	1	-.134	0.000	7.91	1.7	7.88	7.96	.011	.09	2.80	VW	.0000	1.7	1.2	2.2	.1	-.09	2.73
VV2066	2	.401	0.000	.20	88.6	.11	.28	.025	-.15	2.66	UW	-.0000	88.6	88.0	89.2	.2	.23	2.68
WW2066	3	180.000	0.000	-.14	91.0	-.20	-.10	.013	.29	3.14	UV	.0001	91.0	90.7	91.4	.1	.84	3.35
UU2068	1	-.134	0.000	8.01	1.1	7.96	8.05	.011	.03	2.90	VW	-.0000	1.1	.8	1.4	.1	-.25	3.49
VV2068	2	.535	0.000	.01	89.9	-.06	.07	.017	-.10	2.83	UW	-.0000	89.9	89.5	90.4	.1	-.18	2.80
WW2068	3	180.000	0.000	-.15	91.1	.19	-.11	.010	.28	3.33	UV	.0001	91.0	90.8	91.3	.1	.72	2.95

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS	REYNOLDS STRESS		ANGLE INFORMATION MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU2070	1	-.267	0.000	7.42	1.7	7.39	7.46	.010	.15	2.20	VW	.0000	1.7	1.2	2.2	.1	.03	3.08
VV2070	2	0.000	0.000	.17	88.7	.11	.23	.016	.07	3.00	UW	.0000	88.7	88.2	89.2	.1	.15	3.01
WW2070	3	0.000	0.000	.14	88.9	.09	.20	.014	-.12	2.82	UV	.0000	88.9	88.5	89.3	.1	-.01	2.80
UU2071	1	-.267	0.000	7.45	1.3	7.41	7.48	.011	.14	2.81	VW	-.0000	1.3	.8	1.8	.1	.06	2.88
VV2071	2	.067	0.000	-.10	90.8	-.16	-.03	.016	.02	2.79	UW	.0000	90.8	90.2	91.2	.1	-.13	2.92
WW2071	3	180.000	0.000	-.14	91.0	-.19	-.07	.015	.07	2.96	UV	.0001	91.0	90.6	91.4	.1	.23	2.94
UU2072	1	-.267	0.000	7.50	1.0	7.45	7.55	.016	.19	2.56	VW	-.0000	1.0	.5	1.4	.1	-.16	2.72
VV2072	2	.134	0.000	-.02	90.2	-.08	.03	.015	.02	2.93	UW	.0001	90.2	89.7	90.6	.1	.17	2.93
WW2072	3	180.000	0.000	-.13	91.0	-.18	-.07	.015	.23	2.71	UV	.0000	91.0	90.5	91.4	.1	.18	2.61
UU2073	1	-.267	0.000	7.55	1.0	7.50	7.61	.020	-.17	2.26	VW	.0000	1.0	.6	1.3	.1	-.16	2.52
VV2073	2	.201	0.000	.03	89.7	-.02	.10	.014	-.07	3.17	UW	.0000	89.7	89.2	90.2	.1	.24	3.17
WW2073	3	180.000	0.000	-.12	90.9	-.18	-.06	.016	.26	2.74	UV	.0001	90.9	90.4	91.3	.1	.04	2.66
UU2074	1	-.267	0.000	7.68	.8	7.63	7.74	.019	.06	2.40	VW	-.0001	.9	.5	1.2	.1	.12	2.94
VV2074	2	.267	0.000	.07	89.5	.00	.13	.014	.02	3.22	UW	-.0001	89.5	89.0	90.0	.1	-.11	3.23
WW2074	3	180.000	0.000	-.09	90.7	-.15	-.03	.015	.06	2.74	UV	.0000	90.7	90.2	91.1	.1	-.49	2.96
UU2075	1	-.267	0.000	7.76	.9	7.72	7.80	.012	.02	2.57	VW	-.0000	.9	.5	1.4	.1	-.07	3.20
VV2075	2	.334	0.000	.07	89.5	.00	.14	.018	-.13	3.02	UW	-.0001	89.5	89.0	90.0	.1	-.00	3.00
WW2075	3	180.000	0.000	-.10	90.8	-.18	-.04	.015	-.18	3.47	UV	.0000	90.8	90.3	91.3	.1	-.38	3.28
UU2078	1	-.267	0.000	7.90	.8	7.86	7.94	.014	.41	2.63	VW	.0000	.8	.4	1.1	.1	.07	3.04
VV2078	2	.535	0.000	-.02	90.2	-.08	.04	.015	.01	3.10	UW	-.0000	90.1	89.7	90.6	.1	.57	3.12
WW2078	3	180.000	0.000	-.11	90.8	-.15	-.06	.010	.16	3.21	UV	.0001	90.8	90.4	91.0	.1	-1.20	3.22

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS		REYNOLDS STRESS	ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU2080	1	-.535	0.000	7.30	.5	7.27	7.35	.010	-.52	3.34	VW	.0000	.5	.2	1.0	.1	-.08	2.71
VV2080	2	0.000	0.000	.04	89.7	-.02	.12	.014	-.26	3.86	UW	.0000	89.7	89.0	90.2	.1	.63	3.94
WW2080	3	0.000	0.000	-.05	90.4	-.10	-.00	.012	.08	3.03	UV	.0000	90.4	90.0	90.7	.1	-.15	2.99
UU2082	1	-.535	0.000	7.31	.4	7.28	7.33	.008	-.43	2.79	VW	.0000	.4	.1	.7	.1	.04	3.13
VV2082	2	.134	0.000	-.03	90.2	.08	.02	.011	.01	3.29	UW	.0000	90.2	89.8	90.6	.1	.22	3.30
WW2082	3	180.000	0.000	.05	89.6	.01	.09	.013	.08	2.97	UV	.0001	89.6	89.3	90.0	.1	.71	3.01
UU2084	1	-.535	0.000	7.33	.3	7.30	7.36	.007	.14	3.02	VW	.0000	.4	.1	.7	.1	.05	3.36
VV2084	2	.267	0.000	-.01	90.1	.06	.04	.013	-.17	2.89	UW	.0000	90.1	89.7	90.4	.1	.33	2.92
WW2084	3	180.000	0.000	.04	89.7	.00	.08	.010	-.18	3.20	UV	.0000	89.6	89.3	90.0	.1	1.10	3.28
UU2086	1	-.535	0.000	7.38	.5	7.34	7.42	.012	.15	2.78	VW	-.0000	.5	.2	.8	.1	.23	3.23
VV2086	2	.401	0.000	-.00	90.0	-.05	.04	.012	.19	3.10	UW	.0000	90.0	89.7	90.4	.1	.70	3.22
WW2086	3	180.000	0.000	.07	89.5	.03	.11	.011	.09	3.22	UV	.0000	89.5	89.2	89.8	.1	-.64	3.30
UU2088	1	-.535	0.000	7.41	.6	7.36	7.44	.011	.40	2.46	VW	.0000	.6	.3	1.0	.1	.02	3.23
VV2088	2	.535	0.000	-.00	90.0	-.04	.05	.011	.08	3.18	UW	-.0000	90.0	89.6	90.3	.1	.30	3.14
WW2088	3	180.000	0.000	.08	89.4	.04	.13	.011	-.05	3.20	UV	.0000	89.4	89.0	89.7	.1	-.48	3.17
UU2090	1	-.802	0.000	7.34	1.5	7.30	7.37	.012	.28	2.20	VW	.0001	1.5	1.1	1.8	.1	-.40	2.83
VV2090	2	0.000	0.000	.12	89.1	.06	.17	.014	-.34	3.37	UW	.0000	89.1	88.7	89.6	.1	.22	3.36
WW2090	3	0.000	0.000	-.16	91.2	.20	.11	.013	.17	2.66	UV	.0000	91.2	90.9	91.5	.1	.78	2.78
UU2094	1	-.802	0.000	7.34	1.7	7.30	7.38	.015	.06	2.14	VW	.0000	1.7	1.3	2.0	.1	.14	3.19
VV2094	2	.267	0.000	-.15	91.2	.20	.10	.013	.09	2.95	UW	.0000	91.2	90.8	91.5	.1	-.15	2.95
WW2094	3	180.000	0.000	.16	88.8	.11	.19	.010	.11	3.43	UV	.0000	88.8	88.5	89.1	.1	.91	3.40
UU2098	1	-.802	0.000	7.29	3.2	7.09	7.36	.035	.60	3.08	VW	.0016	3.2	2.0	7.2	.7	.56	3.11
VV2098	2	.535	0.000	-.30	92.3	.73	-.16	.080	.51	2.97	UW	.0025	92.3	91.2	95.8	.6	.55	3.04
WW2098	3	180.000	0.000	.29	87.8	.18	.56	.050	.47	2.99	UV	-.0039	87.8	85.5	88.6	.4	-.50	3.06
UU2100	1	-1.070	0.000	7.36	1.6	7.33	7.39	.011	.41	2.26	VW	.0000	1.6	1.3	1.9	.1	-.46	2.84
VV2100	2	0.000	0.000	.09	89.3	.04	.15	.013	.12	3.15	UW	.0000	89.2	88.9	89.7	.1	.55	3.19
WW2100	3	0.000	0.000	-.18	91.4	.22	-.13	.013	.31	2.85	UV	.0000	91.4	91.0	91.7	.1	.38	2.61
UU2104	1	-1.070	0.000	7.38	1.5	7.34	7.42	.013	.24	2.39	VW	-.0000	1.5	1.1	1.8	.1	-.11	3.75
VV2104	2	.267	0.000	-.07	90.5	.13	.01	.013	.27	3.53	UW	.0001	90.5	90.1	91.0	.1	.72	3.69
WW2104	3	180.000	0.000	.18	88.6	.13	.22	.011	.08	3.39	UV	.0000	88.6	88.3	89.0	.1	-.34	3.34
UU2108	1	-1.070	0.000	7.41	1.5	7.37	7.44	.011	.32	2.63	VW	.0000	1.5	1.2	1.8	.1	-.10	2.72
VV2108	2	.535	0.000	-.08	90.7	.13	.02	.014	.07	2.87	UW	-.0000	90.7	90.2	91.0	.1	-.54	2.90
WW2108	3	180.000	0.000	.17	88.7	.13	.22	.010	.10	2.95	UV	.0000	88.6	88.3	89.0	.1	.59	2.83
UU2110	1	-1.605	0.000	7.41	1.5	7.38	7.44	.008	.02	2.61	VW	.0000	1.5	1.1	1.8	.1	-.26	3.02
VV2110	2	0.000	0.000	.09	89.3	.03	.15	.014	.07	3.32	UW	.0000	89.3	88.8	89.8	.1	.37	3.33
WW2110	3	0.000	0.000	-.17	91.3	.22	.12	.013	.07	2.67	UV	.0000	91.3	90.9	91.7	.1	.21	2.67
UU2114	1	-1.605	0.000	7.41	1.7	7.38	7.45	.011	.71	3.57	VW	.0000	1.7	1.5	2.0	.1	-.01	2.74
VV2114	2	.267	0.000	-.09	90.7	-.15	-.04	.014	-.05	2.78	UW	.0000	90.7	90.3	91.1	.1	-.61	2.73
WW2114	3	180.000	0.000	.20	88.5	.15	.24	.012	-.08	3.24	UV	.0001	88.5	88.1	88.8	.1	-.23	3.21
UU2118	1	-1.605	0.000	7.42	1.8	7.29	7.56	.011	.73	4.31	VW	.0000	1.8	1.4	3.0	.1	.06	3.11
VV2118	2	.535	0.000	-.10	90.8	-.25	.04	.016	.02	3.70	UW	.0000	90.8	89.7	92.0	.1	-.43	3.70
WW2118	3	180.000	0.000	.20	88.4	.09	.39	.013	.27	4.21	UV	.0000	88.4	87.0	89.3	.1	-.37	4.02

*Note ($\bar{U}$ values are 2.5% low)

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS	REYNOLDS STRESS		ANGLE INFORMATION MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU3001	1	.267	.655	5.56	10.0	1.04	7.89	.429	-2.88	17.25	VW	.0070	11.7	.1	54.2	5.7	2.93	13.93
VV3001	2	.067	1.825	.12	88.8	-4.03	4.41	.526	.82	10.33	UW	-.0507	88.7	40.6	131.1	6.3	-.78	11.01
WW3001	3	180.000	.534	-.98	100.0	-4.46	3.35	.482	1.49	19.80	UV	.0714	99.9	59.7	143.6	5.3	-1.38	22.09
UU3002	1	.267	.006	4.22	10.7	2.81	5.11	.296	.18	2.70	VW	.0128	11.8	.1	39.9	4.1	.93	9.15
VV3002	2	.134	.445	.28	86.2	-2.02	2.51	.293	1.24	9.51	UW	-.0206	86.2	56.2	122.7	4.0	-1.26	9.93
WW3002	3	180.000	.074	-.74	99.9	-2.17	2.37	.363	1.92	8.77	UV	-.0207	99.9	59.7	119.3	5.0	-1.79	8.74
UU3003	1	.267	.012	2.78	13.2	1.78	3.65	.231	-.20	2.96	VW	.0035	14.5	.2	41.9	5.8	1.13	6.91
VV3003	2	.201	2.483	.27	84.7	-1.17	1.91	.277	1.14	6.19	UW	.0151	84.7	53.1	114.2	6.1	-1.18	6.33
WW3003	3	180.000	.077	-.59	102.0	-1.76	1.53	.283	1.27	6.35	UV	-.0173	101.9	59.7	121.2	5.7	-1.25	6.63
UU3005	1	.267	0.000	6.81	3.7	6.39	7.37	.164	.19	2.17	VW	-.0009	3.8	.1	10.2	1.3	.22	2.43
VV3005	2	.334	0.000	.36	87.0	-.15	1.12	.178	.15	2.31	UW	.0044	87.0	81.1	91.3	1.5	-.13	2.30
WW3005	3	180.000	0.000	-.25	92.1	-.62	.13	.075	.01	3.09	UV	-.0043	92.1	88.9	95.1	.6	-.02	3.07
UU3006	1	.267	0.000	6.65	3.4	6.38	6.93	.068	.01	2.90	VW	-.0002	3.4	.8	6.3	.6	.03	3.06
VV3006	2	.401	0.000	.29	87.5	-.12	.63	.076	-.03	3.13	UW	-.0002	87.5	84.5	91.0	.7	.02	3.13
WW3006	3	180.000	0.000	-.26	92.2	-.56	.04	.068	.02	3.02	UV	-.0001	92.2	89.6	94.8	.6	-.01	3.02
UU3008	1	.267	0.000	6.43	3.1	6.17	6.69	.067	-.04	2.95	VW	-.0001	3.1	.5	5.7	.7	.01	2.97
VV3008	2	.535	0.000	.19	88.4	-.12	.48	.075	.00	3.04	UW	.0000	88.3	85.6	91.1	.7	-.01	3.04
WW3008	3	180.000	0.000	-.29	92.6	.58	.11	.070	.07	2.99	UV	-.0005	92.6	89.0	95.2	.6	-.06	2.99
UU3011	1	.134	.015	5.81	10.0	4.05	6.98	.200	-1.00	7.61	VW	.0206	11.2	.2	39.4	3.5	1.63	11.77
VV3011	2	.067	.312	.20	88.0	-2.81	3.51	.525	.55	4.33	UW	.0570	88.0	56.5	118.6	5.1	-.59	4.64
WW3011	3	180.000	.015	-1.01	99.8	-2.83	2.81	.313	1.66	12.70	UV	.0749	99.8	59.8	118.0	3.1	-1.52	12.60
UU3012	1	.134	.019	4.34	10.7	2.78	5.46	.361	-.49	2.79	VW	-.0060	13.8	.2	40.3	5.9	1.60	7.73
VV3012	2	.134	2.773	.37	85.2	-2.19	3.14	.550	1.07	5.68	UW	-.1221	85.0	51.6	120.0	7.3	-1.05	5.40
WW3012	3	180.000	.896	-.73	99.5	-2.51	2.58	.554	2.13	9.11	UV	-.0466	99.4	59.7	120.3	7.3	-2.16	9.56
UU3013	1	.134	.130	2.91	13.9	1.56	3.95	.269	.36	3.99	VW	.0050	16.5	.2	41.9	6.5	1.32	6.09
VV3013	2	.201	4.796	.38	82.7	-1.76	2.34	.408	.72	5.12	UW	-.0475	82.6	50.3	124.4	8.0	-.69	4.89
WW3013	3	180.000	.791	-.61	101.8	-1.93	1.93	.383	2.33	11.14	UV	-.0208	101.6	59.7	125.5	7.3	-2.33	11.19
UU3015	1	.134	0.000	6.69	6.8	6.32	7.01	.106	-.10	2.55	VW	.0014	6.8	2.9	11.5	1.2	-.03	2.41
VV3015	2	.334	0.000	.76	83.5	.26	1.29	.145	.05	2.32	UW	.0027	83.5	78.9	87.7	1.2	.03	2.37
WW3015	3	180.000	0.000	-.22	91.9	-.56	.07	.072	.01	2.95	UV	-.0012	91.9	89.4	94.8	.6	.02	2.95
UU3016	1	.134	0.000	6.50	5.3	6.25	6.74	.070	-.06	2.92	VW	.0004	5.3	2.9	8.6	.7	.06	3.06
VV3016	2	.401	0.000	.56	85.1	.23	.89	.080	.00	2.93	UW	-.0002	85.1	82.1	87.9	.7	-.02	2.94
WW3016	3	180.000	0.000	-.23	92.0	-.51	.05	.069	.04	2.94	UV	-.0004	92.0	89.5	94.5	.6	-.03	2.93
UU3018	1	.134	0.000	6.30	3.6	6.06	6.60	.069	.04	3.06	VW	-.0001	3.7	.4	6.5	.7	-.05	3.07
VV3018	2	.535	0.000	.31	87.2	-.02	.60	.076	-.11	3.03	UW	.0002	87.2	84.5	90.2	.7	.10	3.03
WW3018	3	180.000	0.000	-.25	92.3	-.52	.10	.071	.10	3.11	UV	-.0007	92.3	89.1	94.7	.6	-.10	3.11
UU3021	1	.067	.031	5.75	11.6	3.72	7.10	.288	-.17	4.66	VW	.0248	13.7	.3	39.9	3.9	1.54	12.39
VV3021	2	.067	.794	.46	85.5	-3.57	3.91	.692	.09	3.29	UW	-.1293	85.4	53.7	127.7	6.8	-.13	3.44
WW3021	3	180.000	.235	-1.08	100.6	-3.04	3.50	.473	2.81	19.04	UV	.0009	100.6	59.7	119.8	4.7	-2.74	18.86
UU3022	1	.067	.207	4.46	10.9	2.80	6.39	.432	.78	3.34	VW	-.0036	15.6	.3	41.7	5.9	1.63	7.35
VV3022	2	.134	2.776	.41	84.8	-3.30	4.07	.680	.52	5.58	UW	-.1284	84.6	48.9	128.1	8.2	-.36	5.22
WW3022	3	180.000	2.801	-.76	99.6	-3.29	3.73	.771	2.17	9.36	UV	.0506	99.4	59.7	123.9	9.4	-2.21	9.16
UU3023	1	.067	.528	3.13	15.4	1.43	5.22	.326	.44	6.71	VW	.0451	18.4	.4	52.3	7.1	1.22	4.62
VV3023	2	.210	6.651	.55	80.3	-2.31	3.06	.561	.40	4.18	UW	.0077	80.7	49.5	126.8	9.4	-.12	3.90
WW3023	3	180.000	1.445	-.67	101.8	-2.75	2.51	.483	2.37	14.53	UV	-.0072	101.8	59.7	141.2	8.0	-2.17	12.84

Note (velocity values are possibly 3% low)

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS		REYNOLDS STRESS	ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU3025	1	.067	0.000	6.50	9.1	6.18	6.80	.086	.03	2.76	VW	.0002	9.1	5.2	13.1	1.1	.35	2.78
VV3025	2	.334	0.000	1.01	81.1	.53	1.46	.124	.38	2.76	UW	.0028	81.1	77.3	85.2	1.0	-.34	2.80
WW3025	3	180.000	0.000	-.21	91.9	-.50	.08	.079	-.12	3.03	UV	.0029	91.9	89.3	94.4	.7	.12	3.04
UU3026	1	.067	0.000	6.35	6.3	6.09	6.63	.071	-.05	2.82	VW	.0000	6.3	3.4	9.0	.7	.05	2.93
VV3026	2	.401	0.000	.66	84.0	.35	.96	.079	.01	2.91	UW	-.0005	84.0	81.3	86.8	.7	-.01	2.91
WW3026	3	180.000	0.000	-.22	92.0	-.49	.07	.072	.02	2.98	UV	-.0004	92.0	89.4	94.5	.6	-.01	2.98
UU3028	1	.067	0.000	6.22	3.9	5.95	6.50	.070	-.03	2.92	VW	.0002	3.9	.8	6.9	.7	-.04	3.06
VV3028	2	.535	0.000	.35	86.8	.02	.63	.076	-.12	3.10	UW	-.0003	86.8	84.2	89.8	.7	.11	3.10
WW3028	3	180.000	0.000	-.24	92.2	-.56	.14	.072	.05	3.07	UV	-.0006	92.2	88.6	95.3	.7	-.05	3.07
UU3035	1	0.000	0.000	6.17	10.1	5.80	6.55	.116	.00	2.43	VW	.0003	10.2	6.3	13.8	.9	-.20	3.06
VV3035	2	.334	0.000	1.09	80.0	.67	1.42	.095	-.20	3.09	UW	-.0022	80.0	76.6	83.9	.9	.23	3.07
WW3035	3	180.000	0.000	-.20	91.8	-.52	.09	.075	-.03	3.05	UV	-.0005	91.8	89.2	94.7	.7	.04	3.05
UU3036	1	0.000	0.000	6.18	6.6	5.91	6.46	.074	-.03	2.84	VW	.0002	6.7	3.6	9.9	.7	.01	3.06
VV3036	2	.401	0.000	.69	83.7	.36	1.03	.076	-.03	3.01	UW	-.0002	83.6	80.3	86.7	.7	-.01	3.04
WW3036	3	180.000	0.000	-.21	91.9	-.49	.16	.073	.01	3.02	UV	-.0001	91.9	88.5	94.5	.7	.02	3.01
UU3038	1	0.000	0.000	6.14	4.0	5.88	6.39	.072	-.01	2.80	VW	-.0001	4.0	1.0	7.4	.7	-.01	3.05
VV3038	2	.535	0.000	.36	86.6	-.07	.69	.077	-.12	3.15	UW	-.0005	86.6	83.6	90.6	.7	.10	3.15
WW3038	3	180.000	0.000	-.22	92.1	.52	.08	.073	.05	3.04	UV	-.0006	92.1	89.3	95.0	.7	-.04	3.03
UU3045	1	-.067	0.000	5.89	8.5	5.57	6.16	.079	-.01	2.86	VW	.0002	8.5	5.3	11.7	.9	-.00	2.97
VV3045	2	.334	0.000	.86	81.7	.52	1.20	.089	-.01	2.74	UW	.0001	81.7	78.4	84.9	.8	.02	2.96
WW3045	3	180.000	0.000	-.17	91.7	-.46	.17	.074	.03	2.99	UV	-.0005	91.7	88.4	94.5	.7	-.01	2.99
UU3046	1	-.067	0.000	6.05	6.2	5.74	6.31	.073	-.07	3.02	VW	-.0000	6.3	3.1	9.8	.7	.05	3.06
VV3046	2	.401	0.000	.63	84.0	.31	.98	.077	.01	2.97	UW	.0000	84.0	80.7	87.0	.7	-.02	2.99
WW3046	3	180.000	0.000	-.19	91.8	-.52	.13	.073	.02	3.01	UV	-.0002	91.8	88.8	94.9	.7	-.01	3.01
UU3048	1	-.067	0.000	6.08	4.0	5.78	6.32	.072	.05	2.95	VW	.0001	4.1	.9	7.1	.7	-.00	3.02
VV3048	2	.535	0.000	.38	86.5	-.01	.68	.077	.10	3.11	UW	-.0004	86.4	83.6	90.1	.7	.08	3.12
WW3048	3	180.000	0.000	-.20	91.9	-.48	.13	.074	.07	3.01	UV	-.0008	91.9	88.7	94.5	.7	-.06	3.01

Note $\bar{u}$ (values possibly 3% low)

