

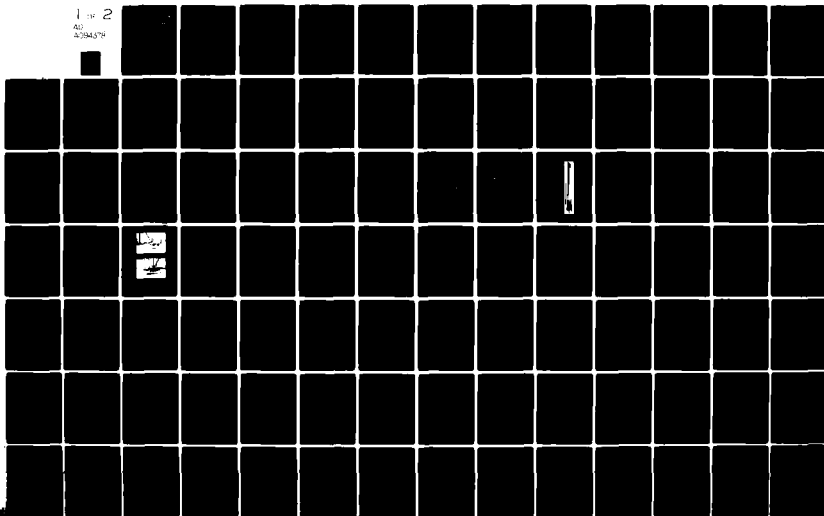
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PROPELLER-DISK WAKE SURVEY DATA FOR MODEL 4989 REPRESENTING THE FF 1052-
CLASS SHIP IN A TURN AND WITH A BASS DYNAMOMETER BOAT

DTNSRDC/SPD-0011-21

**DAVID W. TAYLOR NAVAL SHIP
RESEARCH AND DEVELOPMENT CENTER**

Bethesda, Maryland 20884



LEVEL II

PROPELLER-DISK WAKE SURVEY DATA FOR MODEL 4989
REPRESENTING THE FF 1052-CLASS SHIP IN A TURN AND WITH
A BASS DYNAMOMETER BOAT

BY

WILLIAM G. DAY, JR.
RAE B. HURWITZ

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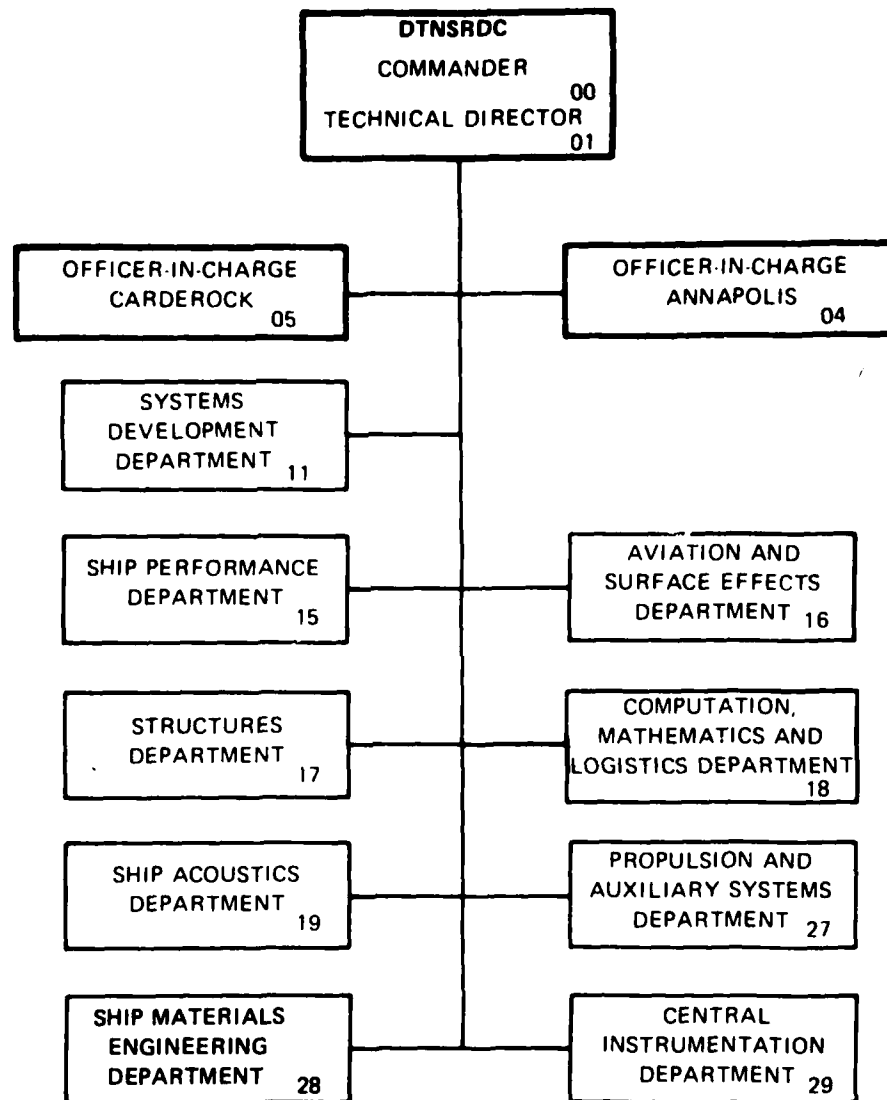
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20. with a yaw angle corresponding to that used in the turning experiments to assess the differences in results for these two techniques.

The results show that the major change in the experiments with and without the dynamometer boat is that the longitudinal velocity component ratio (V_x/V) with the boat is about 12 percent lower than without throughout the circumference of the propeller disk. The higher harmonics (7-10) of the circumferential distribution of both the longitudinal and tangential velocity component ratios are greater for the experiments with the dynamometer boat. As anticipated, there are major changes in the tangential and radial velocity component ratios in turns as compared to straight and ahead operation. The longitudinal component is also affected to some degree. The results of the yawed experiments are not in good agreement with those from the turning experiments.

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NOTATION

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
A_N	COS COEF	The cosine coefficient of the N^{th} harmonic*
B_N	SIN COEF	The sine coefficient of the N^{th} harmonic*
C	C	Pressure reading at center hole of 5-hole pitot tube
D	---	Propeller diameter
J_V	J_V	Apparent advance coefficient $J_V = \frac{V}{nD}$ (dimensionless)
N	N	Harmonic number
n	---	Propeller revolutions
P	P	Pressure
r/R or x	Radius or RAD.	Distance (r) from the propeller axis expressed as a ratio of the propeller radius (R)
R_n	R_n	Reynolds number
R1, R2	R1, R2	Pressure reading at radial holes of 5-hole pitot tube
T1, T2	T1, T2	Pressure reading at tangential holes of 5-hole pitot tube
U/U_∞	U/U_∞	Non-dimensional longitudinal velocity measured by means of boundary layer pitot tubes
V	V	Actual model or ship velocity
$V_b(x, \theta)$	---	Resultant inflow velocity to blade for a given point
$\bar{V}_b(x)$	---	Mean resultant inflow velocity to blade for a given radius
$V_r(x, \theta)$	VR	Radial component of the fluid velocity for a given point (positive toward the shaft centerline)
(* see footnote on page xv)		

NOTATION (CONTINUED)

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
$\bar{V}_r(x)$	---	Mean radial velocity component for a given radius
$V_r(x, \theta)/V$	VR/V	Radial velocity component ratio for a given point
$\bar{V}_r(x)/V$	VRBAR	Mean radial velocity component ratio for a given radius
$V_t(x, \theta)$	VT	Tangential component of the fluid velocity for a given point (positive in a counterclockwise direction looking forward)
$\bar{V}_t(x)$	---	Mean tangential velocity component for a given radius
$V_t(x, \theta)/V$	VT/V	Tangential velocity component ratio for a given point
$\bar{V}_t(x)/V$	VTBAR	Mean tangential velocity component ratio for a given radius
$(\tilde{V}_t(x)/V)_N$	AMPLITUDE	Amplitude (B_N for single screw symmetric; C_N otherwise) of Nth harmonic of the tangential velocity component ratio for a given radius*
$V_x(x, \theta)$	VX	Longitudinal (normal to the plane of survey) component of the fluid velocity for a given point (positive in the astern direction)
$\bar{V}_x(x)$	---	Mean longitudinal velocity component for a given radius
$V_x(x, \theta)/V$	VX/V	Longitudinal velocity component ratio for a given point
$V_x(x)/V$	VXBAR	Mean longitudinal velocity component ratio for a given radius
$(\tilde{V}_x(x)/V)_N$	AMPLITUDE	Amplitude (A_N for single screw symmetric; C_N otherwise) of Nth harmonic of the longitudinal velocity component ratio for a given radius*

NOTATION (CONTINUED)

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
x/L_{WL}	x/L_{WL}	Non-dimensional longitudinal location of boundary layer pitot tubes
ϕ_N	PHASE ANGLE	Phase angle of Nth harmonic*

*The harmonic amplitudes of any circumferential velocity distribution
f (θ) are the coefficients of the Fourier Series:

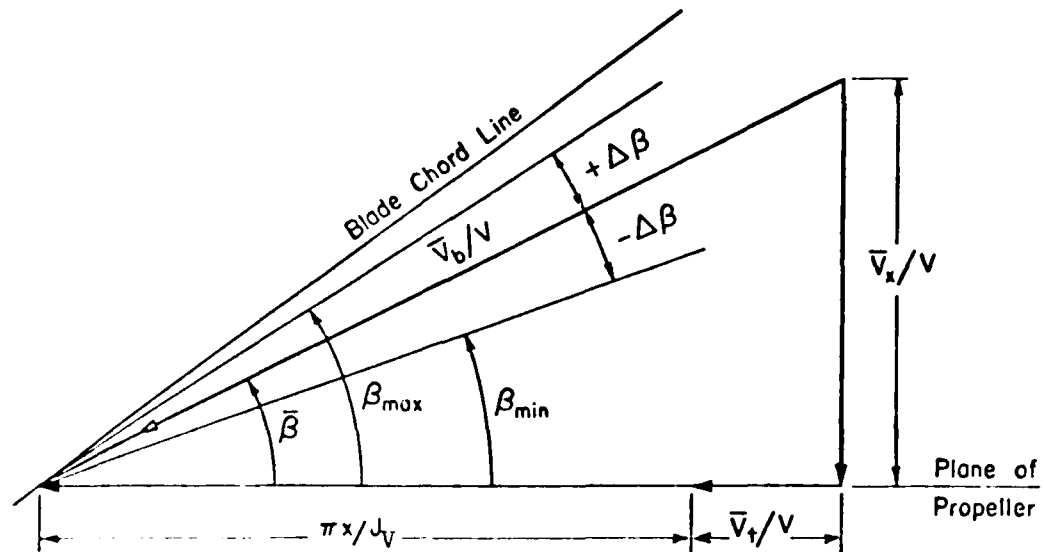
$$\begin{aligned}
 f(\theta) &= A_0 + \sum_{N=1}^N A_N \cos(N\theta) + \sum_{N=1}^N B_N \sin(N\theta) \\
 &= A_0 + \sum_{N=1}^N C_N \sin(N\theta + \phi_N)
 \end{aligned}$$

NOTATION (CONTINUED)

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
1-w(x)	1-WX	Volumetric mean velocity ratio from the hub to a given radius
		$1-w(r/R) = \frac{2 \cdot \int_{r_{hub}/R}^{r/R} (\bar{v}_{x_c}(x)/V) \cdot x \cdot dx}{(r/R)^2 - (r_{hub}/R)^2}$
		where $\bar{v}_{x_c}(x)/V = \int_0^{2\pi} \left[\frac{v_{x_c}(x,\theta)}{2\pi V} \right] d\theta$ and $v_{x_c}(x,\theta)/V = (v_x(x,\theta)/V) - (v_t(x,\theta)/V) \tan(\beta(x,\theta))$
1-w _v (x)	1-WVX	Volumetric mean velocity ratio from the hub to a given radius (without the tangential velocity correction)
		$1-w(r/R) = \frac{2 \cdot \int_{r_{hub}/R}^{r/R} (\bar{v}_x(x)/V) \cdot x \cdot dx}{(r/R)^2 - (r_{hub}/R)^2}$
$\beta(x,\theta)$	---	Advance angle in degrees for a given point
$\bar{\beta}(x)$	BBAR	Mean advance angle in degrees for a given radius
$+\Delta\beta$	BPOS	Variation of the maximum advance angle from the mean for a given radius

NOTATION (CONTINUED)

$-\Delta\beta$	BNEG	Variation of the minimum advance angle from the mean for a given radius
θ	Angle in degrees	Position angle (angular coordinate) in degrees



VELOCITY DIAGRAM OF BETA ANGLES

ENGLISH/SI EQUIVALENTS

ENGLISH	SI
1 inch	25.400 millimetres [0.0254 m (metres)]
1 foot	0.3048 m (metres)
1 foot per second	0.3048 m/sec (metres per second)
1 knot	0.5144 m/sec (metres per second)
1 degree (angle)	0.01745 rad (radians)
1 inch Water (60°F)	248.8 pa (pascals)

ABSTRACT

Experiments are described in which the wake in way of the propeller disk was determined for several conditions on a model of the FF 1052 Class ship in connection with an investigation to determine blade loadings on a controllable pitch propeller. The wake surveys were conducted with and without a dynamometer boat behind the hull model to determine the effects of the presence of the dynamometer boat on the flow through the propeller disk of the model. Next, wake data were obtained for the model in several conditions while turning in the Rotating Arm Facility. Finally, the model was towed in a straight line with a yaw angle corresponding to that used in the turning experiments to assess the differences in results for these two techniques.

The results show that the major change in the experiments with and without the dynamometer boat is that the longitudinal velocity component ratio (V_x/V) with the boat is about 12 percent lower than without throughout the circumference of the propeller disk. The higher harmonics (7-10) of the circumferential distribution of both the longitudinal and tangential velocity component ratios are greater for the experiments with the dynamometer boat. As anticipated, there are major changes in the tangential and radial velocity component ratios in turns as compared to straight and ahead operation. The longitudinal component is also affected to some degree. The results of the yawed experiments are not in good agreement with those from the turning experiments.

ADMINISTRATIVE INFORMATION

The work reported herein was funded by the Naval Sea Systems Command (NAVSEA 05R) Task Area SSL 24001, Task 19977. The work was performed by the David W. Taylor Naval Ship R&D Center (DTNSRDC), Work Units 1-1524-567 and 1-1544-296.

The International System (SI) of units is used in addition to the equivalent English Units in this report.

INTRODUCTION

There has been a major trend in recent designs of combatant ships for the U.S. Navy to use marine gas turbines as prime movers for the main propulsion system. Currently there is no marine reverse gear available within the powering, space and other constraints imposed by this type

of design. The solution to the reversing problem for unidirectional propulsion machinery for a number of years has been the use of the controllable pitch (CP) propeller. The U.S. Navy has had experience in the past in the design of CP propellers for comparatively low powered ships. Structural problems were encountered in the development of CP propellers for a ship of the FF 1052 Class which indicated that insufficient information was available on which to base a design for the power installed in the ships of this class. The work presented in this report has been performed as part of the research and development effort to obtain technical data on which to base more rational designs. More specifically, it is part of a project to investigate the blade loadings to be developed by CP propellers in normal operation.

The catastrophic failure of all the propeller blades on USS BARBEY (FF 1088)¹, which was fitted with a prototype controllable pitch (CP) propeller system, has revealed the need for further extensive investigation into the problems peculiar to high power CP propeller installations. There have also been reports that another ship fitted with a CP propeller similar in type to that on BARBEY encountered a high level of vibrations during maneuvers. Therefore, a series of experiments to investigate change in blade loading is imperative as further installations of CP propellers, including the propellers on the DD 963 Class, are continuing.

It is known that the levels of propeller thrust and torque are significantly higher during turns than in straight ahead operation at a given speed of advance. During a turning maneuver, the wake distribution immediately ahead of the propeller becomes less uniform as the yaw angle of the ship increases. This nonuniformity may cause severe blade loads on a propeller. Since these blade loads may cause several structural problems and consequent material failures, it was considered important to investigate the character and level of these forces on a propulsive system during the turn. The wake survey data presented in this report are part of the experimental effort to determine variations in blade loading for CP propellers.

¹References are listed on page 14.

The objective of this phase of the work was to provide wake measurements on a model of the FF 1052 Class ship while in a turn in order to predict blade loads on the CP propeller. In addition, wake measurements with the model of FF 1052 Class were to be made with and without a dynamometer boat attached to the model to assess the effect of the dynamometer boat in experiments performed to actually measure the loads on a blade of a model controllable pitch propeller.²

The planned approach for this part of the project was to tow Model 4989, representing the FF 1052 Class, in a straight line and measure wake in way of the propeller disk both with and without the dynamometer boat. Then the model was to be towed in the Rotating Arm Tank to permit measurement of the wake in a turn. Finally, the model was to be towed with a yaw angle in a straight line in the Deep Water Basin to determine if the wake in the propeller disk in a turn can be approximated by the wake of a yawed model, thereby saving the extra cost of the Rotating Arm Facility if wake in turns were to be determined for other models.

EXPERIMENTAL PROCEDURE

All velocity surveys for this project were conducted using DTNSRDC Model 4989 which represents the FF 1052 Class ship. The model was fitted with bow sonar dome, bilge keels, roll-stabilizer fins, shaft and struts for all experiments. The particulars of size and loading for the ship and model are presented in Figure 1.

A pitot tube rake, DTNSRDC No. 7, and four differential pressure gages were used to measure the velocities in the plane of the propeller disk at each of five radial locations. The pitot tube rake consisted of 5-hole spherical pitot tubes mounted in a common housing. Figure 2 shows the arrangement of the rake and pitot tubes.

The full-scale propeller disk was 15.0 feet (4.572 m) in diameter. The radii at which the measurements were made, expressed as ratios of the propeller radius (r/R), were 0.330, 0.512, 0.711, 0.911, and 1.082. The propeller plane in which the velocity measurements were taken was 0.5 feet (0.15 m) forward of Station 19. To ensure the proper trim throughout the experiments the model was ballasted to a displacement corresponding to

4000 tons (4064 metric tons) and the trim corresponding to the sinkage and trim for the particular speed of interest. The model was locked at this condition of loading for all experiments.

In conducting an experiment, the runs are made at a constant speed, the input signals from the pitot tubes are integrated over a 5-second period and recorded digitally. Velocity component ratios are computed for each pitot tube and recorded. The rake is rotated to a new angle and the procedure is repeated until data are available throughout the entire propeller disk.

The circumferential distributions of the longitudinal, tangential, and radial velocity component ratios are plotted for each radial location then checked for random errors and conformity to values predicted from past experience. The mean longitudinal, tangential and radial component ratios of the velocity vectors, volumetric mean wake velocity ratio, mean and variations of values of the advance angle are also computed and plotted. Finally, analyses are performed to determine the harmonics of the circumferential distributions of the longitudinal and tangential velocity component ratios at both the experimental and interpolated radii. The amplitudes and phase angles for the first 10 harmonics of the longitudinal and tangential velocities are computed and presented in this report.

Table 1 presents a complete list of all experiments reported herein.

WAKE SURVEYS WITH AND WITHOUT A DYNAMOMETER BOAT- EXPERIMENTS 178 AND 179

A part of the overall project to determine blade loadings on CP propellers required the mounting of a dynamometer boat in close proximity to the stern of Model 4989 as shown in Figure 3. This photograph and the vast majority of the data and graphs presented in this report have been previously published in a report by Boswell, et al². This material is republished in this report primarily for purposes of comparison with data from the other phases of the overall wake survey project.

Wake surveys were conducted with and without the dynamometer boat attached to Model 4989 at the standard conditions of displacement and trim previously specified in this report. The model speed for these experiments corresponded to 28.6 knots (14.7 m/sec) for the full-scale ship.

The experimental data in the form of velocity component ratios are listed in Appendix A. The circumferential distributions of the longitudinal, tangential, and radial velocity component ratios are presented as composite plots in Figures 4 through 7. The radial distributions of the mean velocity component ratios and of the mean advance angle are shown in Figures 8 and 9, respectively. The harmonics of the velocity component ratios for each experiment are presented in Appendix A.

The major difference between the velocity component ratios in the propeller plane with and without the dynamometer boat appears to be the change in the level of the longitudinal velocity component ratio (V_x/V). The value of V_x/V with the dynamometer boat is reduced by approximately 12 percent throughout the circumference of the propeller disk. There is a tendency for the longitudinal harmonics with propeller boat to be larger, particularly for the higher (seventh to tenth) harmonics. The trend of these results is as anticipated.

WAKE SURVEYS IN TURNS- EXPERIMENTS 180, 181, 182, AND 183

Experimental Conditions

The experimental conditions for the wake surveys in the rotating arm tank were derived primarily from full-scale tactical data measured during trials of the USS MEYERCORD (FF 1058). The standard displacement and trim conditions for the model experiments are the same as listed previously. It was known prior to starting these experiments that the steady turn would be the only part of a typical turning maneuver which could be simulated within the limitations imposed by the Rotating Arm Carriage and the wake survey instrumentation. It was decided, therefore, to determine the steady (final) turning diameter, speed, and drift angle at midships for this part of the turn from full-scale data for several typical combinations of approach speed and rudder angles. The approach speeds and rudder angles chosen are listed in Table 2.

Experiments 180 and 181 correspond to the maximum loading expected on the propeller in a turn for this class ship, full power with 35 and 20 degree rudder angles, respectively. Experiments 182 and 183 correspond to trial conditions of the BARBEY during instrumented propeller trials. The first set of conditions, then, will provide a design extreme, and the second set will permit a correlation between values predicted from model data and those measured during full-scale trials.

Model 4989 was fitted for these experiments with DTNSRDC Pitot Tube Rake No. 7 in the usual manner, as described in the Introduction. Prior to conducting these experiments, the model was ballasted to the specified displacement (4000 tons (4064 metric tons)) and trim conditions and thereafter locked in place at the desired yaw angle at midships. Photographs of Model 4989 on the Rotating Arm Carriage during the conduct of Experiment 180 are presented in Figure 10.

The model was accelerated to a speed corresponding to the steady turning speed for the full-scale ship and measurements were taken to determine velocities at a number of angles in the plane of the propeller disk. Periodically measurements were repeated to be sure that no significant drifting of the data occurred. The data have been analyzed as described in the Introduction.

At the end of the Experiment 180 the preliminary data analysis indicated that the velocity component ratios determined for Tube 5 ($r/R = 1.082$) were not reasonable when compared to those for the other radial locations. The problem proved to be a blocked tube which was cleared in time to secure a full set of data for experiments 181 through 183. The data from Tube 5 have not been used in the analysis of data for Experiment 180 as they are obviously incorrect.

Individual data points from each of the four rotating arm wake surveys have been plotted as a function of circumferential position. From these data, the tangential and radial components have been combined to give a vector diagram of the in-plane velocities for each survey. This diagram shows clearly the significant cross-flow in the propeller plane and the resulting confused wake of the shaft and shaft struts.

The in-plane velocity vectors for Experiment 180 are plotted in Figure 11. Figures 12 through 15 present the circumferential distributions of

longitudinal, tangential, and radial velocity component ratios from Experiment 180. The radial distributions of circumferential mean velocities and advance angles are plotted in Figures 16 and 17 respectively.

Velocity data from Experiment 181 are presented in Figures 18 through 25 (arranged in a similar manner). Velocity data from Experiment 182 are presented in Figures 26 through 33. Velocity data from Experiment 183 are presented in Figures 34 through 41.

Appendix B presents the velocity component ratios for Experiments 180, 181, 182, and 183. Harmonic analysis have been performed on the longitudinal and tangential velocity component ratios for these experiments. Tables of the individual harmonic amplitudes and phase angles are also presented in Appendix B. The complete set of sixteen harmonics calculated for each experiment are presented for the four experimental radii and eight interpolated radii.

The calculated mean values of the advance angle (BBAR), and the maximum variations thereof (BPOS) and (BNEG) are shown in tables in Appendix B. The advance angles were calculated using an advance coefficient, J_V , of 0.800. A diagram showing the relationship between the longitudinal and tangential velocity vectors, the advance coefficient, and the advance angles is described on page xvii.

WAKE SURVEYS ON A YAWED MODEL TOWED IN A STRAIGHT LINE EXPERIMENTS 184 AND 185

Experimental Conditions

The purpose of these experiments was to determine whether the results from a model towed in a straight line with a drift (yaw) angle could be substituted for those in a turn as determined from the Rotating Arm Tests. The cost of running a model wake experiment in the Deep Water Basin is substantially less than the cost of the same experiment run in the Rotating Arm Facility. There is also the advantage that the model is not operating in its own wake as is the case in the Rotating Arm Facility.

The experimental conditions of yaw, speed in the turn, and rudder angle listed in Table 2 for the wake in turns were repeated as nearly as practicable for these experiments with the yawed model. The model was fitted with Rake No. 7 with the individual pitot tubes located at the same radius ratio as for the other experiments.

The yawed-model wake survey experiments corresponded to the Rotating Arm wake survey experiments as follows: Experiment 184 corresponds to Experiment 180 with respect to yaw angle and speed, Experiment 185 corresponds to Experiment 182 in similar fashion. Due to limitations of time, only the two wake surveys were run. Nevertheless, the similarity of the data from the four Rotating Arm surveys means that the comparison of yawed-model surveys in these two cases should be sufficient to show whether a yawed model survey can represent a model in a turn as simulated on the Rotating Arm.

The circumferential distributions of V_x/V , V_t/V and V_r/V are presented in graphical form for the wake experiments with the yawed model in Figures 42 through 55. Figures 42 through 46 present the circumferential distributions of longitudinal, tangential, and radial velocity component ratios from Experiment 184. The radial distributions of circumferential mean velocities and advance angles are plotted in Figures 47 and 48, respectively. Velocity data from Experiment 185 are presented in Figures 49 through 55 in a similar manner. Tabulations of the experimental data for values of r/R are listed in Appendix C. The results of harmonic analyses of the circumferential distributions of longitudinal and tangential velocity component ratios are also presented in Appendix C.

DISCUSSION OF RESULTS

The Bass Dynamometer Boat located behind the propeller plane of the model had a significant effect on the velocity component ratios in the propeller plane. The largest effect was shown in the longitudinal velocity component ratios. The restriction of flow caused by the dynamometer boat resulted in mean longitudinal velocity component ratios which were 0.147 to 0.101 lower than those without the boat. The differences in mean tangential velocity component ratios were very small, between 0.011 and 0.006, with no trend higher or lower.

The circumferential distribution of the velocity component ratios was not affected by the dynamometer boat. Figures 4 through 7 show that at every radius the effects of shaft wake, strut wake, and in the case of tangential and radial components the effects of flow upward from the

bottom of the hull, are the same with or without the dynamometer boat.

Hence, it may be stated that from these results the major effect of the Bass Dynamometer Boat on the wake in the propeller plane is a reduction in the longitudinal velocity component ratios due to the blockage caused by such a large bluff body behind the model.

The velocity component ratios from Experiment 180, which are considered typical of those from all the turning experiments, are compared with those from the usual type of wake experiment (in a straight line without dynamometer boat) and with those from the yawed model wake experiments in Figures 56 through 58 for the radius ratios of 0.512, 0.711, and 0.910. It may be noted from these figures that the changes in longitudinal velocity component ratio (V_x/V) are significant in that there is greater asymmetry for the model in a turn (ideally there should be none for the model towed in a straight line). There is also a greater wake defect behind the shaft and struts in the turn. The differences in tangential and radial velocity component ratios are much more significant than for V_x/V . Both circumferential distribution and amplitude of V_t/V and V_r/V have changed substantially for the turn compared to straight line operation.

As stated previously, there is a major limitation in conducting this type of experiment in the Rotating Arm Tank. By the time the model has been accelerated to the desired steady turning speed and data samples are integrated over a 5 second period, the model has turned more than 360 degrees, and is operating in its own wake. An attempt was made during these experiments to alter the sampling time to 1 second. The results from this attempt varied so much they were of little use. Evidently the transients in the flow are of sufficient duration that the full 5 second integration time is necessary. Data from specific points in the propeller disk were checked on several occasions to determine how well they repeated. In every case measurements were repeated within $\pm$ 1 percent which is the normal repeatability of the instrumentation based on calibration and past experience. Based on observations throughout the experiments, it would appear that, although the model is being towed in its own wake, that particular flow is quite constant. The error

in determining the wake in way of the propeller disk due to this effect is most probably constant from one experiment to another at the same speed. The change in level is also likely to be small compared to the rather sizeable changes in velocity component ratios noted from operating in a turn compared to operation straight ahead.

Some additional observations have been made in comparing the data from the wake survey experiments in a turn and in a straight ahead motion. The composite plots of velocity component ratios show that in a large portion of the propeller plane, the longitudinal velocity component ratio was not affected by the turn. In the area of the shafting and struts, however, a much greater effect is shown on the longitudinal velocity component ratios from the turning wake survey. This is probably due to the angle of flow into the appendages causing a much more significant variation in wake.

The largest changes in the velocity component ratios due to the turn are seen in the tangential and radial velocity component ratios. The high angularity of the flow leads to much greater peaks in the circumferential distribution of these components. This effect is shown clearly in Figures 56 through 58. Because circumferential distributions of tangential and radial components were so radically different they were plotted as "in-plane" vectors in Figures 11, 18, 26, and 34. Looking at Figure 11 for example, the cross-flow caused by the combination of drift angle and turning clearly stands out. In addition, the confused flow in the wake of the appendages is seen in the vectors along the 270-degree and 300-degree radial lines in Figure 11.

The conclusion to be drawn from these data is that when the model is towed in a straight-ahead condition the major effect on the variation of the in-plane velocity components (tangential and radial) is due to the upward flow from the bottom of the hull. In the turning condition, however, the major effect on in-plane velocities is due to the cross-flow caused by the drift angle and the turning path. The maximum tangential or radial velocity component ratios in a turn can be as high as three times that of the same model in straight-ahead motion. In fact, the amplitude of the first harmonic of the tangential velocity component ratios at the 0.7 radius is 2.5 times higher for the turning condition.

Although the changes in velocity component ratios are quite dramatic the effect on β angles is small. For example, the circumferential mean β angle for the turning wake survey is less than that for the straight-ahead survey but by less than one degree. The total variation in β ($| + \Delta\beta| + | - \Delta\beta|$) angle is 1.3 degrees greater for the turning wake survey than for the straight-ahead survey. These comparisons are shown in Table 3 in which the data from the wake survey on the rotating arm is presented along with data from the straight-ahead (conventional) wake survey and the yawed-model wake survey.

The attempt to represent the wake of a model which is in a turn on the rotating arm by running a model in the straight towing tank with a drift angle was unsuccessful. As may be seen from the velocity component ratios plotted in Figures 56 through 58, the magnitude and the distribution of velocity component ratios are completely different for the yawed model. In fact, the longitudinal velocity component ratio was actually lower in the case of the yawed model towed in a straight line than for either the straight wake survey or for the turning wake survey. Presumably the wake of the hull had a much larger effect on the velocities in the propeller plane in this case. The wake variations due to the shaft and struts are greater than for the conventional straight wake survey but not nearly as dramatic as those of the turning wake. In short, it may be noted that the yawed condition gives a result that is neither like that of the turning condition nor of the straight-ahead condition. Perhaps such data may be used to analyze the initial portion of a turn, before the hull takes on an angular path or to analyze a pure drifting motion where the hull has some steady drift angle. If the conditions during a steady turn are to be studied, however, the wake data must be obtained from a survey performed on the rotating arm.

At this point, it should be pointed out that there are some limitations on the usefulness of the five-hole pitot tube and associated instrumentation in performing a velocity survey in the propeller plane. As Hadler and Cheng³ have shown, the velocities to be measured must be large enough to obtain significant pressure differences. In all cases, this condition is met by the data reported herein. However, it is known that the five-hole

pitot tube cannot distinguish between a shear flow and a flow from an angle. Since the formation of a shear flow usually involves a boundary layer on a hull surface and since the surveys reported herein are performed in a more open flow behind shaft and struts, there appears to be very little effect on the pitot tube measurement. The large in-plane velocities are in fact due to angularity of the in-flow velocity.

The major limitation on the data reported herein is the fact that these data represent a steady condition. Because the pressure-measuring system is unable to respond to instantaneous changes, as mentioned in the discussion of the rotating arm wake surveys, all data obtained in these experiments are for a steady-state condition. Therefore, the results do not represent any transient conditions which may arise during the execution of a turn. Finally, the data reported herein have been calculated using the calibrations of the five-hole pitot tubes performed in the straight tank. When the pitot tubes were recalibrated on the rotating arm for another experiment, it was found that the calibrations were similar to within a small percentage. Recalculation of a sample set of data using the two different calibrations showed differences in the order of 0.01 to 0.02 on the velocity component ratios. Since these differences were of the order of the experimental accuracy, the rotating arm data were not recalculated. The data are considered valid to within plus or minus 0.2 in all cases.

SUMMARY AND CONCLUSIONS

Three sets of wake survey experiments have been performed on a model of the FF 1052 Class ship. Experiments were performed to measure the effect on propeller disk wake of a Bass Dynamometer Boat mounted downstream of the model, the effect of a steady turn, and the effect of a model towed in a straight line with a drift angle. Data from the first two series were required for calculation of propeller forces and data from the third were obtained to determine if the turning condition could be simulated without the use of a rotating arm.

The Bass Dynamometer Boat significantly lowered the longitudinal velocity component ratios due to blockage of the flow. The circumferential distribution of velocity component ratios was not altered by the presence of the dynamometer boat downstream.

The turning wake surveys performed on the Rotating Arm Facility showed very large changes in the tangential and radial velocity component ratios due to the large cross-flow in the propeller plane. The wake due to the shaft and the struts was more extreme in the case of the turning wake surveys. The first harmonic of tangential velocity component ratios was increased 2.5 times that of a straight-ahead condition.

The results of the yawed-model wake surveys in the straight tank did not reproduce the results of the rotating arm turning wake surveys. The peak values of tangential and radial velocity component ratios are approximately midway between the peak values of the turning wake survey and the conventional straight ahead survey. The longitudinal velocity component ratio for the yawed model towed straight ahead showed a larger value than the other two surveys due presumably to the wake of the hull.

These data may be used in calculations of propeller forces for a controllable pitch propeller in steady motion. The data from the survey with the dynamometer boat may be used for calculation of propeller forces which then may be compared with the results of measurements. The calculation of propeller forces and the measurements have been reported separately.

ACKNOWLEDGEMENTS

The authors are indebted to personnel of the Ship Performance Department of DTNSRDC. Special appreciation is extended to Mr. Robert Roddy for conducting the wake surveys with and without a bass dynamometer boat, and Mr. Alan C. M. Lin for performing the wake surveys on a yawed model in a straight line. The authors also wish to thank Mr. Charles J. Wilson of Operations Research Incorporated for his assistance in the preparation of this report.

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2. Boswell, R. J., et al, "Experimental Unsteady and Mean Loads on a CP Propeller Blade on a Model of the FF-1088 for Simulated Modes of Operation," DTNSRDC Report 76-0125 (Oct 1976).
3. Hadler, J. B. and H. M. Cheng, "Analysis of Experimental Wake Data in Way of Propeller Plane of Single- and Twin-Screw Ship Models," Transactions of Society of Naval Architects and Marine Engineers, Vol. 73, (1963).

Ship		Model
Length at Waterline	126.6 m 415.3 ft	6.486 m 21.28 ft
Beam	14.17 m 46.5 ft	0.727 m 2.385 ft
Draft	4.57 m 15.0 ft	0.234 m 0.769 ft
Displacement	4.064x10 ⁶ Kg (S.W.) 4000 tons (S.W.)	532.4 Kg (F.W.) 0.524 tons (F.W.)

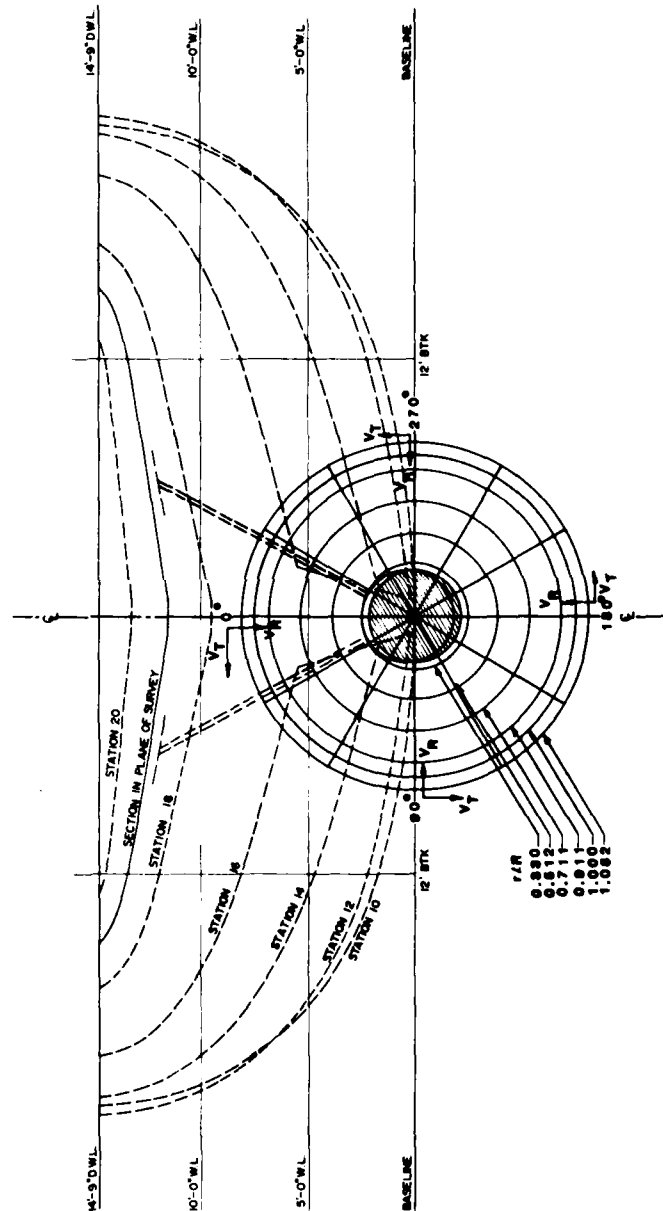


Figure 1 - Ship and Model Particulars for FF1088 Represented by Model 4989

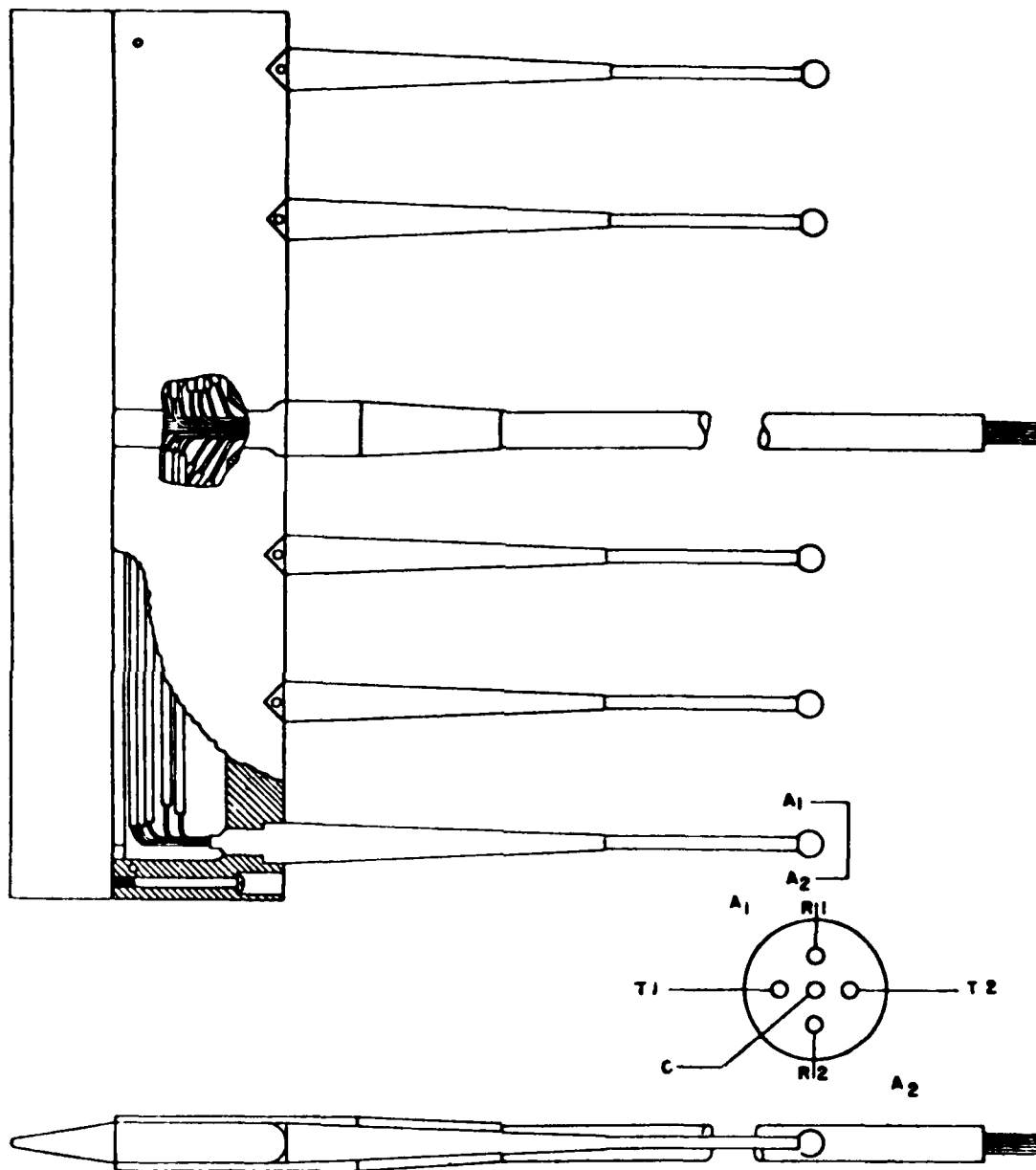


Figure 2 - Rake Arrangement Showing Spherical Head Pitot Tubes

TOWING CARRIAGE

VARIABLE
HEIGHT

FIXED
HEIGHT

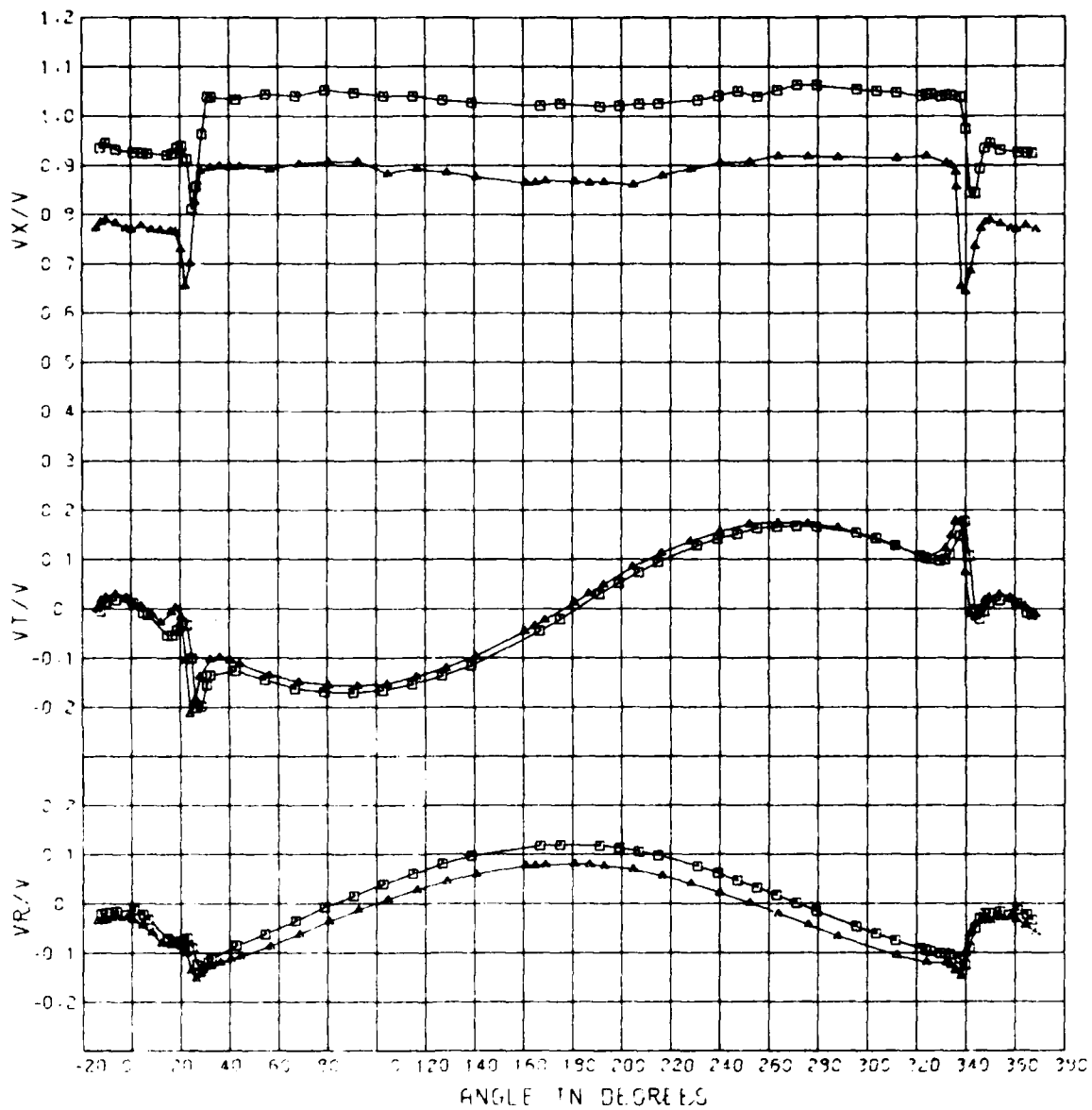


PSD 343455

DOWNSTREAM
DRIVE
HOUSING

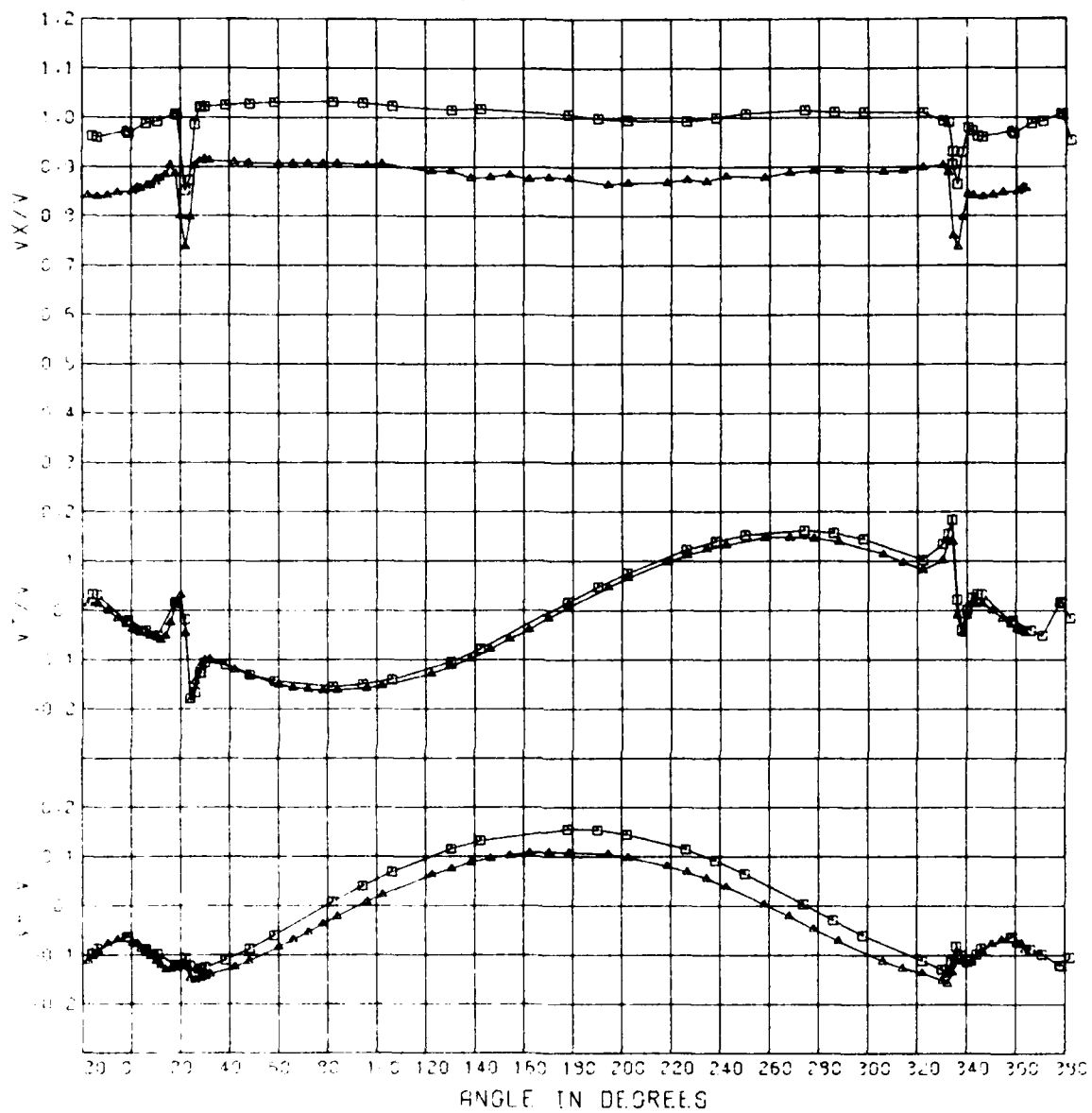
5 MM GAP BETWEEN
PROPELLER AND
UPSTREAM SHAFTING

Figure 3 - Experimental Arrangement of Model 4989 and the Bass Dynamometer Boat



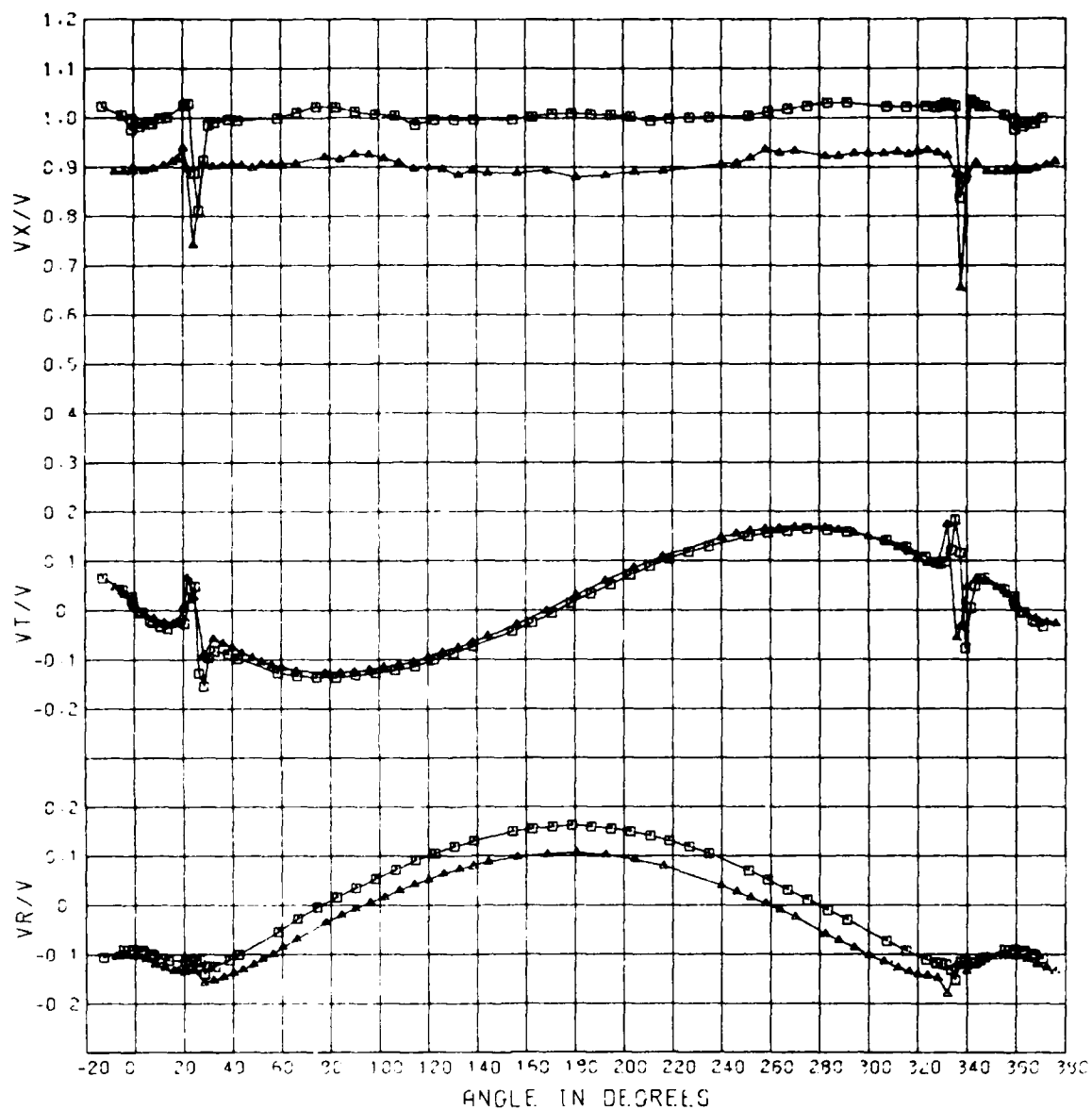
□ WAKE SURVEY OF MODEL 4993 WITHOUT BASS DYN BOAT-EXP 179
 ▲ MODEL 4993 WITH THE BASS DYNAMOMETER BOAT EXP 173

Figure 4 - Composite Plot of Velocity Component Ratios from Experiments
 With and Without the Bass Dynamometer Boat for the 0.512 Radius



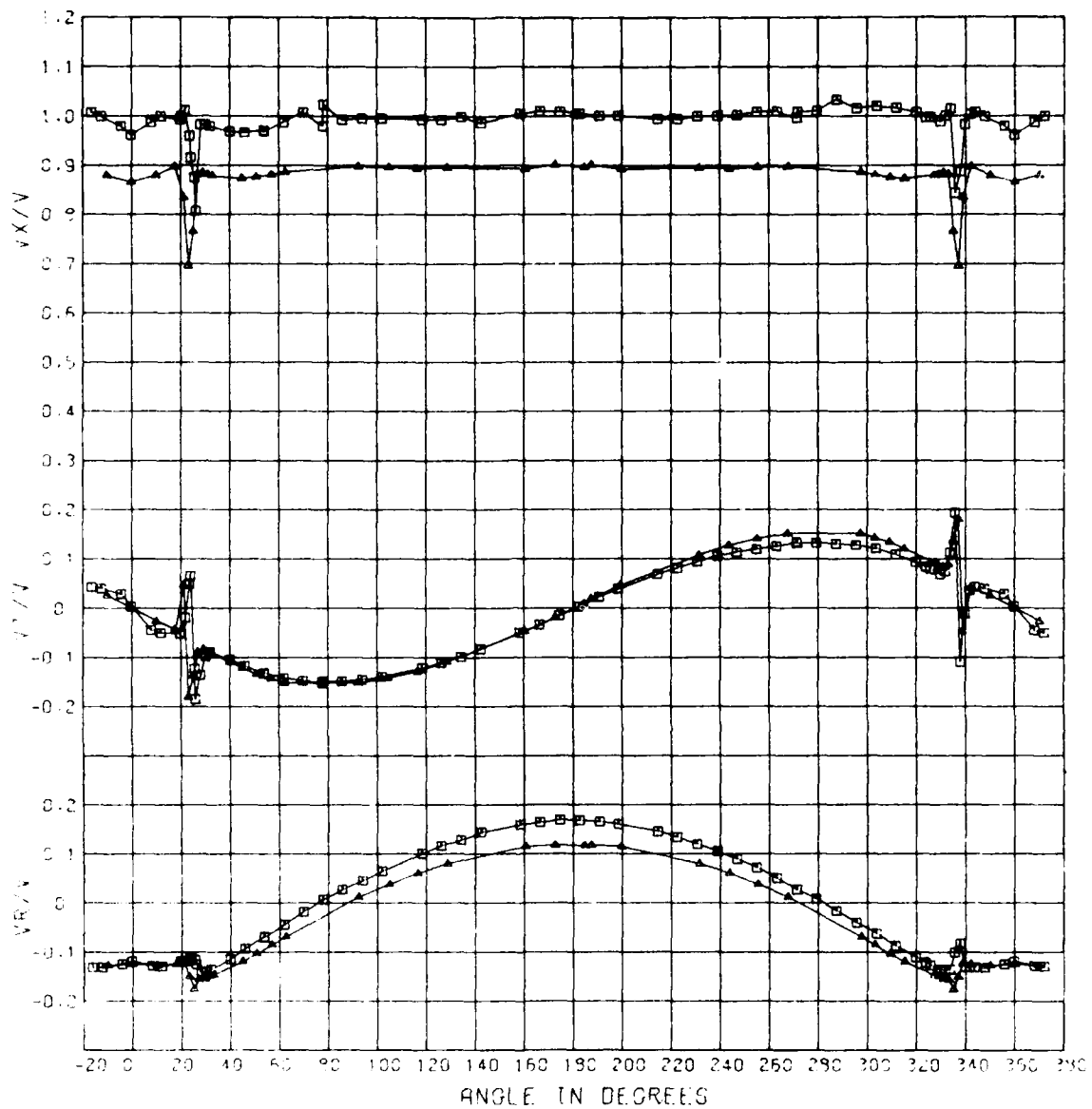
□ WAKE SURVEY OF MODEL 4999 WITHOUT BASS DYN BOAT-EXP 179
 ▲ MODEL 4999 WITH THE BASS DYNAMOMETER BOAT EXP 179