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEWNESS	FLATNESS		REYNOLDS STRESS	MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEWNESS	FLATNESS
				VELOCITY INFORMATION									ANGLE INFORMATION					
UU3041	1	-.067	0.000	5.29	1.5	4.89	5.60	.120	.01	2.65	VW	-.0010	2.3	.0	5.6	.9	.04	2.60
VV3041	2	.067	0.000	.03	87.7	-.42	.47	.118	-.04	2.66	UW	.0076	87.7	85.1	94.6	1.3	.10	2.67
WW3041	3	180.000	0.000	-.14	91.5	-.40	.33	.129	.52	2.78	UV	.0022	91.5	86.4	95.2	1.4	.52	2.88
UU3042	1	-.067	0.000	5.19	2.2	4.61	5.72	.194	-.12	2.35	VW	-.0008	2.9	.0	6.6	1.0	-.31	2.69
VV3042	2	.134	0.000	.16	88.3	-.22	.54	.108	.02	2.52	UW	.0129	88.3	84.3	92.5	1.2	.10	2.59
WW3042	3	180.000	0.000	-.13	91.4	-.54	.42	.160	.64	2.74	UV	.0024	91.4	85.0	95.8	1.8	-.63	2.74
UU3043	1	-.067	0.000	5.20	5.3	4.57	5.79	.241	-.07	2.00	VW	-.0027	5.6	2.4	9.4	1.0	.10	2.06
VV3043	2	.201	0.000	.48	84.8	.17	.76	.079	-.01	2.92	UW	-.0055	84.7	80.9	88.1	1.0	.16	2.93
WW3043	3	180.000	0.000	-.08	90.8	-.44	.45	.145	.62	2.73	UV	.0018	90.8	85.2	94.9	1.6	.27	2.74
UU3044	1	-.067	0.000	5.69	7.4	5.29	6.06	.108	.11	2.71	VW	-.0012	7.5	3.3	12.2	1.4	.11	2.23
VV3044	2	.267	0.000	.74	82.6	.32	1.17	.138	.11	2.26	UW	.0009	82.6	77.9	86.8	1.5	-.12	2.21
WW3044	3	180.000	0.000	-.02	90.2	-.33	.33	.092	.25	2.77	UV	.0034	90.2	86.7	93.2	.9	-.25	2.77
UU3045	1	-.067	0.000	6.11	5.3	5.74	6.43	.080	.01	3.08	VW	-.0002	5.3	2.3	8.3	.8	.06	3.00
VV3045	2	.334	0.000	.56	84.7	.22	.89	.085	-.06	2.78	UW	.0004	84.7	81.8	88.0	.8	.07	2.98
WW3045	3	180.000	0.000	-.05	90.4	-.38	.25	.068	.02	3.01	UV	.0004	90.4	87.7	93.5	.6	-.02	3.02
UU3046	1	-.067	0.000	6.25	3.4	5.96	6.52	.074	.02	2.84	VW	-.0001	3.5	.9	6.6	.6	.06	3.13
VV3046	2	.401	0.000	.36	86.7	.06	.72	.072	.01	3.13	UW	.0003	86.7	83.4	89.5	.7	-.01	3.15
WW3046	3	180.000	0.000	-.09	90.8	-.40	.20	.069	.01	3.01	UV	.0001	90.8	88.2	93.6	.6	-.01	3.01
UU3048	1	-.067	0.000	6.28	2.3	5.95	6.56	.074	.14	3.14	VW	-.0004	2.4	.0	5.4	.7	-.05	3.07
VV3048	2	.535	0.000	.23	87.9	.11	.57	.076	-.18	3.20	UW	.0000	87.9	84.8	91.1	.7	.17	3.20
WW3048	3	180.000	0.000	-.11	91.0	-.38	.25	.071	.03	3.10	UV	-.0003	91.0	87.7	93.5	.6	-.03	3.10
UU3060	1	-.134	0.000	5.41	1.2	5.10	5.69	.077	-.00	2.72	VW	.0001	1.5	.0	4.5	.7	.30	2.83
VV3060	2	0.000	0.000	-.04	90.5	-.33	.28	.074	-.01	2.97	UW	-.0002	90.5	87.0	93.5	.8	.01	2.97
WW3060	3	0.000	0.000	.10	88.9	-.21	.38	.072	-.04	2.95	UV	.0003	88.9	86.1	92.3	.8	.03	2.96
UU3061	1	-.134	0.000	5.42	1.8	5.08	5.76	.086	-.06	2.96	VW	-.0002	2.0	.0	4.9	.8	.10	2.78
VV3061	2	.067	0.000	.14	88.5	-.18	.45	.079	-.04	2.78	UW	.0010	88.5	85.3	92.0	.8	.06	2.98
WW3061	3	180.000	0.000	-.10	91.0	-.38	.22	.081	.12	2.89	UV	.0003	91.0	87.7	94.1	.9	-.12	2.89
UU3062	1	-.134	0.000	5.45	2.9	5.04	5.84	.106	-.04	2.81	VW	-.0003	3.1	.2	6.1	.8	-.02	3.00
VV3062	2	.134	0.000	.27	87.2	-.04	.58	.077	-.00	2.91	UW	.0024	87.2	84.1	90.4	.8	.02	2.94
WW3062	3	180.000	0.000	-.09	90.9	-.40	.26	.070	.14	2.86	UV	.0002	90.9	87.3	94.2	.9	-.13	2.87
UU3063	1	-.134	0.000	5.57	4.3	5.18	5.95	.113	-.08	2.65	VW	-.0005	4.4	1.4	7.2	.7	.04	2.90
VV3063	2	.201	0.000	.41	85.8	.12	.69	.069	.01	2.85	UW	-.0011	85.8	83.0	88.8	.7	-.03	2.84
WW3063	3	180.000	0.000	-.06	90.6	-.36	.20	.086	.14	2.80	UV	.0001	90.6	87.1	93.6	.9	.14	2.81
UU3064	1	-.134	0.000	5.80	4.9	5.51	6.12	.089	-.03	2.80	VW	-.0002	5.0	2.2	8.3	.8	.03	2.95
VV3064	2	.267	0.000	.50	85.1	.21	.83	.076	-.01	2.95	UW	-.0015	85.1	81.7	87.9	.8	-.03	2.96
WW3064	3	180.000	0.000	-.03	90.3	-.31	.33	.074	.10	2.98	UV	.0001	90.3	86.7	93.1	.7	-.10	3.00
UU3065	1	-.134	0.000	6.02	4.4	5.72	6.32	.077	-.06	2.89	VW	-.0003	4.4	1.5	7.1	.7	.03	2.98
VV3065	2	.334	0.000	.46	85.6	.15	.75	.074	.01	2.98	UW	-.0004	85.6	82.9	88.5	.7	-.02	2.96
WW3065	3	180.000	0.000	-.04	90.4	-.33	.23	.069	-.03	3.03	UV	.0002	90.4	87.8	93.1	.7	.03	3.04
UU3066	1	-.134	0.000	6.14	3.0	5.87	6.44	.075	-.05	2.92	VW	-.0002	3.1	.4	6.0	.7	.04	2.97
VV3066	2	.401	0.000	.32	87.0	.03	.61	.073	.01	2.93	UW	.0005	87.0	84.3	89.8	.7	-.01	2.95
WW3066	3	180.000	0.000	-.08	90.7	-.39	.20	.071	-.01	2.91	UV	.0001	90.7	88.1	93.7	.7	.01	2.92
UU3068	1	-.134	0.000	6.22	2.3	5.93	6.59	.075	-.04	2.96	VW	-.0003	2.4	.0	6.7	.7	-.07	3.07
VV3068	2	.535	0.000	.24	87.8	-.22	.75	.077	-.27	3.57	UW	.0001	87.8	83.5	92.0	.7	.27	3.57
WW3068	3	180.000	0.000	-.08	90.7	-.43	.20	.072	.06	3.07	UV	-.0003	90.7	87.5	94.0	.7	-.05	3.08

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS	REYNOLDS STRESS		ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU3070	1	-.267	0.000	5.74	.9	5.42	6.03	.077	-.02	2.93	VW	.0002	1.2	.0	4.8	.6	.45	3.06
VV3070	2	0.000	0.000	-.05	90.5	-.41	.26	.071	.01	3.14	UW	-.0003	90.5	87.4	91.2	.7	.02	3.15
WW3070	3	0.000	0.000	.07	89.3	.29	.34	.068	-.03	2.99	UV	.0002	89.3	86.6	92.8	.7	.03	2.99
UU3071	1	-.267	0.000	5.75	1.3	5.49	6.05	.078	-.02	2.83	VW	-.0002	1.5	.0	4.6	.6	.25	2.89
VV3071	2	.067	0.000	.11	88.9	-.20	.45	.071	-.02	3.03	UW	.0003	88.9	85.4	92.0	.7	.02	3.02
WW3071	3	180.000	0.000	-.07	90.7	.36	.21	.070	-.01	2.99	UV	.0003	90.7	87.9	93.7	.7	.01	2.99
UU3072	1	-.267	0.000	5.79	1.9	5.43	6.10	.079	-.09	2.97	VW	-.0001	2.0	.0	5.9	.7	.09	2.98
VV3072	2	.134	0.000	.17	88.3	-.16	.54	.072	-.05	3.07	UW	.0004	88.3	84.5	91.6	.7	.04	3.08
WW3072	3	180.000	0.000	-.07	90.7	-.33	.27	.071	.06	3.01	UV	.0002	90.7	87.3	93.3	.7	-.06	3.02
UU3073	1	-.267	0.000	5.85	2.2	5.56	6.14	.081	-.10	3.00	VW	-.0001	2.3	.0	5.2	.7	.08	2.90
VV3073	2	.201	0.000	.22	87.9	-.09	.47	.072	.03	2.95	UW	-.0005	87.9	85.3	90.8	.7	-.04	2.94
WW3073	3	180.000	0.000	-.07	90.7	-.34	.22	.072	.07	2.92	UV	-.0002	90.7	87.9	93.3	.7	-.06	2.93
UU3074	1	-.267	0.000	5.96	2.4	5.67	6.23	.078	.06	2.97	VW	-.0003	2.5	.2	6.2	.7	.06	3.04
VV3074	2	.267	0.000	.25	87.6	-.04	.63	.071	.01	3.01	UW	.0003	87.6	83.9	90.4	.7	-.03	3.03
WW3074	3	180.000	0.000	-.04	90.4	-.31	.29	.071	.02	2.95	UV	-.0003	90.4	87.1	92.9	.7	.02	2.96
UU3075	1	-.267	0.000	6.03	2.4	5.71	6.33	.077	-.06	3.02	VW	-.0005	2.5	.0	5.4	.7	.05	2.92
VV3075	2	.334	0.000	.25	87.6	-.03	.54	.072	-.01	2.74	UW	.0003	87.6	84.8	90.3	.7	-.00	2.94
WW3075	3	180.000	0.000	-.04	90.4	-.33	.23	.070	.05	3.04	UV	.0000	90.4	87.7	93.1	.7	-.06	3.04
UU3076	1	-.267	0.000	6.07	2.3	5.72	6.36	.078	-.05	2.98	VW	.0004	2.4	.1	5.0	.7	.02	2.95
VV3076	2	.401	0.000	.24	87.8	.06	.53	.072	.02	2.97	UW	.0008	87.8	85.0	90.6	.7	.02	2.99
WW3076	3	180.000	0.000	-.05	90.5	-.32	.27	.072	.01	2.99	UV	.0001	90.5	87.4	93.1	.7	.01	2.99
UU3078	1	-.267	0.000	6.11	1.7	5.81	6.43	.078	-.03	2.90	VW	-.0003	1.9	.0	4.5	.7	.07	2.85
VV3078	2	.535	0.000	.18	88.3	-.21	.47	.076	-.22	3.28	UW	-.0001	88.3	85.6	92.0	.7	.21	3.28
WW3078	3	180.000	0.000	-.05	90.5	-.41	.25	.073	.05	2.99	UV	-.0004	90.5	87.7	93.8	.7	-.05	2.99

TABLES 3.3-3

FILL NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS	REYNOLDS STRESS		ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU3070	1	-.267	0.000	5.68	1.0	5.42	5.98	.075	.08	2.92	VW	.0001	1.3	.0	4.3	.6	.43	2.95
VV3070	2	0.000	0.000	.09	90.9	.39	.22	.070	-.01	3.02	UW	-.0002	90.9	87.8	93.9	.7	.03	3.04
WW3070	3	0.000	0.000	.04	89.6	-.23	.36	.068	-.02	2.99	UV	.0004	89.6	86.3	92.3	.7	.02	2.99
UU3071	1	-.267	0.000	5.69	1.5	5.39	6.02	.079	-.10	3.03	VW	.0001	1.7	.0	4.4	.7	.20	2.85
VV3071	2	.067	0.000	.15	88.5	-.20	.41	.071	.00	2.95	UW	-.0002	88.5	85.9	92.0	.7	.01	2.95
WW3071	3	180.000	0.000	-.04	90.4	-.30	.28	.068	.02	2.99	UV	-.0004	90.4	87.1	93.0	.7	.02	3.00
UU3072	1	-.267	0.000	5.74	2.1	5.43	6.13	.076	.03	2.95	VW	.0001	2.2	.1	6.9	.7	.10	3.04
VV3072	2	.134	0.000	.21	87.9	-.11	.51	.070	.03	3.01	UW	.0005	87.9	81.8	91.1	.7	.04	3.03
WW3072	3	180.000	0.000	-.04	90.4	-.63	.28	.070	.00	3.14	UV	.0001	90.4	87.1	96.2	.7	.09	3.14
UU3073	1	-.267	0.000	5.80	2.5	5.53	6.09	.075	-.02	2.87	VW	-.0001	2.6	.1	5.4	.7	.04	2.97
VV3073	2	.201	0.000	.25	87.6	-.03	.54	.071	-.01	3.01	UW	-.0006	87.5	84.7	90.3	.7	-.09	3.01
WW3073	3	180.000	0.000	-.04	90.4	.31	.27	.071	-.01	2.91	UV	.0005	90.4	87.3	93.0	.7	.01	2.92
UU3074	1	-.267	0.000	5.87	3.2	5.58	6.15	.077	-.07	2.92	VW	.0001	3.3	.5	6.5	.7	.07	3.07
VV3074	2	.267	0.000	.33	86.8	.04	.66	.069	.05	3.02	UW	.0001	86.8	83.5	89.6	.7	-.06	3.09
WW3074	3	180.000	0.000	-.00	90.0	-.26	.29	.071	.05	2.96	UV	.0004	90.0	87.1	92.5	.7	.05	2.96
UU3075	1	-.267	0.000	5.93	3.3	5.67	6.23	.075	.01	2.93	VW	.0002	3.3	.7	6.6	.7	.03	2.91
VV3075	2	.334	0.000	.34	86.7	.07	.66	.070	.00	2.91	UW	-.0003	86.7	83.5	89.4	.7	-.02	2.90
WW3075	3	180.000	0.000	.01	89.9	-.30	.29	.071	.00	2.97	UV	.0005	89.9	87.2	92.9	.7	.00	2.97
UU3076	1	-.267	0.000	5.98	3.1	5.70	6.22	.074	-.04	2.80	VW	.0004	3.2	.7	6.1	.7	.03	3.00
VV3076	2	.401	0.000	.33	86.9	.07	.64	.071	.01	2.73	UW	.0005	86.9	83.9	89.3	.7	-.02	2.96
WW3076	3	180.000	0.000	.00	90.0	.27	.25	.071	.08	2.90	UV	-.0007	90.0	87.6	92.6	.7	-.09	2.91
UU3078	1	-.267	0.000	6.02	2.6	5.76	6.33	.078	-.06	2.82	VW	-.0003	2.7	.1	5.9	.7	-.02	3.10
VV3078	2	.535	0.000	.28	87.4	-.09	.61	.077	-.10	3.19	UW	-.0002	87.4	84.1	90.9	.7	.09	3.19
WW3078	3	180.000	0.000	.02	89.8	.24	.33	.073	.12	2.98	UV	.0009	89.8	86.8	92.3	.7	-.12	2.97
UU3080	1	-.535	0.000	5.77	.8	5.69	6.24	.074	.05	2.92	VW	.0002	1.1	.0	3.4	.5	.52	2.96
VV3080	2	0.000	0.000	-.08	90.7	-.34	.20	.073	-.00	2.92	UW	.0001	90.7	88.1	93.3	.7	.02	2.93
WW3080	3	0.000	0.000	-.01	90.1	-.35	.28	.069	.01	3.01	UV	-.0002	90.1	87.3	93.3	.7	.01	3.02
UU3082	1	-.535	0.000	5.98	1.0	5.69	6.27	.080	.06	2.93	VW	-.0002	1.2	.0	4.1	.6	.40	2.88
VV3082	2	.134	0.000	.10	89.0	.22	.42	.073	.03	2.94	UW	.0004	89.0	85.9	92.1	.7	.03	2.95
WW3082	3	180.000	0.000	.00	90.0	.28	.34	.071	.03	2.99	UV	-.0001	90.0	86.7	92.7	.7	-.03	3.00
UU3084	1	-.535	0.000	6.02	1.1	5.70	6.27	.077	.07	3.01	VW	.0002	1.4	.0	4.4	.6	.34	2.92
VV3084	2	.267	0.000	.12	88.9	-.16	.45	.073	.04	3.01	UW	.0003	88.9	85.6	91.5	.7	-.04	3.03
WW3084	3	180.000	0.000	.01	89.9	.31	.36	.072	.02	2.96	UV	.0004	89.9	86.6	92.9	.7	.02	2.96
UU3086	1	-.535	0.000	6.03	1.2	5.71	6.35	.077	.03	3.01	VW	.0004	1.4	.0	4.5	.6	.21	2.72
VV3086	2	.401	0.000	.13	88.8	-.19	.47	.074	.01	2.88	UW	.0009	88.8	85.5	91.8	.7	.01	2.89
WW3086	3	180.000	0.000	.02	89.8	.32	.34	.073	-.05	2.98	UV	.0003	89.8	86.8	93.0	.7	.05	2.99
UU3088	1	-.535	0.000	6.02	1.1	5.73	6.30	.080	.07	2.83	VW	.0004	1.4	.0	4.6	.6	.32	2.95
VV3088	2	.535	0.000	.12	88.9	.42	.47	.082	-.24	3.51	UW	.0000	88.9	85.6	94.1	.8	.23	3.53
WW3088	3	180.000	0.000	.03	89.7	-.26	.39	.076	.11	3.18	UV	.0008	89.7	86.2	92.5	.7	-.11	3.19
UU3090	1	-.802	0.000	6.01	.7	5.69	6.33	.079	.01	2.99	VW	.0000	1.1	.0	5.0	.6	.56	3.17
VV3090	2	0.000	0.000	-.07	90.7	.41	.27	.077	.01	2.98	UW	.0001	90.6	87.5	93.9	.7	-.01	2.99
WW3090	3	0.000	0.000	-.02	90.2	.51	.27	.074	-.07	3.07	UV	-.0001	90.2	87.4	94.9	.7	.07	3.09
UU3094	1	-.802	0.000	6.03	.9	5.72	6.32	.081	.05	2.90	VW	-.0005	1.2	.0	4.1	.6	.43	2.96
VV3094	2	.267	0.000	.09	89.1	-.20	.42	.076	.04	3.00	UW	.0008	89.1	86.0	91.9	.7	-.04	3.01
WW3094	3	180.000	0.000	.04	89.7	-.27	.34	.075	.03	3.08	UV	.0005	89.7	86.7	92.5	.7	-.04	3.09

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS		REYNOLDS STRESS	ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU3098	1	-.802	0.000	6.00	1.1	5.71	6.32	.084	.01	2.88	VW	-.0005	1.4	.0	5.9	.6	.32	2.91
VV3098	2	.535	0.000	.10	89.0	-.29	.42	.083	-.19	3.24	UW	-.0000	89.0	86.0	92.8	.8	.19	3.24
WW3098	3	180.000	0.000	.05	89.5	-.43	.63	.079	.09	3.21	UV	-.0007	89.5	84.2	94.2	.8	-.10	3.21
UU3100	1	-1.070	0.000	6.04	.9	5.75	6.35	.082	-.03	2.81	VW	.0002	1.3	.0	4.7	.6	.50	3.07
VV3100	2	0.000	0.000	-.09	90.8	-.44	.25	.079	-.05	3.02	UW	-.0000	90.8	87.7	94.2	.8	.05	3.03
WW3100	3	0.000	0.000	-.05	90.4	-.42	.27	.075	-.04	3.10	UV	-.0003	90.4	87.4	94.0	.7	.05	3.10
UU3104	1	-1.070	0.000	6.03	1.0	5.75	6.33	.083	.11	2.85	VW	.0003	1.3	.0	4.5	.6	.39	2.88
VV3104	2	.267	0.000	.09	89.2	-.21	.43	.081	-.01	2.95	UW	.0009	89.2	85.9	92.1	.8	.01	2.96
WW3104	3	180.000	0.000	.05	89.5	-.29	.47	.079	.02	3.07	UV	-.0005	89.5	85.5	92.7	.8	-.03	3.07
UU3108	1	-1.070	0.000	6.01	1.0	5.54	6.36	.088	-.11	3.04	VW	.0006	1.4	.0	4.6	.6	.38	2.99
VV3108	2	.535	0.000	.08	89.2	-.42	.45	.088	-.21	3.38	UW	.0002	89.2	85.7	94.1	.8	.21	3.41
WW3108	3	180.000	0.000	.07	89.3	-.29	.43	.082	.08	3.08	UV	-.0008	89.3	85.9	92.7	.8	-.09	3.08
UU3110	1	-1.605	0.000	6.06	1.0	5.71	6.39	.088	-.06	3.05	VW	.0003	1.4	.0	4.7	.7	.47	3.05
VV3110	2	0.000	0.000	-.09	90.8	-.40	.28	.087	-.03	3.03	UW	-.0007	90.8	87.3	94.6	.8	.04	3.05
WW3110	3	0.000	0.000	-.06	90.6	-.40	.27	.084	-.09	3.00	UV	-.0003	90.6	87.5	94.6	.8	.10	3.01
UU3114	1	-1.605	0.000	6.07	1.1	5.69	6.42	.090	.00	2.94	VW	-.0009	1.4	.0	4.2	.7	.35	2.83
VV3114	2	.267	0.000	.09	89.2	-.27	.45	.088	.03	2.93	UW	.0009	89.2	85.8	92.6	.8	-.04	2.94
WW3114	3	180.000	0.000	.08	89.3	-.26	.43	.086	.06	2.99	UV	-.0007	89.3	85.9	92.4	.8	-.08	3.01
UU3118	1	-1.605	0.000	6.02	1.2	5.65	6.36	.092	-.05	2.84	VW	-.0008	1.6	.0	5.5	.7	.32	2.88
VV3118	2	.535	0.000	.09	89.1	-.40	.56	.094	-.18	3.43	UW	.0001	89.1	84.5	94.6	.9	.18	3.45
WW3118	3	180.000	0.000	.08	89.2	-.27	.46	.088	.02	3.10	UV	.0008	89.2	85.5	92.6	.8	-.03	3.10

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS		REYNOLDS STRESS	ANGLE INFORMATION MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU4001	1	.267	4.768	6.18	16.4	1.98	9.70	.894	-.99	4.28	VW	.1302	19.9	.1	54.8	9.0	1.11	3.80
VV4001	2	.067	7.578	.01	87.9	-5.49	5.67	1.244	.03	4.52	UW	-.2041	89.7	45.0	134.2	11.2	-.07	4.39
WW4001	3	180.000	.849	-1.82	106.4	-5.93	4.07	.902	.59	7.61	UV	-.2521	106.2	59.7	144.3	8.6	-.46	7.78
UU4002	1	.267	.009	5.25	15.2	3.50	6.52	.402	-.27	2.82	VW	.0463	15.9	.3	41.6	4.3	.45	6.80
VV4002	2	.134	.686	.42	85.6	-2.92	3.29	.419	.69	6.63	UW	-.0657	85.5	54.0	116.7	4.5	-.66	6.37
WW4002	3	180.000	0.000	-1.36	104.5	-3.50	1.80	.327	1.74	9.35	UV	-.0509	104.6	70.4	123.7	3.8	-1.19	7.10
UU4003	1	.267	.034	4.18	14.6	2.84	5.19	.202	-.40	5.68	VW	.0052	15.3	.3	41.1	4.0	-.29	7.29
VV4003	2	.201	.395	.33	85.6	-2.03	2.40	.349	-.52	6.15	UW	-.0093	85.6	57.5	120.0	4.7	.47	6.76
WW4003	3	180.000	.003	-1.04	103.9	-2.36	2.22	.292	1.68	7.48	UV	-.0350	103.8	59.7	122.6	3.9	-1.64	7.67
UU4005	1	.267	0.000	8.44	3.8	7.86	9.03	.225	.11	1.93	VW	-.0006	4.0	.3	8.4	1.3	.21	2.22
VV4005	2	.334	0.000	.42	87.2	-.23	1.14	.248	.06	2.03	UW	.0041	87.2	82.3	91.6	1.7	-.05	2.03
WW4005	3	180.000	0.000	-.38	92.5	-.82	.04	.092	.01	3.13	UV	-.0065	92.5	89.7	95.6	.6	.01	3.12
UU4006	1	.267	0.000	8.31	3.7	8.00	8.60	.083	.02	2.84	VW	.0001	3.7	1.2	6.4	.6	.03	2.94
VV4006	2	.401	0.000	.36	87.5	-.08	.74	.095	-.02	3.03	UW	-.0010	87.5	84.9	90.6	.7	-.00	3.03
WW4006	3	180.000	0.000	-.39	92.7	-.74	-.01	.087	.10	2.96	UV	-.0004	92.7	90.1	95.1	.6	-.09	2.96
UU4008	1	.267	0.000	8.14	3.5	7.82	8.46	.082	-.07	2.98	VW	-.0001	3.5	.7	6.2	.7	-.04	3.03
VV4008	2	.535	0.000	.25	88.2	-.19	.64	.094	-.06	3.07	UW	.0003	88.2	85.5	91.3	.7	.05	3.07
WW4008	3	180.000	0.000	-.43	93.0	-.80	-.05	.089	.06	3.02	UV	-.0008	93.0	90.3	95.7	.6	-.05	3.02
UU4011	1	.134	.096	6.82	16.6	4.78	8.28	.293	-.60	5.73	VW	.0383	17.4	.1	41.4	3.8	.99	11.45
VV4011	2	.067	.926	.45	86.4	-4.23	4.26	.687	-.18	5.64	UW	-.0970	86.3	56.4	125.2	5.6	.23	5.81
WW4011	3	180.000	0.000	-1.97	106.1	-4.42	1.90	.394	1.95	13.92	UV	-.1302	106.0	73.9	123.6	3.3	-1.76	12.65
UU4012	1	.134	.043	5.56	14.2	3.43	8.13	.405	.81	5.98	VW	.0321	15.5	.3	42.4	5.4	1.68	8.12
VV4012	2	.134	2.603	.54	84.6	-2.78	5.04	.624	1.34	7.58	UW	-.0771	84.6	51.9	123.2	6.3	-1.18	6.81
WW4012	3	180.000	.188	-1.30	103.1	-3.84	3.79	.486	2.45	15.62	UV	-.0905	103.0	59.7	125.4	5.1	-2.34	15.76
UU4013	1	.134	.031	4.42	15.0	2.81	5.55	.346	-.58	2.92	VW	.0039	16.3	.2	41.6	5.5	.84	5.81
VV4013	2	.201	2.081	.54	83.2	-2.31	3.22	.440	.66	6.52	UW	-.0816	83.1	52.3	121.9	5.8	-.78	6.64
WW4013	3	180.000	.303	-1.05	103.3	-2.68	2.58	.467	2.46	12.31	UV	-.0585	103.1	59.7	123.6	6.0	-2.40	12.79
UU4015	1	.134	0.000	8.34	6.1	7.86	8.82	.165	.02	2.12	VW	-.0026	6.1	2.6	10.1	1.1	.12	2.55
VV4015	2	.334	0.000	.83	84.3	.35	1.42	.159	.13	2.48	UW	-.0006	84.3	80.4	87.6	1.1	-.14	2.48
WW4015	3	180.000	0.000	-.34	92.3	-.72	.10	.091	.10	3.08	UV	-.0020	92.3	89.3	94.8	.6	-.11	3.09
UU4016	1	.134	0.000	8.17	5.1	7.84	8.49	.084	-.09	2.93	VW	.0001	5.1	2.4	7.9	.7	.08	3.01
VV4016	2	.401	0.000	.64	85.6	.22	1.02	.096	.00	3.00	UW	-.0010	85.6	82.7	88.4	.7	-.03	3.00
WW4016	3	180.000	0.000	-.35	92.4	-.71	.10	.091	.06	2.99	UV	-.0007	92.4	89.3	94.9	.6	-.05	2.99
UU4018	1	.134	0.000	7.99	3.8	7.64	8.27	.085	-.11	2.90	VW	-.0002	3.9	1.0	6.8	.7	-.03	3.02
VV4018	2	.535	0.000	.38	87.3	-.06	.74	.096	-.10	3.09	UW	.0002	87.3	84.5	90.4	.7	.09	3.11
WW4018	3	180.000	0.000	-.38	92.7	-.76	.01	.090	.09	3.14	UV	-.0011	92.7	89.9	95.4	.6	-.09	3.15
UU4021	1	.067	.090	6.91	16.7	4.46	8.62	.417	-.16	3.30	VW	.0451	18.7	.1	42.4	4.7	.28	6.43
VV4021	2	.067	1.751	.75	84.0	-3.98	4.90	1.045	-.05	2.51	UW	-.3172	83.8	50.0	125.5	8.4	.05	2.56
WW4021	3	180.000	.062	-1.93	105.5	-4.40	4.11	.579	2.28	13.56	UV	-.0701	105.3	59.7	125.3	4.7	-2.21	13.50
UU4022	1	.067	.080	5.71	14.0	3.47	8.83	.595	.30	2.21	VW	-.0038	17.1	.3	44.5	5.7	.69	5.22
VV4022	2	.134	2.158	.61	84.1	-3.25	5.16	.778	.70	5.36	UW	-.2693	83.8	48.5	122.1	7.6	-.48	4.34
WW4022	3	180.000	1.478	-1.28	102.6	-4.04	4.93	.859	2.38	12.28	UV	.0591	102.4	59.7	129.6	8.3	-2.36	11.61
UU4023	1	.067	.019	4.64	15.2	2.95	6.50	.562	.95	2.80	VW	-.0344	17.7	.2	43.0	5.7	1.31	6.14
VV4023	2	.201	3.560	.77	80.8	-2.49	4.07	.542	1.65	7.97	UW	-.0274	80.9	47.5	123.0	6.5	-1.56	7.40
WW4023	3	180.000	1.800	-1.00	102.0	-3.39	3.37	.748	2.19	10.77	UV	.0387	101.9	59.7	123.9	8.6	-2.42	11.22