Figure 5 - Composite Plot of Velocity Component Ratios from Experiments
 With and Without the Bass Dynamometer Boat for the 0.711 Radius



□ WAKE SURVEY OF MODEL 4399 WITHOUT BASS DYN BOAT-EXP 179
 ▲ MODEL 4399 WITH THE BASS DYNAMOMETER BOAT EXP 179

Figure 6 - Composite Plot of Velocity Component Ratios from Experiments
 With and Without the Bass Dynamometer Boat for the 0.910 Radius



□ WAKE SURVEY OF MODEL 4989 WITHOUT BASS DYN BOAT-EXP 179
 ▲ MODEL 4989 WITH THE BASS DYNAMOMETER BOAT EXP 179

Figure 7 - Composite Plot of Velocity Component Ratios from Experiments
 With and Without the Bass Dynamometer Boat for the 1.082 Radius

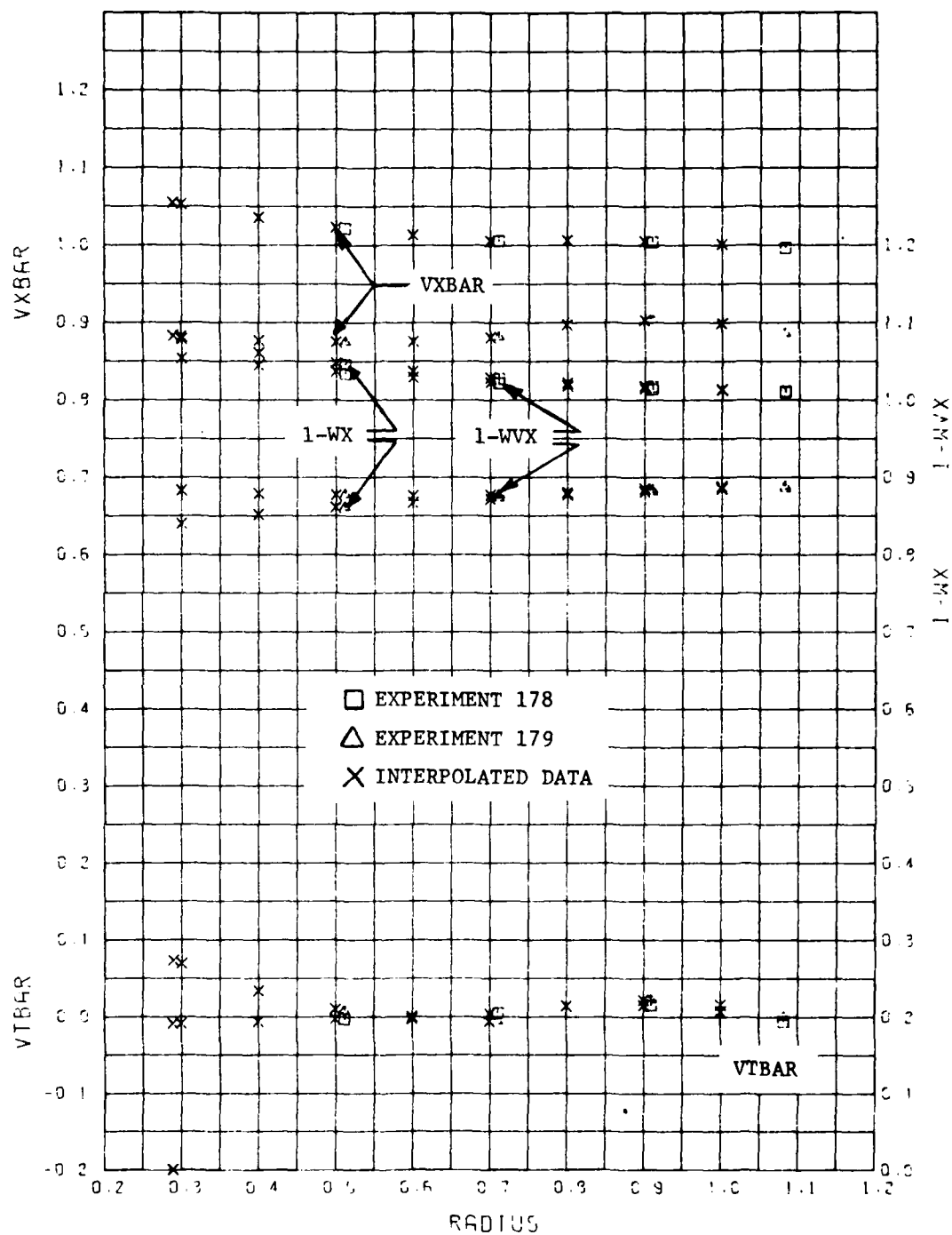


Figure 8 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake from Experiments With and Without the Bass Dynamometer Boat

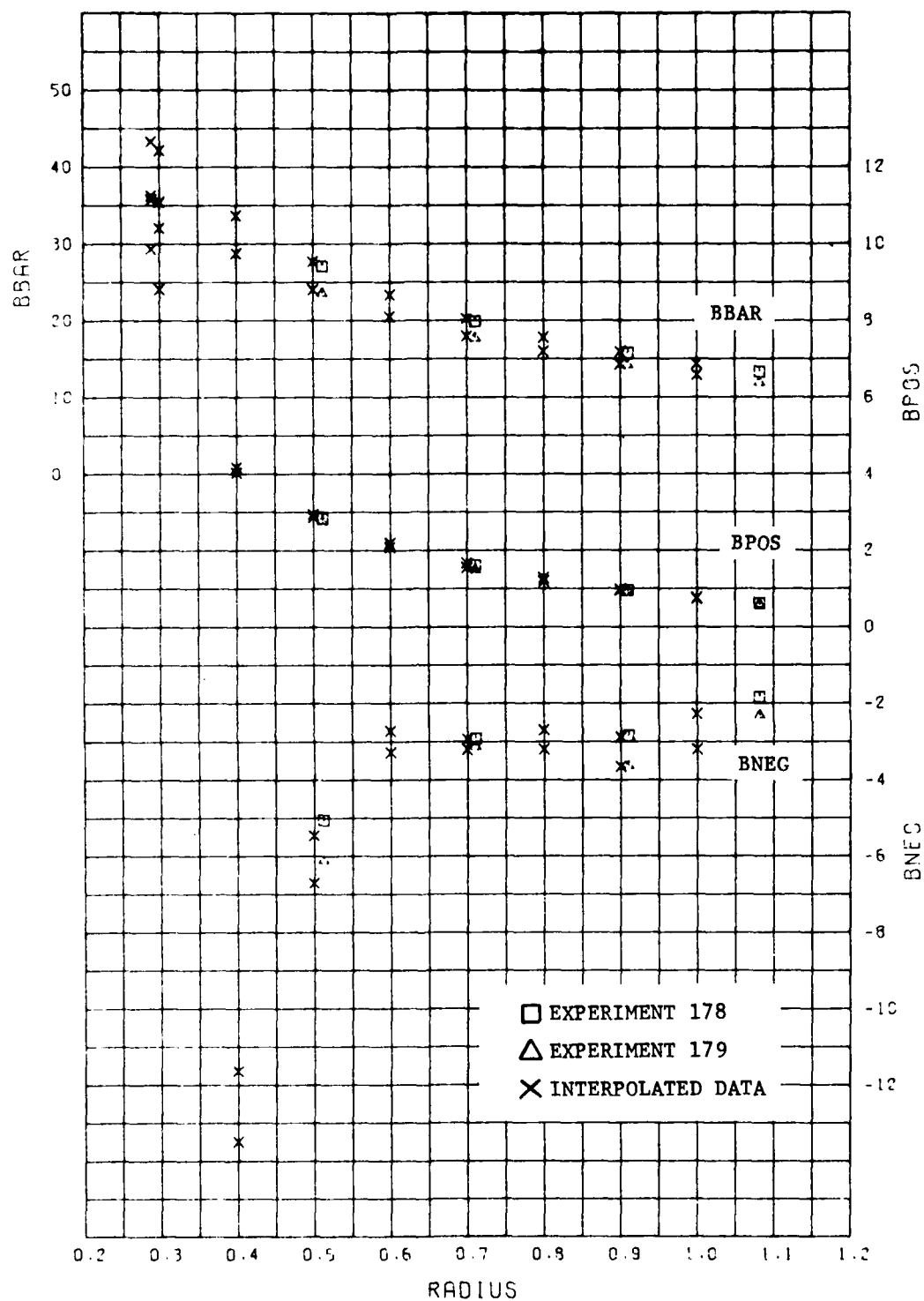


Figure 9 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle from Experiments With and Without the Bass Dynamometer Boat



PSD 344219



PSD 344220

Figure 10 - DTNSRDC Model 4989 Attached to the Rotating Arm

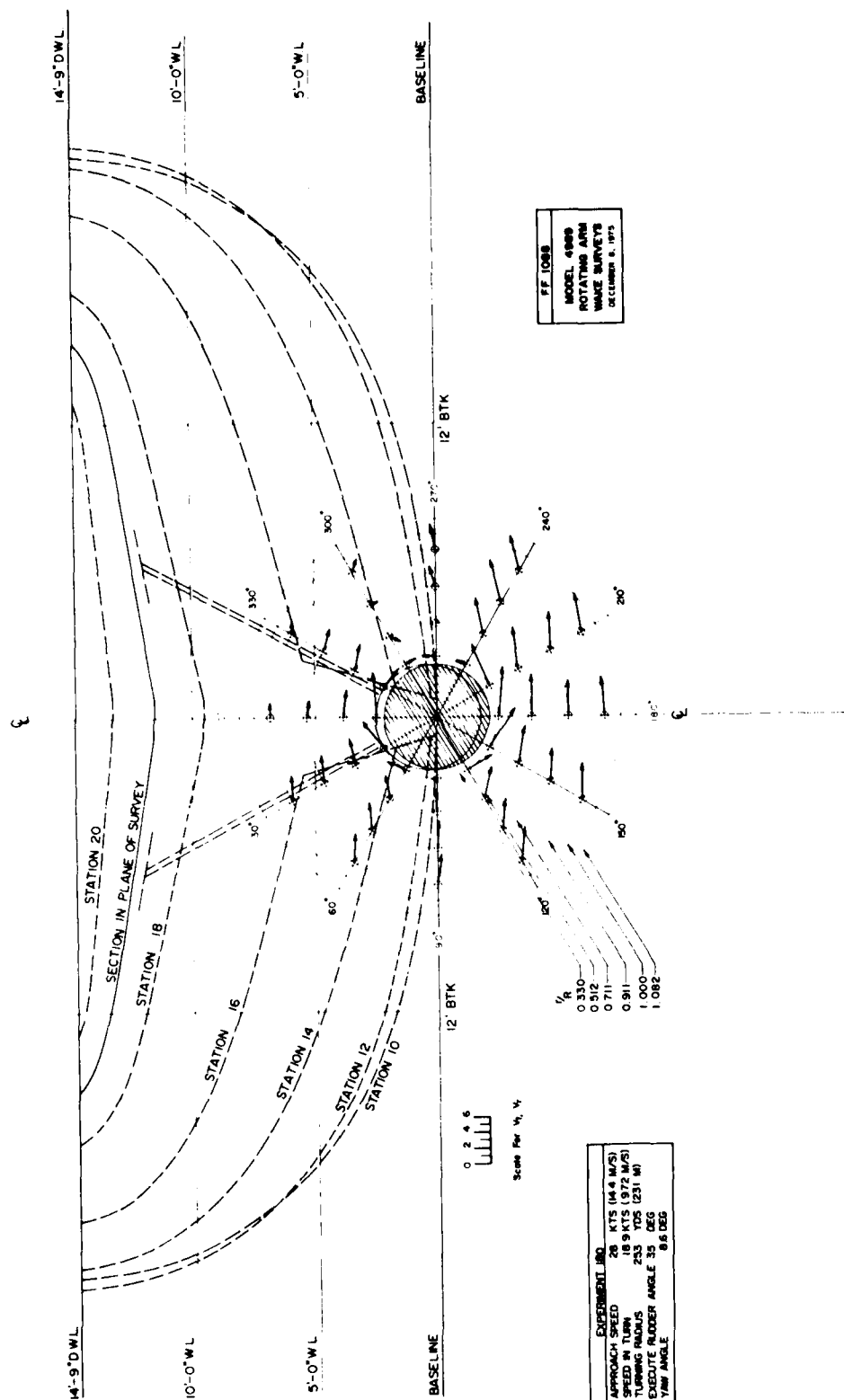


Figure 11 - Velocity Vector Diagram of the Flow In the Propeller Plane for Experiment 180

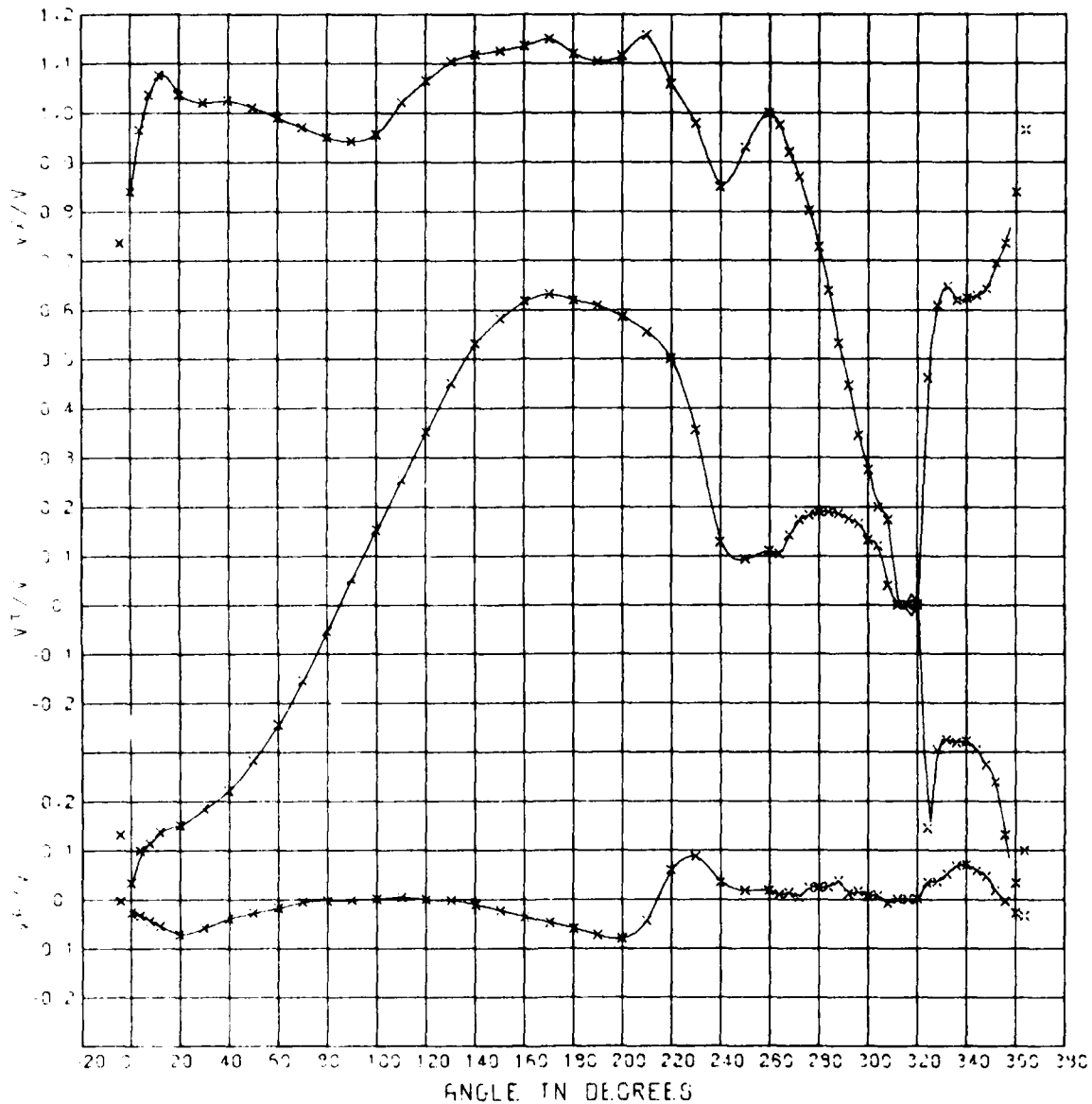


Figure 12 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = .330 for Experiment 180

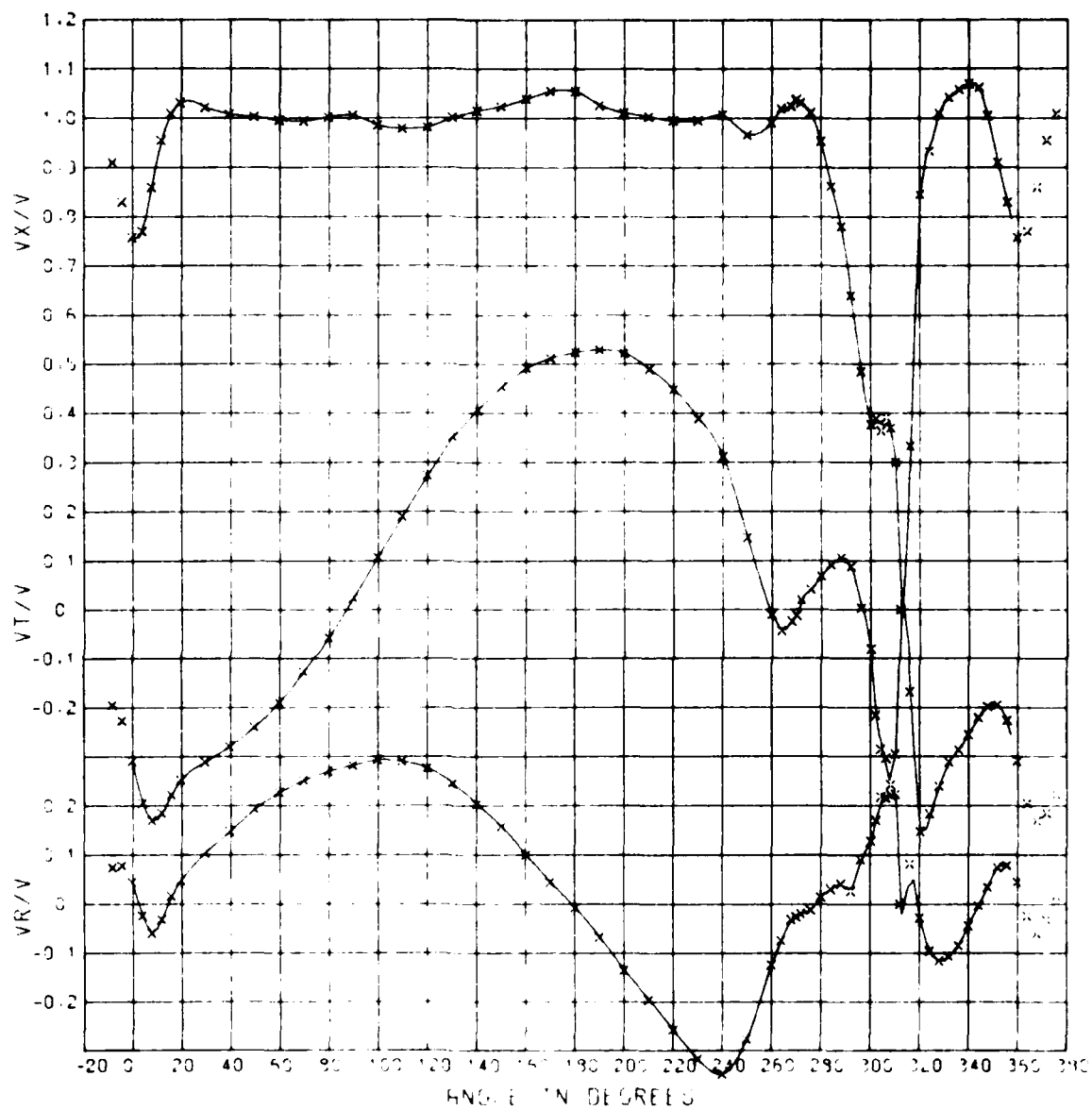


Figure 13 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = .512 for Experiment 180

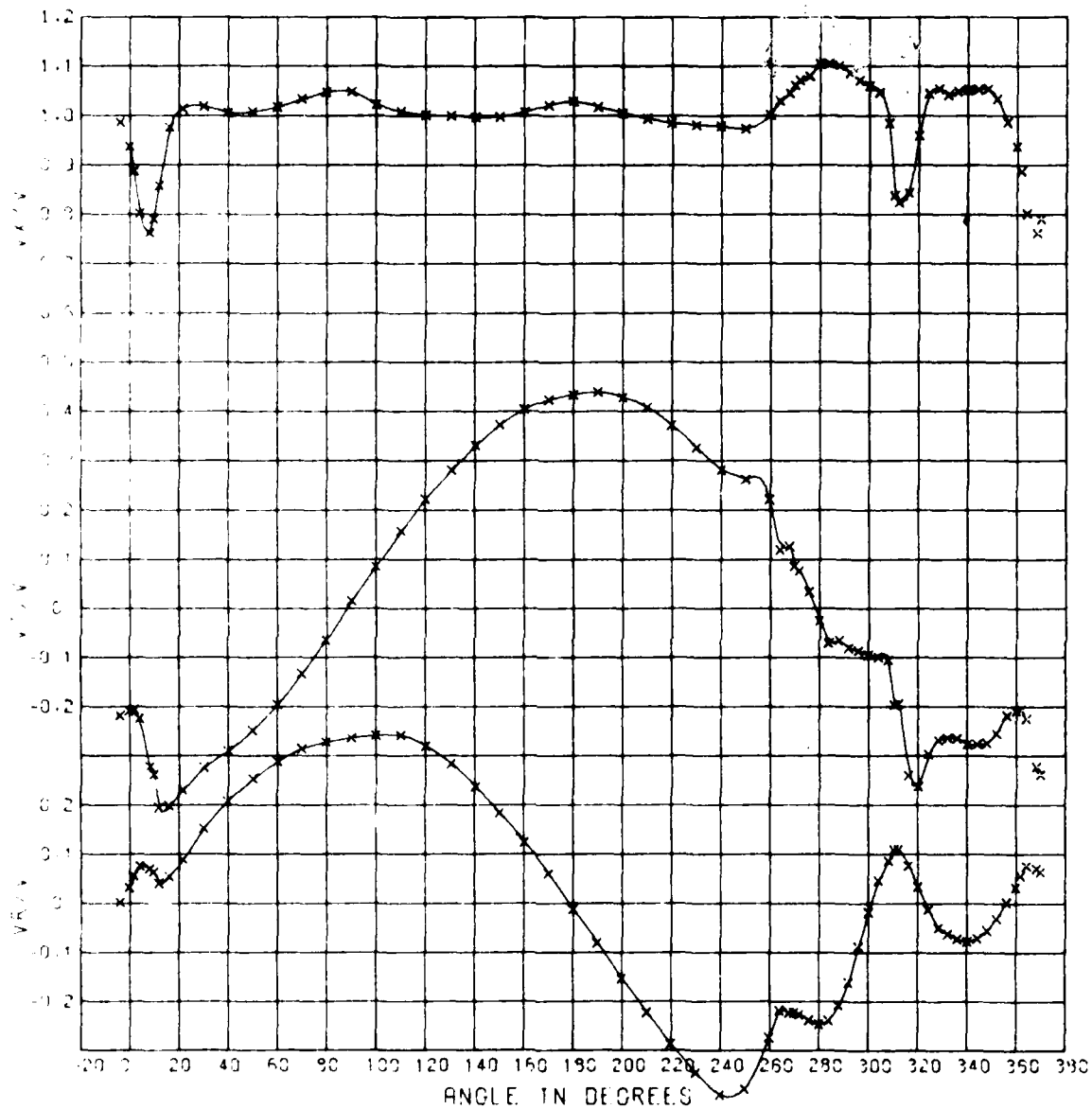


Figure 14 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 180

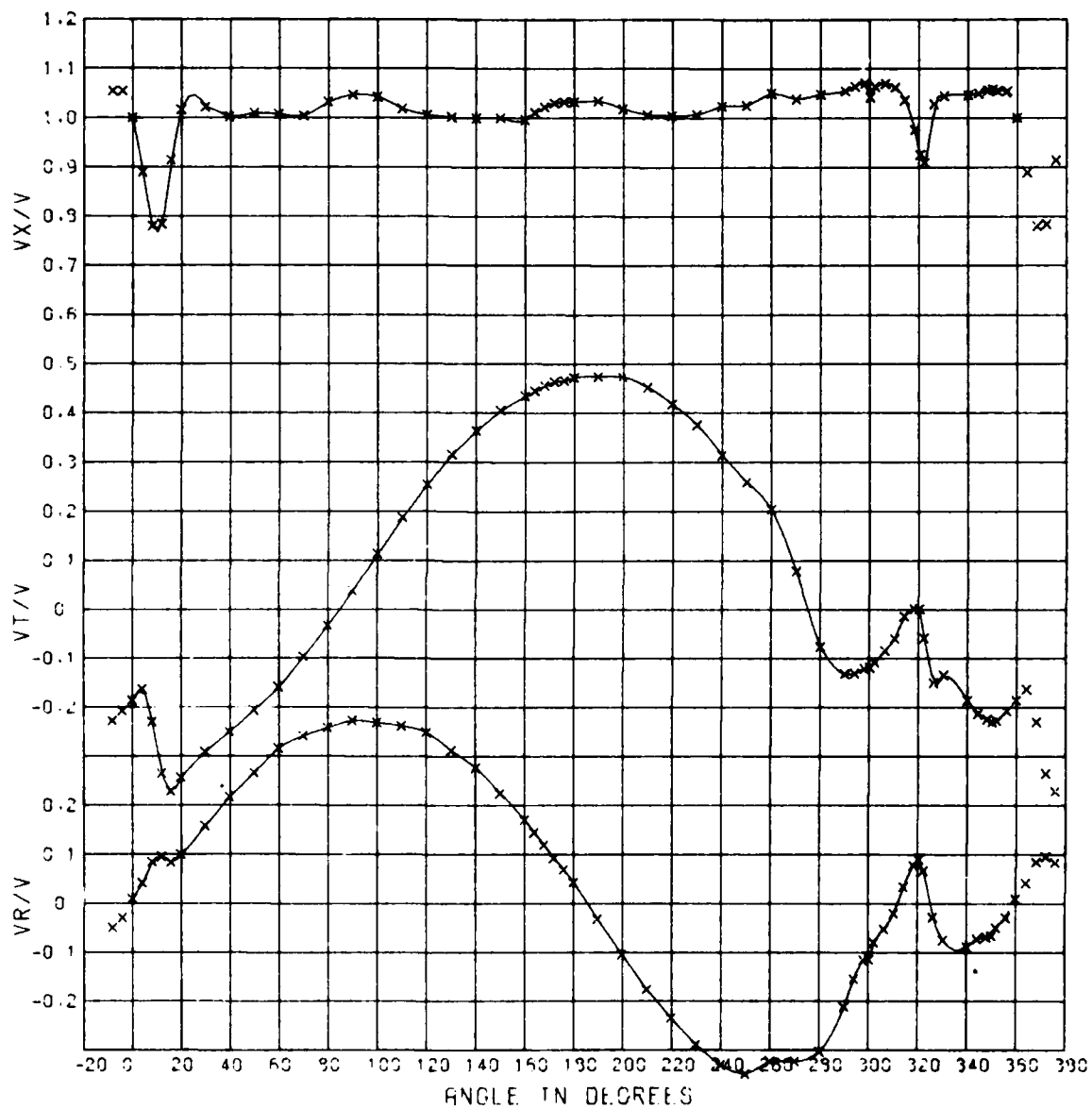


Figure 15 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.911 for Experiment 180