Note (velocity values are possibly 2.5% low)

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS		REYNOLDS STRESS	MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
				VELOCITY INFORMATION									ANGLE INFORMATION					
UU4025	1	.067	0.000	8.16	7.4	7.66	8.62	.155	.07	2.35	VW	.0043	7.4	3.5	12.2	1.6	.14	2.01
VV4025	2	.334	0.000	1.02	82.9	.42	1.67	.231	.12	1.76	UW	.0030	82.9	78.3	87.1	1.6	-.15	2.01
WW4025	3	180.000	0.000	-.29	92.0	-.72	.14	.102	.07	3.01	UV	.0057	92.0	89.0	95.2	.7	.12	3.03
UU4026	1	.067	0.000	8.04	5.7	7.67	8.37	.087	.02	2.86	VW	.0001	5.8	3.0	8.8	.7	.05	3.05
VV4026	2	.401	0.000	.75	84.7	.33	1.18	.100	.00	3.06	UW	-.0010	84.7	81.6	87.6	.7	-.03	3.07
WW4026	3	180.000	0.000	-.30	92.2	-.66	.09	.090	.10	3.05	UV	-.0006	92.1	89.3	94.7	.6	-.09	3.05
UU4028	1	.067	0.000	7.90	3.8	7.57	8.22	.087	-.07	3.03	VW	-.0000	3.9	.4	7.5	.7	-.06	3.13
VV4028	2	.535	0.000	.41	87.1	-.06	.85	.097	.10	3.15	UW	.0002	87.1	83.7	90.4	.7	.10	3.16
WW4028	3	180.000	0.000	-.34	92.5	-.71	.05	.091	.07	3.04	UV	-.0010	92.4	89.6	95.1	.7	-.06	3.05
UU4035	1	0.000	0.000	7.81	9.4	7.35	8.28	.152	.04	2.35	VW	.0017	9.4	5.9	13.2	.9	-.21	3.02
VV4035	2	.334	0.000	1.27	80.8	.76	1.79	.124	-.18	2.99	UW	-.0037	80.8	77.0	84.5	.9	.23	3.00
WW4035	3	180.000	0.000	-.27	92.0	-.68	.10	.094	.05	2.99	UV	-.0005	92.0	89.3	94.9	.7	-.03	2.99
UU4036	1	0.000	0.000	7.86	6.3	7.48	8.19	.091	-.09	2.96	VW	.0001	6.3	2.9	9.7	.7	.08	3.07
VV4036	2	.401	0.000	.81	84.1	.34	1.22	.096	.01	3.05	UW	-.0011	84.1	81.1	87.5	.7	-.05	3.06
WW4036	3	180.000	0.000	-.29	92.1	-.65	.12	.090	.05	2.96	UV	-.0004	92.1	89.1	94.7	.7	-.04	2.97
UU4038	1	0.000	0.000	7.81	3.9	7.46	8.13	.086	-.03	2.87	VW	-.0000	4.0	.8	7.1	.7	.03	3.07
VV4038	2	.535	0.000	.43	86.8	.00	.84	.096	-.06	3.09	UW	-.0001	86.8	83.8	90.0	.7	.05	3.09
WW4038	3	180.000	0.000	-.32	92.3	-.72	.06	.093	.04	3.02	UV	-.0010	92.3	89.5	95.3	.7	-.04	3.02
UU4045	1	-.067	0.000	7.47	8.0	7.10	7.82	.095	-.04	2.90	VW	.0006	8.0	4.8	12.2	.9	-.00	2.98
VV4045	2	.334	0.000	1.02	82.2	.60	1.51	.113	-.02	2.93	UW	-.0001	82.2	78.4	85.5	.9	.03	2.96
WW4045	3	180.000	0.000	-.23	91.8	-.65	.20	.094	.06	3.12	UV	-.0005	91.8	88.5	95.1	.7	-.05	3.12
UU4046	1	-.067	0.000	7.66	6.0	7.32	8.01	.091	.00	2.86	VW	.0004	6.0	3.1	9.9	.7	.11	3.03
VV4046	2	.401	0.000	.75	84.4	.39	1.22	.096	.05	3.02	UW	-.0010	84.4	80.8	87.1	.7	-.09	3.03
WW4046	3	180.000	0.000	-.27	92.0	.62	.18	.092	.04	3.04	UV	-.0004	92.0	88.7	94.6	.7	-.04	3.04
UU4048	1	-.067	0.000	7.70	4.0	7.40	8.04	.087	.02	2.84	VW	.0002	4.1	.5	6.8	.7	-.02	3.14
VV4048	2	.535	0.000	.46	86.6	-.01	.85	.097	-.08	3.11	UW	-.0000	86.6	83.7	90.1	.7	.07	3.12
WW4048	3	180.000	0.000	-.28	92.1	-.66	.19	.093	.05	3.07	UV	-.0008	92.1	88.6	94.9	.7	-.04	3.07

Note (Velocity values are possibly 2.5% low)

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS	REYNOLDS STRESS		ANGLE INFORMATION MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU4041	1	-.067	0.000	6.73	2.4	6.09	7.24	.181	-.06	2.33	VW	-.0030	3.1	.0	6.7	1.2	-.30	2.44
VV4041	2	.067	0.000	.24	88.0	-.39	.81	.186	-.02	2.24	UW	.0234	88.0	83.3	93.5	1.5	.00	2.28
WW4041	3	180.000	0.000	-.14	91.2	-.66	.52	.210	.34	2.25	UV	.0054	91.2	85.6	95.6	1.8	-.35	2.26
UU4042	1	-.067	0.000	6.66	3.4	5.80	7.38	.305	-.10	2.00	VW	-.0013	4.0	.1	9.4	1.2	-.48	2.77
VV4042	2	.134	0.000	.38	86.7	-.13	.87	.151	-.01	2.42	UW	.0346	86.8	83.0	91.2	1.2	.12	2.55
WW4042	3	180.000	0.000	-.11	90.9	-.92	.76	.254	.64	2.41	UV	.0030	90.9	83.6	97.6	2.2	-.64	2.42
UU4043	1	-.067	0.000	6.74	6.3	5.86	7.57	.350	-.14	1.91	VW	-.0080	6.6	2.9	10.6	1.0	.18	2.89
VV4043	2	.201	0.000	.74	83.7	.34	1.14	.098	.05	3.10	UW	-.0118	83.7	79.8	87.2	1.0	-.22	2.77
WW4043	3	180.000	0.000	-.04	90.3	.54	.72	.218	.80	2.81	UV	.0032	90.3	83.7	94.3	1.9	-.81	2.84
UU4044	1	-.067	0.000	7.30	7.7	6.83	7.82	.150	.07	2.46	VW	-.0028	7.8	3.7	12.6	1.6	.16	2.06
VV4044	2	.267	0.000	.99	82.3	.47	1.59	.195	.16	2.11	UW	-.0196	82.2	77.4	86.4	1.6	-.17	2.06
WW4044	3	180.000	0.000	-.02	90.2	-.45	.58	.125	.31	2.73	UV	.0081	90.2	85.5	93.5	1.0	-.31	2.74
UU4045	1	-.067	0.000	7.73	5.6	7.38	8.13	.100	-.01	2.96	VW	.0002	5.6	2.3	8.7	.8	.01	2.82
VV4045	2	.334	0.000	.76	84.4	.29	1.17	.115	.00	2.80	UW	.0006	84.4	81.3	87.9	.8	.00	2.87
WW4045	3	180.000	0.000	-.04	90.3	-.42	.32	.089	.03	2.97	UV	.0011	90.3	87.6	93.1	.7	.03	2.97
UU4046	1	-.067	0.000	7.87	3.9	7.52	8.21	.091	-.03	2.98	VW	-.0001	3.9	.9	6.5	.6	.03	3.08
VV4046	2	.401	0.000	.53	86.2	.12	.88	.089	-.01	3.07	UW	.0005	86.2	83.6	89.1	.6	-.01	3.08
WW4046	3	180.000	0.000	-.10	90.7	-.44	.22	.085	.11	2.95	UV	.0002	90.7	88.4	93.2	.6	-.10	2.95
UU4048	1	-.067	0.000	7.88	2.3	7.52	8.29	.092	.01	3.04	VW	-.0003	2.4	.1	5.7	.7	.01	2.99
VV4048	2	.535	0.000	.29	87.9	-.19	.70	.095	-.12	3.17	UW	.0003	87.9	84.7	91.4	.7	.12	3.19
WW4048	3	180.000	0.000	-.13	91.0	-.49	.23	.088	.01	3.08	UV	-.0006	91.0	88.3	93.5	.6	-.01	3.08
UU4060	1	-.134	0.000	6.86	1.3	6.46	7.18	.096	-.08	2.90	VW	.0005	1.5	.0	5.0	.7	.32	2.87
VV4060	2	0.000	0.000	-.09	90.7	-.58	.33	.092	-.01	3.07	UW	-.0001	90.7	87.3	94.9	.8	.02	3.08
WW4060	3	0.000	0.000	.13	89.0	-.25	.48	.088	-.01	2.97	UV	-.0002	88.9	85.8	92.1	.7	.02	2.96
UU4061	1	-.134	0.000	6.90	2.0	6.50	7.29	.108	-.03	2.86	VW	-.0005	2.2	.0	5.4	.8	.08	2.76
VV4061	2	.067	0.000	.21	88.2	-.22	.61	.103	.03	2.95	UW	.0016	88.2	85.0	91.8	.9	.04	2.95
WW4061	3	180.000	0.000	-.11	90.9	-.48	.43	.106	.11	2.89	UV	-.0002	90.9	86.4	94.0	.9	-.11	2.89
UU4062	1	-.134	0.000	6.96	3.0	6.49	7.47	.142	-.03	2.70	VW	-.0005	3.2	.1	6.7	.8	-.05	2.94
VV4062	2	.134	0.000	.36	87.1	-.10	.79	.098	-.05	2.98	UW	.0048	87.1	83.7	90.8	.8	.07	3.02
WW4062	3	180.000	0.000	-.08	90.7	-.50	.36	.119	.17	2.77	UV	-.0001	90.7	87.0	94.1	1.0	-.17	2.78
UU4063	1	-.134	0.000	7.10	4.3	6.65	7.61	.146	-.03	2.56	VW	-.0011	4.4	1.4	7.4	.7	-.01	3.04
VV4063	2	.201	0.000	.53	85.7	.15	.92	.089	.05	3.00	UW	.0011	85.7	82.6	88.8	.7	.02	2.99
WW4063	3	180.000	0.000	-.07	90.5	-.45	.36	.113	.15	2.83	UV	.0003	90.5	87.0	93.5	.9	-.16	2.84
UU4064	1	-.134	0.000	7.37	4.8	6.98	7.80	.112	.03	2.85	VW	-.0005	4.8	1.1	8.4	.8	.02	2.96
VV4064	2	.267	0.000	.62	85.2	.15	1.01	.100	.02	2.96	UW	-.0030	85.2	82.0	88.9	.8	-.02	2.95
WW4064	3	180.000	0.000	-.04	90.3	-.49	.31	.097	.05	2.96	UV	-.0001	90.3	87.6	93.8	.8	-.05	2.97
UU4065	1	-.134	0.000	7.63	4.2	7.23	7.99	.097	-.06	2.95	VW	-.0006	4.2	1.5	7.7	.7	.03	2.97
VV4065	2	.334	0.000	.56	85.8	.16	.99	.097	-.01	2.97	UW	-.0011	85.8	82.5	88.8	.7	.00	2.96
WW4065	3	180.000	0.000	-.04	90.3	-.41	.34	.090	.02	3.03	UV	.0005	90.3	87.5	93.1	.7	-.02	3.03
UU4066	1	-.134	0.000	7.78	3.3	7.43	8.10	.093	-.05	2.82	VW	-.0001	3.3	.6	6.8	.7	-.01	3.06
VV4066	2	.401	0.000	.43	86.8	-.07	.90	.092	-.04	3.04	UW	.0004	86.8	83.4	90.5	.7	.03	3.06
WW4066	3	180.000	0.000	-.09	90.7	-.43	.35	.087	.05	3.04	UV	.0002	90.7	87.4	93.2	.6	-.05	3.04
UU4068	1	-.134	0.000	7.83	2.2	7.36	8.21	.094	-.06	3.01	VW	-.0006	2.3	.1	5.2	.7	-.01	3.01
VV4068	2	.535	0.000	.28	87.9	-.27	.68	.095	-.19	3.39	UW	.0003	87.9	85.0	92.0	.7	.10	3.42
WW4068	3	180.000	0.000	-.12	90.8	-.58	.25	.091	.00	3.00	UV	.0004	90.8	88.2	94.3	.7	-.00	3.00

TABLES 3.3-3

FILE NAME	AXIS	POSITION	LIMITS EXCEEDED (%) TIME	VELOCITY INFORMATION: MEAN VEL.	ANGLE FROM	MIN. VEL.	MAX. VEL.	RMS VEL.	SKEW-NESS	FLAT-NESS	REYNOLDS STRESS		ANGLE INFORMATION: MEAN ANGLE	MIN. ANGLE	MAX. ANGLE	RMS ANGLE	SKEW-NESS	FLAT-NESS
UU4070	1	-.267	0.000	7.25	1.0	6.86	7.62	.096	-.08	2.94	VW	.0002	1.3	.0	4.2	.6	.40	2.94
VV4070	2	0.000	0.000	-.08	90.6	.46	.34	.092	-.01	3.03	UW	-.0007	90.6	87.3	93.7	.7	.01	3.04
WW4070	3	0.000	0.000	.10	89.2	-.31	.49	.087	.03	3.05	UV	-.0000	89.2	86.1	92.5	.7	-.03	3.05
UU4071	1	-.267	0.000	7.30	1.3	6.94	7.72	.096	.00	2.89	VW	-.0006	1.5	.0	4.5	.6	.22	2.94
VV4071	2	.067	0.000	.14	88.9	-.23	.56	.093	.01	3.04	UW	.0003	88.9	85.6	91.8	.7	-.02	3.04
WW4071	3	180.000	0.000	-.09	90.7	-.43	.30	.087	.06	3.03	UV	.0000	90.7	87.6	93.4	.7	-.06	3.04
UU4072	1	-.267	0.000	7.32	1.8	6.75	7.66	.099	-.04	2.78	VW	-.0001	1.9	.0	5.0	.7	.14	2.90
VV4072	2	.134	0.000	.21	88.3	-.19	.62	.092	-.00	2.98	UW	.0005	88.3	85.2	91.5	.7	.00	2.99
WW4072	3	180.000	0.000	-.09	90.7	-.42	.32	.091	.07	2.98	UV	.0001	90.7	87.5	93.3	.7	-.07	2.98
UU4073	1	-.267	0.000	7.38	2.2	6.90	7.76	.096	-.05	2.99	VW	.0006	2.3	.1	5.7	.7	.05	2.90
VV4073	2	.201	0.000	.27	87.9	-.10	.65	.092	-.00	3.04	UW	-.0009	87.9	84.9	91.4	.7	-.01	3.02
WW4073	3	180.000	0.000	-.09	90.7	-.50	.32	.091	.06	3.00	UV	-.0003	90.7	87.5	93.8	.7	-.06	3.01
UU4074	1	-.267	0.000	7.49	2.3	7.12	7.83	.096	-.06	2.97	VW	-.0005	2.4	.1	6.1	.7	.07	2.97
VV4074	2	.267	0.000	.30	87.7	-.09	.70	.091	.01	3.01	UW	.0003	87.7	84.5	90.7	.7	-.02	3.03
WW4074	3	180.000	0.000	-.07	90.5	-.44	.34	.090	.07	3.06	UV	-.0003	90.5	87.3	93.3	.7	-.07	3.07
UU4075	1	-.267	0.000	7.58	2.3	7.21	7.93	.095	-.05	2.85	VW	.0001	2.4	.2	5.2	.7	.09	2.95
VV4075	2	.334	0.000	.30	87.8	-.07	.63	.090	.00	2.96	UW	-.0006	87.7	85.1	90.5	.7	-.01	2.94
WW4075	3	180.000	0.000	-.07	90.5	.43	.35	.090	.02	3.00	UV	-.0001	90.5	87.3	93.3	.7	-.02	3.01
UU4076	1	-.267	0.000	7.65	2.2	7.26	7.99	.091	.04	2.90	VW	-.0001	2.3	.1	6.0	.7	.05	2.96
VV4076	2	.401	0.000	.28	87.9	-.14	.79	.092	-.06	3.00	UW	.0005	87.9	84.0	91.0	.7	.05	3.02
WW4076	3	180.000	0.000	-.09	90.7	-.43	.28	.088	.03	3.02	UV	.0000	90.6	87.9	93.1	.7	-.03	3.02
UU4078	1	-.267	0.000	7.69	1.6	7.29	8.06	.095	-.08	3.02	VW	-.0005	1.8	.0	4.7	.7	.15	2.86
VV4078	2	.535	0.000	.20	88.5	-.23	.62	.090	-.11	3.12	UW	.0002	88.5	85.3	91.7	.7	.10	3.12
WW4078	3	180.000	0.000	-.08	90.6	-.44	.33	.092	.04	3.07	UV	.0004	90.6	87.5	93.3	.7	-.04	3.07

APPENDIX A - COORDINATE TRANSFORMATIONS

The reduction algorithm for the TSI model 1294 probe calculates the velocity components along the sensor coordinate system. To find the values of the velocity components in the tunnel coordinate system several intermediate transformations must be made. Figure A-1 details the different coordinate systems that will be discussed here.

Consider the general derivation of the transformation tensor that relates the magnitudes of vector quantities (u_i) in the "unprimed" cartesian coordinate system to the magnitudes (u_i''') resolved in a "triple primed" system. To transform from the unprimed system to the triple primed system three intermediate transformations must be made. The first transformation is a rotation of α_1 degrees about the x_1 axis. The second transformation is a rotation of α_2 degrees about the new x_2' axis. The third transformation is a rotation of α_3 degrees about the x_3'' axis.+ These transformations can be stated mathematically as

(1) For α_1 rotation

$u_k' = c_{km}u_m$ where $c_{km} =$

k = \ m =	1	2	3
1	1	0	0
2	0	$\cos\alpha_1$	$\sin\alpha_1$
3	0	$-\sin\alpha_1$	$\cos\alpha_1$

(2) For α_2 rotation

$u_j'' = b_{jk}u_k'$ where $b_{jk} =$

j = \ k =	1	2	3
1	$\cos\alpha_2$	0	$-\sin\alpha_2$
2	0	1	0
3	$\sin\alpha_2$	0	$\cos\alpha_2$

+The sense of the angular rotations are defined as follows: Looking from the positive to negative direction along the axis in question a positive angle requires the counterclockwise rotation of the other two axes.

(3) For α_3 rotation

$$u_i''' = a_{ij}u_j'' \quad \text{where} \quad a_{ij} = \begin{array}{c|ccc} i \backslash j & 1 & 2 & 3 \\ \hline 1 & \cos\alpha_3 & \sin\alpha_3 & 0 \\ 2 & -\sin\alpha_3 & \cos\alpha_3 & 0 \\ 3 & 0 & 0 & 1 \end{array}$$

The components of the intermediate transformation tensors (c_{km}, b_{jk}, and a_{ij}) may be obtained from inspection. For example c_{km} is the cosine of the angle between the $k^{\underline{th}}$ primed and the $m^{\underline{th}}$ unprimed coordinate axis, i.e., $c_{km} = \cos(x_k', x_m)$.

Grouping the three transformations into one completes the general derivation of the vector component relationships between the unprimed and the triple primed systems.

$$u_i''' = a_{ij}b_{jk}c_{km}u_m = A_{im}u_m$$

$$\text{where} \quad A_{im} = \begin{bmatrix} \cos\alpha_2\cos\alpha_3 & \cos\alpha_1\sin\alpha_3 + \sin\alpha_1\sin\alpha_2\cos\alpha_3 & \sin\alpha_1\sin\alpha_3 - \cos\alpha_1\sin\alpha_2\cos\alpha_3 \\ -\cos\alpha_2\sin\alpha_3 & \cos\alpha_1\cos\alpha_3 - \sin\alpha_1\sin\alpha_2\sin\alpha_3 & \sin\alpha_1\cos\alpha_3 + \cos\alpha_1\sin\alpha_2\sin\alpha_3 \\ \sin\alpha_2 & -\sin\alpha_1\cos\alpha_2 & \cos\alpha_1\cos\alpha_2 \end{bmatrix}$$

It should be noted that the transpose of $A_{im} = A_{im}^T = A_{mi}$ can be used to transform vector components in the triple prime system to those in the unprimed system, i.e., $u_i = A_{mi}u_m'''$.

The geometric relationship between the sensor coordinates and the probe coordinates is always fixed, but the relationship between the probe coordinates and the wind-tunnel coordinate also needs to be formalized before an overall transformation from sensor coordinates to wind-tunnel coordinates can be stipulated. During physical placement of the probe within the wind-tunnel, one starts with the probe coordinates aligned with the wind-tunnel coordinates. The probe and thus the probe coordinate system is first rotated γ_3 degrees about the x_3^{***} axis, then γ_2 degrees about the new x_2^{**} axis, and then γ_1 degrees about the new x_1^{*} axis. After these rotations of the probe by its supporting mechanism are completed, the probe is in position to take data.[1]

To find the coordinate tranformations that are necessary to convert vector components in the sensor system (unprimed) coordinates to the probe system (triple primed) coordinates, consider the reverse transform, i.e., probes system to sensors. It is seen in Figure A-1 that a rotation sequence of $\alpha_1 = 0$, $\alpha_2 = 35.26$, and $\alpha_3 = -45.0$ will achieve the desired orientation. This transform can be written as

$$u_i = A_{ij} u_j'''$$

where A_{ij} is calculated from the general derivation given previously. We are more interested in the reverse transform, i.e. sensor to probe. This is found by taking the transpose of tensor A_{ij} above, i.e.

$$u_i''' = A_{ij}^T u_j = A_{ji} u_j \quad .$$

Inserting $\alpha_1 = 0$, $\alpha_2 = 35.26$, and $\alpha_3 = -45.0$ into the equations for the components of A_{ji} one finds that the transformation tensor for conversion of velocity components in the sensor system to velocity components in the probe system is

$$A_{ji} = \begin{bmatrix} 1/\sqrt{3} & 1/\sqrt{3} & 1/\sqrt{3} \\ -1/\sqrt{2} & 1/\sqrt{2} & 0 \\ -1/\sqrt{6} & -1/\sqrt{6} & 2/\sqrt{6} \end{bmatrix}$$

---

[1]The reason for aligning the probe away from the tunnel coordinates is that the probes x_1 axis should be in approximate alignment with the expected mean velocity vector. This will increase the accuracy of the measurement. For low-to-moderate turbulence levels it insures that the velocity vector never leaves the sensor coordinate system octant in which measurements are possible.