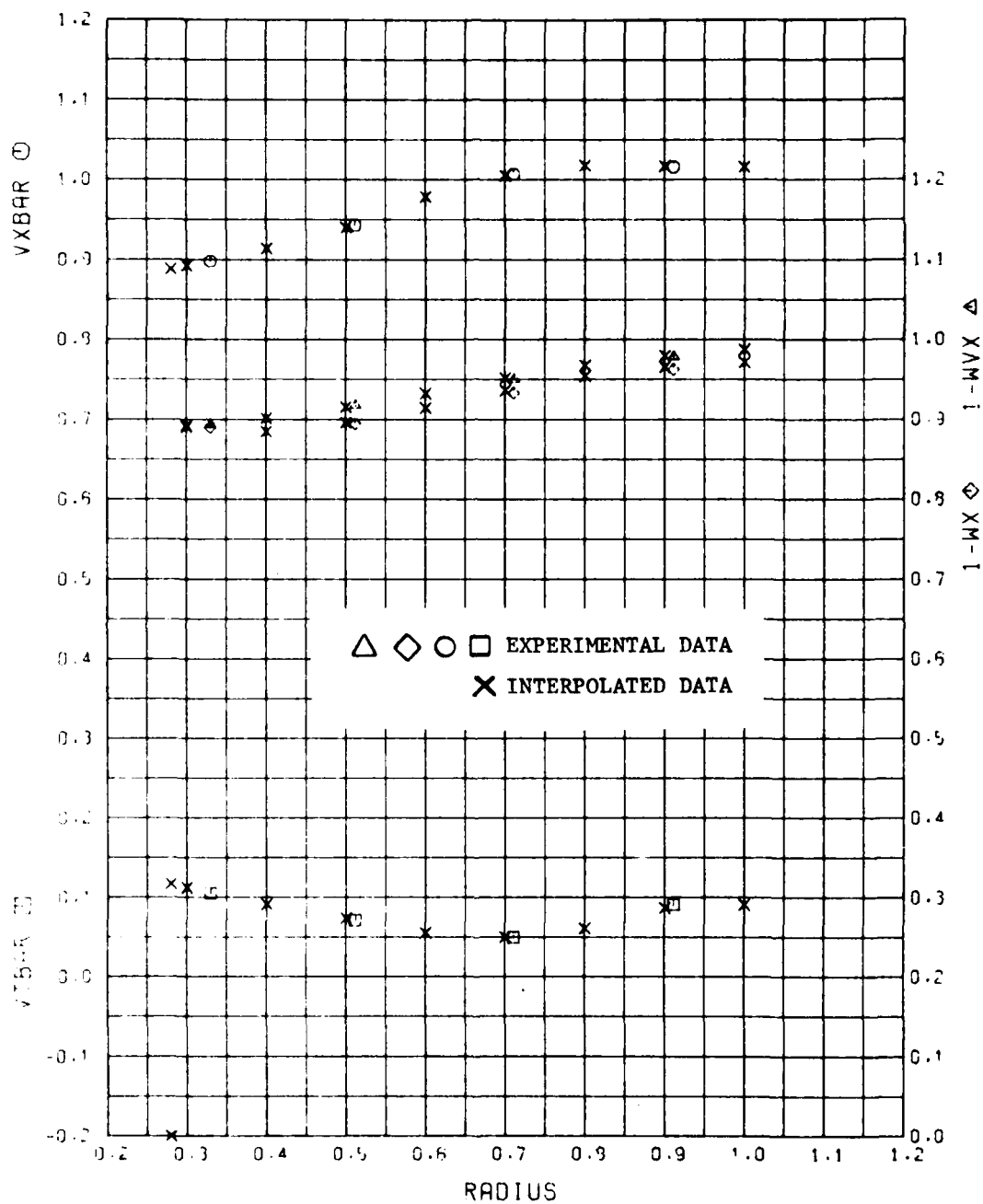


Figure 16 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 180

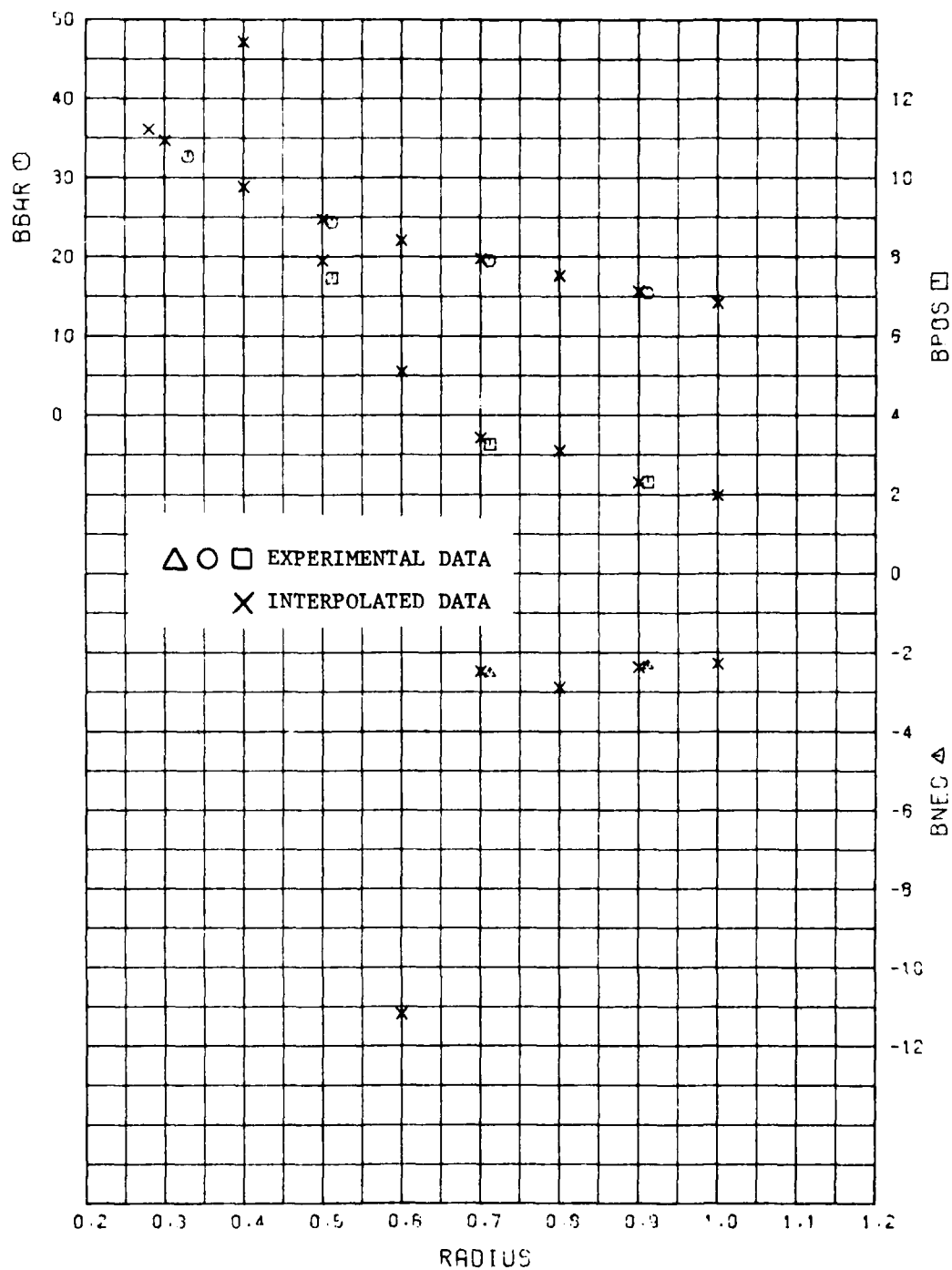


Figure 17 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 180

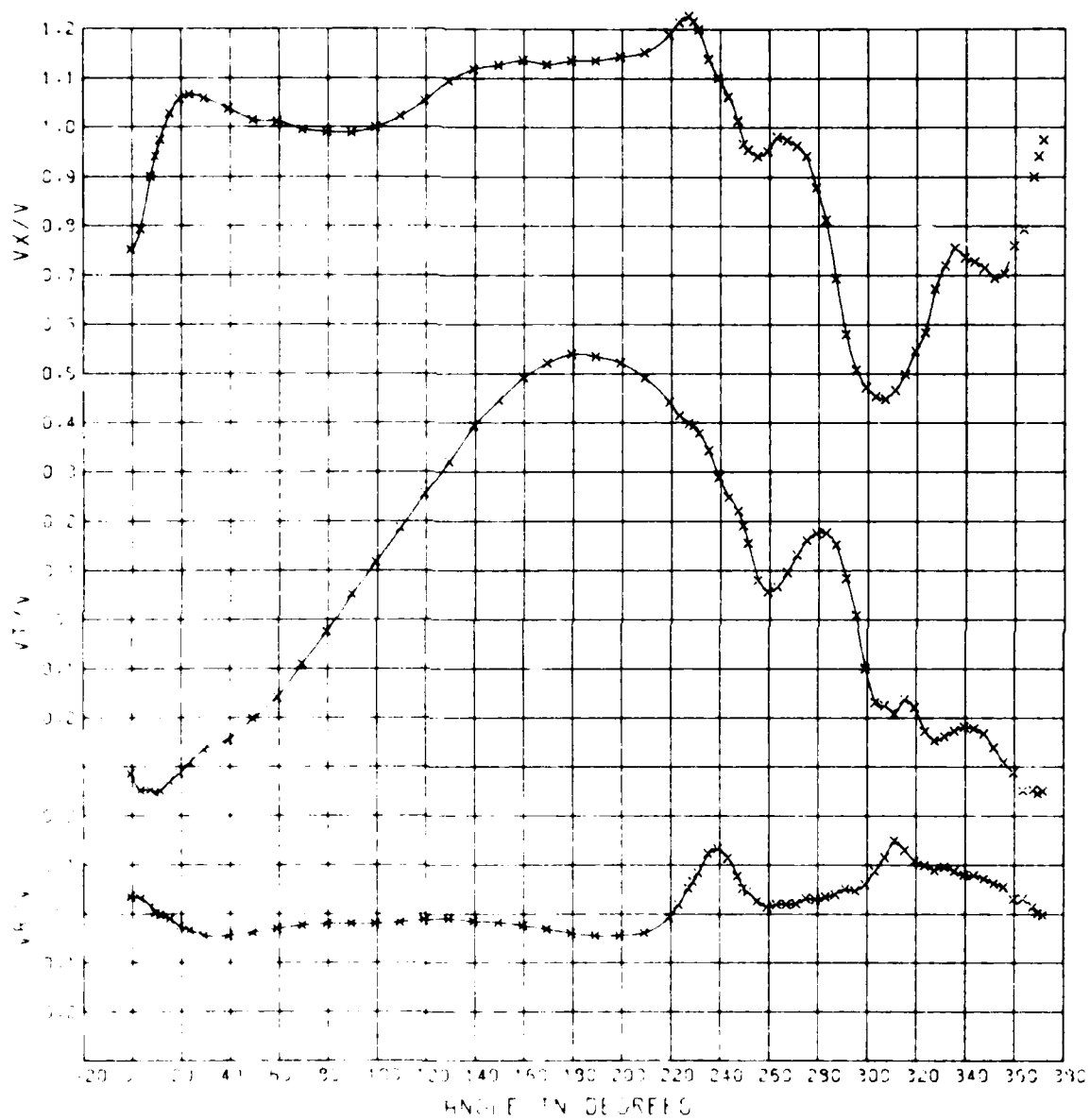


Figure 19 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.330 for Experiment 181

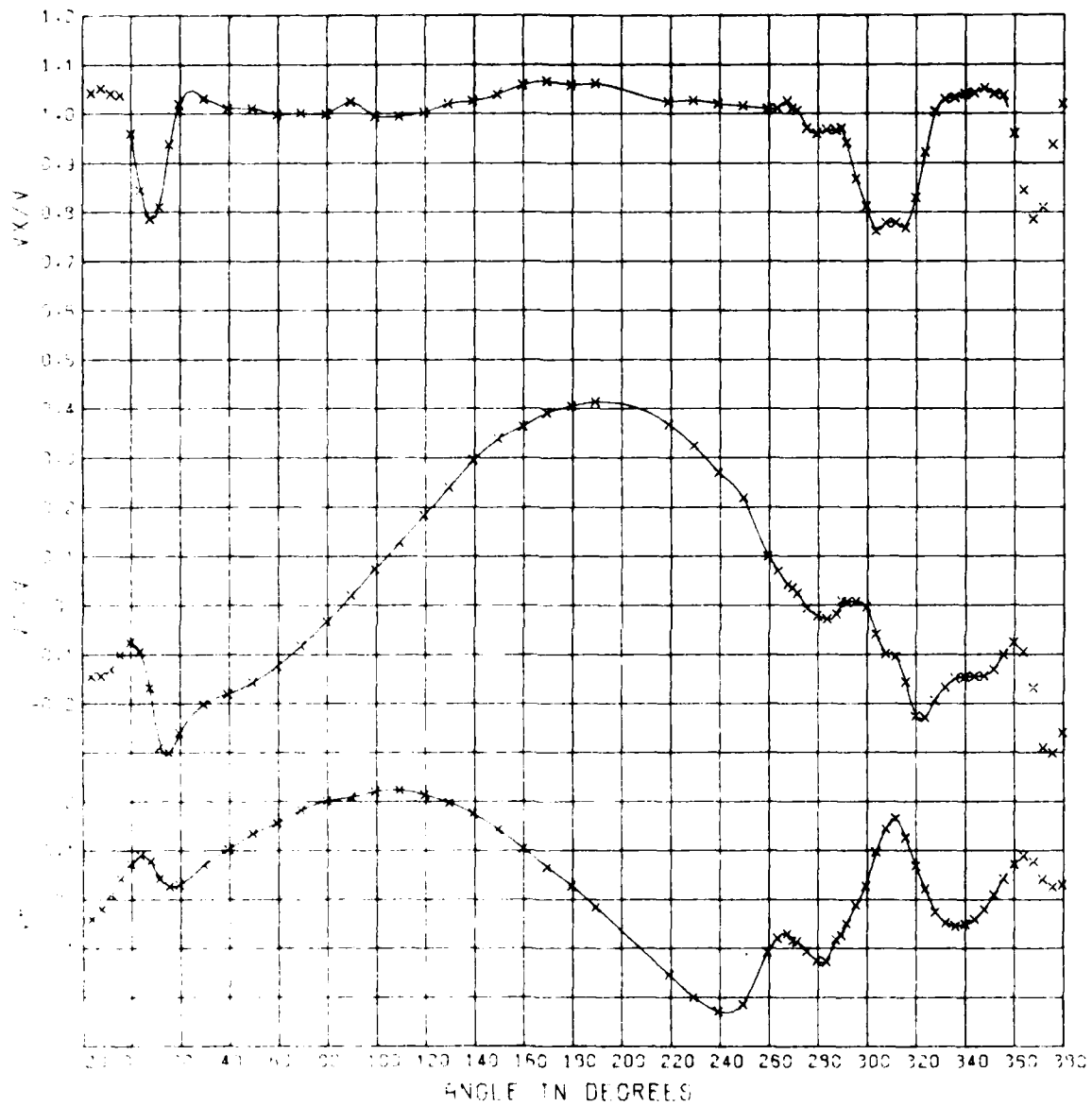


Figure 20 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 181

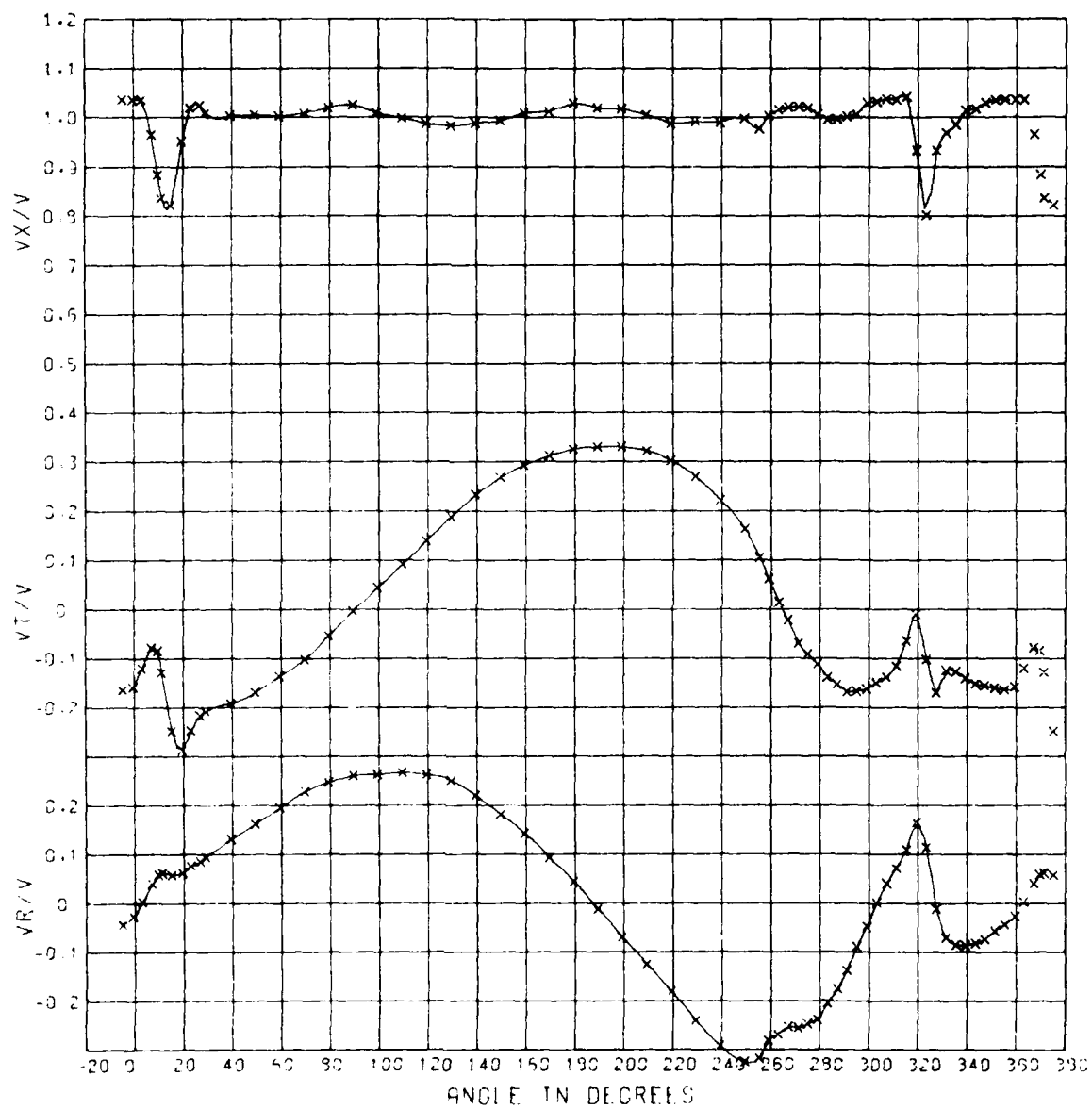


Figure 21 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 181

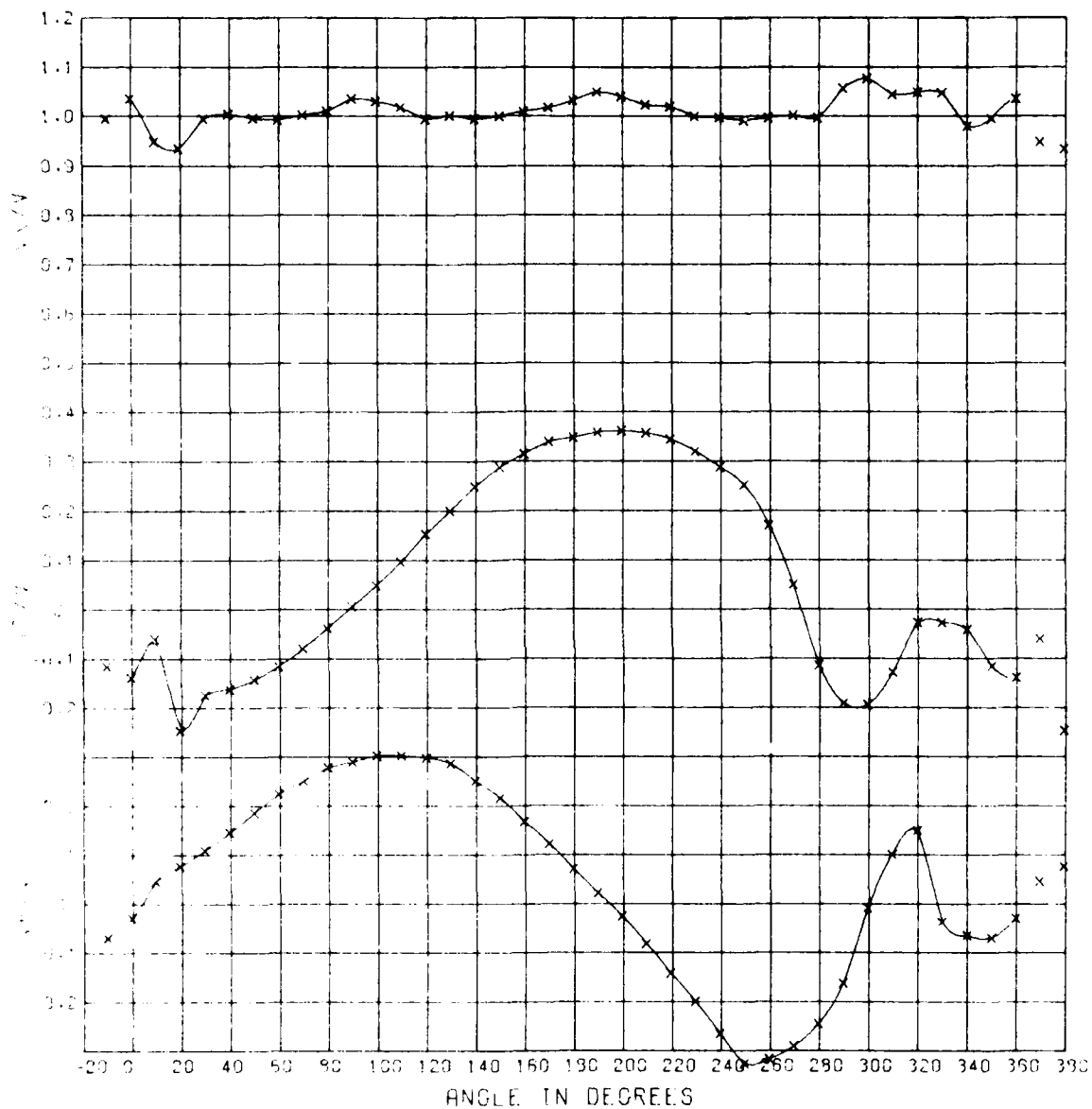


Figure 22 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.911 for Experiment 181

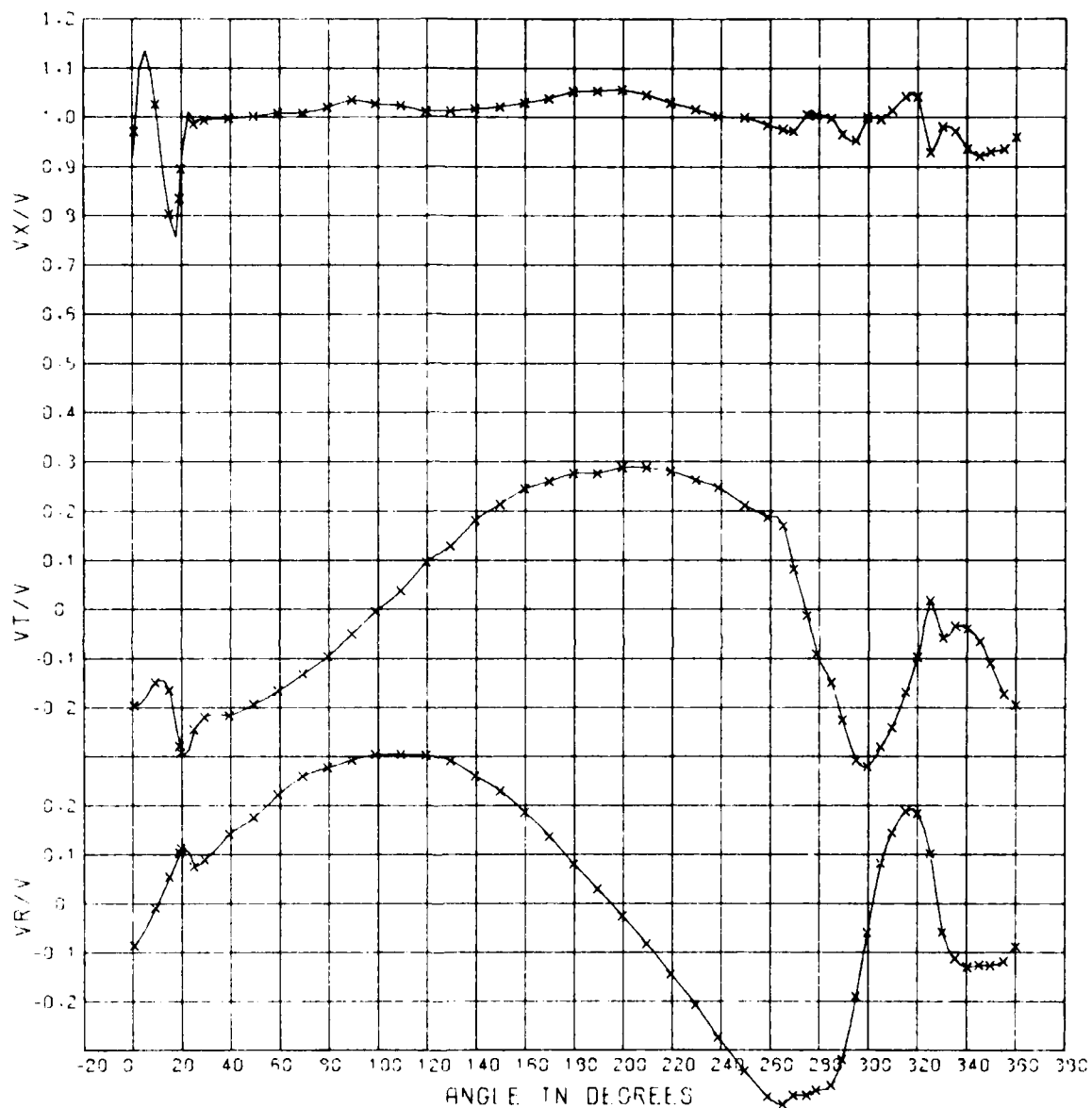


Figure 23 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 1.082 for Experiment 181