To convert the velocity components resolved in the probe coordinate system to those of the wind-tunnel system one must reverse the rotational order that was used during the physical placement of the probe.

$$u_k^* = c_{km} u_m''' \quad \text{then} \quad u_j^{**} = b_{jk} u_k^* \quad \text{then}$$

$$u_i^{***} = a_{ij} u_j^{**} \quad \Rightarrow \quad u_i^{***} = B_{im} u_m'''$$

where the angles α_1, α_2, α_3 that make up the general transformation tensor are now defined as $-\gamma_1$, $-\gamma_2$, and $-\gamma_3$ respectively.

Combining the two transformation tensors derived above, one for sensor to probe conversion and the other for probe to tunnel conversion, into one overall transformation tensor for sensor to tunnel system conversion yields (note that the indices have been changed for convenience)

$$u_j''' = A_{ji} u_i \quad \text{and} \quad u_k^{***} = B_{kj} u_j'''$$

$$u_k^{***} = B_{kj} A_{ji} u_i = C_{ki} u_i$$

where u_k^{***} ≡ velocity components in the tunnel coordinate system

u_i ≡ velocity components in the sensor coordinate system

B_{kj} ≡ general transformation tensor with $\alpha_1 = -\gamma_1$, $\alpha_2 = -\gamma_2$, $\alpha_3 = -\gamma_3$

A_{ji} ≡ transpose of the general transformation tensor with $\alpha_1 = 0$, $\alpha_2 = 35.26$, $\alpha_3 = -45$.

Since the elements of C_{ki} are the cosine of the angle between the i^{th} sensor coordinate and the k^{th} tunnel coordinate, the yaw angles in calibration mode are easily calculated as

$$\phi_i = 90.0 - \arccos C_{1i} = \arcsin C_{1i}.$$

To convert from the rectangular tunnel coordinates to an axisymmetric tunnel coordinate system it is only necessary to rotate the rectangular system about the x_1 axis so that the measurement location is contained within the $x_1 - x_2$ plane. This angle of rotation is given by the following conditional statements

1) if $x_2 = 0$ and $x_3 = 0$ then $\beta = 0$
2) if $x_2 = 0$ and $x_3 > 0$ then $\beta = 90.0$
3) if $x_2 = 0$ and $x_3 < 0$ then $\beta = -90.0$
4) if $x_2 < 0$ then $\beta = \arctan(x_3/x_2) + 180.0$
5) if $x_2 > 0$ then $\beta = \arctan(x_3/x_2)$.

The transformation can be summarized as

$$u_m^o = d_{mk} u_k^{***} = d_{mk} C_{ki} u_i = D_{mi} u_i$$

where u_m^o ≡ velocity components in the axisymmetric tunnel system, and

d_{mk} ≡ general transformation tensor with $\alpha_1 = \beta$, $\alpha_2 = 0$, $\alpha_3 = 0$.