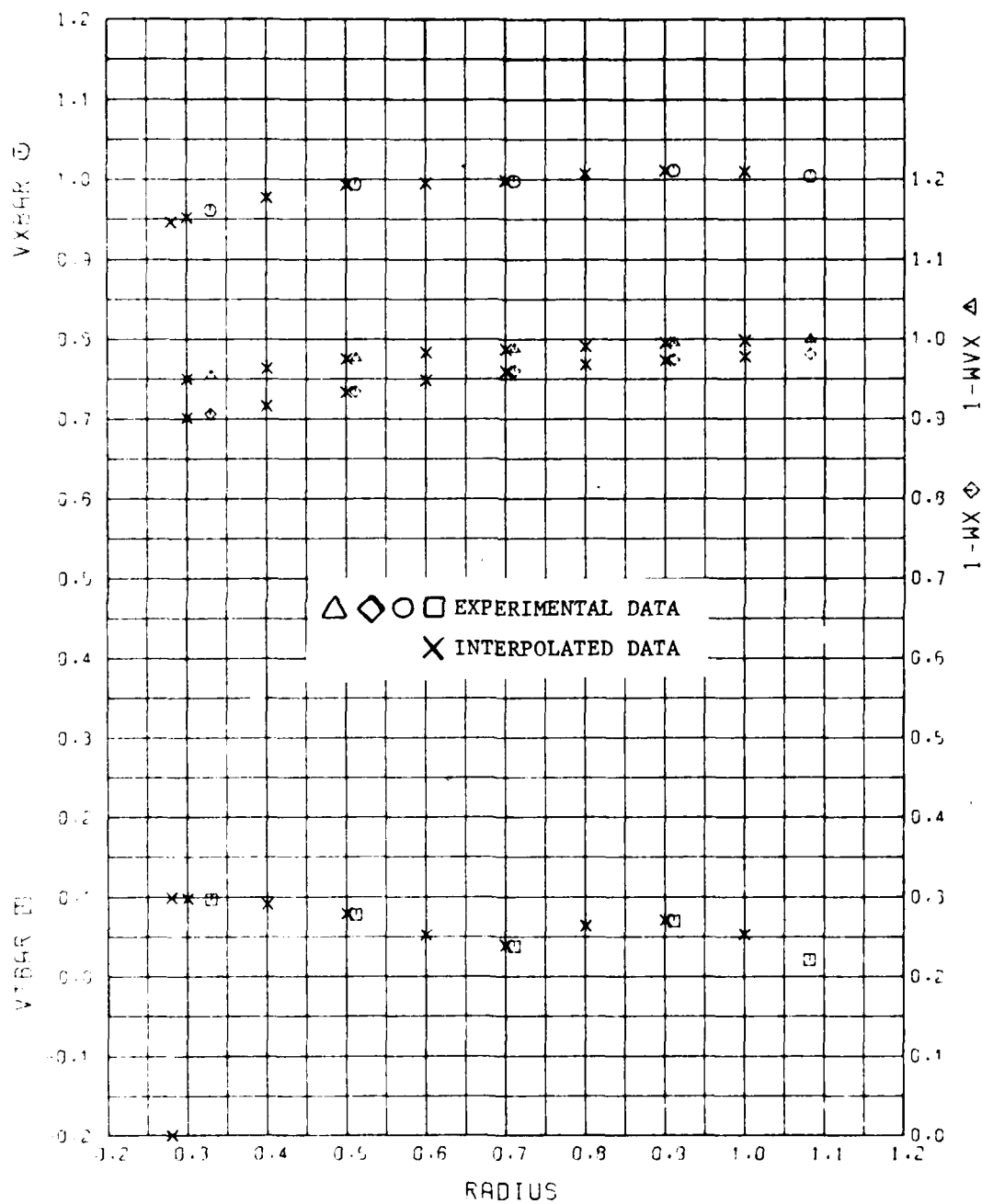


Figure 24 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 181

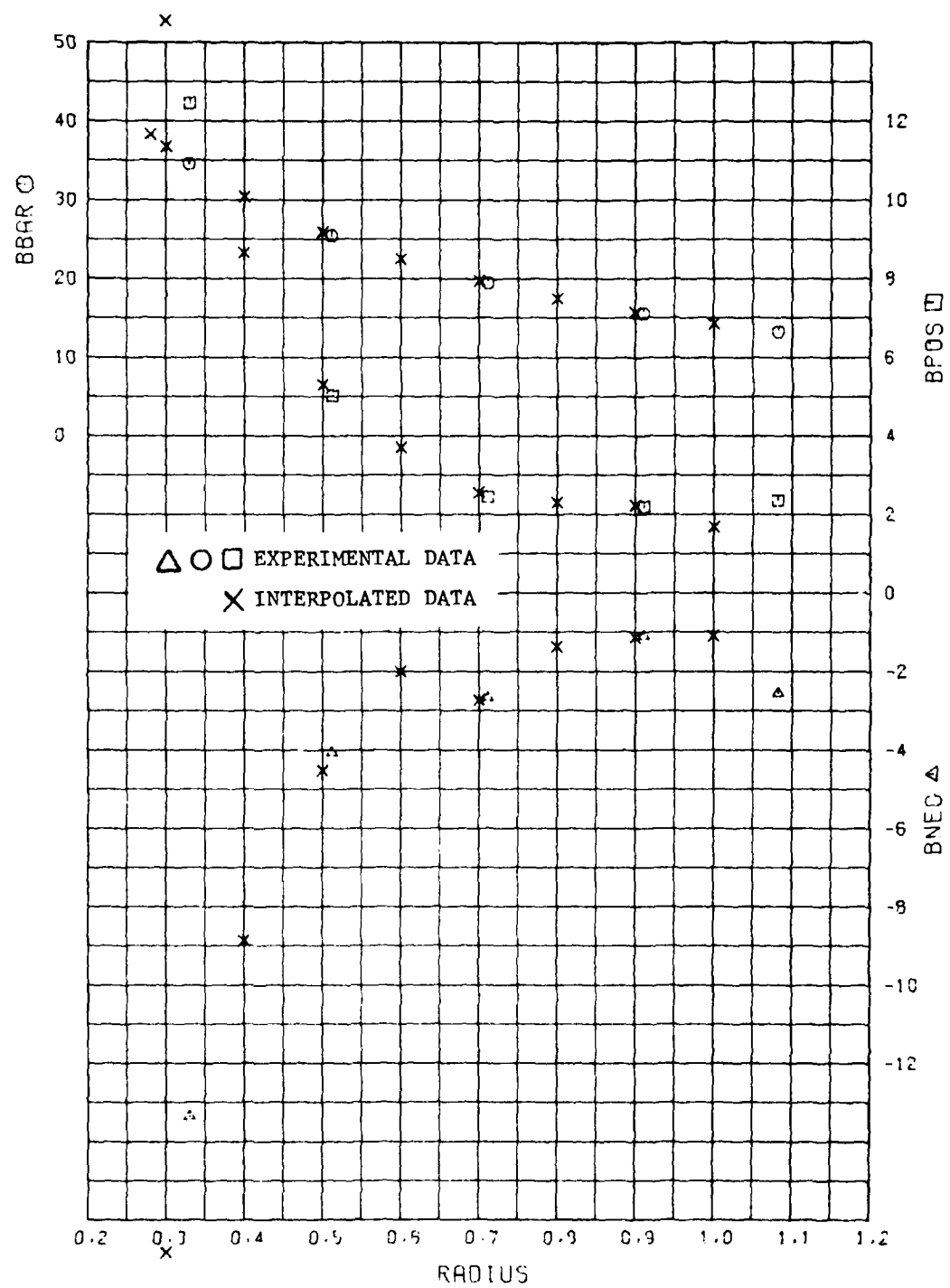


Figure 25 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 181

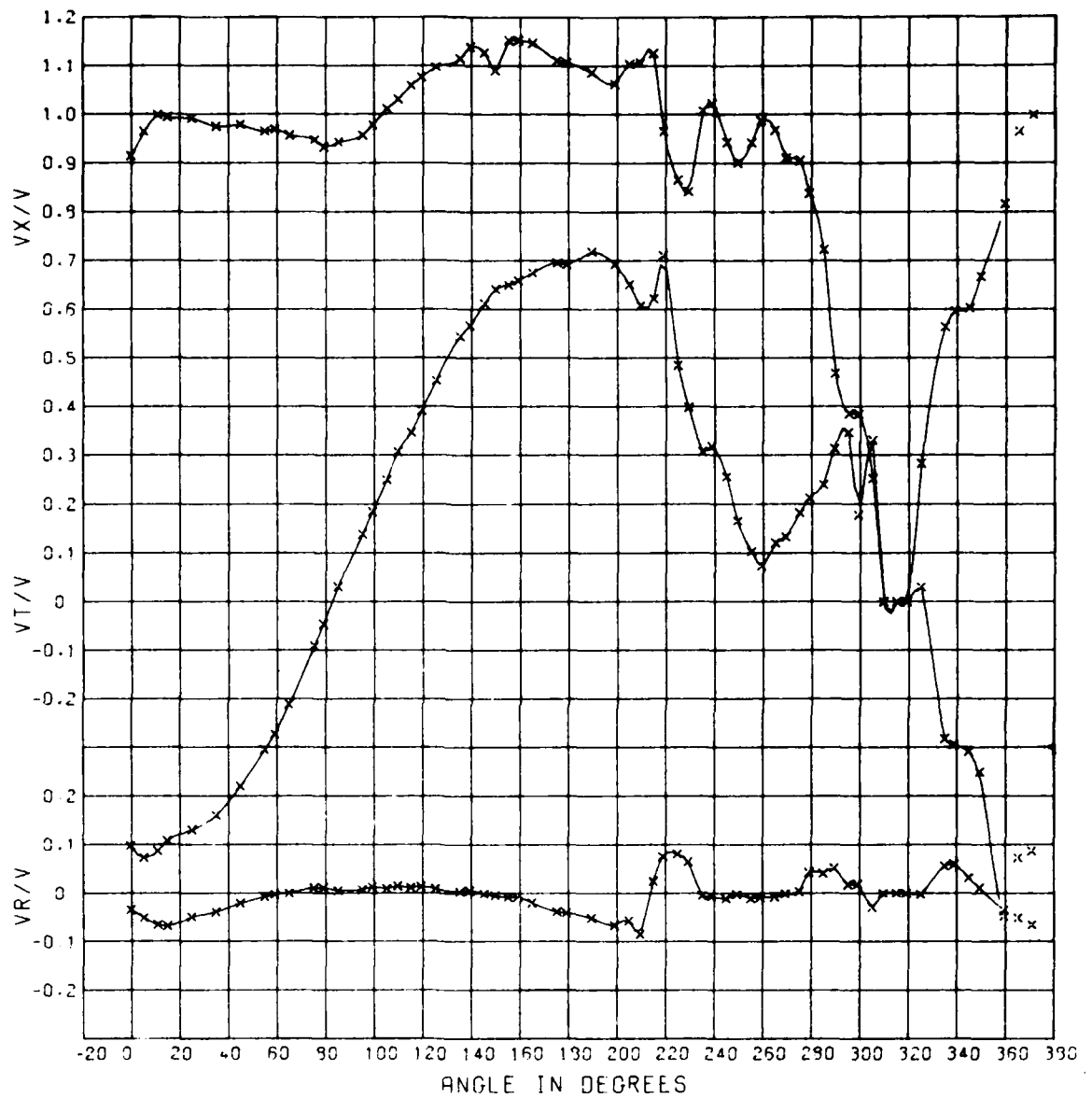


Figure 27 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratio - Radius Ratio = 0.330 for Experiment 182

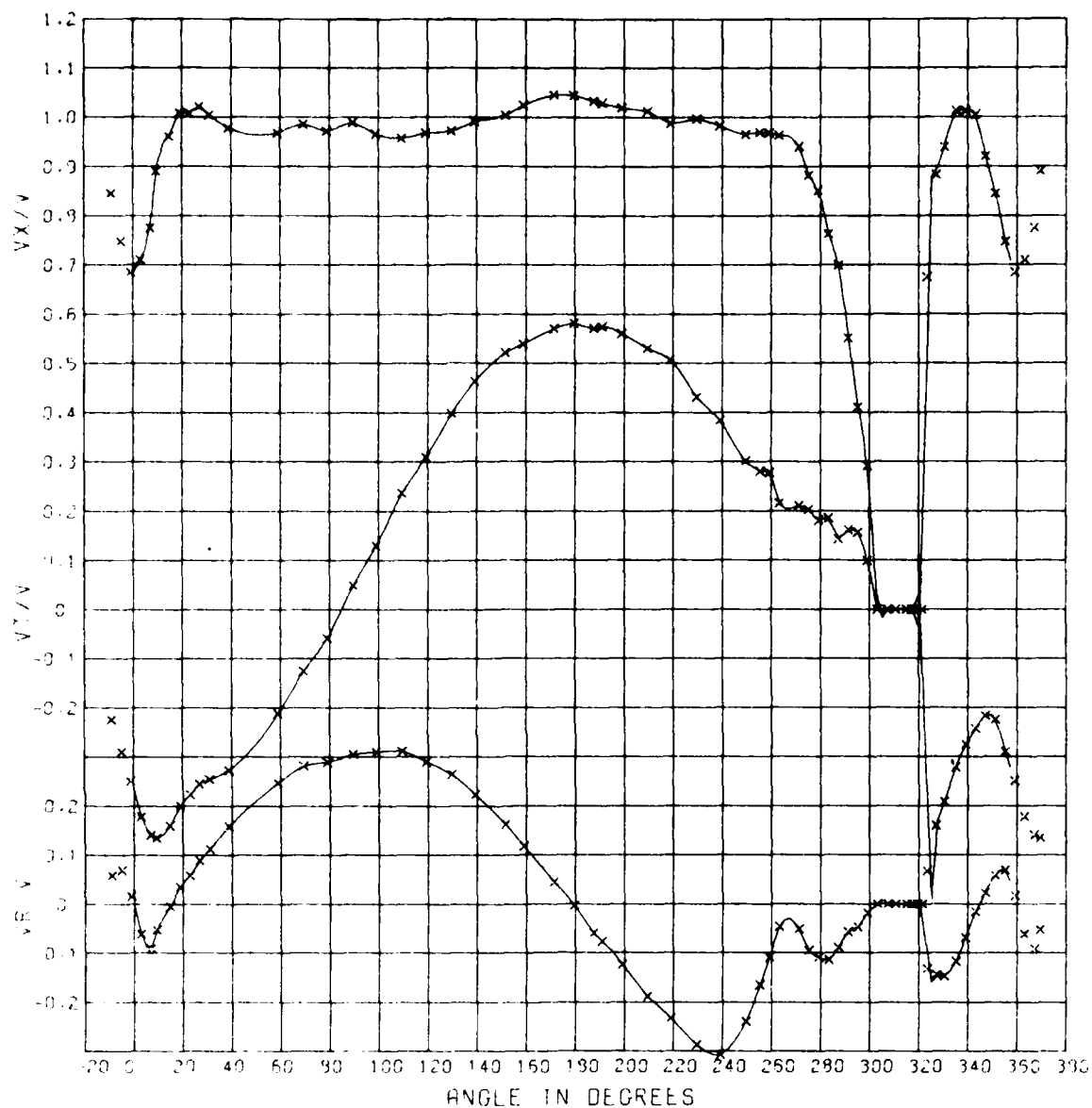


Figure 28 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 182

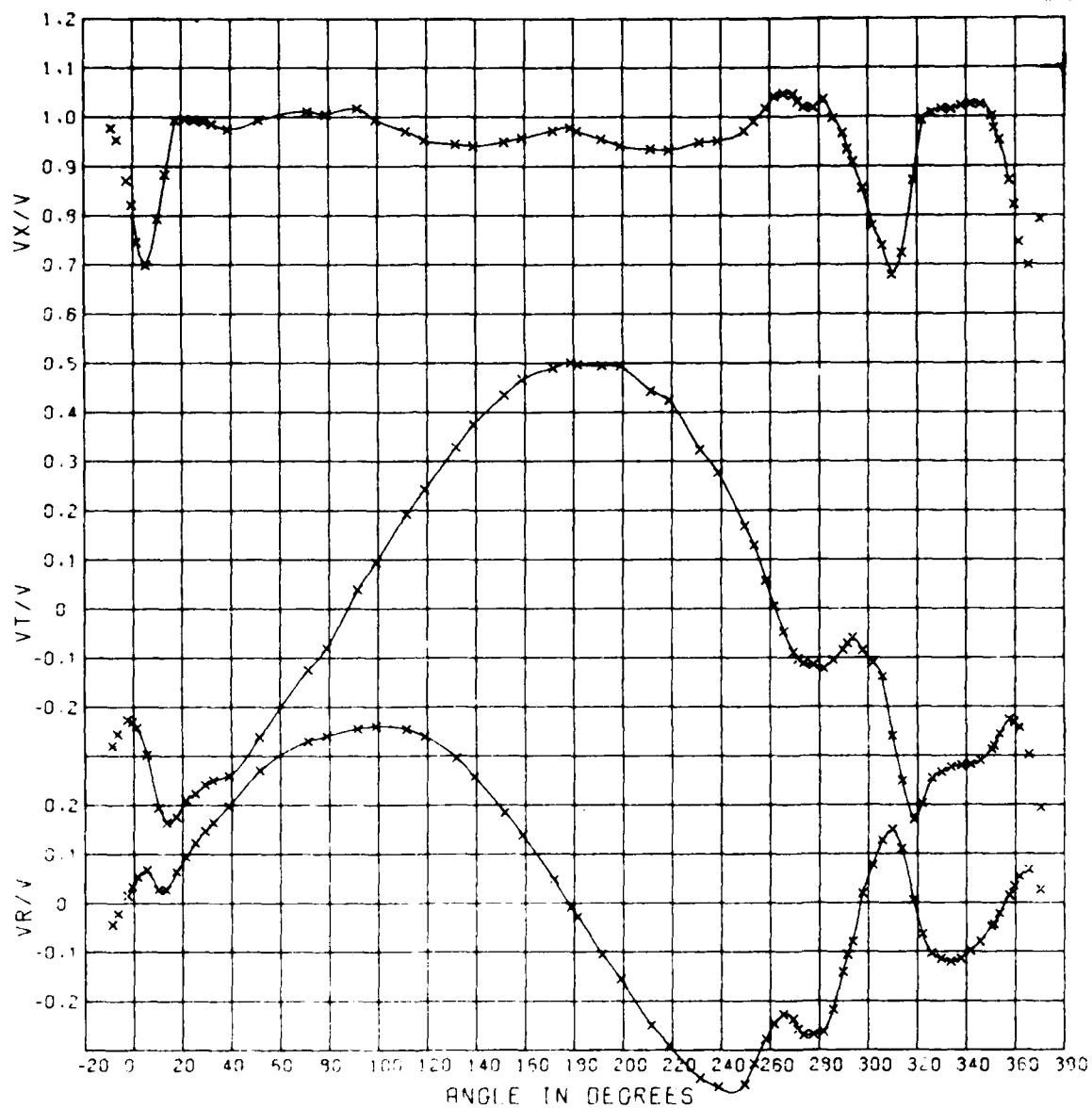


Figure 29 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 182

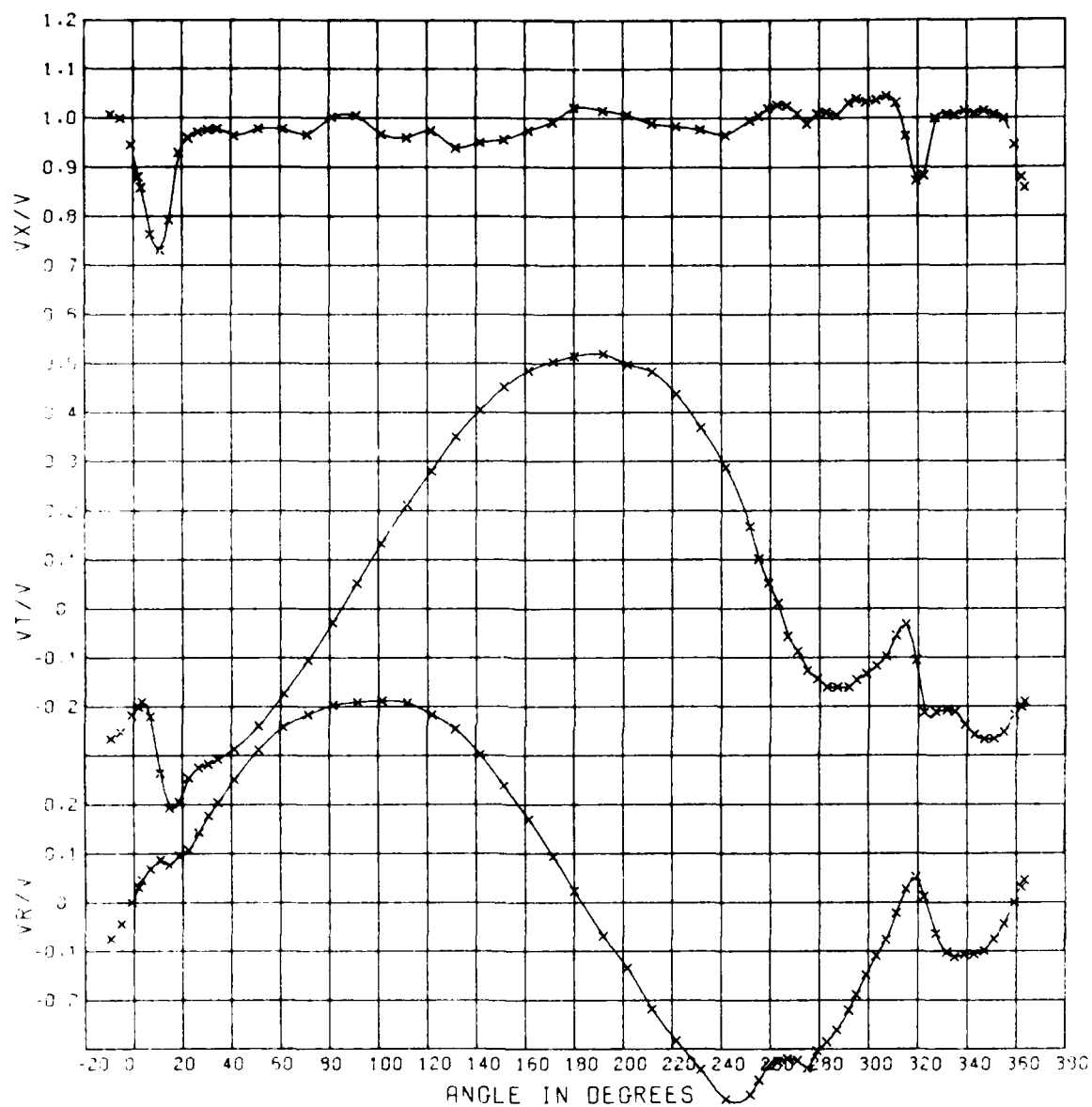


Figure 30 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.911 for Experiment 182

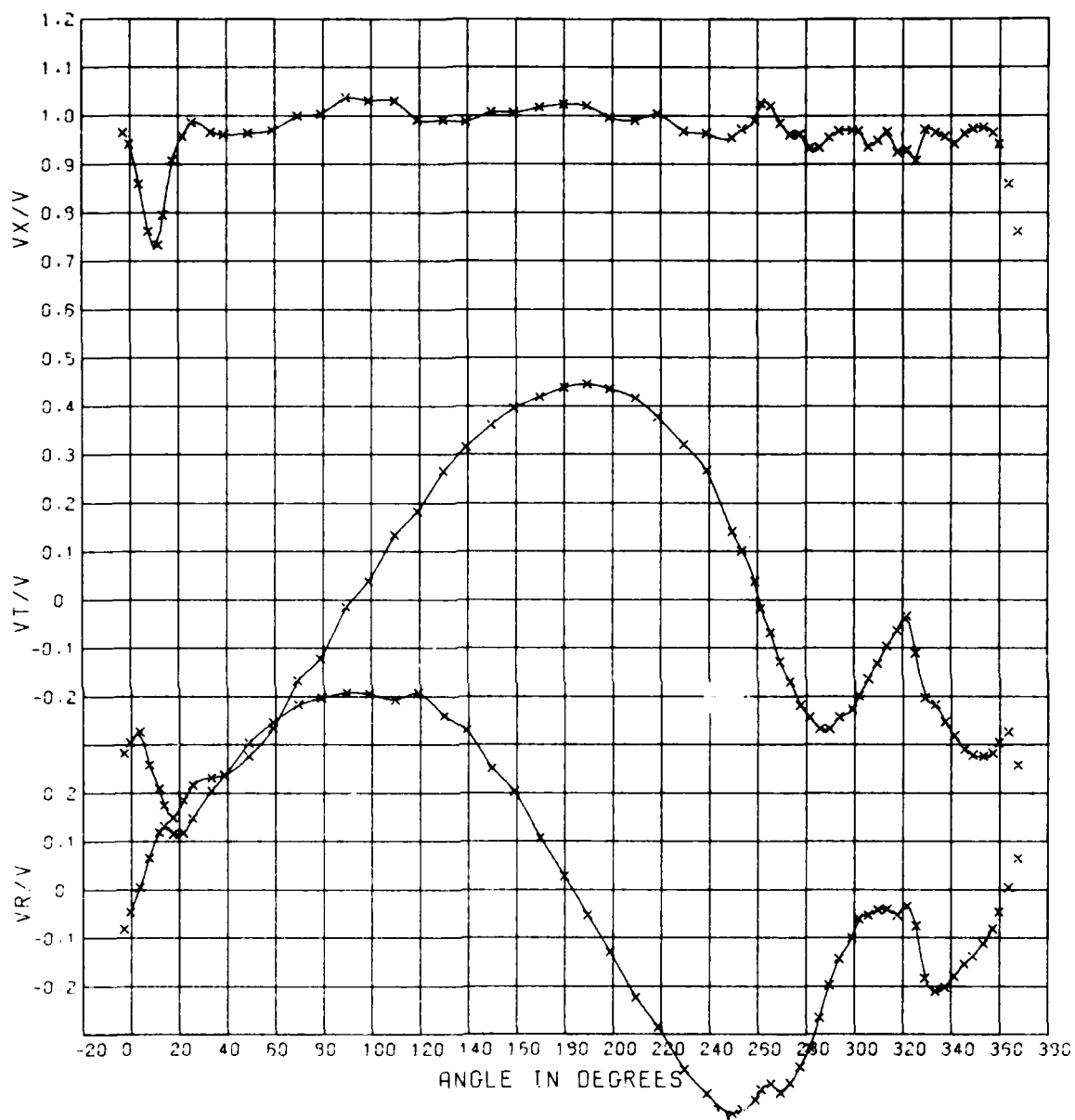


Figure 31 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 1.082 for Experiment 182