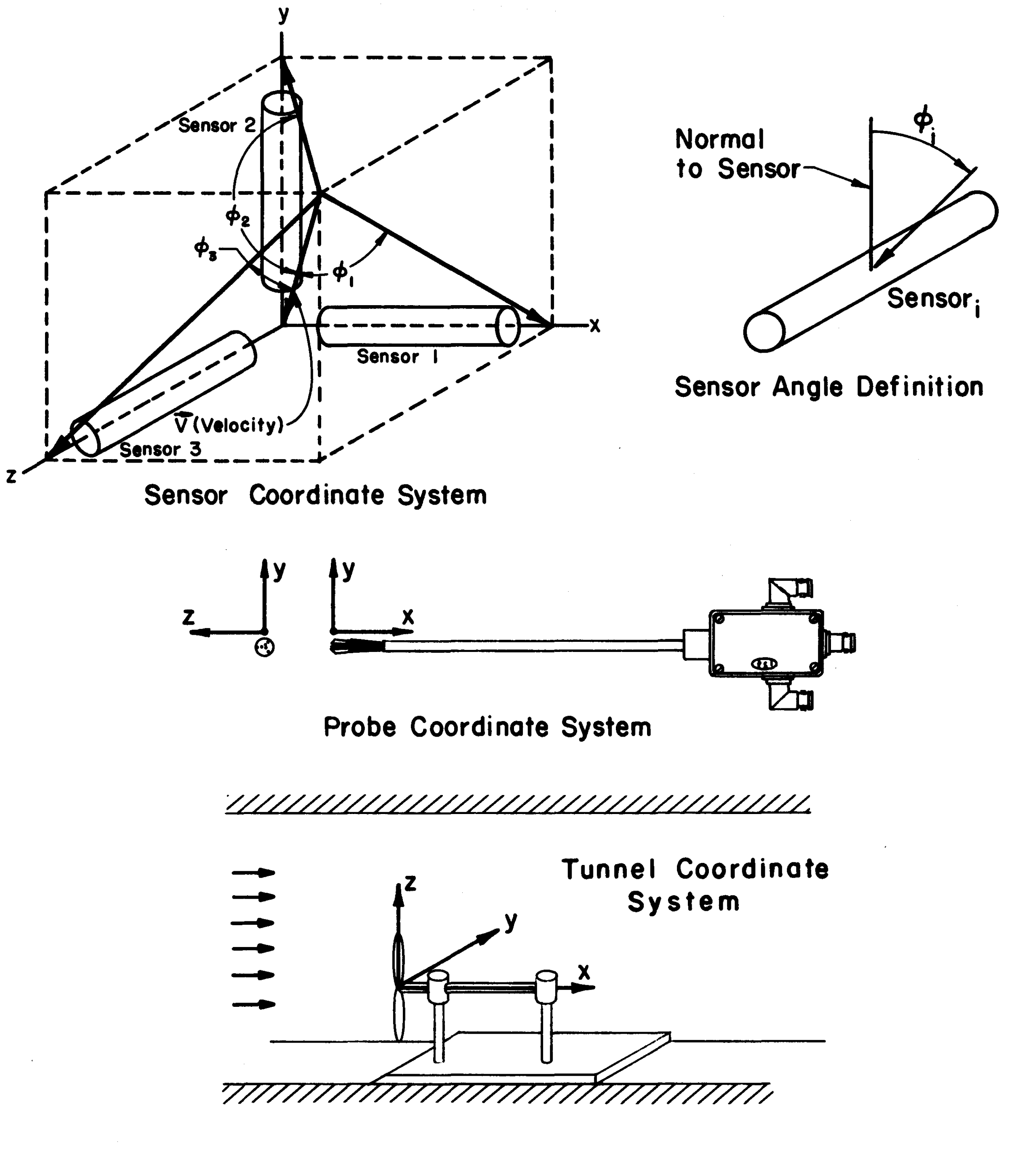


FIGURE A-1 Sensor, Probe, and Tunnel Coordinate Systems

APPENDIX B - COMPUTER PROGRAMS

```
FTN4,L
      PROGRAM CAL3D(3,70)
C**CALIBRATES TSI 1294 3D PROBE
      COMMON A(3),B(3),C(3),FK(3),TEMP,PRES,UMIN,UMAX,ANGMN(3),ANGMX(3)
     +         SUP(3),AMP(3)
      DIMENSION IPAR(5),ICH(3),ANG(3)
      CALL RMPAR(IPAR)
      LU=IPAR(1)
      IF(LU.LT.1)LU=1
      CALL LIBER(LU)
      WRITE(LU,100)
      READ(LU,*)ICH(1),TEMP,PRES
                ICH(2)=ICH(1)+1
                ICH(3)=ICH(1)+2
      WRITE(LU,102)(ICH(I),I=1,3)
      READ(LU,*)(SUP(I),I=1,3)
      WRITE(LU,104)(ICH(I),I=1,3)
      READ(LU,*)(AMP(I),I=1,3)
1     WRITE(LU,110)
      IF(NOYES(LU))2,1,3
2        CONTINUE
         WRITE(LU,120)(ICH(I),I=1,3)
         READ(LU,*)(FK(I),I=1,3)
         WRITE(LU,130)
         READ(LU,*)(ANG(I),I=1,3)
         CALL CLVEL(0,ICH,ANG,LU)
         GO TO 6
3     CONTINUE
         CALL CLVEL(1,ICH,ANG,LU)
         WRITE(LU,140)
         READ(LU,*)DEL P
                   U=4.75*SQRT((TEMP+273.)*DEL P/PRES)
         CALL CLANG(ICH,U,LU)
6     CONTINUE
      WRITE(LU,150)
      IF(NOYES(LU))8,6,7
7        CONTINUE
         CALL WRCAL(LU)
8     CONTINUE
      WRITE(LU,160)
100   FORMAT("ENTER CHAN. 1, TEMP.(C), PRESSURE(IN HG) _")
102   FORMAT("ENTER SUPPRESSION   FOR CHANS. "I2","I2","I2"    _")
104   FORMAT("ENTER AMPLIFICATION FOR CHANS. "I2","I2","I2"    _")
110   FORMAT("DETERMINE YAW FACTOR K -?                       _")
120   FORMAT("ENTER YAW FACTOR K FOR CHANS.  "I2","I2","I2"    _")
130   FORMAT("ENTER ANGLES OF ROTATION ABOUT X,Y,Z AXIS _")
140   FORMAT(//"ENTER PRESSURE FOR ANGLE CALIBRATION-      _")
150   FORMAT("WISH TO WRITE TO CAL. FILE -               _")
160   FORMAT("RUN COMPLETE")
      END
```

```
C*******************************************************************
      SUBROUTINE CLVEL(IOP,ICH,ANG,LU)
      COMMON A(3),B(3),C(3),FK(3),TEMP,PRES,UMIN,UMAX,ANGMN(3),ANGMX(3),
     +         SUP(3),AMP(3)
      DIMENSION ICH(3),ANG(3),VANG(3),U(25),E(25,3),EMN(3),ERMS(3)
      CALL FANG(ANG,VANG)
      WRITE(LU,100)(ICH(I),I=1,3)
      N=0
      UMIN=1.0E10
      UMAX=-1.0E10
10    CONTINUE
        N=N+1
        WRITE(LU,110)
        READ(LU,*)DEL P
        IF(DEL P.GE.0.0)GO TO 20
           N=N-2
           GO TO 10
20      CONTINUE
        IF(N.EQ.1)GO TO 25
           UMIN=AMIN1(UMIN,U(N-1))
           UMAX=AMAX1(UMAX,U(N-1))
25      CONTINUE
        IF(DEL P.EQ.0.0)GO TO 40
        U(N)=4.75*SQRT((TEMP+273.)*DEL P/PRES)
        CALL DATIN(ICH,EMN,ERMS,LU)
        DO 30 I=1,3
             E(N,I)=EMN(I)/AMP(I)+SUP(I)
30      CONTINUE
        WRITE(LU,120)(EMN(I),ERMS(I),I=1,3),U(N)
      GO TO 10
40    CONTINUE
      N=N-1
      DO 50 I=1,3
           Z=VANG(I)*3.14159/180.
           WRITE(LU,130)ICH(I),VANG(I)
           READ(LU,*)C(I)
           WRITE(LU,140)
           AFAC=1.0
           IF(IOP.EQ.0)AFAC=SQRT(COS(Z)**2+(FK(I)*SIN(Z))**2)
           CALL FTVEL(LU,E(1,I),U,N,AFAC,A(I),B(I),C(I))
           CALL OUTVL(LU,E(1,I),U,N,AFAC,A(I),B(I),C(I))
50     CONTINUE
      RETURN
100   FORMAT(/'ZERO PRESSURE WILL EXIT LOOP'/
     +         'NEG. PRESSURE WILL DELETE PREVIOUS ENTRY'//
     +         'CHANNEL NO. ='15X,I2,2(12X,I2)/
     +         24X,3('MEAN    RMS'4X)'SPEED (M/S)')
110   FORMAT('PRESSURE (MM HG)-? _')
120   FORMAT(24X,6(F5.3,2X)F6.3)
130   FORMAT(//'*****VELOCITY CURVE FIT RESULTS FOR CHANNEL 'I2' YAW='
     +         F5.1' *****'/'ENTER ESTIMATE FOR VEL. EXP. C     _')
140   FORMAT(7X'C'12X'A'12X'B'11X'F(C)'10X'E RMS'10X'U RMS')
      END
```

```
C**********************************************************************
      SUBROUTINE FTVEL(LU,E,U,N,AFAC,A,B,C)
      DIMENSION E(N),U(N)
      DELT=0.05
      SVDEL=DELT
1     CONTINUE
      DO 30 I=1,35
            ZEST=F OF C(E,U,N,AFAC,C,A,B)
            SUM1=0.0
            SUM2=0.0
            SUM3=0.0
            DO 10 K=1,N
                  SUM1=SUM1+(E(K)*E(K)-A-B*(AFAC*U(K))**C)**2
                  ROOT=A+B*(AFAC*U(K))**C
                  IF(ROOT.LT.0.)ROOT=1.E30
                  SUM2=SUM2+(E(K)-SQRT(ROOT))**2
                  ROOT=(E(K)*E(K)-A)/B
                  IF(ROOT.LT.0.)ROOT=1.E30
                  SUM3=SUM3+(U(K)-ROOT**(1./C)/AFAC)**2
10          CONTINUE
            DEV1=SQRT(SUM1/FLOAT(N))
            DEV2=SQRT(SUM2/FLOAT(N))
            DEV3=SQRT(SUM3/FLOAT(N))
            WRITE(LU,110)C,A,B,ZEST,DEV2,DEV3
            IF(I.EQ.1)GO TO 20
               DELT=-ZEST*SDELT/(ZEST-SZEST)
               ADEL=ABS(DELT)
               IF(ADEL.LT.0.001)GO TO 40
               IF(ADEL.GT.SVDEL)DELT=SVDEL*DELT/ADEL
20          CONTINUE
            C=C+DELT
            SZEST=ZEST
            SDELT=DELT
30    CONTINUE
40    CONTINUE
      WRITE(LU,120)
      IF(NOYES(LU))60,40,50
50       CONTINUE
         WRITE(LU,130)
         READ(LU,*)C
         GO TO 1
60    CONTINUE
      RETURN
110   FORMAT(6(3X,F10.5))
120   FORMAT('WISH TO ENTER NEW ESTIMATE FOR C  ?        _')
130   FORMAT('ENTER ESTIMATE FOR VEL. EXP. C             _')
      END
C**********************************************************************
      FUNCTION F OF C(E,U,N,AFAC,C,A,B)
      DIMENSION E(N),U(N)
      FN=FLOAT(N)
      T1=0.0
      T2=0.0
      T3=0.0
      T4=0.0
      DO 1 I=1,N
           U1=(U(I)*AFAC)**C
           T1=T1+E(I)*E(I)
           T2=T2+U1
           T3=T3+E(I)*E(I)*U1
           T4=T4+U1*U1
1     CONTINUE
      B=(T1*T2/FN-T3)/(T2*T2/FN-T4)
      A=(T1-B*T2)/FN
      T5=0.0
      DO 2 I=1,N
           U1=U(I)*AFAC
           T5=T5+(U1**C)*ALOG(U1)*(E(I)*E(I)-A-B*U1**C)
2     CONTINUE
      F OF C=T5
      RETURN
      END
```

```
C*********************************************************************
      SUBROUTINE OUTVL(LU,E,U,N,AFAC,A,B,C)
      DIMENSION E(N),U(N)
      WRITE(LU,100)
      DO 10 I=1,N
            UCAL=((E(I)*E(I)-A)/B)**(1.0/C)/AFAC
            ERR=(UCAL-U(I))*100.0/U(I)
            WRITE(LU,110)E(I),U(I),UCAL,ERR
10    CONTINUE
      RETURN
100   FORMAT('VOLTAGE   VELOCITY   VELOCITY   ERROR'/
     +        11X'ACTUAL    CALCULATED    (%)'/)
110   FORMAT(F7.3,3X,F7.2,5X,F7.2,2X,F5.1)
      END
```

```
C**********************************************************************
      SUBROUTINE CLANG(ICH,U,LU)
      COMMON A(3),B(3),C(3),FK(3),TEMP,PRES,UMIN,UMAX,ANGMN(3),ANGMX(3),
     +             SUP(3),AMP(3)
      DIMENSION ICH(3),VANG(25,3),E(25,3),ERMS(3),EMN(3),ANG(3),VANG1(3)
      WRITE(LU,100)(ICH(I),I=1,3)
      N=0
      DO 10 I=1,3
            ANGMN(I)=360.0
            ANGMX(I)=-360.0
10    CONTINUE
20    CONTINUE
        N=N+1
        WRITE(LU,110)
        READ(LU,*)(ANG(I),I=1,3)
            IF(ANG(1).LE.360.0)GO TO 30
               N=N-2
               GO TO 20
30          CONTINUE
            IF(N.EQ.1)GO TO 45
               DO 40 I=1,3
                     ANGMN(I)=AMIN1(ANGMN(I),VANG(N 1,I))
                     ANGMX(I)=AMAX1(ANGMX(I),VANG(N-1,I))
40             CONTINUE
45          CONTINUE
            IF(ANG(1).EQ.360.0)GO TO 70
        CALL FANG(ANG,VANG1)
        DO 50 I=1,3
              VANG(N,I)=VANG1(I)
50      CONTINUE
        CALL DATIN(ICH,EMN,ERMS,LU)
        DO 60 I=1,3
              E(N,I)=EMN(I)/AMP(I)+SUP(I)
60      CONTINUE
        WRITE(LU,120)(VANG1(I),I=1,3),(EMN(I),ERMS(I),I=1,3)
      GO TO 20
70    CONTINUE
      N=N-1
      DO 80 I=1,3
            WRITE(LU,130)ICH(I),U
            READ(LU,*)FK(I)
            WRITE(LU,140)
            CALL FTANG(LU,E(1,I),VANG(1,I),N,U,A(I),C(I),B(I),FK(I))
            CALL OUTAG(LU,E(1,I),VANG(1,I),N,U,A(I),B(I),C(I),FK(I))
80    CONTINUE
81    WRITE(LU,150)
      IF(NOYES(LU))90,81,82
82       CONTINUE
         WRITE(LU,160)
         READ(LU,*)FK(1)
         WRITE(LU,170)
         DO 85 I=1,3
               FK(I)=FK(1)
               ZEST=F OF K(E(1,I),VANG(1,I),N,U,A(I),C(I),FK(I),B(I))
               WRITE(LU,180)A(I),B(I),C(I),FK(I),ZEST

85       CONTINUE
86       WRITE(LU,190)
         IF(NOYES(LU))82,86,90
90    CONTINUE
      RETURN
100   FORMAT(/'ANGLE = 360.0 WILL EXIT LOOP'/
     +         'ANGLE > 360.0 WILL DELETE PREVIOUS ENTRY'//
     +        'CHANNEL NO. ='25X,I2,2(12X,I2)/
     +        34X,3('MEAN    RMS'4X))
110   FORMAT('ROT. ANGLES(3)-? _')
120   FORMAT('YAW='3(F5.1','),12X,6(F5.3,2X))
130   FORMAT(//'*****ANGLE CURVE FIT RESULTS FOR CHANNEL 'I2
     +        '   VELOCITY= 'F6.2' *****'/
     +        'ENTER ESTIMATE FOR YAW FACTOR K - _')
140   FORMAT(7X'K'12X'B'11X'F(C)'11X'RMS'10X'E RMS'6X'< RMS')
150   FORMAT('WISH TO FORCE EQUALITY OF 'K' FOR ALL 3 CHANS.   _')
160   FORMAT('ENTER DESIRED 'K'                                _')
170   FORMAT(/4X'A'9X'B'9X'C'9X'K'7X'F(C)')
180   FORMAT(4(F8.3,2X),Γ8.5)
190   FORMAT('ARE VALUES OK -                                  _')
      END
```

```
C*********************************************************************
      SUBROUTINE FTANG(LU,E,ANG,N,U,A,C,B,FK)
      DIMENSION E(N),ANG(N)
      CONST=3.14159/180.
      DELT=0.02
      SVDEL=DELT
1     CONTINUE
      DO 30 I=1,35
            ZEST=F OF K(E,ANG,N,U,A,C,FK,B)
            SUM1=0.0
            SUM2=0.0
            SUM3=0.0
            DO 10 K=1,N
                  Z=ANG(K)*CONST
                  Y=(E(K)*E(K)-A)/U**C
                  X=SQRT(COS(Z)**2+(FK*SIN(Z))**2)
                  SUM1=SUM1+(Y-B*X**C)**2
                  ROOT=B*(U*X)**C+A
                  IF(ROOT.LT.0.)ROOT=1.E30
                  SUM2=SUM2+(E(K)-SQRT(ROOT))**2
                  ROOT=(E(K)*E(K)-A)/B
                  IF(ROOT.LT.0.)GO TO 5
                  UEFF=ROOT**(1./C)
                  IF(UEFF.GT.U)GO TO 5
                     ARG=SQRT((1.-(UEFF/U)**2)/(1.-FK*FK))
                     ANGLE=ATAN(ARG/SQRT(1.-ARG*ARG))
                     SUM3=SUM3+(Z-ANGLE)**2
                     GO TO 10
5                 CONTINUE
                  SUM3=1.E30
10          CONTINUE
            DEV1=SQRT(SUM1/FLOAT(N))
            DEV2=SQRT(SUM2/FLOAT(N))
            DEV3=SQRT(SUM3/FLOAT(N))/CONST
            WRITE(LU,110)FK,B,ZEST,DEV1,DEV2,DEV3
            IF(I.EQ.1)GO TO 20
            DELT=-ZEST*SDELT/(ZEST-SZEST)
            ADEL=ABS(DELT)
            IF(ADEL.LT.0.0002)GO TO 40
            IF(ADEL.GT.SVDEL)DELT=SVDEL*DELT/ADEL
20          CONTINUE
            FK=FK+DELT
            SZEST=ZEST
            SDELT=DELT
30    CONTINUE
40    CONTINUE
      WRITE(LU,120)
      IF(NOYES(LU))60,40,50
50       CONTINUE
         WRITE(LU,130)
         READ(LU,*)FK
         GO TO 1
60    CONTINUE
      RETURN
110   FORMAT(6(3X,F10.5))
120   FORMAT('WISH TO ENTER NEW ESTIMATE FOR K - ?        _')
130   FORMAT('ENTER ESTIMATE FOR YAW FACTOR  K -          _')
      END
```

```
C*********************************************************************
      FUNCTION F OF K(E,ANG,N,U,A,C,FK,B)
      DIMENSION E(N),ANG(N)
      T1=0.0
      T2=0.0
      T3=0.0
      T4=0.0
      DO 1 I=1,N
           Z=ANG(I)*3.14159/180.
           Y=(E(I)*E(I)-A)/U**C
           X=COS(Z)*COS(Z)+FK*FK*SIN(Z)*SIN(Z)
           T1=T1+Y*X**(C/2.0)
           T2=T2+X**C
           T3=T3+SIN(Z)*SIN(Z)*X**(C-1.0)
           T4=T4+Y*SIN(Z)*SIN(Z)*X**(C/2.0-1)
1     CONTINUE
      B=T1/T2
      F OF K=B*T3-T4
      RETURN
      END
```

```
C**********************************************************************
      SUBROUTINE OUTAG(LU,E,VANG,N,U,A,B,C,FK)
      DIMENSION E(N),VANG(N)
      CONST=180.0/3.14159
      WRITE(LU,100)
      DO 10 I=1,N
            ROOT=(E(I)*E(I)-A)/B
            IF(ROOT.LT.0.)ROOT=1.E30
            UEFF=ROOT**(1.0/C)
            IF(UEFF.LE.U)GO TO 1
               ANG=1.E30
               ERR=1.E30
               GO TO 5
1           CONTINUE
            ARG=SQRT((1.0-(UEFF/U)**2)/(1.0-FK*FK))
            ANG=ATAN(ARG/SQRT(1.0-ARG*ARG))*CONST
            ERR=ANG-VANG(I)
5           CONTINUE
            WRITE(LU,110)E(I),VANG(I),ANG,ERR
10    CONTINUE
      RETURN
100   FORMAT('VOLTAGE      ANGLE       ANGLE     ERROR'/
     +       11X'ACTUAL    CALCULATED (DEG)'/)
110   FORMAT(F7.3,3X,F7.2,5X,F7.2,2X,F5.1)
      END

C**********************************************************************
      SUBROUTINE FANG(ANG,VANG)
      DIMENSION ANG(3),VANG(3),A(3,3),B(3,3)
      CONST=3.14159/180.0
      X=0.0*CONST
      Y=35.26*CONST
      Z=-45.0*CONST
      CALL TRXYZ(A,X,Y,Z)
      X=ANG(1)*CONST
      Y=ANG(2)*CONST
      Z=ANG(3)*CONST
      CALL TRXYZ(B,X,Y,Z)
C......................................NOTE THAT THE TRANSPOSE OF 'A'
C                                      IS USED IN THE FOLLOWING MATRICE
C                                      MULT. TO CHANGE THE DIRECTION
C                                      OF THE TRANSFORMATION THAT FORMED
C                                      'A'.
      DO 2 J=1,3
          SUM=0.0
          DO 1 I=1,3
              SUM=SUM+B(1,I)*A(J,I)
1         CONTINUE
          VANG(J)=ATAN(SUM/SQRT(1.0-SUM*SUM))/CONST
2     CONTINUE
      RETURN
      END

C**********************************************************************
      SUBROUTINE TRXYZ(A,X,Y,Z)
      DIMENSION A(3,3)
      A(1,1)=COS(Y)*COS(Z)
      A(1,2)=COS(X)*SIN(Z)+SIN(X)*SIN(Y)*COS(Z)
      A(1,3)=SIN(X)*SIN(Z)-COS(X)*SIN(Y)*COS(Z)
      A(2,1)=-COS(Y)*SIN(Z)
      A(2,2)=-SIN(X)*SIN(Y)*SIN(Z)+COS(X)*COS(Z)
      A(2,3)=SIN(X)*COS(Z)+COS(X)*SIN(Y)*SIN(Z)
      A(3,1)=SIN(Y)
      A(3,2)=-SIN(X)*COS(Y)
      A(3,3)=COS(X)*COS(Y)
      RETURN
      END
```

```
C*********************************************************************
      SUBROUTINE DATIN(ICH,E,RMS,LU)
      DIMENSION NAMP(3),ISIZE(2),IPAR(5),IDCB(144),NAMF(5),ICH(3),
     +          E(3),RMS(3)
      DATA NAMP,NAMF /2HDA,2HTA,2H  ,2HSC,2HRA,2HTC,2HDN,16/
      IF(LU.NE.1.AND.LU.NE.26)CALL NAMIT(LU,NAMF)
      IRATE=100
      NSAM=256
      ISIZE(1)=(NSAM/128)*3+1
      CALL PURGE(IDCB,IERR,NAMF,NAMF(4),NAMF(5))
      CALL CREAT(IDCB,IERR,NAMF,ISIZE,1,NAMF(4),NAMF(5))
         IF(IERR.LT.0)GO TO 1000
      CALL CLOSE(IDCB)
      CALL OPEN(IDCB,IERR,NAMF,1,NAMF(4),NAMF(5))
         IF(IERR.LT.0)GO TO 1000
      CALL EXEC(23,NAMP,ICH(1),ICH(3),IRATE,NSAM,0,NAMF,5)
         CALL RMPAR(IPAR)
         IF(IPAR(1).LT.0)GO TO 1010
      WRITE(LU,100)
      CALL POSNT(IDCB,IERR,1,1)
         IF(IERR.LT.0)GO TO 1000
      CALL VOLTS(IDCB,E,RMS,LU)
      CALL CLOSE(IDCB)
      CALL PURGE(IDCB,IERR,NAMF,NAMF(4),NAMF(5))
      RETURN
1000  CONTINUE
      WRITE(LU,110)IERR
      GO TO 1020
1010  CONTINUE
      WRITE(LU,120)IPAR(1)
1020  CONTINUE
      CALL CLOSE(IDCB)
      CALL PURGE(IDCB,IERR,NAMF,NAMF(4),NAMF(5))
      WRITE(LU,130)
      STOP
100   FORMAT("_")
110   FORMAT("FILE MANAGER ERROR "I3" IN SUBROUTINE DATIN")
120   FORMAT("DATA PROGRAM ERROR NO. "I3" SEE DATA PROGRAM ERROR CODE")
130   FORMAT("RUN COMPLETE")
      END
C*********************************************************************
      SUBROUTINE VOLTS(IDCB,E,RMS,LU)
      DIMENSION IDCB(144),IBUF(768),E(3),RMS(3),SUM(3)
      CALL READF(IDCB,IERR,IBUF,768)
         IF(IERR.LT.0)GO TO 1000
      DO 1 I=1,3
         SUM(I)=0.0
1     CONTINUE
      DO 3 I=1,768,3
         DO 2 J=1,3
            SUM(J)=SUM(J)+FLOAT(IBUF(I+J-1))
2        CONTINUE
3     CONTINUE
      DO 4 I=1,3
         E(I)=SUM(I)/256.0
4     CONTINUE
      DO 5 I=1,3
         SUM(I)=0.0
5     CONTINUE
      DO 7 I=1,768,3
         DO 6 J=1,3
            X=FLOAT(IBUF(I+J-1))
            SUM(J)=SUM(J)+(X-E(J))*(X-E(J))
6        CONTINUE
7     CONTINUE
      DO 8 I=1,3
         RMS(I)=SQRT(SUM(I)/256.0)/3275.2
         E(I)=E(I)/3275.2
8     CONTINUE
      RETURN
1000  CONTINUE
      WRITE(LU,100)IERR
      STOP
100   FORMAT("FMGR ERROR "I5" IN VOLTS")
      END
```

```
C**********************************************************************
      SUBROUTINE WRCAL(LU)
      COMMON A(3),B(3),C(3),FK(3),TEMP,PRES,UMIN,UMAX,ANGMN(3),ANGMX(3),
     +       SUP(3),AMP(3)
      DIMENSION IDCB(144),IBUF(18),CAL(9),NAM(5),ISIZ(2)
      EQUIVALENCE (IBUF(1),CAL(1))
      DATA NAM,ISIZ /2HVE,2HLC,2HAL,2HDN,16,1,18/
      CALL CREAT(IDCB,IERR,NAM,ISIZ,2,NAM(4),NAM(5))
           IF(IERR.GE.0)GO TO 1
           IF(IERR.NE.-2)GO TO 1000
           CALL OPEN(IDCB,IERR,NAM,0,NAM(4),NAM(5))
                IF(IERR.LT.0)GO TO 1000
1     CONTINUE
      DO 2 I=1,3
           CAL(1)=A(I)
           CAL(2)=B(I)
           CAL(3)=C(I)
           CAL(4)=FK(I)
           CAL(5)=TEMP
           CAL(6)=UMIN
           CAL(7)=UMAX
           CAL(8)=SUP(I)
           CAL(9)=AMP(I)
           CALL WRITF(IDCB,IERR,IBUF,18)
                IF(IERR.LT.0)GO TO 1000
2     CONTINUE
      CALL CLOSE(IDCB)
      RETURN
1000  CONTINUE
      WRITE(LU,100)IERR
      STOP
100   FORMAT("FMGR ERROR "I5" IN WRCAL")
      END
```

```
FTN4,L
      PROGRAM DAT3D(3,80)
C
C**DESIGNED TO BE USED WITH THE TSI 1294 3D HOT FILM PROBE.
C**IT USES THE REDUCTION TECHNIQUES DESCRIBED IN TSI TB 5 TO OBTAIN
C**THE U,V,W TIME SERIES.
C
      COMMON /WK/ IPAR(5)
      DIMENSION POS(6),A(3,3)
      CALL RMPAR(IPAR)
      LU=IPAR(1)
      IF(LU.LT.1)LU=1
      CALL LIBER(LU)
      CALL INPUT(IFST,IRATE,NSAM,NSEG,SL,IAXIS,LU)
1     CONTINUE
         CALL FILES(NSAM,NSEG,LU)
         CALL SETUP(POS,A,IAXIS,LU)
2        WRITE(LU,110)
         IF(NOYES(LU))5,2,4
4        CONTINUE
         CALL DATIN(IFST,IRATE,NSAM,NSEG,LU)
               IF(IFBRK(DM).LT.0)GO TO 5
         WRITE(LU,130)
         CALL CONVT(NSAM,NSEG,POS,A,SL,LU)
         CALL REDUC(NSAM,NSEG,SL,LU)
         CALL SAVIT(IRATE,NSAM,NSEG,SL,POS,LU)
         CALL F INFO(NSAM,IRATE,NSEG,SL,LU)
5        CONTINUE
         CALL PURG(NSAM,NSEG,LU)
6        WRITE(LU,140)
         IF(NOYES(LU))7,6,1
7     CONTINUE
      WRITE(LU,150)
110   FORMAT('READY-?                                                     _')
130   FORMAT('*****DATA RECORD OBTAINED*****'//)
140   FORMAT('WANT TO RUN AGAIN-?                                         _')
150   FORMAT('RUN COMPLETE')
      END
```

```
C*********************************************************************
      BLOCK DATA
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /CAL/ A(3),B(3),C(3),RK,T(2),F(2),UMIN,UMAX,SUP(3),AMP(3)
      COMMON /TAB/ CALIB(101,3),CSLPE(3),CICPT(3),NC PTS
      COMMON /VAL/ VMN(3),VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3),NERR(3)
      COMMON /WK/ IDUM(1158)
      DATA NC PTS,NAME /101,2HSC,2HRA,2HTC,2HDN,16/
      DATA NAMD(1,2),NAMD(1,3) /2HVV,2HWW/
      END

C*********************************************************************
      SUBROUTINE INPUT(IFST,IRATE,NSAM,NSEG,SL,IAXIS,LU)
1     CONTINUE
         WRITE(LU,100)
         READ(LU,*)IFST,IRATE,NSAM,NSEG,OPTEMP
         NSAM=((NSAM+127)/128)*128
         RATE=RATE1(IRATE)
         NCHAN=3
         ILST=IFST+NCHAN-1
         TIME=FLOAT(NSEG)*FLOAT(NSAM)/RATE
         WRITE(LU,110)NSAM,NSEG,RATE,TIME,IFST,NCHAN,OPTEMP
2        CONTINUE
         WRITE(LU,120)
         IF(NOYES(LU))1,2,3
3     CONTINUE
      WRITE(LU,130)
      READ(LU,140)IAXIS
      CALL VELCL(IFST,OPTEMP,SL,LU)
      RETURN
100   FORMAT('ENTER CHAN 1, RATE, SAMPLES, SEGMENTS, TEMP.- _')
110   FORMAT('NO. OF SAMPLES=              'I5/
     +       'NO. OF SEGMENTS=             'I5/
     +       'SAMPLE RATE=               'F7.2/
     +       'TIME DURATION=            'F8.2/
     +       'FIRST CHANNEL=                 'I2/
     +       'NO. CHANNELS=                  'I2/
     +       'OPERATION TEMP.=            'F5.1/)
120   FORMAT('ENTRIES OK-?                                  _')
130   FORMAT('TYPE OF AXIS (RECT. OR CYLINDER)              _')
140   FORMAT(A2)
      END
```

```
C***********************************************************************
      SUBROUTINE VELCL(IFST,OPTEMP,SL,LU)
      COMMON /CAL/ A(3),B(3),C(3),RK,T(2),F(2),UMIN,UMAX,SUP(3),AMP(3)
      COMMON /FIL/ IDCB(144),IDUM(452)
      COMMON /WK/  IBUF(10)
      DIMENSION NAME(5)
      EQUIVALENCE (IBUF(1),A1),(IBUF(3),B1),(IBUF(5),C1),(IBUF(7),RK1),
     +            (IBUF(9),CLTEM1),(IBUF(11),UMIN1),(IBUF(13),UMAX1),
     +            (IBUF(15),SUP1),(IBUF(17),AMP1)
      DATA NAME /2HVE,2HLC,2HAL,2HDN,16/
      CALL OPEN(IDCB,IERR,NAME,0,NAME(4),NAME(5))
           CALL ERROR(LU,IERR,2HVE,IDCB,0,1)
      DO 10 IC=1,3
            CALL READF(IDCB,IERR,IBUF)
                 CALL ERROR(LU,IERR,2HVE,IDCB,0,1)
            A(IC)=A1
            B(IC)=B1
            C(IC)=C1
            RK=RK1
            CLTEMP=CLTEM1
            UMIN=UMIN1
            UMAX=UMAX1
            SUP(IC)=SUP1
            AMP(IC)=AMP1
10    CONTINUE
20    WRITE(LU,100)
      IF(NOYES(LU))80,20,30
30    WRITE(LU,110)
      DO 40 IC=1,3
            ICH=IC+IFST-1
            WRITE(LU,120)ICH,A(IC),B(IC),C(IC),RK,CLTEMP,UMIN,UMAX
     +                   ,SUP(IC),AMP(IC)
40    CONTINUE
80    CONTINUE
      SL=UMAX/32752.0
      T(1)=CLTEMP
      T(2)=OPTEMP
      CALL TABLE
      CALL CLOSE(IDCB)
      RETURN
100   FORMAT(/'WISH TO SEE CALIBRATION FILE-?          _')
110   FORMAT('CHANNEL   A'6X'B'7X'C'7X'K '1X'CAL TEMP'2X'UMIN'
     +       '      UMAX  SUPPRES AMPLIFY')
120   FORMAT(1X,I2,4X,F6.3,2X,F6.4,2X,F6.4,2X,F5.3,2X,F4.1,2X,
     +       F6.2,2X,F6.2,2X,F6.3,2X,F5.2)
      END
```

```
C***********************************************************************
      SUBROUTINE TABLE
      COMMON /CAL/ A(3),B(3),C(3),RK,T(2),F(2),UMIN,UMAX,SUP(3),AMP(3)
      COMMON /TAB/ CALIB(101,3),CSLPE(3),CICPT(3),NC PTS
C     DATA ALPHA /0.00392/
      DATA PI /3.14159/
      F(1)=2.+RK*RK
      F(2)=1.-RK*RK
      TFAC=1.0
C     TFAC=SQRT(1./(1.+ALPHA*(T(1)-T(2))/0.5))
C     AFACMN=SQRT(COS(PI/2.)**2+(RK*SIN(PI/2.))**2)
      AFACMN=RK
C     AFACMX=SQRT(COS(0.0)**2+(RK*SIN(0.0))**2)
      AFACMX=1.0
      DO 2 J=1,3
           ERMIN=SQRT(TFAC*(A(J)+B(J)*(UMIN*AFACMN)**C(J)))
           EMIN=(ERMIN-SUP(J))*AMP(J)
           IF(EMIN.LT.-10.0)EMIN=-10.0
           ERMAX=SQRT(TFAC*(A(J)+B(J)*(UMAX*AFACMX)**C(J)))
           EMAX=(ERMAX-SUP(J))*AMP(J)
           IF(EMAX.GT.10.0)EMAX=10.0
           DEL E=(EMAX-EMIN)/FLOAT(NC PTS-1)
           E=EMIN-DEL E
           POW=2.0/C(J)
           DO 1 I=1,NC PTS
                E=E+DEL E
                ER=E/AMP(J)+SUP(J)
                CALIB(I,J)=((ER*ER/TFAC-A(J))/B(J))**POW
1          CONTINUE
           CMIN=EMIN*3275.2
           CMAX=EMAX*3275.2
           CSLPE(J)=FLOAT(NC PTS-1)/(CMAX-CMIN)
           CICPT(J)=-CSLPE*CMIN+1.0
2     CONTINUE
      RETURN
      END

C***********************************************************************
      SUBROUTINE FILES(NSAM,NSEG,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /WK/  ISIZE(2)
1     CONTINUE
      WRITE(LU,100)
      CALL GNAME(LU,NAMD(1,1),NAMD(4,1),NAMD(5,1),1)
      NAMD(1,1)=2HUU
      NAMD(2,2)=NAMD(2,1)
      NAMD(2,3)=NAMD(2,1)
      NAMD(3,2)=NAMD(3,1)
      NAMD(3,3)=NAMD(3,1)
      NAMD(4,2)=NAMD(4,1)
      NAMD(4,3)=NAMD(4,1)
      NAMD(5,2)=NAMD(5,1)
      NAMD(5,3)=NAMD(5,1)
      ISIZE(1)=(NSAM/128)*NSEG+1
      DO 2 I=1,3
           IF(I.EQ.3.AND.NSEG.LT.3)ISIZE(1)=(NSAM/128)*3+1
           CALL CREAT(IDCBD(1,I),IERR,NAMD(1,I),ISIZE,1,NAMD(4,I),
     +                  NAMD(5,I))
                IF(IERR.LT.0)GO TO 1000
2     CONTINUE
      CALL CLOSE(IDCBD(1,3))
      CALL OPEN(IDCBD(1,3),IERR,NAMD(1,3),1,NAMD(4,3),NAMD(5,3))
           IF(IERR.LT.0)GO TO 1000
      ISIZE(1)=(NSAM/128)*3*NSEG+1
      CALL PURGE(IDCB,IERR,NAME,NAME(4),NAME(5))
      CALL CREAT(IDCB,IERR,NAME,ISIZE,1,NAME(4),NAME(5))
           IF(IERR.LT.0)GO TO 1000
      RETURN
1000  CONTINUE
      CALL ERROR(LU,IERR,2HFI,IDCB,1,0)
      WRITE(LU,110)
1010  IF(NOYES(LU))1020,1010,1
1020  CONTINUE
      STOP 1000
100   FORMAT(/'ENTER DATA FILE NAMR-                                  _')
110   FORMAT(/'WISH TO RE-ENTER NAMR-                                 _')
      END
```

```
C*********************************************************************
      SUBROUTINE SETUP(POS,C,IAXIS,LU)
C
C**CALCULATES THE DIRECTION COSINE TENSOR 'C(3,3)' FOR THE COORDINATE
C  TRANSFORMATION FROM 1294 3D PROBES SENSOR COORDINATES TO THOSE OF THE
C  DESIRED TUNNEL COORDINATES  'IAXIS'=2HRE FOR RECTANGULAR SYSTEM,
C  'IAXIS'=2HCY FOR CYLINDERICAL SYSTEM.
C  POS(1,2,3) ARE THE LOCATIONS OF THE PROBE IN THE TUNNEL COORDINATES
C  X, Y & Z RESPECTIVELY. WHEN A CONVERSION IS MADE FROM RECTANGULAR
C  TO CYLINERICAL COORDINATES, X REMAINS THE SAME AND POS(2&3) ARE
C  CHANGED FROM THE INPUTED Y, Z VALUES TO R, THETA VALUES.
C  FOR THE CYLINDERICAL SYSTEM, WHEN LOOKING DOWN (+TO-) THE POSITIVE
C  X AXIS THE THETA COMPONENT IS POSITIVE IN THE COUNTERCLOCKWISE SENSE.
C  POS(4,5&6) ARE THE ROTATIONAL ANGLES ABOUT THE X, Y & Z AXIS OF THE
C  PROBE SUPPORT COORDINATES FROM AN INITIAL ALIGNMENT WITH THE TUNNEL
C  COORDINATES RESPECTIVELY. THE ROTATIONAL SEQUENCE MUST BE IN THE ORDER
C  ABOUT Z, THEN Y, THEN X SINCE PROBE COORDINATES WILL NO LONGER BE ALIGN
C  WITH TUNNEL COORDINATES AFTER THE FIRST ROTATION. THE SENSE OF THE
C  ROTATION IS: LOOKING DOWN (+TO-) THE POSITIVE AXIS OF THE PROBE
C  COORDINATE SYSTEM THE OTHER TWO AXIS ARE ROTATED IN A CLOCKWISE
C**DIRECTION RESULTS IN A POSITIVE ANGLE.
C
      COMMON /WK/  A(3,3),B(3,3)
      DIMENSION POS(6),C(3,3)
      DATA PI /3.14159/
      CONST=PI/180.0
C...................................FIND TRANSFORMATION TENSOR 'A' FOR
C                                   PROBE TO SENSOR CONVERSION.
      ROT X=0.0*CONST
      ROT Y=35.26*CONST
      ROT Z=-45.0*CONST
      CALL TRXYZ(A,ROT X,ROT Y,ROT Z)
C...................................TAKE TRANSPOSE OF 'A' TO FIND
C                                   SENSOR TO PROBE CONVERSION.
      DO 20 I=1,2
         DO 10 J=I+1,3
            SAVE=A(I,J)
            A(I,J)=A(J,I)
            A(J,I)=SAVE
10       CONTINUE
20    CONTINUE
C...................................FIND TRANSFORMATION TENSOR 'B' FOR
C                                   PROBE TO TUNNEL CONVERSION.
      WRITE(LU,100)
      READ(LU,*)POS
      ROT X=POS(4)*CONST
      ROT Y=POS(5)*CONST
      ROT Z=POS(6)*CONST
      CALL TRXYZ(B,ROT X,ROT Y,ROT Z)
C...................................CALCULATE TOTAL TRANSFORMATION TEN
C                                   'C' FOR SENSOR TO TUNNEL CONVERSIO
      CALL TMULT(A,B,C)
      IF(IAXIS.NE.2HCY)RETURN
C...................................CONVERT FROM RECT. COOR. TO CYL.
C                                   COOR. BY CALCULATING THE TRANS.
```

```
C                                                    TENSOR 'A' FOR THE ROTATION ABOUT
C                                                    THE X AXIS (THETA=ATAN(Z/Y)) THAT
C                                                    IS NECESSARY. THEN RECALCULATE
C                                                    'C' TO INCLUDE THIS LAST TRANS.
      Y=POS(2)
      Z=POS(3)
      IF(Y.EQ.0.0.AND.Z.GE.0.0)GO TO 21
                                GO TO 22
21       CONTINUE
         THETA=PI/2.0
         GO TO 25
22                              CONTINUE
      IF(Y.EQ.0.0.AND.Z.LT.0.0)GO TO 23
                                GO TO 24
23       CONTINUE
         THETA=-PI/2.0
         GO TO 25
24                              CONTINUE
         THETA=ATAN(Z/Y)
         IF(Y.LT.0.0)THETA=THETA+PI
25    CONTINUE
      POS(2)=SQRT(Y*Y+Z*Z)
      POS(3)=THETA/CONST
      DO 40 I=1,3
            DO 30 J=1,3
                  A(I,J)=C(I,J)
30          CONTINUE
40    CONTINUE
      CALL TRXYZ(B,THETA,0.,0.)
      CALL TMULT(A,B,C)
      RETURN
100   FORMAT('ENTER X, Y, Z, ROT X, ROT Y, ROTZ              _')
      END

C*********************************************************************
      SUBROUTINE TRXYZ(A,X,Y,Z)
C
C   FINDS THE CARTESIAN COORDINATE TRANSFORMATION TENSOR FOR ROTATIONS
C   ABOUT X AXIS, THEN Y AXIS, THEN Z AXIS. POSITIVE ROTATION IS
C   COUNTERCLOCKWISE WHEN LOOKING FROM + TO - ON THE AXIS.
C
      DIMENSION A(3,3)
      A(1,1)=COS(Y)*COS(Z)
      A(1,2)=COS(X)*SIN(Z)+SIN(X)*SIN(Y)*COS(Z)
      A(1,3)=SIN(X)*SIN(Z)-COS(X)*SIN(Y)*COS(Z)
      A(2,1)=-COS(Y)*SIN(Z)
      A(2,2)=-SIN(X)*SIN(Y)*SIN(Z)+COS(X)*COS(Z)
      A(2,3)=SIN(X)*COS(Z)+COS(X)*SIN(Y)*SIN(Z)
      A(3,1)=SIN(Y)
      A(3,2)=-SIN(X)*COS(Y)
      A(3,3)=COS(X)*COS(Y)
      RETURN
      END

C*********************************************************************
      SUBROUTINE TMULT(A,B,C)
      DIMENSION A(3,3),B(3,3),C(3,3)
      DO 30 I=1,3
            DO 20 J=1,3
                  C(I,J)=0.0
                  DO 10 K=1,3
                        C(I,J)=C(I,J)+B(I,K)*A(K,J)
10                CONTINUE
20          CONTINUE
30    CONTINUE
      RETURN
      END
```

```
C***********************************************************************
      SUBROUTINE DATIN(IFST,IRATE,NSAM,NSEG,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /WK/  IPAR(5)
      DIMENSION NAMP(3)
      DATA NAMP /2HDA,2HTA,2H  /
      IF(LU.NE.1.AND.LU.NE.26)CALL NAMIT(LU,NAMP)
      IP=0
      IF(IRATE.GT.3125)IP=1
      ILST=IFST+2
      DO 1 ISEG=1,NSEG
           CALL EXEC(23,NAMP,IFST,ILST,IRATE,NSAM,IP,NAMD(1,3),5)
                CALL RMPAR(IPAR)
                CALL ERROR(LU,IERR,2HDA,IDCB,1,1)
           CALL FILL(IDCB,IDCBD(1,3),NSAM,ISEG,LU)
1     CONTINUE
      CALL POSNT(IDCB,IERR,1,1)
      CALL POSNT(IDCBD(1,3),IERR,1,1)
      RETURN
      END

C***********************************************************************
      SUBROUTINE FILL(IDCB,IDCBD,NSAM,ISEG,LU)
      COMMON /WK/ IBUF(128)
      DIMENSION IDCB(144),IDCBD(144)
      IBLKS=(NSAM/128)*3
      IPOS=(ISEG-1)*IBLKS
      DO 1 IREC=1,IBLKS
           CALL READF(IDCBD,IERR,IBUF,128,LEN,IREC)
                CALL ERROR(LU,IERR,2HFL,IDCB,1,1)
           JREC=IPOS+IREC
           CALL WRITF(IDCB,IERR,IBUF,128,JREC)
                CALL ERROR(LU,IERR,2HFL,IDCB,1,1)
1     CONTINUE
      RETURN
      END
```

```
C*******************************************************************
      SUBROUTINE CONVT(NSAM,NSEG,POS,A,SL,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /VAL/ V(3),IDUM(36),NERR(3)
      COMMON /WK/  IBUF(384),IBUFD(128,3),SUM(3),JERR(3)
      DIMENSION POS(6),A(3,3)
      DO 10 I=1,3
            JERR(I)=0
            NERR(I)=0
            SUM(I)=0.0
10    CONTINUE
      NBLKS=(NSAM/128)*NSEG
      DO 5 I=1,NBLKS
           CALL READF(IDCB,IERR,IBUF,384)
                CALL ERROR(LU,IERR,2HCO,IDCB,1,1)
           IPOS=-2
           DO 3 J=1,128
                IPOS=IPOS+3
                CALL UVW(IBUF(IPOS),V,VTOT,JERR,LU)
                CALL CHECK(V,VTOT,NERR)
                CALL TCOOR(V,A)
                DO 1 K=1,3
                     IBUFD(J,K)=IFIX(V(K)/SL)
                     SUM(K)=SUM(K)+V(K)
1               CONTINUE
3          CONTINUE
           DO 4 K=1,3
                CALL WRITF(IDCBD(1,K),IERR,IBUFD(1,K),128)
                     CALL ERROR(LU,IERR,2HCO,IDCB,1,1)
4          CONTINUE
5     CONTINUE
      DO 6 K=1,3
            V(K)=SUM(K)/(128.0*FLOAT(NBLKS))
6     CONTINUE
      CALL OUT1(NAMD,POS,V,SL,JERR,NERR,LU)
      CALL PURGE(IDCB,IERR,NAME,NAME(4),NAME(5))
      RETURN
      END

C*********************************************************************
      SUBROUTINE UVW(IAD,V,VTOT,JERR,LU)
      COMMON /CAL/ A(3),B(3),C(3),RK,T(2),F(2),UMIN,UMAX,SUP(3),AMP(3)
      COMMON /TAB/ CALIB(101,3),CSLPE(3),CICPT(3),NC PTS
      DIMENSION IAD(3),V(3),JERR(3),VEFF2(3)
      SUM=0.0
      DO 10 I=1,3
            BIN=FLOAT(IAD(I))*CSLPE(I)+CICPT(I)
            N=IFIX(BIN)
            IF(N.GE.1)GO TO 2
               JERR(1)=JERR(1)+1
               BIN=1.0
               N=1
               GO TO 4
2           CONTINUE
            IF(N.LE.100)GO TO 4
               JERR(2)=JERR(2)+1
               BIN=101.0
               N=100
4           CONTINUE
            DEL=(CALIB(N+1,I)-CALIB(N,I))*(BIN-FLOAT(N))
            VEFF2(I)=CALIB(N,I)+DEL
            SUM=SUM+VEFF2(I)
10    CONTINUE
      VTOT2=SUM/F(1)
      DO 30 I=1,3
            TEMPX=VTOT2-VEFF2(I)
            IF(TEMPX.GE.0.0)GO TO 20
               TEMPX=0.0
               JERR(3)=JERR(3)+1
20          CONTINUE
            V(I)=SQRT(TEMPX/F(2))
30    CONTINUE
      VTOT=SQRT(VTOT2)
      RETURN
      END
```

```
C*********************************************************************
      SUBROUTINE CHECK(V,VTOT,NERR)
      DIMENSION V(3),NERR(3)
      DATA SIN10,SIN80 /0.1736,0.9848/
      DO 1 I=1,3
           X=V(I)/VTOT
           IF(X.LT.SIN10.OR.X.GT.SIN80)NERR(I)=NERR(I)+1
1     CONTINUE
      RETURN
      END

C*********************************************************************
      SUBROUTINE TCOOR(V,A)
      DIMENSION V(3),A(3,3),VTUN(3)
      DO 2 I=1,3
           VTUN(I)=0.0
           DO 1 J=1,3
                VTUN(I)=VTUN(I)+A(I,J)*V(J)
1          CONTINUE
2     CONTINUE
      DO 3 I=1,3
           V(I)=VTUN(I)
3     CONTINUE
      RETURN
      END

C*********************************************************************
      SUBROUTINE OUT1(NAMD,POS,V,SL,JERR,NERR,LU)
      COMMON /WK/  ANGLE(3)
      DIMENSION NAMD(5,3),POS(6),V(3),JERR(3),NERR(3)
      WRITE(LU,100)
      DO 1 J=1,3
1     WRITE(LU,110)(NAMD(I,J),I=1,3),(POS(I),I=1,6),V(J),SL
      VTOT=SQRT(V(1)*V(1)+V(2)*V(2)+V(3)*V(3))
      WRITE(LU,120)VTOT
      DO 2 I=1,3
           ANGLE(I)=ATAN(V(I)/SQRT((VTOT-V(I))*(VTOT+V(I))))
           ANGLE(I)=90.0-ANGLE(I)*180.0/3.14159
2     CONTINUE
      WRITE(LU,130)(ANGLE(I),I=1,3)
      IF(JERR(1).NE.0)WRITE(LU,140)JERR(1)
      IF(JERR(2).NE.0)WRITE(LU,145)JERR(2)
      IF(JERR(3).NE.0)WRITE(LU,150)JERR(3)
      IF(NERR(1).NE.0.OR.NERR(2).NE.0.OR.NERR(3).NE.0)
     +   WRITE(LU,160)(NERR(I),I=1,3)
      RETURN
100   FORMAT(' FILE          LINEAR POSITION     ROTATIONAL POSITION(DEG)'
     +      ' MEAN VEL.  CONVERSION '/' NAME                X      Y       Z '
     +      '      X        Y       Z                     CONSTANT')
110   FORMAT(3A2,5X,6(F7.2),4X,F7.2,3X,G11.4)
120   FORMAT(/'MEAN TOTAL VELOCITY ='F7.1)
130   FORMAT('MEAN COMP.ANGLES     = 'F6.1' FROM X AXIS'/
     +      '                        'F6.1' FROM Y AXIS'/
     +      '                        'F6.1' FROM Z AXIS'/)
140   FORMAT(/'!!!!! LOWER CAL. RANGE WAS EXCEEDED 'I5' TIMES !!!!!'/)
145   FORMAT(/'!!!!! UPPER CAL. RANGE WAS EXCEEDED 'I5' TIMES !!!!!'/)
150   FORMAT(/'!!!!! CALCULATIONAL ERROR OCCURED 'I5' TIMES !!!!!'/)
160   FORMAT(/'!!! VELOCITY VECTOR 1 EXCEEDED DIR. LIMITS 'I5' TIMES'
     +       /'!!! VELOCITY VECTOR 2 EXCEEDED DIR. LIMITS 'I5' TIMES'
     +       /'!!! VELOCITY VECTOR 3 EXCEEDED DIR. LIMITS 'I5' TIMES')
      END
```

```
C***********************************************************************
      SUBROUTINE REDUC(NSAM,NSEG,SL,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /VAL/ VMN(3),VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3),NERR(3)
      COMMON /WK/  IBUFD(128,3),V(128,3),CVMN(3)
      DO 1 I=1,3
           CALL POSNT(IDCBD(1,I),IERR,1,1)
                CALL ERROR(LU,IERR,2HRE,IDCB,1,1)
           CVMN(I)=VMN(I)/SL
           VMIN(I)=1.E30
           VMAX(I)=-1.E30
1     CONTINUE
      NBLKS=(NSAM/128)*NSEG
      DO 4 I=1,NBLKS
           DO 3 J=1,3
                CALL READF(IDCBD(1,J),IERR,IBUFD(1,J),128)
                     CALL ERROR(LU,IERR,2HRE,IDCB,1,1)
                DO 2 K=1,128
                     V(K,J)=FLOAT(IBUFD(K,J))
                     VMIN(J)=AMIN1(VMIN(J),V(K,J))
                     VMAX(J)=AMAX1(VMAX(J),V(K,J))
2               CONTINUE
                CALL MOMET(V(1,J),CVMN(J),VMOMT(1,J),I)
3          CONTINUE
           CALL STRES(V,CVMN,VSTRS,I)
4     CONTINUE
      DO 5 I=1,3
           VMOMT(2,I)=VMOMT(2,I)/(VMOMT(1,I)**1.5)
           VMOMT(3,I)=VMOMT(3,I)/(VMOMT(1,I)*VMOMT(1,I))
           VMOMT(1,I)=SL*SQRT(VMOMT(1,I))
           VSTRS(I)=VSTRS(I)*SL*SL
           VMIN(I)=VMIN(I)*SL
           VMAX(I)=VMAX(I)*SL
5     CONTINUE
      CALL OUT2(VMOMT,VSTRS,VMIN,VMAX,LU)
      RETURN
      END
```

```
C***********************************************************************
      SUBROUTINE MOMET(V,VMN,VMOMT,N)
      DIMENSION V(128),VMOMT(3)
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      WIGHT=1.0/FLOAT(N)
      DO 1 I=1,128
           X=V(I)-VMN
           XX=X*X
      SUM1=SUM1+XX
      SUM2=SUM2+XX*X
      SUM3=SUM3+XX*XX
1     CONTINUE
      VMOMT(1)=VMOMT(1)*(1.-WIGHT)+SUM1*WIGHT/128.0
      VMOMT(2)=VMOMT(2)*(1.-WIGHT)+SUM2*WIGHT/128.0
      VMOMT(3)=VMOMT(3)*(1.-WIGHT)+SUM3*WIGHT/128.0
      RETURN
      END
```

```
C***********************************************************************
      SUBROUTINE STRES(VEL,VMN,VSTRS,N)
      DIMENSION VEL(128,3),VMN(3),VSTRS(3)
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      WIGHT=1.0/FLOAT(N)
      DO 1 I=1,128
            U=VEL(I,1)-VMN(1)
            V=VEL(I,2)-VMN(2)
            W=VEL(I,3)-VMN(3)
            SUM1=SUM1+U*W
            SUM2=SUM2+U*V
            SUM3=SUM3+V*W
1     CONTINUE
      VSTRS(1)=VSTRS(1)*(1.-WIGHT)+SUM1*WIGHT/128.0
      VSTRS(2)=VSTRS(2)*(1.-WIGHT)+SUM2*WIGHT/128.0
      VSTRS(3)=VSTRS(3)*(1.-WIGHT)+SUM3*WIGHT/128.0
      RETURN
      END

C***********************************************************************
      SUBROUTINE OUT2(VMOMT,VSTRS,VMIN,VMAX,LU)
      DIMENSION VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3)
      WRITE(LU,100)
      WRITE(LU,102)(VMIN(I),I=1,3)
      WRITE(LU,104)(VMAX(I),I=1,3)
      WRITE(LU,110)(VMOMT(1,I),I=1,3)
      WRITE(LU,120)((VMOMT(I,J),J=1,3),I=2,3)
      WRITE(LU,130)(VSTRS(I),I=1,3)
      RETURN
100   FORMAT(22X'U'9X'V'9X'W')
102   FORMAT(/2X'MIN. VELOCITY=   '3(F8.3,2X))
104   FORMAT(2X'MAX. VELOCITY=   '3(F8.3,2X))
110   FORMAT(2X'RMS VELOCITY =   '3(F8.3,2X))
120   FORMAT(2X'SKEWNESS     =   '3(F8.3,2X)/
     +        2X'FLATNESS     =   '3(F8.3,2X))
130   FORMAT(/22X'UW'8X'UV'8X'VW'/
     +        2X'REY. STRESS  =   '3(F8.5,2X))
      END
```

```
C*****************************************************************
       SUBROUTINE SAVIT(IRATE,NSAM,NSEG,SL,POS,LU)
       COMMON /FIL/ IDUM(581),NAMD(5,3)
       COMMON /CAL/ A(3),B(3),C(3),RK,T(2),F(2),UMIN,UMAX,SUP(3),AMP(3)
       COMMON /VAL/ VMN(3),VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3),NERR(3)
       COMMON /WK/  IBUF(102),IB2(18),IB3(24)
       DIMENSION POS(6),POS1(6),A1(3),IB1(15),IB4(45),NAM(5)
       EQUIVALENCE (IB1(1),NAMD(1,1)),(IB2(1),RATE),(IB2(3),NSAM1),
      +            (IB2(4),NSEG1),(IB2(5),SL1),(IB2(7),POS1(1)),
      +            (IB3(1),A1(1)),(IB4(1),VMN(1))
       DATA NAM /2HVA,2HLU,2HES,2HDN,16/
10     WRITE(LU,100)
       IF(NOYES(LU))7,10,11
11     CONTINUE
       RATE=RATE1(IRATE)
       NSAM1=NSAM
       NSEG1=NSEG
       SL1=SL
       DO 1 I=1,6
            POS1(I)=POS(I)
1      CONTINUE
       DO 3 I=1,15
            IBUF(I)=IB1(I)
3      CONTINUE
       DO 4 I=1,18
            J=I+15
            IBUF(J)=IB2(I)
4      CONTINUE
       DO 5 I=1,24
            J=I+33
            IBUF(J)=IB3(I)
5      CONTINUE
       DO 6 I=1,45
            J=I+57
            IBUF(J)=IB4(I)
6      CONTINUE
       CALL WREC(IBUF,102,NAM,LU)
7      CONTINUE
       RETURN
100    FORMAT(/'WISH TO SAVE RESULTS ON FILE VALUES:DN:16 -?  _')
       END


C*****************************************************************
       SUBROUTINE F INFO(NSAM,IRATE,NSEG,SL,LU)
       COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
       COMMON /VAL/ VMN(3),VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3),NERR(3)
       COMMON /WK/  IBUF(128)
       EQUIVALENCE (IBUF(1),NSM),(IBUF(2),RATE),(IBUF(4),IBLOC),
      +            (IBUF(5),RMN),(IBUF(7),RMS),(IBUF(9),SLPE)
       NSM=NSAM
       RATE=RATE1(IRATE)
       IBLOC=(NSAM/128)*NSEG
       SLPE=1.0/SL
       DO 10 I=1,3
              RMN=VMN(I)
              RMS=VMOMT(1,I)
              CALL WRITF(IDCBD(1,I),IERR,IBUF,128,(IBLOC+1))
                   CALL ERROR(LU,IERR,2HF ,IDCB,1,0)
10     CONTINUE
       RETURN
       END
```

```
C**********************************************************************
         SUBROUTINE WREC(IB,N,NAM,LU)
         COMMON /WK/  ISAV(200),IDCB(144),ISIZ(2),IB1(10)
         DIMENSION IB(N),NAM(5)
         ISIZ(1)=24
         ISIZ(2)=N
         CALL OPEN(IDCB,IERR,NAM,2,NAM(4),NAM(5))
              IF(IERR.EQ.-6)CALL CREAT(IDCB,IERR,NAM,ISIZ,3,NAM(4),NAM(5))
              CALL ERROR(LU,IERR,2HWR,IDCB,1,1)
10       CONTINUE
         CALL READF(IDCB,IERR,IB1,10,LEN)
              CALL ERROR(LU,IERR,2HWR,IDCB,1,1)
         IF(LEN.NE.-1)GO TO 10
         CALL POSNT(IDCB,IERR,-1)
              CALL ERROR(LU,IERR,2HWR,IDCB,1,1)
         CALL WRITF(IDCB,IERR,IB,N)
              CALL ERROR(LU,IERR,2HWR,IDCB,1,1)
         CALL CLOSE(IDCB)
         RETURN
         END

C**********************************************************************
         SUBROUTINE PURG(NSAM,NSEG,LU)
         COMMON /FIL/ IDUM(149),IDCBD(144,3),NAMD(5,3)
         COMMON /WK/  IB(10)
         DIMENSION NAM(5)
         DATA NAM,N /2HTR,2HAN,2HSF,2HDN,16,10/
         ITRUN=0
         IF(NSEG.LT.3)ITRUN=(3-NSEG)*(NSAM/128)
         IANSW=2HNO
10       WRITE(LU,100)
         IF(NOYES(LU))30,10,20
20       CONTINUE
         IANSW=2HYE
30       CONTINUE
         DO 50 I=1,3
               CALL CLOSE(IDCBD(1,I))
               IF(IANSW.EQ.2HYE)GO TO 40
                  CALL CODE
                  WRITE(IB,110)(NAMD(J,I),J=1,5)
                  CALL WREC(IB,N,NAM,LU)
                  IF(I.NE.3)GO TO 50
                     CALL OPEN(IDCBD,IERR,NAMD(1,3),0,NAMD(4,3),NAMD(5,3))
                          CALL ERROR(LU,IERR,2HPU,IDCB,0,0)
                     CALL CLOSE(IDCBD,IERR,ITRUN)
                          CALL ERROR(LU,IERR,2HPU,IDCB,0,0)
                     GO TO 50
40             CONTINUE
               CALL PURGE(IDCBD(1,I),IERR,NAMD(1,I),NAMD(4,I),NAMD(5,I))
50       CONTINUE
         IF(IANSW.EQ.2HYE)WRITE(LU,120)((NAMD(I,J),I=1,3),J=1,3)
         RETURN
100      FORMAT('WISH TO PURGE DATA FILES-?                       _')
110      FORMAT(':PU,'3A2':'I5':'I3)
120      FORMAT(/'PURGED FILES ARE '3(4X,3A2)/)
         END
```

```
C***********************************************************************
      SUBROUTINE ERROR(LU,IERR,LOC,IDCB,IPUR,ISTOP)
      DIMENSION IDCB(144)
      IF(IERR.GE.0)RETURN
      CALL CLOSE(IDCB)
      IF(LOC.NE.2HDA)WRITE(LU,100)IERR,LOC