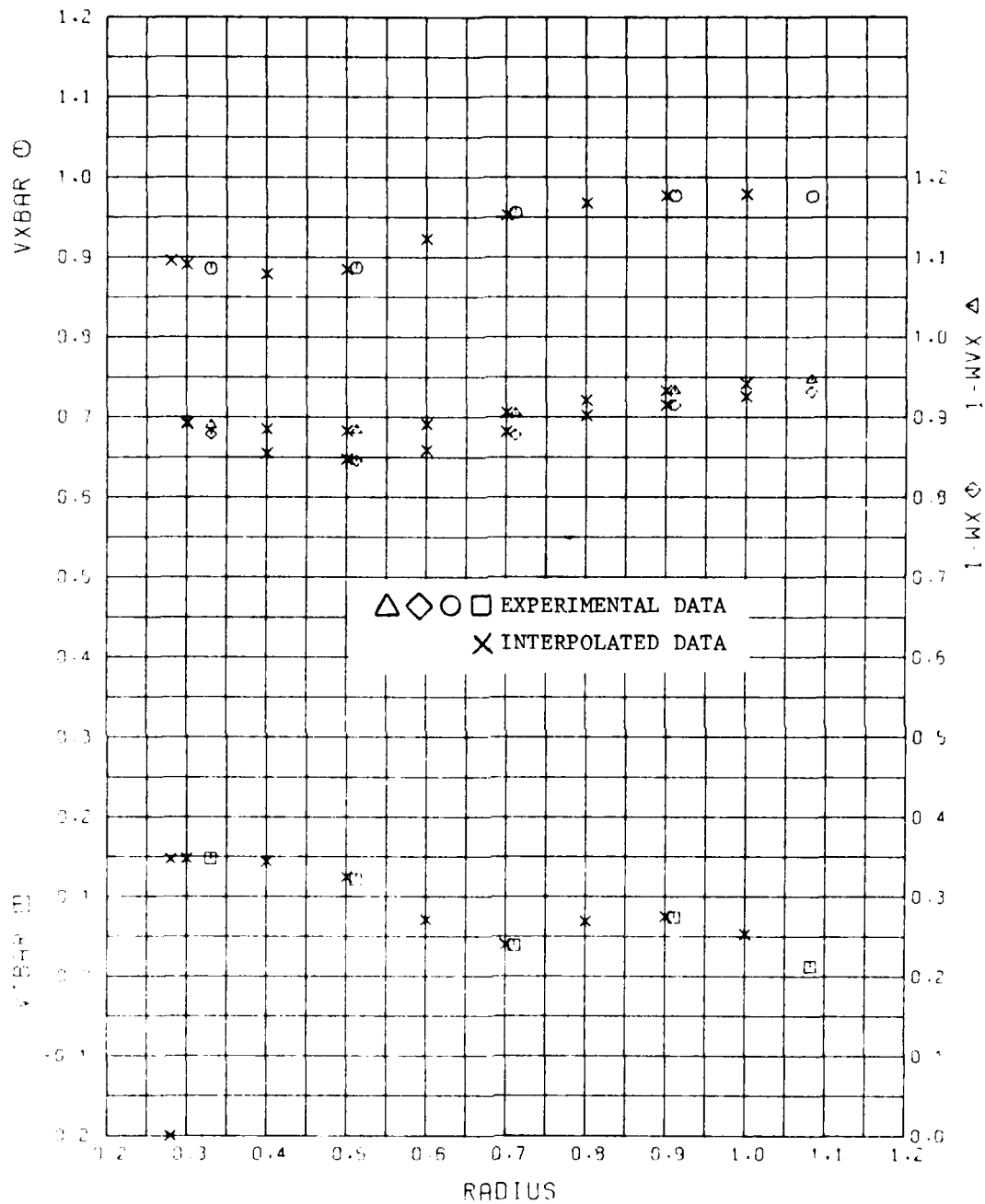


Figure 32 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 182

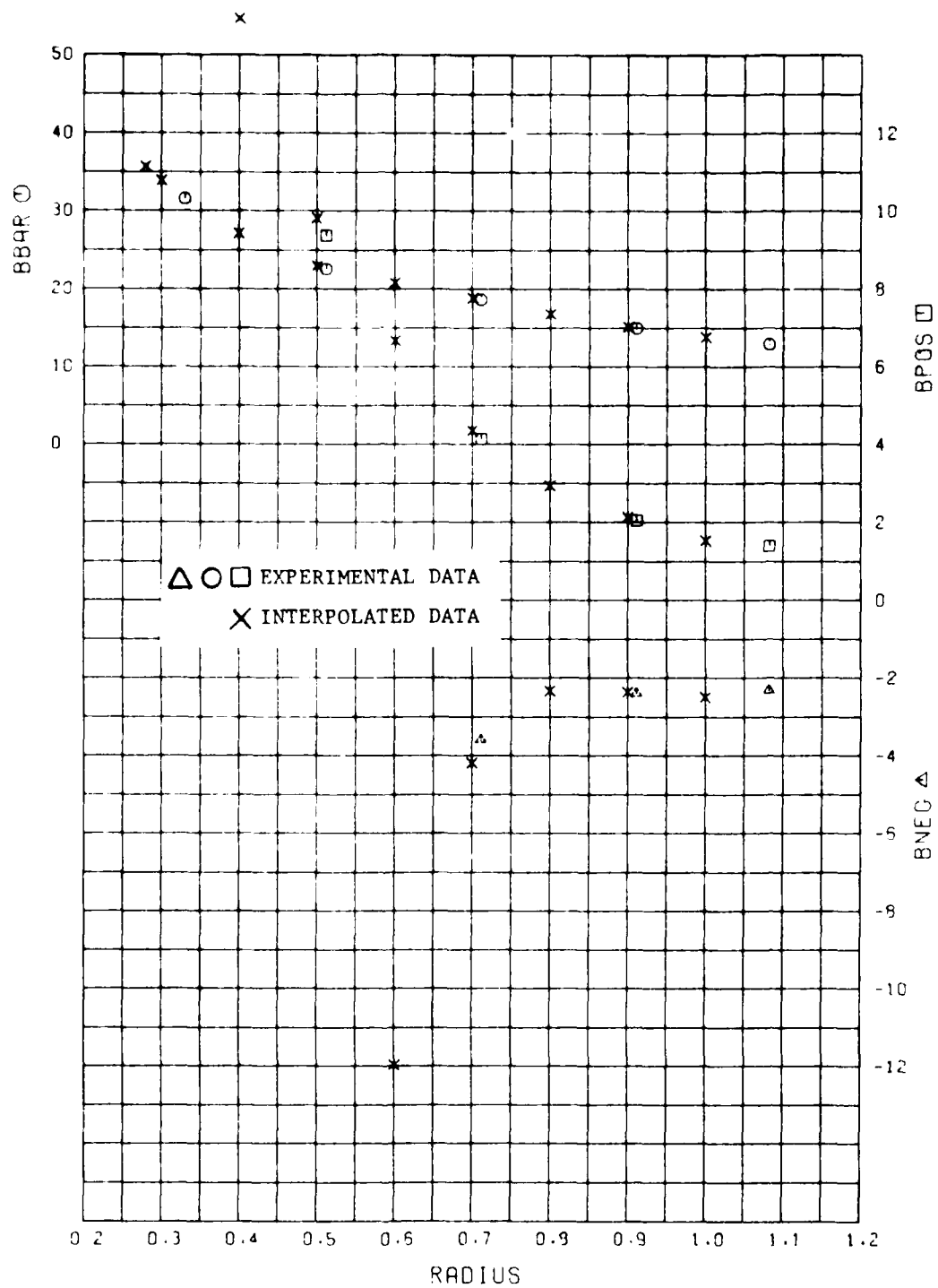


Figure 33 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 182

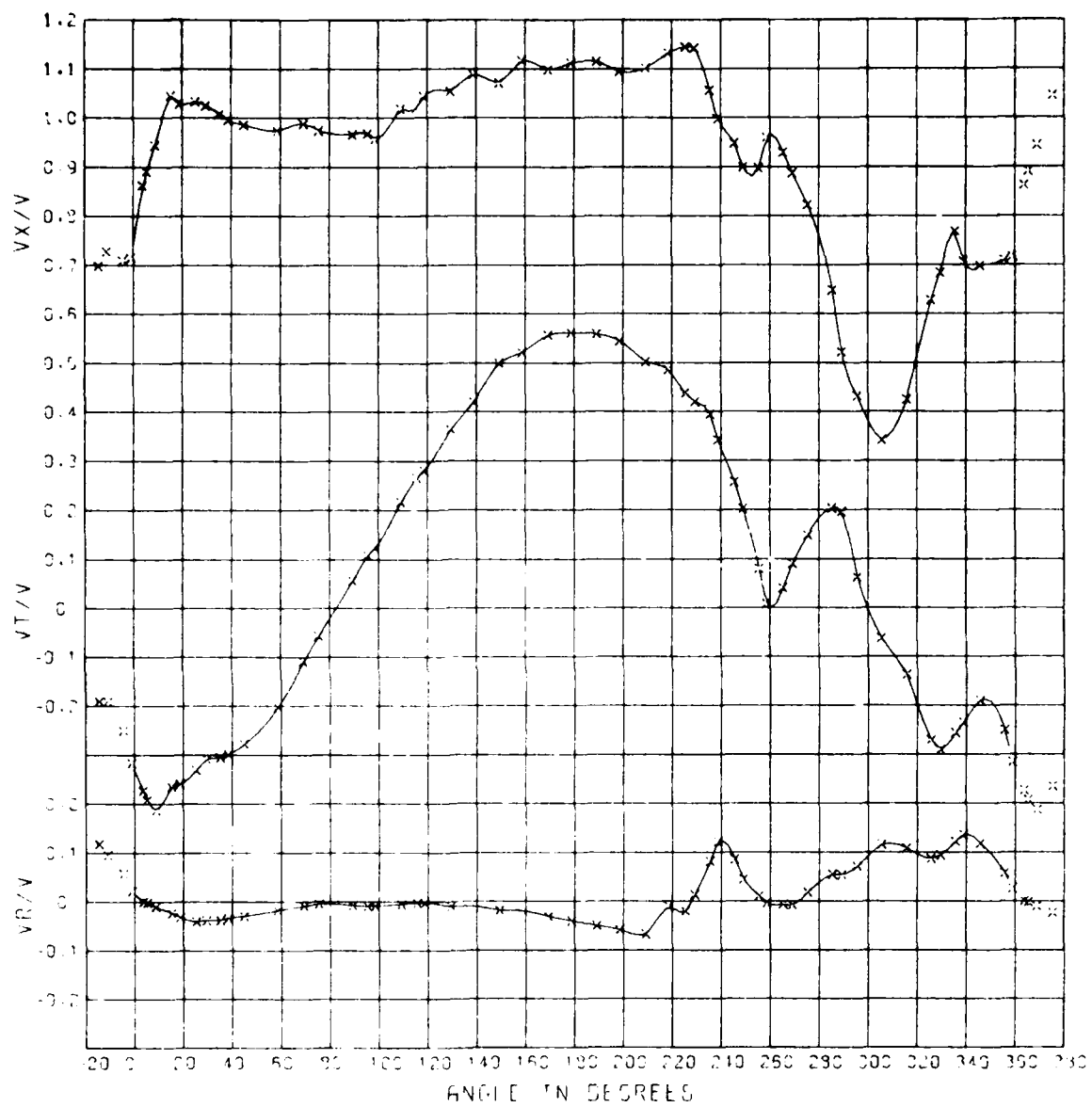


Figure 35 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio - 0.330 for Experiment 183

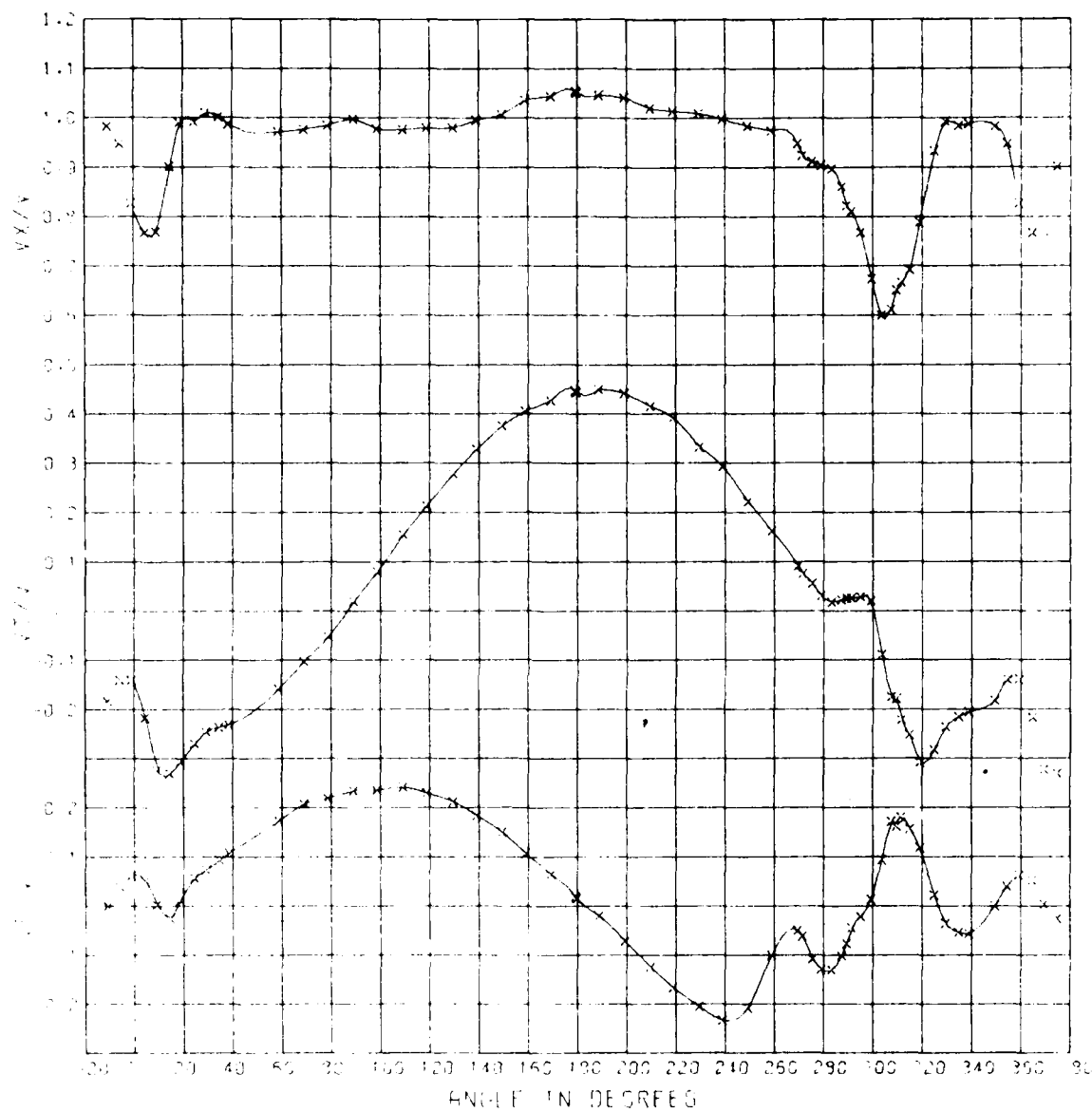


Figure 36 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 183

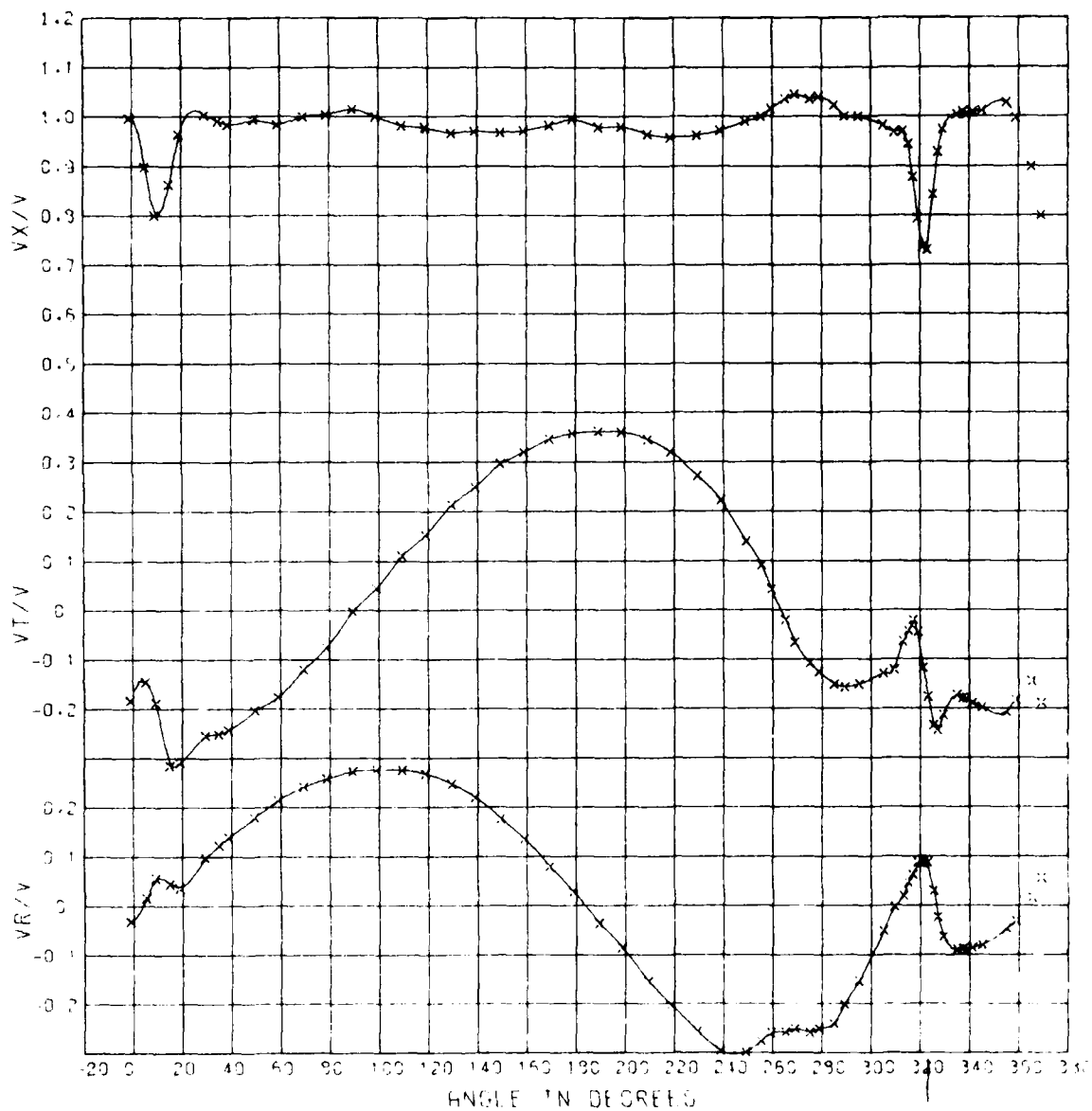


Figure 37 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 183

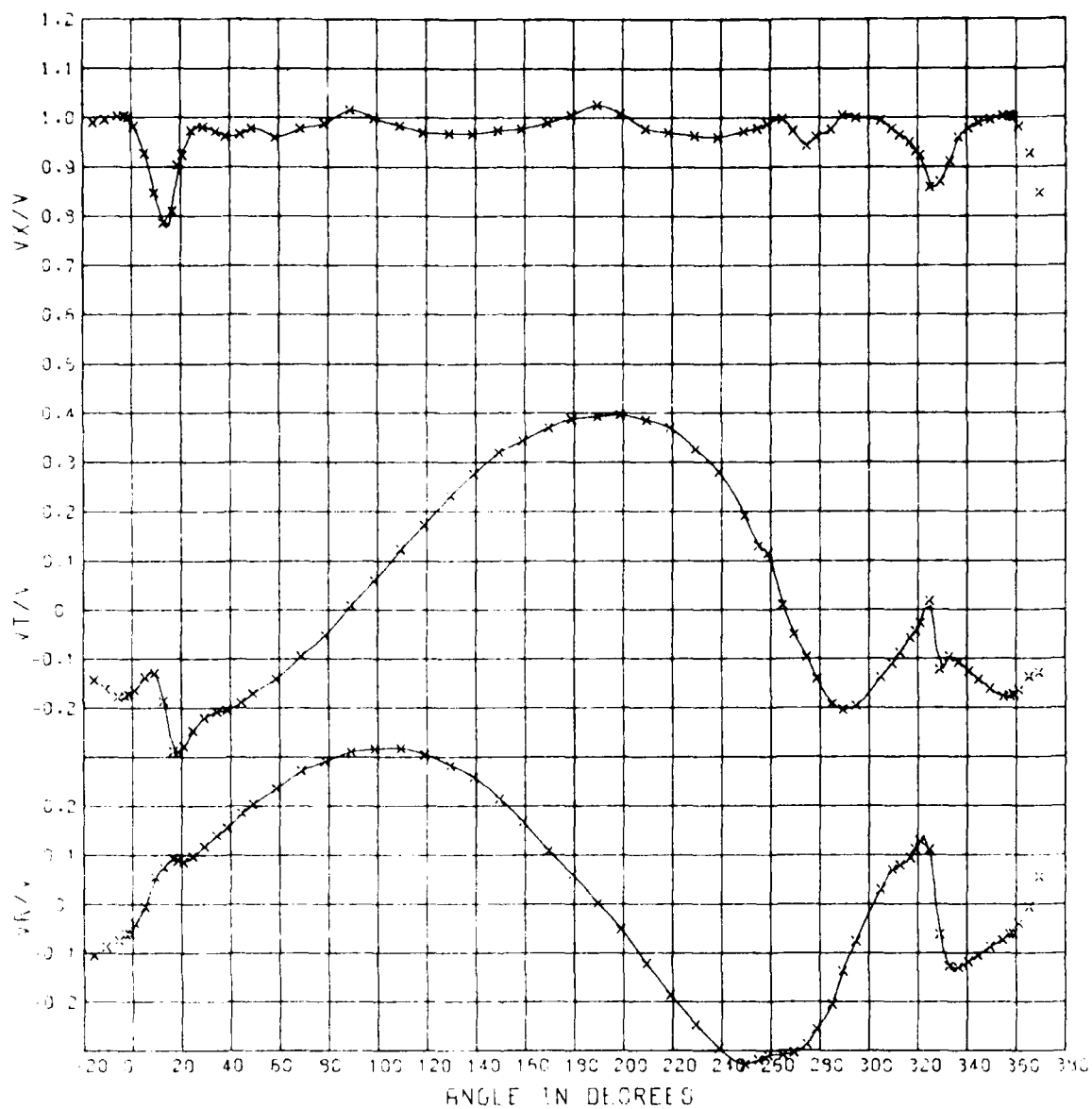


Figure 38 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.911 for Experiment 183

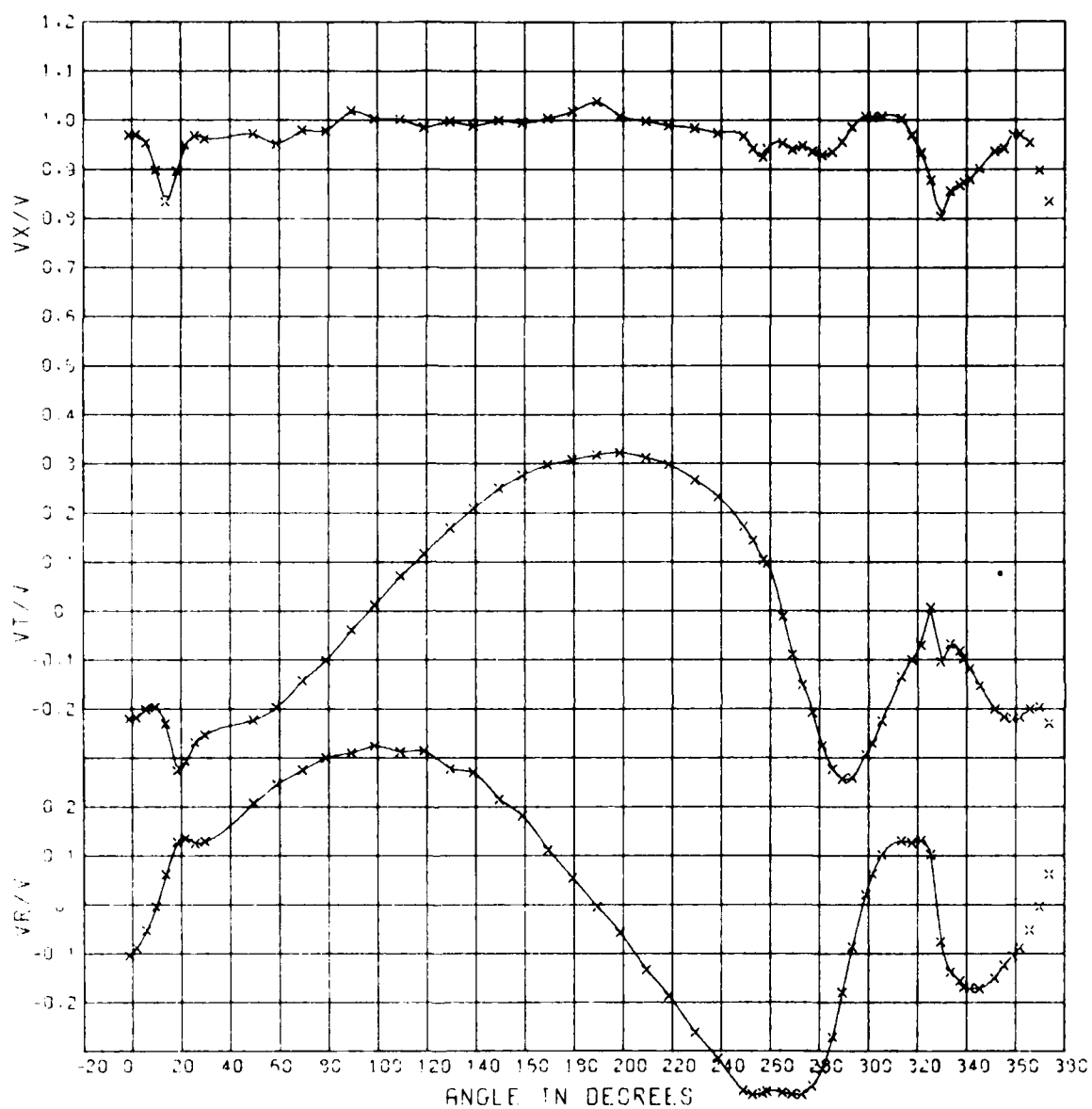


Figure 39 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 1.082 for Experiment 183

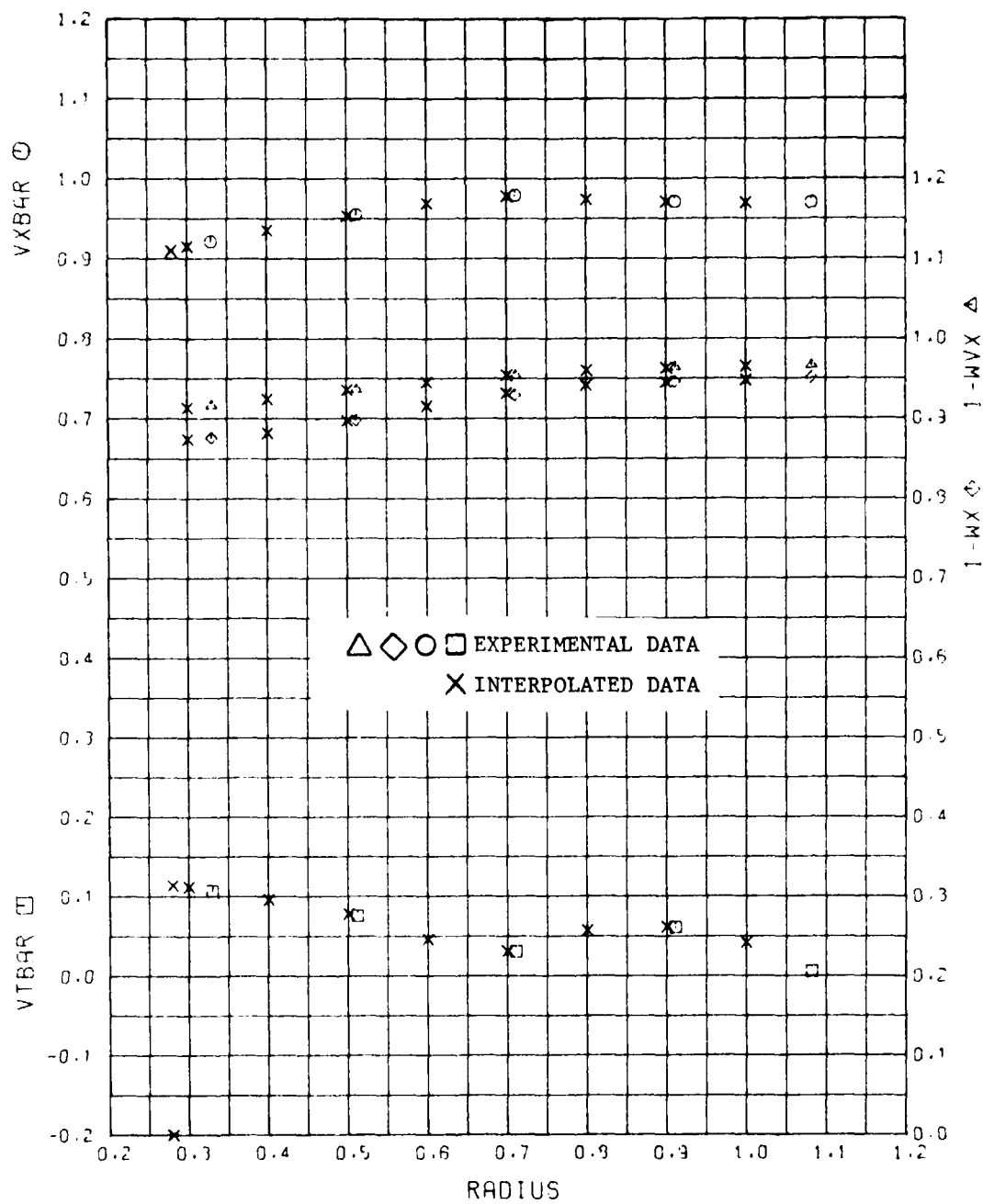


Figure 40 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 183

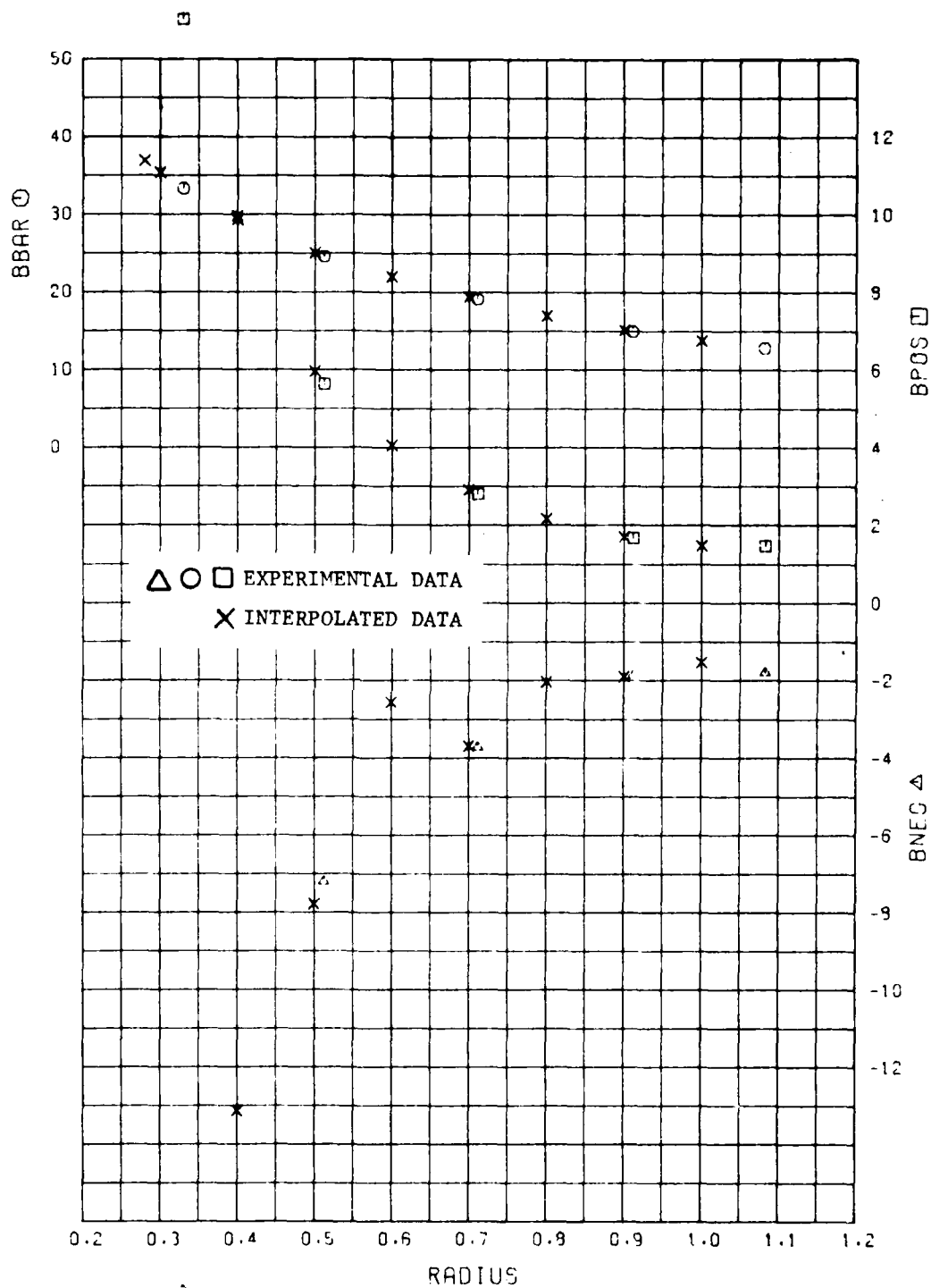


Figure 41 - Radial Distribution for the Mean Advance Angle and Advance Angle Variations for Experiment 183