      IF(LOC.EQ.2HDA)WRITE(LU,110)IERR,LOC
      IF(IPUR.EQ.1)CALL PURG(0,3,LU)
      IF(ISTOP.EQ.1)STOP 1111
      RETURN
100   FORMAT(' FMGR ERROR 'I5' IN 'A2)
110   FORMAT(' DATA PROGRAM ERROR 'I5' IN 'A2)
      END

C***********************************************************************
      FUNCTION RATE1(IRATE)
      IP=0
      IF(IRATE.GT.3125)IP=1
      RATE1=FLOAT(3125*(IP+1))/FLOAT(3125*(IP+1)/IRATE)
      RETURN
      END
```

```
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FTN4,L
      PROGRAM DAT1(3,80)
C
C**DESIGNED TO BE USED WITH THE TSI 1294 3D HOT FILM PROBE.
C**ACQUIRES DATA ONLY
C
      DIMENSION IPAR(5),POS(6)
      CALL RMPAR(IPAR)
      LU=IPAR(1)
      IF(LU.LT.1)LU=1
      CALL LIBER(LU)
      CALL INPUT(IFST,IRATE,NSAM,NSEG,OPTEMP,LU)
1     CONTINUE
         CALL FILES(NSAM,NSEG,LU)
         WRITE(LU,100)
         READ(LU,*)POS
2        WRITE(LU,110)
         IF(NOYES(LU))5,2,4
4        CONTINUE
         CALL DATIN(IFST,IRATE,NSAM,NSEG,LU)
              IF(IFBRK(DM).LT.0)GO TO 5
         WRITE(LU,130)
         CALL F INFO(NSAM,IRATE,NSEG,POS,OPTEMP,LU)
5        CONTINUE
         CALL PURG(LU)
6        WRITE(LU,140)
         IF(NOYES(LU))7,6,1
7     CONTINUE
      WRITE(LU,150)
100   FORMAT('ENTER X, Y, Z, ROT X, ROT Y, ROT Z                    _')
110   FORMAT('READY-?                                               _')
130   FORMAT('*****DATA RECORD OBTAINED*****')
140   FORMAT('WANT TO RUN AGAIN-?                                   _')
150   FORMAT('RUN COMPLETE')
      END
```

```
C*********************************************************************
      SUBROUTINE INPUT(IFST,IRATE,NSAM,NSEG,OPTEMP,LU)
1     CONTINUE
         WRITE(LU,100)
         READ(LU,*)IFST,IRATE,NSAM,NSEG,OPTEMP
         NSAM=((NSAM+127)/128)*128
         RATE=RATE1(IRATE)
         NCHAN=3
         ILST=IFST+NCHAN-1
         TIME=FLOAT(NSEG)*FLOAT(NSAM)/RATE
         WRITE(LU,110)NSAM,NSEG,RATE,TIME,IFST,NCHAN,OPTEMP
2        CONTINUE
         WRITE(LU,120)
         IF(NOYES(LU))1,2,3
3     CONTINUE
      RETURN
100   FORMAT('ENTER CHAN 1, RATE, SAMPLES, SEGMENTS , TEMP.-_')
110   FORMAT('NO. OF SAMPLES=              'I5/
     +       'NO. OF SEGMENTS=             'I5/
     +          'SAMPLE RATE=           'F7.2/
     +          'TIME DURATION=         'F8.2/
     +          'FIRST CHANNEL=               'I2/
     +          'NO. CHANNELS=                'I2/
     +          'TEMPERATURE=           'F7.1/)
120   FORMAT('ENTRIES OK-?                                    _')
      END

C*********************************************************************
      SUBROUTINE FILES(NSAM,NSEG,LU)
      COMMON /FIL/  IDCB(144),NAME(5),IDCBS(144),NAMS(5)
      DIMENSION ISIZE(2)
1     CONTINUE
      WRITE(LU,100)
      CALL GNAME(LU,NAME,NAME(4),NAME(5),1)
      ISIZE(1)=(NSAM/128)*NSEG*3+1
      CALL CREAT(IDCB,IERR,NAME,ISIZE,1,NAME(4),NAME(5))
           IF(IERR.LT.0)GO TO 1000
      ISIZE(1)=(NSAM/128)*3+1
      CALL PURGE(IDCBS,IERR,NAMS,NAMS(4),NAMS(5))
      CALL CREAT(IDCBS,IERR,NAMS,ISIZE,1,NAMS(4),NAMS(5))
           IF(IERR.LT.0)GO TO 1000
      CALL CLOSE(IDCBS)
      CALL OPEN(IDCBS,IERR,NAMS,1,NAMS(4),NAMS(5))
           IF(IERR.LT.0)GO TO 1000
      RETURN
1000  CONTINUE
      CALL ERROR(LU,IERR,2HFI,IDCB,1,0)
      WRITE(LU,110)
1010  IF(NOYES(LU))1020,1010,1
1020  CONTINUE
      STOP 1000
100   FORMAT(/'ENTER DATA FILE NAMR-                              _')
110   FORMAT(/'WISH TO RE-ENTER NAMR-                             _')
      END
```

```
C**********************************************************************
      SUBROUTINE DATIN(IFST,IRATE,NSAM,NSEG,LU)
      COMMON /FIL/  IDCB(144),NAME(5),IDCBS(144),NAMS(5)
      DIMENSION NAMP(3),IPAR(5)
      DATA NAMP /2HDA,2HTA,2H  /
      IF(LU.NE.1.AND.LU.NE.26)CALL NAMIT(LU,NAMP)
      IP=0
      IF(IRATE.GT.3125)IP=1
      ILST=IFST+2
      DO 1 ISEG=1,NSEG
           CALL EXEC(23,NAMP,IFST,ILST,IRATE,NSAM,IP,NAMS,5)
                CALL RMPAR(IPAR)
                CALL ERROR(LU,IERR,2HDA,IDCB,1,1)
           CALL FILL(IDCB,IDCBS,NSAM,ISEG,LU)
1     CONTINUE
      CALL PURGE(IDCBS,IERR,NAMS,NAMS(4),NAMS(5))
      RETURN
      END

C**********************************************************************
      SUBROUTINE FILL(IDCB,IDCBS,NSAM,ISEG,LU)
      DIMENSION IDCB(144),IDCBS(144),IBUF(128)
      IBLKS=(NSAM/128)*3
      IPOS=(ISEG-1)*IBLKS
      DO 1 IREC=1,IBLKS
           CALL READF(IDCBS,IERR,IBUF,128,LEN,IREC)
                CALL ERROR(LU,IERR,2HFL,IDCB,1,1)
           JREC=IPOS+IREC
           CALL WRITF(IDCB,IERR,IBUF,128,JREC)
                CALL ERROR(LU,IERR,2HFL,IDCB,1,1)
1     CONTINUE
      RETURN
      END

C*******************************************************************
      SUBROUTINE F INFO(NSAM,IRATE,NSEG,POS,OPTEMP,LU)
      COMMON /FIL/  IDCB(144),NAME(5),IDCBS(144),NAMS(5)
      DIMENSION IBUF(128),POS(6),POS1(6)
      EQUIVALENCE (IBUF(1),NSM),(IBUF(2),RATE),(IBUF(4),IBLOC),
     +              (IBUF(5),POS1(1)),(IBUF(17),OPTEM)
      NSM=NSAM
      RATE=RATE1(IRATE)
      IBLOC=(NSAM/128)*NSEG
      OPTEM=OPTEMP
      DO 5 I=1,6
           POS1(I)=POS(I)
5     CONTINUE
      JBLOC=IBLOC*3
      CALL WRITF(IDCB,IERR,IBUF,128,(JBLOC+1))
           CALL ERROR(LU,IERR,2HF ,IDCB,1,0)
10    CONTINUE
      RETURN
      END
```

```
C*******************************************************************
      SUBROUTINE WREC(IB,N,NAM,LU)
      DIMENSION IDCB(144),ISIZ(2),IB1(10),IB(N),NAM(5)
      ISIZ(1)=24
      ISIZ(2)=N
      CALL OPEN(IDCB,IERR,NAM,2,NAM(4),NAM(5))
           IF(IERR.EQ.-6)CALL CREAT(IDCB,IERR,NAM,ISIZ,3,NAM(4),NAM(5))
           CALL ERROR(LU,IERR,2HWR,IDCB,1,1)
10    CONTINUE
      CALL READF(IDCB,IERR,IB1,10,LEN)
           CALL ERROR(LU,IERR,2HWR,IDCB,1,1)
      IF(LEN.NE.-1)GO TO 10
      CALL POSNT(IDCB,IERR,-1)
           CALL ERROR(LU,IERR,2HWR,IDCB,1,1)
      CALL WRITF(IDCB,IERR,IB,N)
           CALL ERROR(LU,IERR,2HWR,IDCB,1,1)
      CALL CLOSE(IDCB)
      RETURN
      END

C*******************************************************************
      SUBROUTINE PURG(LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBS(144),NAMS(5)
      DIMENSION NAM(5),IB(10)
      DATA NAM,N /2HTR,2HAN,2HSF,2HDN,16,10/
      IANSW=2HNO
10    WRITE(LU,100)
      IF(NOYES(LU))30,10,20
20    CONTINUE
      IANSW=2HYE
30    CONTINUE
      CALL CLOSE(IDCB)
      IF(IANSW.EQ.2HYE)GO TO 40
         CALL CODE
         WRITE(IB,110)(NAME(J),J=1,5)
         CALL WREC(IB,N,NAM,LU)
         GO TO 50
40    CONTINUE
      CALL PURGE(IDCB,IERR,NAME,NAME(4),NAME(5))
50    CONTINUE
      IF(IANSW.EQ.2HYE)WRITE(LU,120)(NAME(I),I=1,3)
      RETURN
100   FORMAT("WISH TO PURGE DATA FILE -?                        _")
110   FORMAT(":PU,"3A2":"I5":"I3)
120   FORMAT(/"PURGED FILES ARE "3(4X,3A2)/)
      END

C*******************************************************************
      SUBROUTINE ERROR(LU,IERR,LOC,IDCB,IPUR,ISTOP)
      DIMENSION IDCB(144)
      IF(IERR.GE.0)RETURN
      CALL CLOSE(IDCB)
      IF(LOC.NE.2HDA)WRITE(LU,100)IERR,LOC
      IF(LOC.EQ.2HDA)WRITE(LU,110)IERR,LOC
      IF(IPUR.EQ.1)CALL PURG(LU)
      IF(ISTOP.EQ.1)STOP 1111
      RETURN
100   FORMAT(" FMGR ERROR "I5" IN "A2)
110   FORMAT(" DATA PROGRAM ERROR "I5" IN "A2)
      END
C*******************************************************************
      FUNCTION RATE1(IRATE)
      IP=0
      IF(IRATE.GT.3125)IP=1
      RATE1=FLOAT(3125*(IP+1))/FLOAT(3125*(IP+1)/IRATE)
      RETURN
      END

FTN4 COMPILER: HP92060-16092 REV. 1901 (781201)
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```
FTN4,L
      PROGRAM DAT2(3,90)
C
C**DESIGNED TO BE USED WITH THE TSI 1294 3D HOT FILM PROBE.
C**IT USES THE REDUCTION TECHNIQUES DESCRIBED IN TSI TB 8 TO OBTAIN
C**THE U,V,W TIME SERIES.
C
      COMMON /WK/ IPAR(5)
      DIMENSION POS(6),A(3,3),NAMTR(5),NAMCL(5),NAMTR2(5),NAMVL(5)
      CALL RMPAR(IPAR)
      LU=IPAR(1)
      IF(LU.LT.1)LU=1
      CALL LIBER(LU)
      CALL INNAM(NAMTR,NAMCL,NAMTR2,NAMVL,IAXIS,ICR,IPUR,LU)
      CALL VELCL(NAMCL,SL,LU)
      NC=0
1     CONTINUE
         NC=NC+1
         CALL TRFIL(NAMTR,NC,IEND,LU)
              IF(IEND.EQ.1)GO TO 7
         CALL INPUT(RATE,NSAM,NSEG,POS,LU)
         CALL FILES(NSAM,NSEG,ICR,LU)
         CALL SETUP(POS,A,IAXIS,LU)
         CALL CONVT(NSAM,NSEG,POS,A,SL,LU)
         CALL REDUC(NSAM,NSEG,SL,LU)
         CALL ANGTM(NSAM,NSEG,LU)
         CALL SAVIT(RATE,NSAM,NSEG,SL,POS,NAMVL,LU)
         CALL F INFO(NSAM,RATE,NSEG,SL,LU)
         CALL TRANS(NAMTR2,IPUR,LU)
         IF(IPUR.NE.0)CALL PURG(LU)
         GO TO 1
7     CONTINUE
      NC=NC-1
      WRITE(LU,150)NC
150   FORMAT(/"RUN COMPLETE ON "I5" RUNS")
      END

C*******************************************************************
      BLOCK DATA
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /CAL/ A(3),B(3),C(3),RK,T(2),F(2),UMIN,UMAX,SUP(3),AMP(3)
      COMMON /TAB/ CALIB(101,3),CSLPE(3),CICPT(3),NC PTS
      COMMON /VAL/ VMN(3),VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3),NERR(3)
     +            ,AGMIN(3),AGMAX(3),AMN(3),AMOMT(3,3)
      COMMON /WK/ IDUM(1158)
      DATA NC PTS,NAME /101,2HSC,2HRA,2HTC,2HDN,16/
      DATA NAMD(1,1),NAMD(1,2),NAMD(1,3) /2HUU,2HVV,2HWW/
      END
```

```
C*************************************************************************
      SUBROUTINE INNAM(NAMTR,NAMCL,NAMTR2,NAMVL,IAXIS,ICR,IPUR,LU)
      DIMENSION NAMTR(5),NAMCL(5),NAMTR2(5),NAMVL(5)
      WRITE(LU,100)
      READ(LU,110)IAXIS
      WRITE(LU,170)
      READ(LU,*)IPUR
      WRITE(LU,120)
      CALL GNAME(LU,NAMTR,NAMTR(4),NAMTR(5),1)
      IF(IPUR.NE.0)GO TO 10
         WRITE(LU,130)
         CALL GNAME(LU,NAMTR2,NAMTR2(4),NAMTR2(5),1)
10    CONTINUE
      WRITE(LU,140)
      CALL GNAME(LU,NAMCL,NAMCL(4),NAMCL(5),1)
      WRITE(LU,150)
      CALL GNAME(LU,NAMVL,NAMVL(4),NAMVL(5),1)
      WRITE(LU,160)
      READ(LU,*)ICR
      RETURN
100   FORMAT("TYPE OF AXIS (RECT. OR CYL.)-                     _")
110   FORMAT(A2)
120   FORMAT("ENTER TRANSFER FILE NAMR-(IN)                     _")
130   FORMAT("ENTER TRANSFER FILE NAMR-(OUT)                    _")
140   FORMAT("ENTER CALIBRATION FILE NAMR-                      _")
150   FORMAT("ENTER VALUES FILE NAMR-                           _")
160   FORMAT("ENTER CART. NO. FOR U, V, W, FILES                _")
170   FORMAT("ENTER '0' TO SAVE U, V, W, FILES                  _")
      END

C*************************************************************************
      SUBROUTINE TRFIL(NAMTR,NC,IEND,LU)
      COMMON /FIL/ IDCB(144),NAME(5)
      COMMON /WK/  IBUF(36),ITEN(10)
      DIMENSION NAMTR(5)
      CALL OPEN(IDCB,IERR,NAMTR,0,NAMTR(4),NAMTR(5))
           CALL ERROR(LU,IERR,2HTR)
      CALL POSNT(IDCB,IERR,NC,1)
      IEND=0
      ISCR=1
      CALL READF(IDCB,IERR,IBUF,36,LEN2)
           CALL ERROR(LU,IERR,2HTR)
      LEN=LEN2*2
      IF(IBUF(1).EQ.2H::)GO TO 20
      IF(LEN.LT.1)GO TO 20
      CALL NAMR(ITEN,IBUF,LEN,ISCR)
      IF(NAMR(ITEN,IBUF,LEN,ISCR))20,10
10    IF(IP1(0,ITEN(4)).NE.3)GO TO 20
         NAME(1)=ITEN(1)
         NAME(2)=ITEN(2)
         NAME(3)=ITEN(3)
         NAME(4)=0
         IF(IP1(1,ITEN(4)).NE.0)NAME(4)=ITEN(5)
         NAME(5)=0
         IF(IP1(2,ITEN(4)).EQ.1)NAME(5)=ITEN(6)
         CALL CLOSE(IDCB)
         CALL OPEN(IDCB,IERR,NAME,0,NAME(4),NAME(5))
              CALL ERROR(LU,IERR,2HTR)
         RETURN
20    CONTINUE
      CALL PURGE(IDCB,IERR,NAMTR,NAMTR(4),NAMTR(5))
      IEND=1
      RETURN
      END
```

```
C**********************************************************************
      FUNCTION IP1(IPR,IWORD)
      JWORD=IWORD/(4**IPR)
      IP1=MOD(JWORD,4)
      RETURN
      END

C**********************************************************************
      SUBROUTINE INPUT(RATE,NSAM,NSEG,POS,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDUM(447)
      COMMON /CAL/ DUM(10),T(2),DUM1(10)
      COMMON /WK/  IB(128)
      DIMENSION POS(6),POS1(6)
      EQUIVALENCE (IB(1),NSAM1),(IB(2),RATE1),(IB(4),IBLOC),
     +            (IB(5),POS1(1)),(IB(17),OPTEMP)
      NBLOC=IDCB(6)/2
      CALL READF(IDCB,IERR,IB,128,LEN,NBLOC)
           CALL ERROR(LU,IERR,2HIP)
      CALL POSNT(IDCB,IERR,1,1)
      DO 10 I=1,6
            POS(I)=POS1(I)
 10   CONTINUE
      T(2)=OPTEMP
      NSAM=NSAM1
      RATE=RATE1
      NSEG=IBLOC/(NSAM/128)
      TIME=FLOAT(NSEG)*FLOAT(NSAM)/RATE
      WRITE(LU,110)NSAM,NSEG,RATE,TIME,OPTEMP
      RETURN
 110  FORMAT(///'*****************************************************'
     +       /'NO. OF SAMPLES=           'I5/
     +       'NO. OF SEGMENTS=           'I5/
     +       'SAMPLE RATE=             'F7.2/
     +       'TIME DURATION=          'F8.2/
     +       'OPERATION TEMP.=           'F5.1/)
      END
```

```
C*****************************************************************************
      SUBROUTINE VELCL(NAMCL,SL,LU)
      COMMON /CAL/ A(3),B(3),C(3),RK,T(2),F(2),UMIN,UMAX,SUP(3),AMP(3)
      COMMON /FIL/ IDCB(144)
      COMMON /WK/  IBUF(18)
      DIMENSION NAMCL(5)
      EQUIVALENCE (IBUF(1),A1),(IBUF(3),B1),(IBUF(5),C1),(IBUF(7),RK1),
     +            (IBUF(9),CLTEM1),(IBUF(11),UMIN1),(IBUF(13),UMAX1),
     +            (IBUF(15),SUP1),(IBUF(17),AMP1)
      CALL OPEN(IDCB,IERR,NAMCL,0,NAMCL(4),NAMCL(5))
         CALL ERROR(LU,IERR,2HVE)
      DO 10 IC=1,3
          CALL READF(IDCB,IERR,IBUF)
             CALL ERROR(LU,IERR,2HVE)
          A(IC)=A1
          B(IC)=B1
          C(IC)=C1
          RK=RK1
          CLTEMP=CLTEM1
          UMIN=UMIN1
          UMAX=UMAX1
          SUP(IC)=SUP1
          AMP(IC)=AMP1
10    CONTINUE
      WRITE(LU,110)
      DO 40 IC=1,3
          WRITE(LU,120)IC,A(IC),B(IC),C(IC),RK,CLTEMP,UMIN,UMAX
     +                 ,SUP(IC),AMP(IC)
40    CONTINUE
20    CONTINUE
      SL=UMAX/32752.0
      T(1)=CLTEMP
      CALL TABLE
      CALL CLOSE(IDCB)
      RETURN
110   FORMAT("CHANNEL    A"6X"B"7X"C"7X"K  "1X"CAL TEMP"2X"UMIN"
     +       "      UMAX   SUPPRES AMPLIFY")
120   FORMAT(1X,I2,4X,F6.3,2X,F6.4,2X,F6.4,2X,F5.3,2X,F4.1,2X,
     +       F6.2,2X,F6.2,2X,F6.3,2X,F5.2)
      END
```

```
C*******************************************************************
      SUBROUTINE TABLE
      COMMON /CAL/ A(3),B(3),C(3),RK,T(2),F(2),UMIN,UMAX,SUP(3),AMP(3)
      COMMON /TAB/ CALIB(101,3),CSLPE(3),CICPT(3),NC PTS
C     DATA ALPHA /0.00392/
      DATA PI /3.14159/
      F(1)=2.+RK*RK
      F(2)=1.-RK*RK
      TFAC=1.0
C     TFAC=SQRT(1./(1.+ALPHA*(T(1)-T(2))/0.5))
C     AFACMN=SQRT(COS(PI/2.)**2+(RK*SIN(PI/2.))**2)
      AFACMN=RK
C     AFACMX=SQRT(COS(0.0)**2+(RK*SIN(0.0))**2)
      AFACMX=1.0
      DO 2 J=1,3
            ERMIN=SQRT(TFAC*(A(J)+B(J)*(UMIN*AFACMN)**C(J)))
            EMIN=(ERMIN-SUP(J))*AMP(J)
            IF(EMIN.LT.-10.0)EMIN=-10.0
            ERMAX=SQRT(TFAC*(A(J)+B(J)*(UMAX*AFACMX)**C(J)))
            EMAX=(ERMAX-SUP(J))*AMP(J)
            IF(EMAX.GT.10.0)EMAX=10.0
            DEL E=(EMAX-EMIN)/FLOAT(NC PTS-1)
            E=EMIN-DEL E
            POW=2.0/C(J)
            DO 1 I=1,NC PTS
                  E=E+DEL E
                  ER=E/AMP(J)+SUP(J)
                  CALIB(I,J)=((ER*ER/TFAC-A(J))/B(J))**POW
 1          CONTINUE
            CMIN=EMIN*3275.2
            CMAX=EMAX*3275.2
            CSLPE(J)=FLOAT(NC PTS-1)/(CMAX-CMIN)
            CICPT(J)=-CSLPE*CMIN+1.0
 2    CONTINUE
      RETURN
      END

C*******************************************************************
      SUBROUTINE FILES(NSAM,NSEG,ICR,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /WK/  ISIZE(2)
      NAMD(2,1)=NAME(2)
      NAMD(2,2)=NAME(2)
      NAMD(2,3)=NAME(2)
      NAMD(3,1)=NAME(3)
      NAMD(3,2)=NAME(3)
      NAMD(3,3)=NAME(3)
      NAMD(4,1)=NAME(4)
      NAMD(4,2)=NAME(4)
      NAMD(4,3)=NAME(4)
      NAMD(5,1)=ICR
      NAMD(5,2)=ICR
      NAMD(5,3)=ICR
      ISIZE(1)=(NSAM/128)*NSEG+1
      DO 2 I=1,3
            CALL CREAT(IDCBD(1,I),IERR,NAMD(1,I),ISIZE,1,NAMD(4,I),
     +                 NAMD(5,I))
                  CALL ERROR(LU,IERR,2HFI)
            CALL CLOSE(IDCBD(1,I))
            CALL OPEN(IDCBD(1,I),IERR,NAMD(1,I),1,NAMD(4,I),NAMD(5,I))
                  CALL ERROR(LU,IERR,2HFI)
 2    CONTINUE
      RETURN
      END
```

```
C*********************************************************************
      SUBROUTINE SETUP(POS,C,IAXIS,LU)
C
C**CALCULATES THE DIRECTION COSINE TENSOR 'C(3,3)' FOR THE COORDINATE
C   TRANSFORMATION FROM 1294 3D PROBES SENSOR COORDINATES TO THOSE OF THE
C   DESIRED TUNNEL COORDINATES  'IAXIS'=2HRE FOR RECTANGULAR SYSTEM,
C   'IAXIS'=2HCY FOR CYLINDERICAL SYSTEM.
C   POS(1,2,3) ARE THE LOCATIONS OF THE PROBE IN THE TUNNEL COORDINATES
C   X, Y & Z RESPECTIVELY. WHEN A CONVERSION IS MADE FROM RECTANGULAR
C   TO CYLINERICAL COORDINATES, X REMAINS THE SAME AND POS(2&3) ARE
C   CHANGED FROM THE INPUTED Y, Z VALUES TO R, THETA VALUES.
C   FOR THE CYLINDERICAL SYSTEM, WHEN LOOKING DOWN (+TO-) THE POSITIVE
C   X AXIS THE THETA COMPONENT IS POSITIVE IN THE COUNTERCLOCKWISE SENSE.
C   POS(4,5&6) ARE THE ROTATIONAL ANGLES ABOUT THE X, Y & Z AXIS OF THE
C   PROBE SUPPORT COORDINATES FROM AN INITIAL ALIGNMENT WITH THE TUNNEL
C   COORDINATES RESPECTIVELY. THE ROTATIONAL SEQUENCE MUST BE IN THE ORDER
C   ABOUT Z, THEN Y, THEN X SINCE PROBE COORDINATES WILL NO LONGER BE ALIGNED
C   WITH TUNNEL COORDINATES AFTER THE FIRST ROTATION. THE SENSE OF THE
C   ROTATION IS: LOOKING DOWN (+TO-) THE POSITIVE AXIS OF THE PROBE
C   COORDINATE SYSTEM THE OTHER TWO AXIS ARE ROTATED IN A CLOCKWISE
C**DIRECTION RESULTS IN A POSITIVE ANGLE.
C
      COMMON /WK/  A(3,3),B(3,3)
      DIMENSION POS(6),C(3,3)
      DATA PI /3.14159/
      CONST=PI/180.0
C.....................................FIND TRANSFORMATION TENSOR 'A' FOR
C                                      PROBE TO SENSOR CONVERSION.
      ROT X=0.0*CONST
      ROT Y=35.26*CONST
      ROT Z=-45.0*CONST
      CALL TRXYZ(A,ROT X,ROT Y,ROT Z)
C.....................................TAKE TRANSPOSE OF 'A' TO FIND
C                                      SENSOR TO PROBE CONVERSION.
      DO 20 I=1,2
            DO 10 J=I+1,3
                  SAVE=A(I,J)
                  A(I,J)=A(J,I)
                  A(J,I)=SAVE
10          CONTINUE
20    CONTINUE
C.....................................FIND TRANSFORMATION TENSOR 'B' FOR
C                                      PROBE TO TUNNEL CONVERSION.
      ROT X=POS(4)*CONST
      ROT Y=POS(5)*CONST
      ROT Z=POS(6)*CONST
      CALL TRXYZ(B,ROT X,ROT Y,ROT Z)
C.....................................CALCULATE TOTAL TRANSFORMATION TENSO
C                                      'C' FOR SENSOR TO TUNNEL CONVERSION.
      CALL TMULT(A,B,C)
      IF(IAXIS.NE.2HCY)RETURN
C.....................................CONVERT FROM RECT. COOR. TO CYL.
C                                      COOR. BY CALCULATING THE TRANS.
C                                      TENSOR 'A' FOR THE ROTATION ABOUT
C                                      THE X AXIS (THETA=ATAN(Z/Y)) THAT
```

```
C                                                  IS NECESSARY. THEN RECALCULATE
C                                                  'C' TO INCLUDE THIS LAST TRANS.
      Y=POS(2)
      Z=POS(3)
      IF(Y.EQ.0.0.AND.Z.EQ.0.0)GO TO 21
                               GO TO 22
21       CONTINUE
         THETA=0.0
         GO TO 27
22                             CONTINUE
      IF(Y.EQ.0.0.AND.Z.GT.0.0)GO TO 23
                               GO TO 24
23       CONTINUE
         THETA=PI/2.0
         GO TO 27
24                             CONTINUE
      IF(Y.EQ.0.0.AND.Z.LT.0.0)GO TO 25
                               GO TO 26
25       CONTINUE
         THETA=-PI/2.0
         GO TO 27
26                             CONTINUE
         THETA=ATAN(Z/Y)
         IF(Y.LT.0.0)THETA=THETA+PI
27    CONTINUE
      POS(2)=SQRT(Y*Y+Z*Z)
      POS(3)=THETA/CONST
      DO 40 I=1,3
            DO 30 J=1,3
                  A(I,J)=C(I,J)
30          CONTINUE
40    CONTINUE
      CALL TRXYZ(B,THETA,0.,0.)
      CALL TMULT(A,B,C)
      RETURN
      END

C***********************************************************************
      SUBROUTINE TRXYZ(A,X,Y,Z)
C
C  FINDS THE CARTESIAN COORDINATE TRANSFORMATION TENSOR FOR ROTATIONS
C  ABOUT X AXIS, THEN Y AXIS, THEN Z AXIS. POSITIVE ROTATION IS
C  COUNTERCLOCKWISE WHEN LOOKING FROM + TO - ON THE AXIS.
C
      DIMENSION A(3,3)
      A(1,1)=COS(Y)*COS(Z)
      A(1,2)=COS(X)*SIN(Z)+SIN(X)*SIN(Y)*COS(Z)
      A(1,3)=SIN(X)*SIN(Z)-COS(X)*SIN(Y)*COS(Z)
      A(2,1)=-COS(Y)*SIN(Z)
      A(2,2)=-SIN(X)*SIN(Y)*SIN(Z)+COS(X)*COS(Z)
      A(2,3)=SIN(X)*COS(Z)+COS(X)*SIN(Y)*SIN(Z)
      A(3,1)=SIN(Y)
      A(3,2)=-SIN(X)*COS(Y)
      A(3,3)=COS(X)*COS(Y)
      RETURN
      END
```

```
C*********************************************************************
      SUBROUTINE TMULT(A,B,C)
      DIMENSION A(3,3),B(3,3),C(3,3)
      DO 30 I=1,3
            DO 20 J=1,3
                  C(I,J)=0.0
                  DO 10 K=1,3
                        C(I,J)=C(I,J)+B(I,K)*A(K,J)
10                CONTINUE
20          CONTINUE
30    CONTINUE
      RETURN
      END