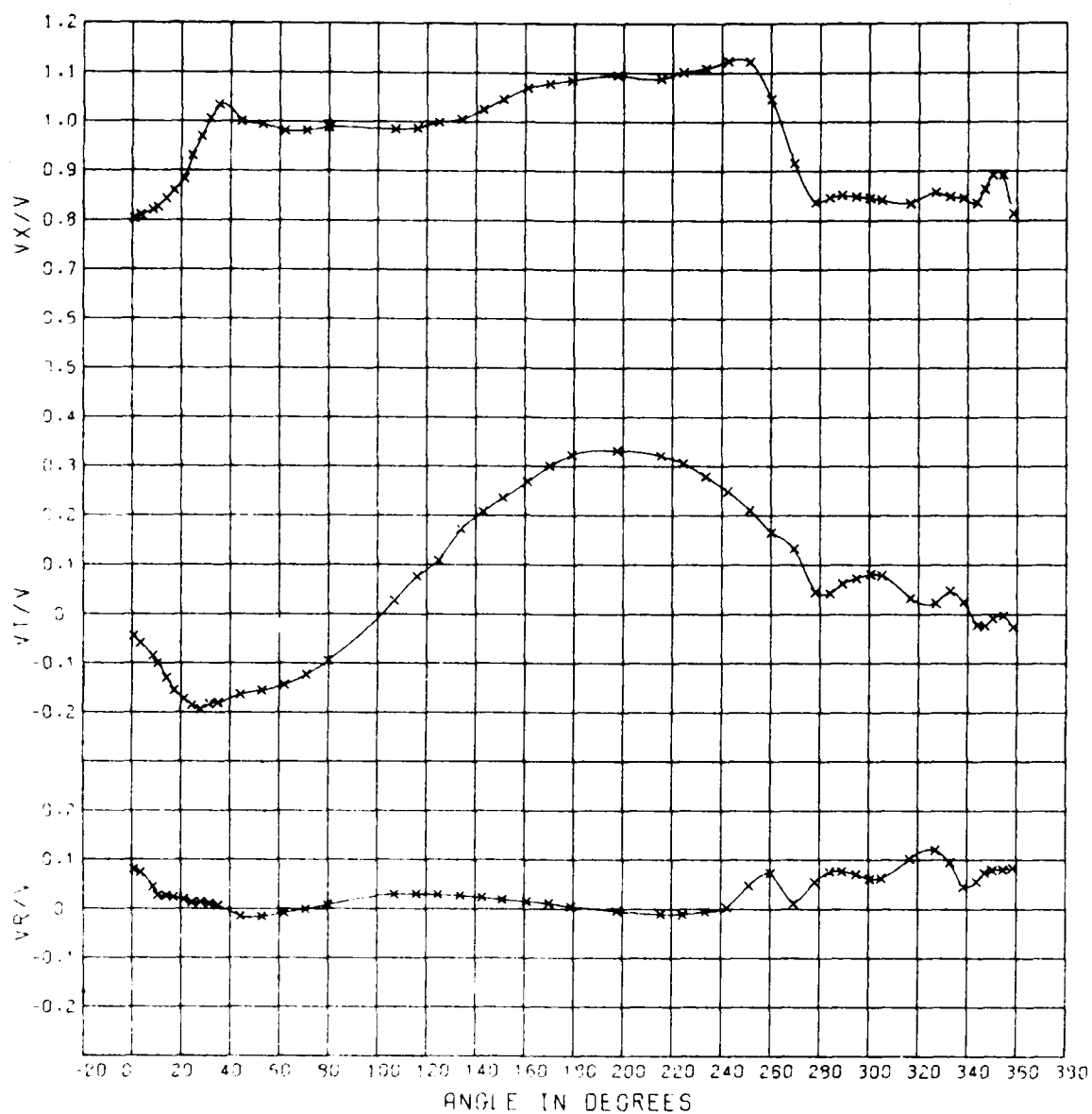


Figure 42 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.330 for Experiment 184

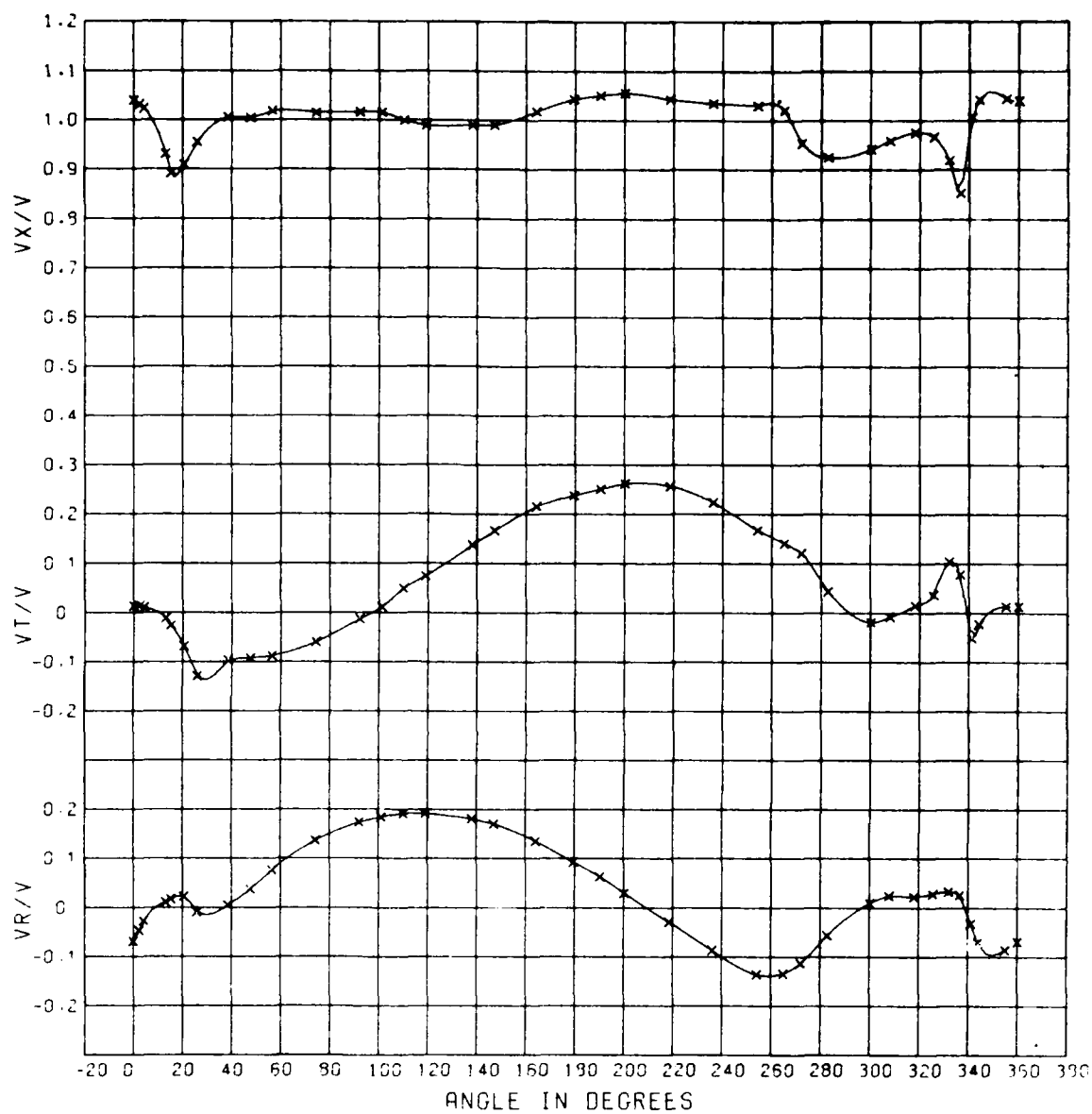


Figure 43 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 184

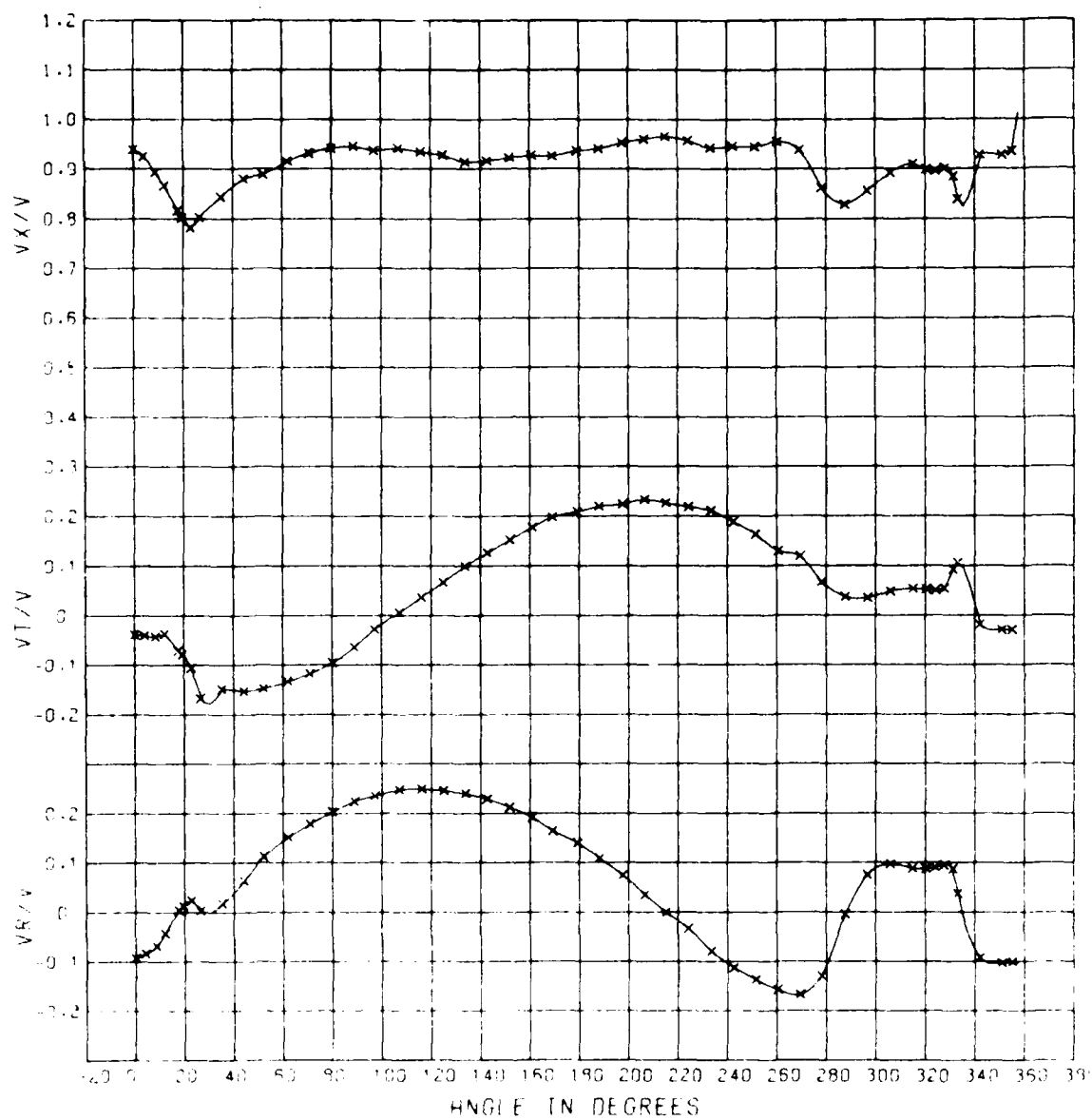


Figure 44 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 184

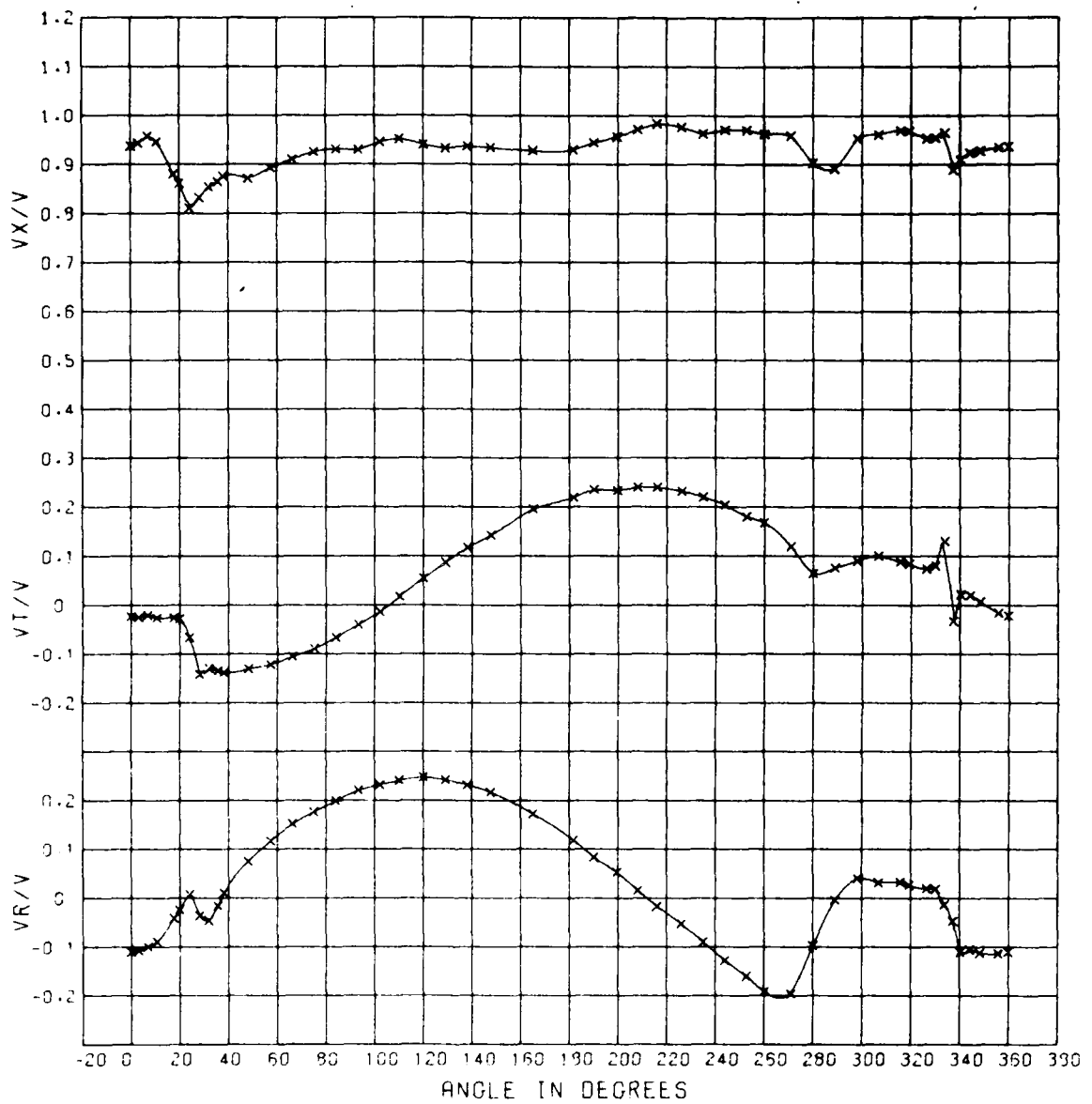


Figure 45 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.910 for Experiment 184

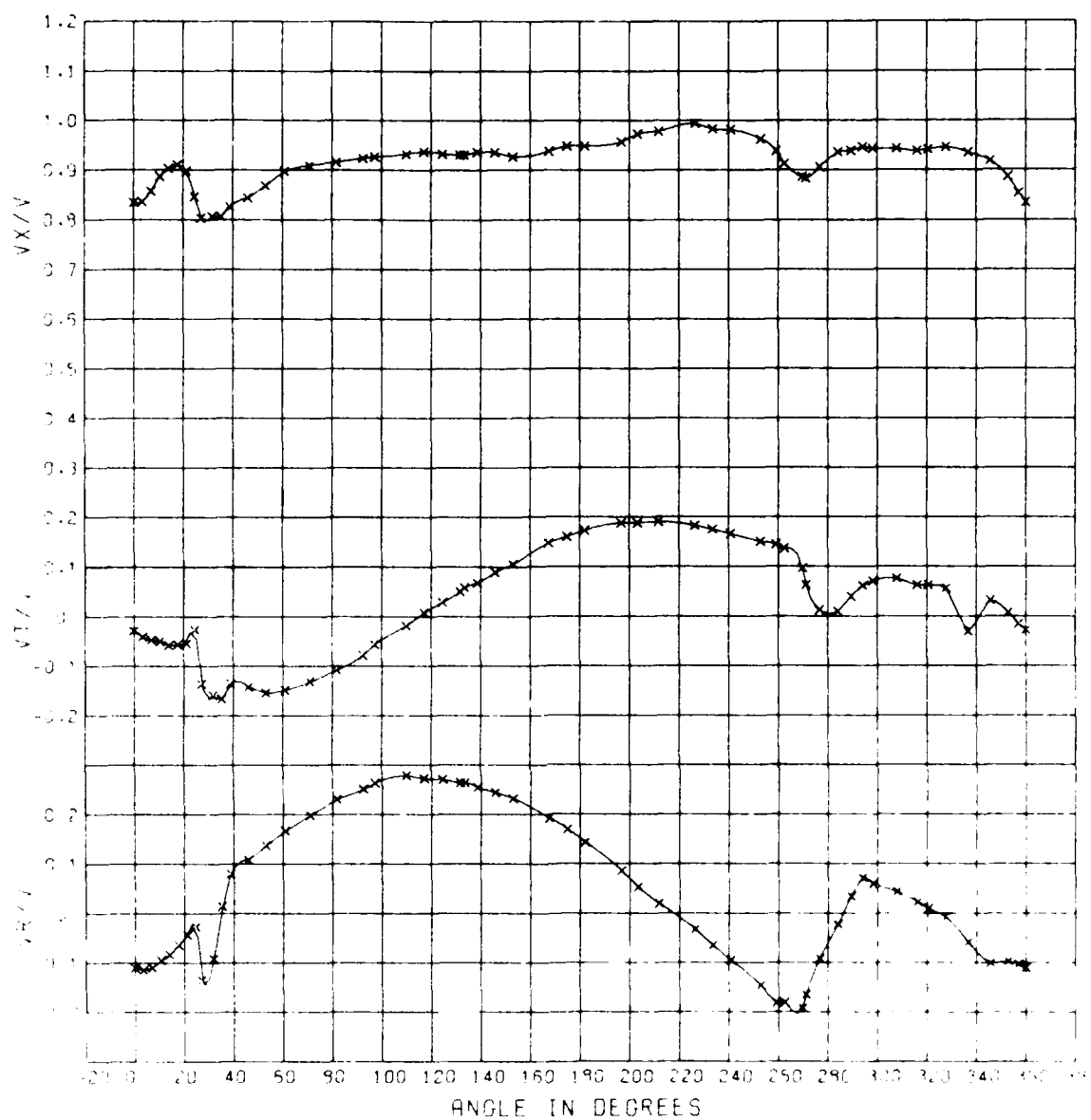


Figure 46 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 1.082 for Experiment 184

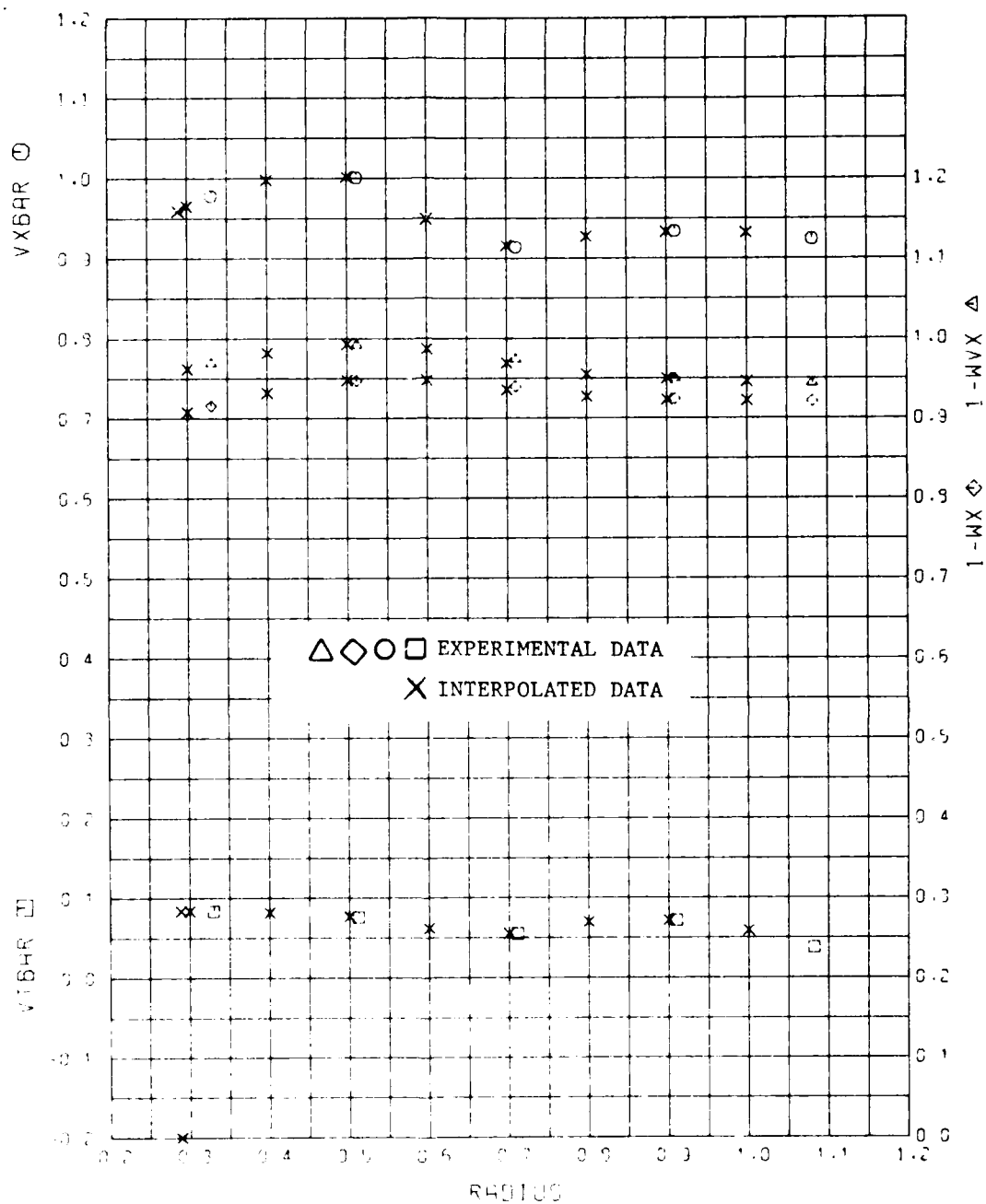


Figure 47 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 184

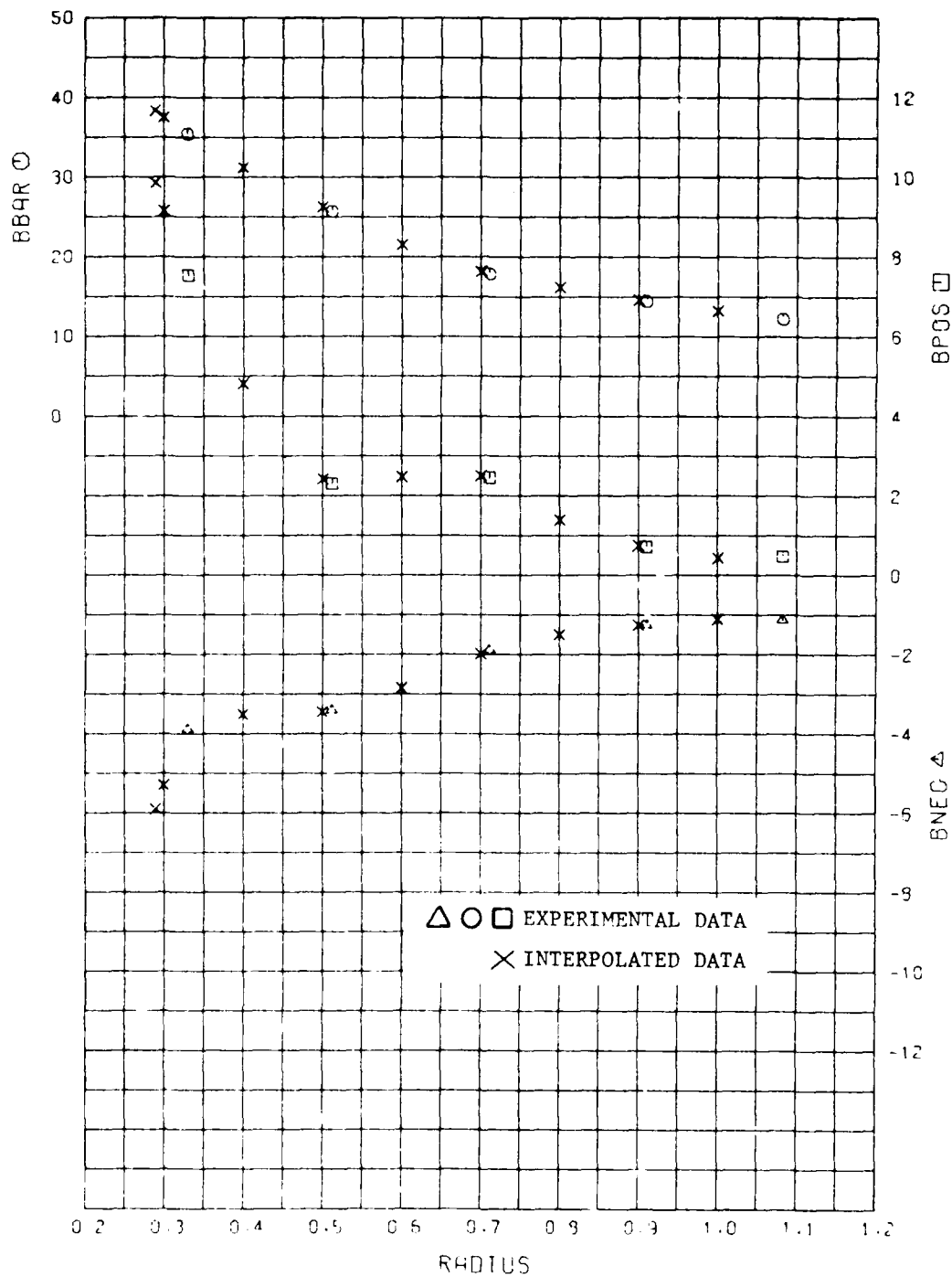


Figure 48 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 184

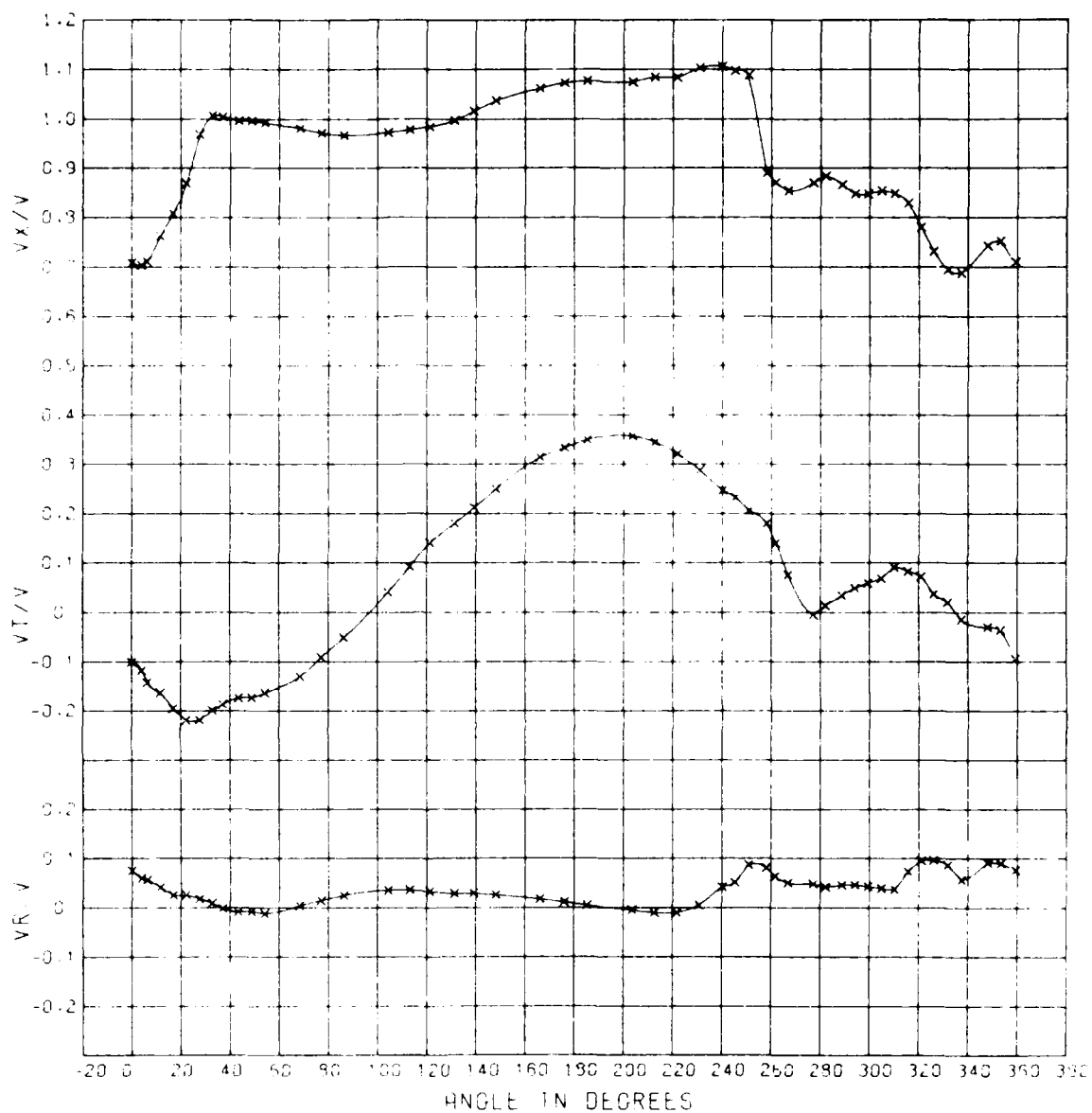


Figure 49 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.330 for Experiment 185