C*********************************************************************
      SUBROUTINE CONVT(NSAM,NSEG,POS,A,SL,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /VAL/ V(3),IDUM(36),NERR(3)
      COMMON /WK/  IBUF(384),IBUFD(128,3),SUM(3),JERR(3)
      DIMENSION POS(6),A(3,3)
      DO 10 I=1,3
            JERR(I)=0
            NERR(I)=0
            SUM(I)=0.0
10    CONTINUE
      NBLKS=(NSAM/128)*NSEG
      DO 5 I=1,NBLKS
           CALL READF(IDCB,IERR,IBUF,384)
                CALL ERROR(LU,IERR,2HCO)
           IPOS=-2
           DO 3 J=1,128
                IPOS=IPOS+3
                CALL UVW(IBUF(IPOS),V,VTOT,JERR,LU)
                CALL CHECK(V,VTOT,NERR)
                CALL TCOOR(V,A)
                DO 1 K=1,3
                     IBUFD(J,K)=IFIX(V(K)/SL)
                     SUM(K)=SUM(K)+V(K)
1               CONTINUE
3          CONTINUE
           DO 4 K=1,3
                CALL WRITF(IDCBD(1,K),IERR,IBUFD(1,K),128)
                     CALL ERROR(LU,IERR,2HCO)
4          CONTINUE
5     CONTINUE
      DO 6 K=1,3
           V(K)=SUM(K)/(128.0*FLOAT(NBLKS))
6     CONTINUE
      CALL OUT1(NAMD,POS,V,SL,JERR,NERR,LU)
      CALL PURGE(IDCB,IERR,NAME,NAME(4),NAME(5))
      RETURN
      END
```

```
C*****************************************************************************
      SUBROUTINE UVW(IAD,V,VTOT,JERR,LU)
      COMMON /CAL/ A(3),B(3),C(3),RK,T(2),F(2),UMIN,UMAX,SUP(3),AMP(3)
      COMMON /TAB/ CALIB(101,3),CSLPE(3),CICPT(3),NC PTS
      DIMENSION IAD(3),V(3),JERR(3),VEFF2(3)
      SUM=0.0
      DO 10 I=1,3
            BIN=FLOAT(IAD(I))*CSLPE(I)+CICPT(I)
            N=IFIX(BIN)
            IF(N.GE.1)GO TO 2
               JERR(1)=JERR(1)+1
               BIN=1.0
               N=1
               GO TO 4
2           CONTINUE
            IF(N.LE.100)GO TO 4
               JERR(2)=JERR(2)+1
               BIN=101.0
               N=100
4           CONTINUE
            DEL=(CALIB(N+1,I)-CALIB(N,I))*(BIN-FLOAT(N))
            VEFF2(I)=CALIB(N,I)+DEL
            SUM=SUM+VEFF2(I)
10    CONTINUE
      VTOT2=SUM/F(1)
      DO 30 I=1,3
            TEMPX=VTOT2-VEFF2(I)
            IF(TEMPX.GE.0.0)GO TO 20
               TEMPX=0.0
               JERR(3)=JERR(3)+1
20          CONTINUE
            V(I)=SQRT(TEMPX/F(2))
30    CONTINUE
      VTOT=SQRT(VTOT2)
      RETURN
      END

C*****************************************************************************
      SUBROUTINE CHECK(V,VTOT,NERR)
      DIMENSION V(3),NERR(3)
      DATA SIN10,SIN80 /0.1736,0.9848/
      DO 1 I=1,3
          X=V(I)/VTOT
          IF(X.LT.SIN10.OR.X.GT.SIN80)NERR(I)=NERR(I)+1
1     CONTINUE
      RETURN
      END

C*****************************************************************************
      SUBROUTINE TCOOR(V,A)
      DIMENSION V(3),A(3,3),VTUN(3)
      DO 2 I=1,3
          VTUN(I)=0.0
          DO 1 J=1,3
               VTUN(I)=VTUN(I)+A(I,J)*V(J)
1         CONTINUE
2     CONTINUE
      DO 3 I=1,3
          V(I)=VTUN(I)
3     CONTINUE
      RETURN
      END
```

```
C*******************************************************************
      SUBROUTINE OUT1(NAMD,POS,V,SL,JERR,NERR,LU)
      COMMON /WK/  ANGLE(3)
      DIMENSION NAMD(5,3),POS(6),V(3),JERR(3),NERR(3)
      WRITE(LU,100)
      DO 1  J=1,3
1     WRITE(LU,110)(NAMD(I,J),I=1,3),(POS(I),I=1,6),V(J),SL
      VTOT=SQRT(V(1)*V(1)+V(2)*V(2)+V(3)*V(3))
      WRITE(LU,120)VTOT
      DO 2  I=1,3
          ANGLE(I)=ATAN(V(I)/SQRT((VTOT-V(I))*(VTOT+V(I))))
          ANGLE(I)=90.0-ANGLE(I)*180.0/3.14159
2     CONTINUE
      WRITE(LU,130)(ANGLE(I),I=1,3)
      IF(JERR(1).NE.0)WRITE(LU,140)JERR(1)
      IF(JERR(2).NE.0)WRITE(LU,145)JERR(2)
      IF(JERR(3).NE.0)WRITE(LU,150)JERR(3)
      IF(NERR(1).NE.0.OR.NERR(2).NE.0.OR.NERR(3).NE.0)
     +   WRITE(LU,160)(NERR(I),I=1,3)
      RETURN
100   FORMAT(' FILE          LINEAR POSITION     ROTATIONAL POSITION(DEG)'
     +      ' MEAN VEL.  CONVERSION '/' NAME                  X        Y        Z '
     +      '        X          Y          Z                    CONSTANT')
110   FORMAT(3A2,5X,6(F7.2),4X,F7.2,3X,G11.4)
120   FORMAT(/'MEAN TOTAL VELOCITY ='F7.1)
130   FORMAT('MEAN COMP.ANGLES      = 'F6.1' FROM X AXIS'/
     +      '                        'F6.1' FROM Y AXIS'/
     +      '                        'F6.1' FROM Z AXIS'/)
140   FORMAT(/'!!!!! LOWER CAL. RANGE WAS EXCEEDED 'I5' TIMES !!!!!'/)
145   FORMAT(/'!!!!! UPPER CAL. RANGE WAS EXCEEDED 'I5' TIMES !!!!!'/)
150   FORMAT(/'!!!!! CALCULATIONAL ERROR OCCURED 'I5' TIMES !!!!!'/)
160   FORMAT(/'!!! VELOCITY VECTOR 1 EXCEEDED DIR. LIMITS 'I5' TIMES'
     +      /'!!! VELOCITY VECTOR 2 EXCEEDED DIR. LIMITS 'I5' TIMES'
     +      /'!!! VELOCITY VECTOR 3 EXCEEDED DIR. LIMITS 'I5' TIMES')
      END
```

```
C***********************************************************************
      SUBROUTINE REDUC(NSAM,NSEG,SL,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /VAL/ VMN(3),VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3),NERR(3)
      COMMON /WK/  IBUFD(128,3),V(128,3),CVMN(3)
      DO 1 I=1,3
            CALL POSNT(IDCBD(1,I),IERR,1,1)
                  CALL ERROR(LU,IERR,2HRE)
            CVMN(I)=VMN(I)/SL
            VMIN(I)=1.E30
            VMAX(I)=-1.E30
1     CONTINUE
      NBLKS=(NSAM/128)*NSEG
      DO 4 I=1,NBLKS
            DO 3 J=1,3
                  CALL READF(IDCBD(1,J),IERR,IBUFD(1,J),128)
                        CALL ERROR(LU,IERR,2HRE)
                  DO 2 K=1,128
                        V(K,J)=FLOAT(IBUFD(K,J))
                        VMIN(J)=AMIN1(VMIN(J),V(K,J))
                        VMAX(J)=AMAX1(VMAX(J),V(K,J))
2                 CONTINUE
                  CALL MOMET(V(1,J),CVMN(J),VMOMT(1,J),I)
3           CONTINUE
            CALL STRES(V,CVMN,VSTRS,I)
4     CONTINUE
      DO 5 I=1,3
            VMOMT(2,I)=VMOMT(2,I)/(VMOMT(1,I)**1.5)
            VMOMT(3,I)=VMOMT(3,I)/(VMOMT(1,I)*VMOMT(1,I))
            VMOMT(1,I)=SL*SQRT(VMOMT(1,I))
            VSTRS(I)=VSTRS(I)*SL*SL
            VMIN(I)=VMIN(I)*SL
            VMAX(I)=VMAX(I)*SL
5     CONTINUE
      CALL OUT2(VMOMT,VSTRS,VMIN,VMAX,LU)
      RETURN
      END

C***********************************************************************
      SUBROUTINE MOMET(V,VMN,VMOMT,N)
      DIMENSION V(128),VMOMT(3)
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      WIGHT=1.0/FLOAT(N)
      DO 1 I=1,128
            X=V(I)-VMN
            XX=X*X
      SUM1=SUM1+XX
      SUM2=SUM2+XX*X
      SUM3=SUM3+XX*XX
1     CONTINUE
      VMOMT(1)=VMOMT(1)*(1.-WIGHT)+SUM1*WIGHT/128.0
      VMOMT(2)=VMOMT(2)*(1.-WIGHT)+SUM2*WIGHT/128.0
      VMOMT(3)=VMOMT(3)*(1.-WIGHT)+SUM3*WIGHT/128.0
      RETURN
      END
```

```
C*********************************************************************
      SUBROUTINE STRES(VEL,VMN,VSTRS,N)
      DIMENSION VEL(128,3),VMN(3),VSTRS(3)
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      WIGHT=1.0/FLOAT(N)
      DO 1 I=1,128
           U=VEL(I,1)-VMN(1)
           V=VEL(I,2)-VMN(2)
           W=VEL(I,3)-VMN(3)
           SUM1=SUM1+U*W
           SUM2=SUM2+U*V
           SUM3=SUM3+V*W
1     CONTINUE
      VSTRS(1)=VSTRS(1)*(1.-WIGHT)+SUM1*WIGHT/128.0
      VSTRS(2)=VSTRS(2)*(1.-WIGHT)+SUM2*WIGHT/128.0
      VSTRS(3)=VSTRS(3)*(1.-WIGHT)+SUM3*WIGHT/128.0
      RETURN
      END

C*********************************************************************
      SUBROUTINE OUT2(VMOMT,VSTRS,VMIN,VMAX,LU)
      DIMENSION VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3)
      WRITE(LU,100)
      WRITE(LU,102)(VMIN(I),I=1,3)
      WRITE(LU,104)(VMAX(I),I=1,3)
      WRITE(LU,110)(VMOMT(1,I),I=1,3)
      WRITE(LU,120)((VMOMT(I,J),J=1,3),I=2,3)
      WRITE(LU,130)(VSTRS(I),I=1,3)
      RETURN
100   FORMAT(22X'U'9X'V'9X'W')
102   FORMAT(/2X'MIN. VELOCITY=   '3(F8.3,2X))
104   FORMAT(2X'MAX. VELOCITY=   '3(F8.3,2X))
110   FORMAT(2X'RMS VELOCITY =   '3(F8.3,2X))
120   FORMAT(2X'SKEWNESS     =   '3(F8.3,2X)/
     +       2X'FLATNESS     =   '3(F8.3,2X))
130   FORMAT(/22X'UW'8X'UV'8X'VW'/
     +       2X'REY. STRESS  =    '3(F8.5,2X))
      END

C*********************************************************************
      SUBROUTINE ANGTM(NSAM,NSEG,LU)
      COMMON /VAL/ IDUM(45),AGMIN(3),AGMAX(3),AMN(3),AMOMT(3,3)
      COMMON /FIL/ IDUM1(581),NAMD(5,3)
      DIMENSION IB(36),NAMP(3)
      EQUIVALENCE (IB(1),AGMIN(1))
      DATA NAMP /2HAN,2HGT,2HM /
      CALL EXEC(23,NAMP,NSAM,NSEG,LU,ID,ID,NAMD,15)
      CALL EXEC(14,1,IB,36)
      RETURN
      END
```

```
C*********************************************************************
      SUBROUTINE SAVIT(RATE,NSAM,NSEG,SL,POS,NAMVL,LU)
      COMMON /FIL/ IDUM(581),NAMD(5,3)
      COMMON /VAL/ VMN(3),VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3),NERR(3)
     +              ,AGMIN(3),AGMAX(3),AMN(3),AMOMT(3,3)
      COMMON /WK/  IBUF(114),IB2(18)
      DIMENSION POS(6),POS1(6),IB1(15),IB4(81),NAMVL(5)
      EQUIVALENCE (IB1(1),NAMD(1,1)),(IB2(1),RATE1),(IB2(3),NSAM1),
     +              (IB2(4),NSEG1),(IB2(5),SL1),(IB2(7),POS1(1)),
     +              (IB4(1),VMN(1))
      RATE1=RATE
      NSAM1=NSAM
      NSEG1=NSEG
      SL1=SL
      DO 1 I=1,6
           POS1(I)=POS(I)
1     CONTINUE
      DO 3 I=1,15
           IBUF(I)=IB1(I)
3     CONTINUE
      DO 4 I=1,18
           J=I+15
           IBUF(J)=IB2(I)
4     CONTINUE
      DO 6 I=1,81
           J=I+33
           IBUF(J)=IB4(I)
6     CONTINUE
      CALL WREC(IBUF,114,NAMVL,LU)
7     CONTINUE
      RETURN
      END
```

```
C*********************************************************************
      SUBROUTINE F INFO(NSAM,RATE,NSEG,SL,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      COMMON /VAL/ VMN(3),VMOMT(3,3),VSTRS(3),VMIN(3),VMAX(3),NERR(3)
      COMMON /WK/  IBUF(128)
      EQUIVALENCE (IBUF(1),NSM),(IBUF(2),RATE1),(IBUF(4),IBLOC),
     +              (IBUF(5),RMN),(IBUF(7),RMS),(IBUF(9),SLPE)
      NSM=NSAM
      RATE1=RATE
      IBLOC=(NSAM/128)*NSEG
      SLPE=1.0/SL
      DO 10 I=1,3
           RMN=VMN(I)
           RMS=VMOMT(1,I)
           CALL WRITF(IDCBD(1,I),IERR,IBUF,128,(IBLOC+1))
                CALL ERROR(LU,IERR,2HF )
10    CONTINUE
      RETURN
      END
```

```
C*****************************************************************
      SUBROUTINE WREC(IB,N,NAM,LU)
      COMMON /WK/  ISAV(200),IDCB(144),ISIZ(2),IB1(10)
      DIMENSION IB(1),NAM(5)
      ISIZ(1)=24
      ISIZ(2)=N
      CALL OPEN(IDCB,IERR,NAM,2,NAM(4),NAM(5))
           IF(IERR.EQ.-6)CALL CREAT(IDCB,IERR,NAM,ISIZ,3,NAM(4),NAM(5))
           CALL ERROR(LU,IERR,2HWR)
10    CONTINUE
      CALL READF(IDCB,IERR,IB1,10,LEN)
           CALL ERROR(LU,IERR,2HWR)
      IF(LEN.NE.-1)GO TO 10
      CALL POSNT(IDCB,IERR,-1)
           CALL ERROR(LU,IERR,2HWR)
      CALL WRITF(IDCB,IERR,IB,N)
           CALL ERROR(LU,IERR,2HWR)
      CALL CLOSE(IDCB)
      RETURN
      END
```

```
C*****************************************************************
      SUBROUTINE TRANS(NAMTR2,IPUR,LU)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      DIMENSION NAMTR2(5),IB(10)
      DO 10 I=1,3
            CALL CLOSE(IDCBD(1,I))
            IF(IPUR.NE.0)GO TO 10
               CALL CODE
               WRITE(IB,100)(NAMD(J,I),J=1,5)
               CALL WREC(IB,10,NAMTR2,LU)
10    CONTINUE
      RETURN
100   FORMAT(':PU,'3A2':'I5':'I3)
      END
```

```
C*****************************************************************
      SUBROUTINE ERROR(LU,IERR,LOC)
      COMMON /FIL/ IDCB(144),NAME(5),IDCBD(144,3),NAMD(5,3)
      IF(IERR.GE.0)RETURN
      CALL CLOSE(IDCB)
      DO 10 I=1,3
            CALL CLOSE(IDCBD(1,I))
10    CONTINUE
      WRITE(LU,100)IERR,LOC
      STOP 1111
100   FORMAT(' FMGR ERROR 'I5' IN 'A2)
      END
```

```
FTN4,L
      PROGRAM ANGTM(3,85)
      DIMENSION ID(15),IB(36),IDCB(144,3),AMN(3),AMOMT(3,3),AGMIN(3),
     +          AGMAX(3),IPAR(5),NAMD(5,3)
      EQUIVALENCE (ID(1),NAMD(1,1)),(IPAR(1),NSAM),
     +            (IPAR(2),NSEG),(IPAR(3),LU),
     +            (IB(1),AGMIN(1)),(IB(7),AGMAX(1)),(IB(13),AMN(1)),
     +            (IB(19),AMOMT(1,1))
      CALL RMPAR(IPAR)
      CALL LIBER(LU)
      CALL EXEC(14,1,ID,15)
      DO 10 I=1,3
            CALL OPEN(IDCB(1,I),IERR,NAMD(1,I),1,NAMD(4,I),NAMD(5,I))
                 CALL ERROR(LU,IERR,2HAN)
10    CONTINUE
      CALL ANGLE(NSAM,NSEG,IDCB,AMN,AMOMT,AGMIN,AGMAX,LU)
      DO 20 I=1,3
            CALL CLOSE(IDCB(1,I))
20    CONTINUE
      CALL EXEC(14,2,IB,36)
      END
```

```
C**********************************************************************
      SUBROUTINE ANGLE(NSAM,NSEG,IDCB,AMN,AMOMT,AGMIN,AGMAX,LU)
      DIMENSION AMN(3),AMOMT(3,3),AGMIN(3),AGMAX(3),IDCB(144,3),
     +          IB(128,3),V(128,3),SUM(3)
      DATA PI2,CON /1.5708,57.292/
      NBLKS=(NSAM/128)*NSEG
      DO 5 J=1,3
            SUM(J)=0.0
            AGMIN(J)=1.E30
            AGMAX(J)=-1.E30
5     CONTINUE
      DO 35 I=1,NBLKS
            DO 15 J=1,3
                  CALL READF(IDCB(1,J),IERR,IB(1,J),128,LEN,I)
                        CALL ERROR(LU,IERR,2HAN)
                  DO 10 K=1,128
                        V(K,J)=FLOAT(IB(K,J))
10                CONTINUE
15          CONTINUE
            DO 30 K=1,128
                  SUMT=0.0
                  DO 20 J=1,3
                        SUMT=SUMT+V(K,J)*V(K,J)
20                CONTINUE
                  VT=SQRT(SUMT)
                  DO 25 J=1,3
                        AGR=V(K,J)/SQRT((VT-V(K,J))*(VT+V(K,J)))
                        ANG=PI2-ATAN(AGR)
                        SUM(J)=SUM(J)+ANG
                        AGMIN(J)=AMIN1(AGMIN(J),ANG)
                        AGMAX(J)=AMAX1(AGMAX(J),ANG)
C                       IB(K,J)=IFIX(ANG*CON*100.0)
25                CONTINUE
30          CONTINUE
35    CONTINUE
      DO 40 J=1,3
            AMN(J)=SUM(J)/(FLOAT(NBLKS)*128.0)
40    CONTINUE
      DO 80 I=1,NBLKS
            DO 55 J=1,3
                  CALL READF(IDCB(1,J),IERR,IB(1,J),128,LEN,I)
                        CALL ERROR(LU,IERR,2HAN)
                  DO 50 K=1,128
                        V(K,J)=FLOAT(IB(K,J))
50                CONTINUE
55          CONTINUE
            DO 70 K=1,128
                  SUMT=0.0
                  DO 60 J=1,3
                        SUMT=SUMT+V(K,J)*V(K,J)
60                CONTINUE
                  VT=SQRT(SUMT)
                  DO 65 J=1,3
                        AGR=V(K,J)/SQRT((VT-V(K,J))*(VT+V(K,J)))
                        ANG=PI2-ATAN(AGR)
```



```
                        V(K,J)=ANG
65                CONTINUE
70          CONTINUE
            DO 75 J=1,3
                  CALL MOMET(V(1,J),AMN(J),AMOMT(1,J),I)
75          CONTINUE
80    CONTINUE
      DO 85 J=1,3
            AGMIN(J)=AGMIN(J)*CON
            AGMAX(J)=AGMAX(J)*CON
            AMN(J)=AMN(J)*CON
            AMOMT(2,J)=AMOMT(2,J)/(AMOMT(1,J)**1.5)
            AMOMT(3,J)=AMOMT(3,J)/(AMOMT(1,J)**2)
            AMOMT(1,J)=SQRT(AMOMT(1,J))*CON
85    CONTINUE
      CALL OUT3(AGMIN,AGMAX,AMN,AMOMT,LU)
      RETURN
      END
```

```
C**********************************************************************
      SUBROUTINE MOMET(V,VMN,VMOMT,N)
      DIMENSION V(128),VMOMT(3)
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      WIGHT=1.0/FLOAT(N)
      DO 1  I=1,128
          X=V(I)-VMN
          XX=X*X
      SUM1=SUM1+XX
      SUM2=SUM2+XX*X
      SUM3=SUM3+XX*XX
1     CONTINUE
      VMOMT(1)=VMOMT(1)*(1.-WIGHT)+SUM1*WIGHT/128.0
      VMOMT(2)=VMOMT(2)*(1.-WIGHT)+SUM2*WIGHT/128.0
      VMOMT(3)=VMOMT(3)*(1.-WIGHT)+SUM3*WIGHT/128.0
      RETURN
      END


C**********************************************************************
      SUBROUTINE OUT3(AGMIN,AGMAX,AMN,AMOMT,LU)
      DIMENSION AGMIN(3),AGMAX(3),AMN(3),AMOMT(3,3)
      WRITE(LU,100)
      WRITE(LU,110)(AGMIN(I),I=1,3)
      WRITE(LU,120)(AGMAX(I),I=1,3)
      WRITE(LU,130)(AMN(I),I=1,3)
      WRITE(LU,140)((AMOMT(I,J),J=1,3),I=1,3)
      RETURN
100   FORMAT(/"ANGLES FROM AXIS"6X"1"9X"2"9X"3"/)
110   FORMAT(2X"MIN. ANGLE=      "3(F8.3,2X))
120   FORMAT(2X"MAX. ANGLE=      "3(F8.3,2X))
130   FORMAT(2X"MEAN ANGLE=      "3(F8.3,2X))
140   FORMAT(2X"RMS  ANGLE=      "3(F8.3,2X)/
     +       2X"SKEWNESS   =     "3(F8.3,2X)/
     +       2X"FLATNESS   =     "3(F8.3,2X))
      END

C**********************************************************************
      SUBROUTINE ERROR(LU,IERR,LOC)
      IF(IERR.GE.0)RETURN
      WRITE(LU,100)IERR
      RETURN
100   FORMAT("FMGR ERROR "I5" IN SON PROGRAM ANGTM")
      END
```

```
FTN4,L
C**********************************************************************
      PROGRAM PRT3(3,80)
C
C WRITTEN BY DAVE NEFF TO OUTPUT RESULTS FROM U,V,W VELOCITY INFO.
C OBTAINED FROM PROGRAM DAT2 ON THE LINE PRINTER IN REPORT FORMAT.
C
      DIMENSION IDCB(144),IPAR(5),NAME(3),IORDER(200)
      CALL RMPAR(IPAR)
      LU=IPAR(1)
      IF(LU.LT.1)LU=1
      CALL LIBER(LU)
      WRITE(LU,1)
      CALL GNAME(LU,NAME,ISEC,ICR,1)
      CALL OPEN(IDCB,IERR,NAME,0,ISEC,ICR)
         IF(IERR.LT.0)CALL ERR(IERR,1)
      CALL SORT(IDCB,IORDER,LAST)
      CALL OUT(IDCB,IORDER,LAST,LU)
      CALL CLOSE(IDCB)
      WRITE(LU,5)
1     FORMAT('ENTER RESULTS FILE NAME:SEC:CR- _')
5     FORMAT('RUN COMPLETE')
      END
```

```
C*********************************************************************
      SUBROUTINE OUT(IDCB,IORDER,LAST,LU)
C**WRITES OUT THE RESULTS TO THE LINE PRINTER
      DIMENSION IDCB(144),IB(114),NAMD(5,3),POS(6),
     +          VMN(3),VMOMT(3,3),VSTRS(3),ILAB1(3),ANG(3),
     +          ILAB2(3),IORDER(200),AERR(3),NERR(3),VMIN(3),VMAX(3),
     +          AGMIN(3),AGMAX(3),AMN(3),AMOMT(3,3)
      EQUIVALENCE (IB(1),NAMD(1,1)),(IB(16),RATE),(IB(18),NSAM),
     +            (IB(19),NSEG),(IB(20),SL),(IB(22),POS(1)),
     +            (IB(34),VMN(1)),(IB(40),VMOMT(1,1)),(IB(50),VSTRS(1)),
     +            (IB(64),VMIN(1)),(IB(70),VMAX(1)),(IB(76),NERR(1)),
     +            (IB(79),AGMIN(1)),(IB(85),AGMAX(1)),(IB(91),AMN(1)),
     +            (IB(97),AMOMT(1,1))
      DATA ILAB1,ILAB2 /2HVW,2HUW,2HUV,2H1 ,2H2 ,2H3 /
      CALL POSNT(IDCB,IERR,1,1)
           IF(IERR.LT.0)CALL ERR(IERR,8)
      CALL LURQ(1,27,1)
      IK=0
 1    CONTINUE
      DO 3 K=1,16
           IK=IK+1
           IF(IK.GT.LAST)GO TO 5
           IF(K.EQ.1)WRITE(27,100)
           CALL POSNT(IDCB,IERR,IORDER(IK),1)
                IF(IERR.LT.0)CALL ERR(IERR,10)
           CALL READF(IDCB,IERR,IB,114,LEN)
                IF(IERR.LT.0)CALL ERR(IERR,9)
           VTMN=SQRT(VMN(1)*VMN(1)+VMN(2)*VMN(2)+VMN(3)*VMN(3))
           DO 2 I=1,3
                AERR(I)=100.0*FLOAT(NERR(I))/(FLOAT(NSAM)*FLOAT(NSEG))
                ANG(I)=ATAN(VMN(I)/SQRT((VTMN-VMN(I))*(VTMN+VMN(I))))
                ANG(I)=90.0-ANG(I)*180.0/3.14159
                WRITE(27,110)(NAMD(J,I),J=1,3),ILAB2(I),POS(I),AERR(I),
     +                   VMN(I),ANG(I),VMIN(I),VMAX(I),(VMOMT(J,I),J=1,3),
     +                   ILAB1(I),VSTRS(I),AMN(I),AGMIN(I),AGMAX(I),
     +                   (AMOMT(J,I),J=1,3)
 2         CONTINUE
           WRITE(27,120)
 3    CONTINUE
      GO TO 1
 5    CONTINUE
      WRITE(27,130)
      CALL LURQ(0,27,1)
      RETURN
 100  FORMAT(' 'FILE AXIS POSITION LIMITS ---------------'
     +         'VELOCITY INFORMATION---------------------   ------'
     +         'ANGLE INFORMATION-----------------'/
     +         '  NAME'16X'EXCEEDED  MEAN  ANGLE  MIN.    MAX.   RMS'
     +         '    SKEW-  FLAT-  REYNOLDS   MEAN   MIN.    MAX.   '
     +         'RMS  SKEW-   FLAT '/
     +         22X'(%) TIME   VEL.   FROM   VEL.   VEL.   VEL.  NESS'
     +         '    NESS    STRESS    ANGLE  ANGLE  ANGLE ANGLE NESS'
     +         '    NESS'/)
 110  FORMAT(1X,3A2,2X,A2,2X,F8.3,1X,F7.3,1X,F6.2,1X,F6.1,1X,F6.2,1X,
     +         F6.2,1X,F6.3,1X,F5.2,1X,F6.2,1X,A2,1X,F7.4,1X,F6.1,1X,
```



```
     +         F6.1,1X,F6.1,1X,F4.1,2X,F5.2,1X,F6.2)
 120  FORMAT(' ')
 130  FORMAT(' ')
      END
```

```
C**********************************************************************
      SUBROUTINE SORT(IDCB,IORDER,LAST)
      DIMENSION IDCB(144),IORDER(200),IB(3),NUM(200)
      I=0
10    CONTINUE
         I=I+1
         CALL READF(IDCB,IERR,IB,3,LEN)
              IF(IERR.LT.0)CALL ERR(IERR,11)
         IF(LEN.EQ.-1)GO TO 20
         N1=(IB(3)*256)/256-48
         N2=IB(3)/256-48
         N3=(IB(2)*256)/256-48
         NUM(I)=N3*100+N2*10+N1
      GO TO 10
20    CONTINUE
      N=I-1
      K=1
      DO 40 I=1,1000
          IFLAG=0
          DO 30 J=1,N
               IF(NUM(J).NE.(I-1))GO TO 30
                   IORDER(K)=J
                   IFLAG=1
30        CONTINUE
          IF(IFLAG.NE.0)K=K+1
40    CONTINUE
      LAST=K-1
      RETURN
      END
```

FTN4 COMPILER: HP92060-16092 REV. 1901 (781201)

** NO WARNINGS ** NO ERRORS ** PROGRAM = 00369 COMMON = 00000

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```
C**********************************************************************
      SUBROUTINE ERR(IERR,LOC)
      WRITE(1,1)IERR,LOC
      STOP
1     FORMAT("FMGR ERROR "I3" AT LOCATION "I3)
      END
```

FTN4 COMPILER: HP92060-16092 REV. 1901 (781201)

** NO WARNINGS ** NO ERRORS ** PROGRAM = 00037 COMMON = 00000