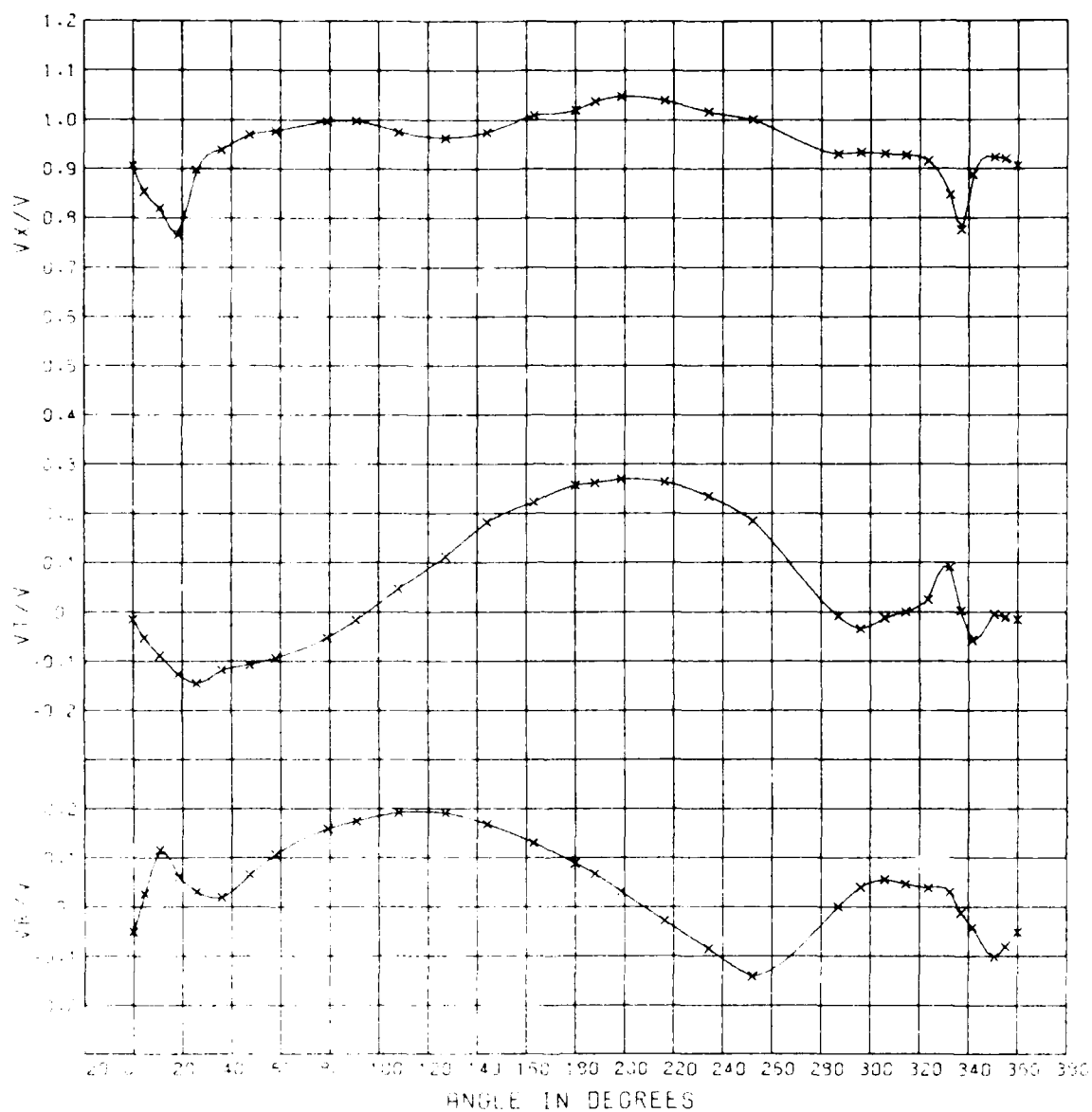


Figure 50 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 185

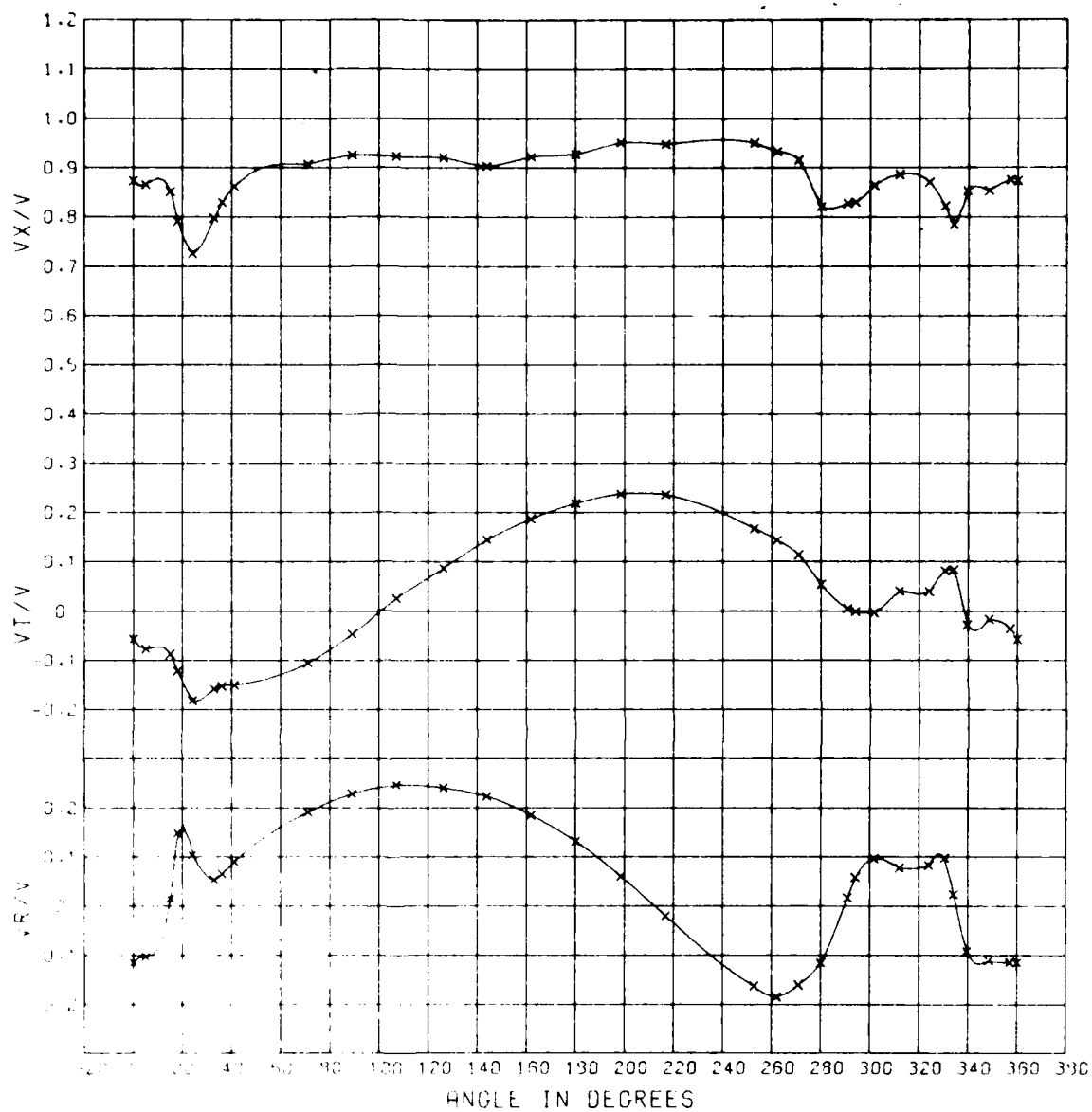


Figure 51 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 185

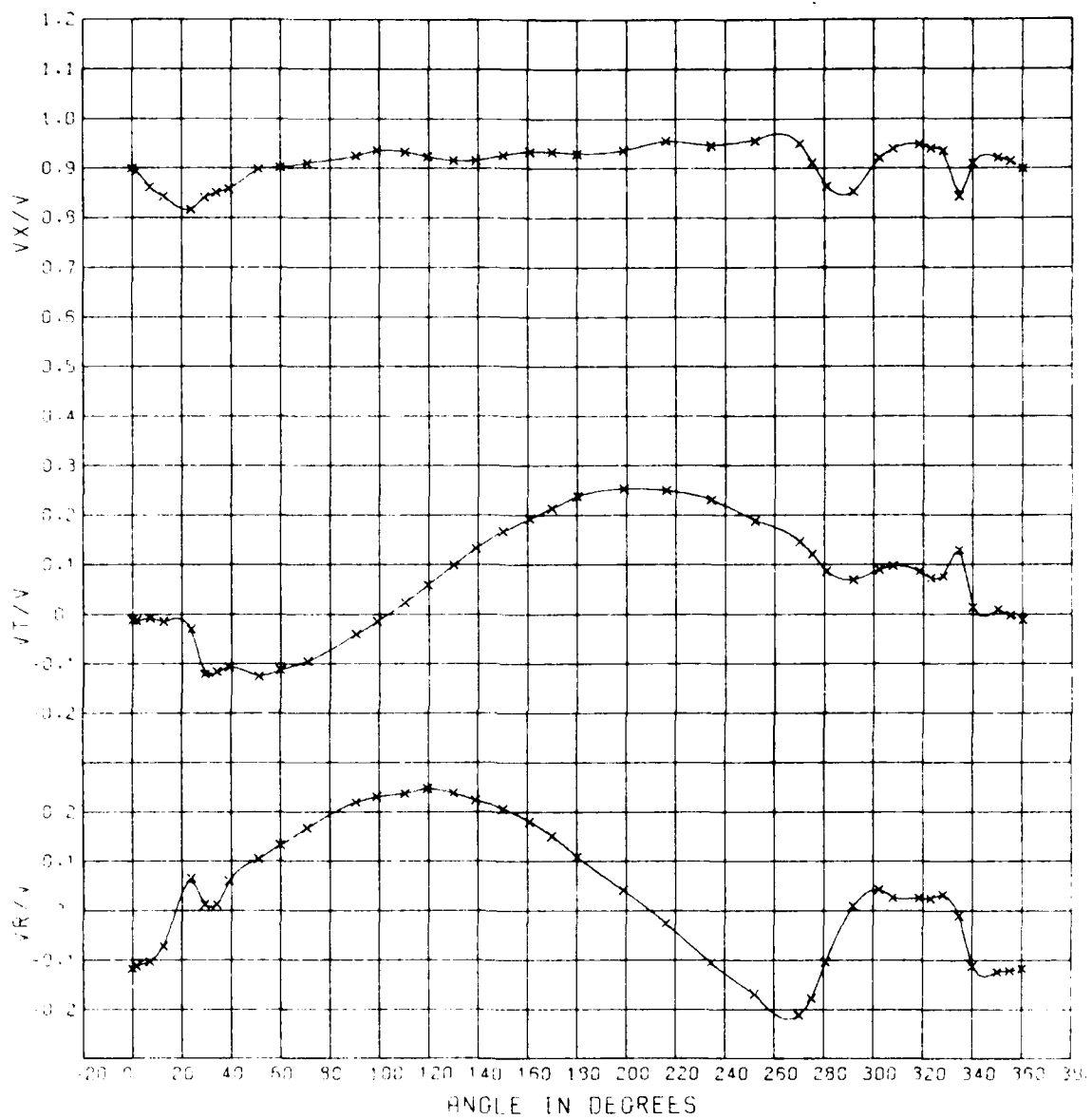


Figure 52 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.910 for Experiment 185

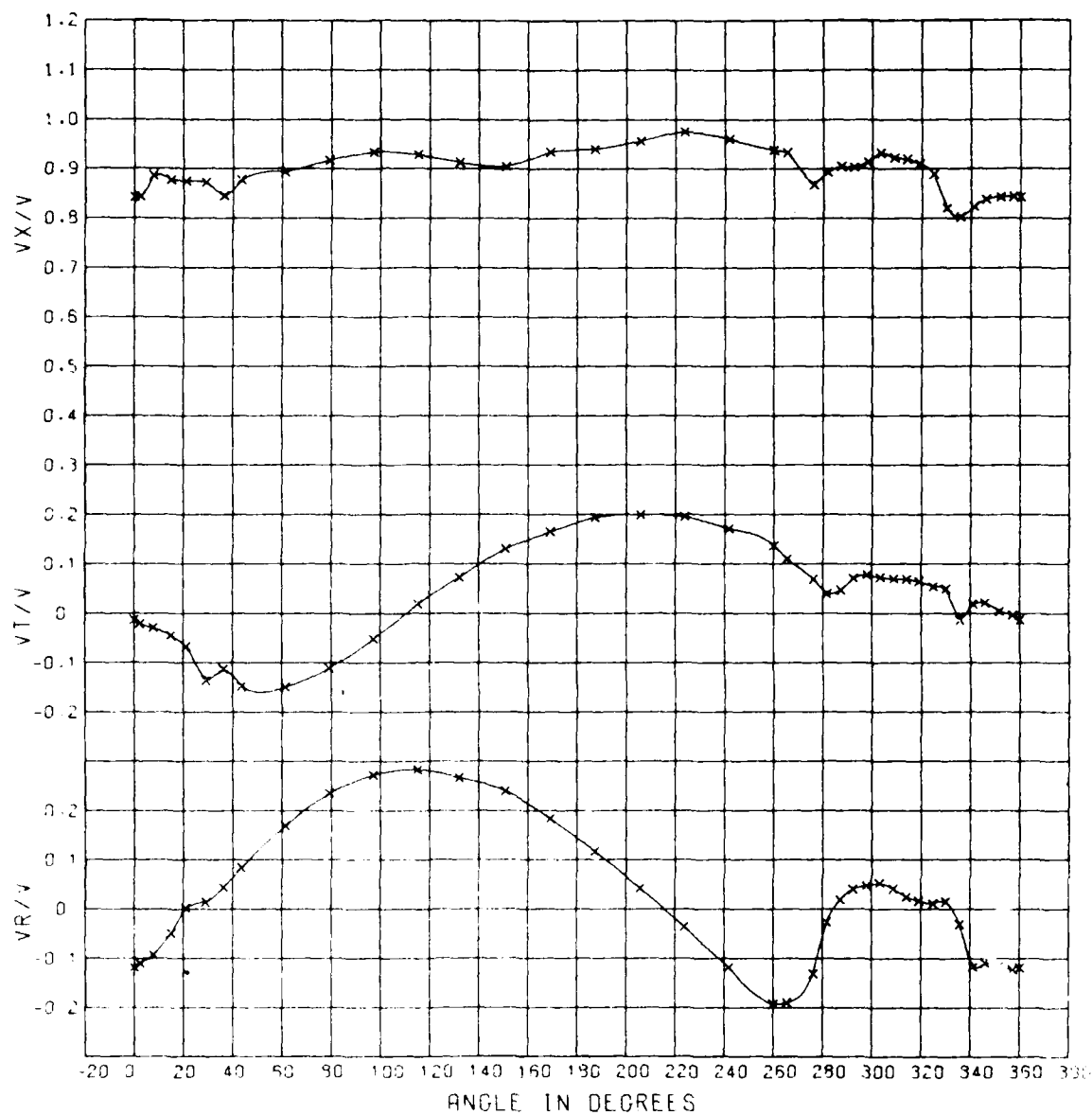


Figure 53 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity component Ratios - Radius Ratio = 1.082 for Experiment 185

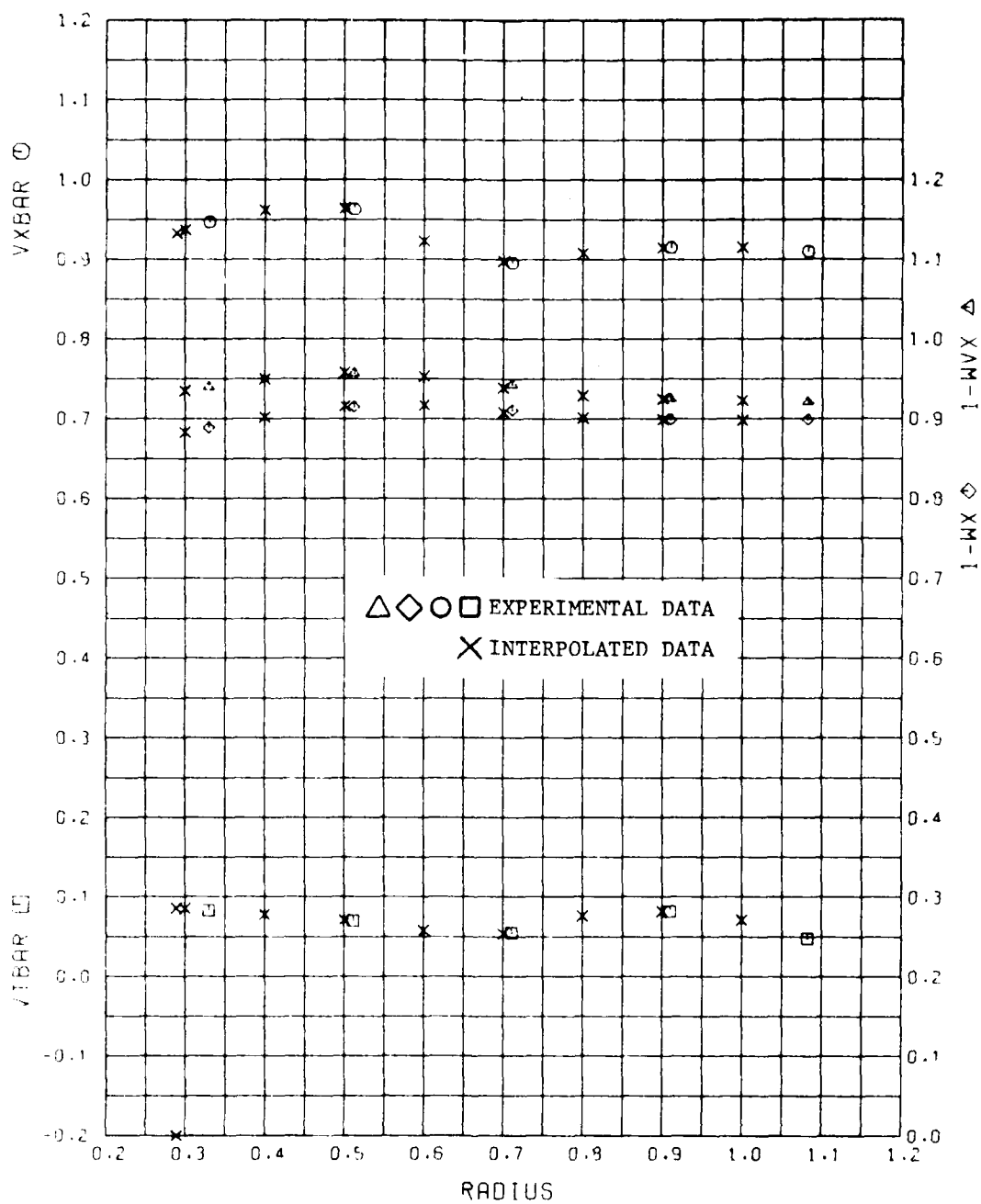


Figure 54 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 185

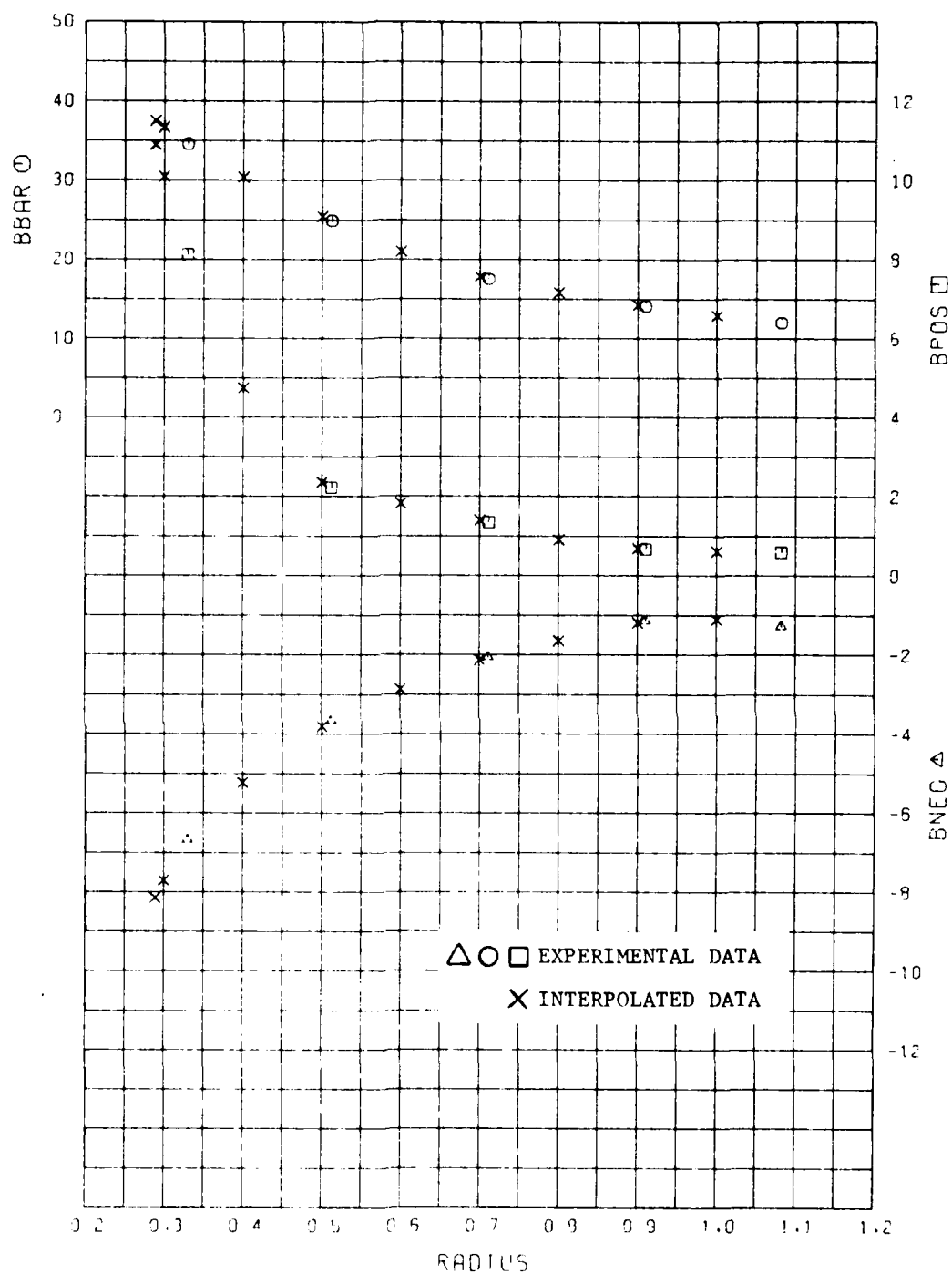


Figure 55 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 185

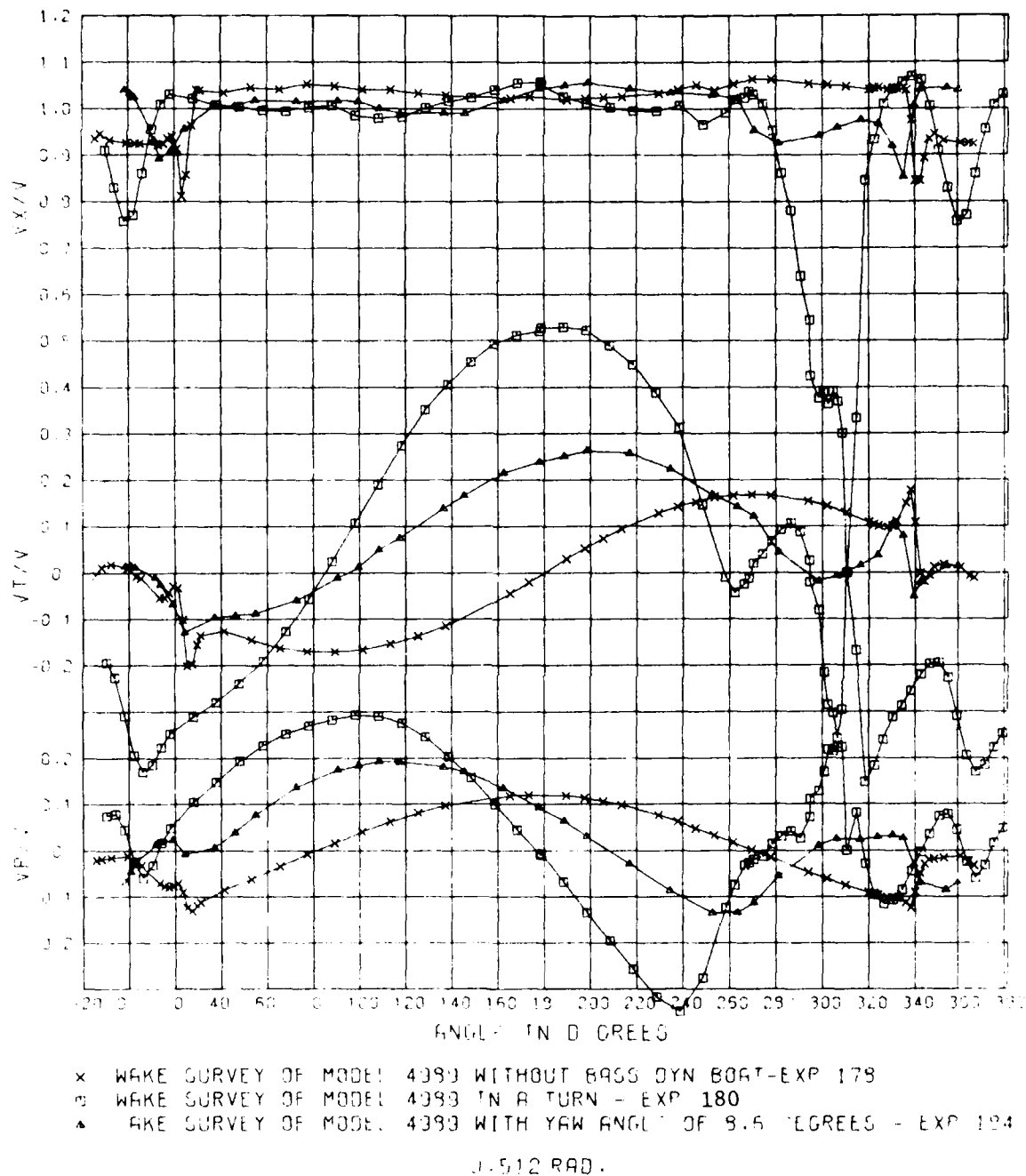


Figure 56 - Composite Plot of Velocity Component Ratios for Experiments 178, 180, and 184 for the 0.512 Radius

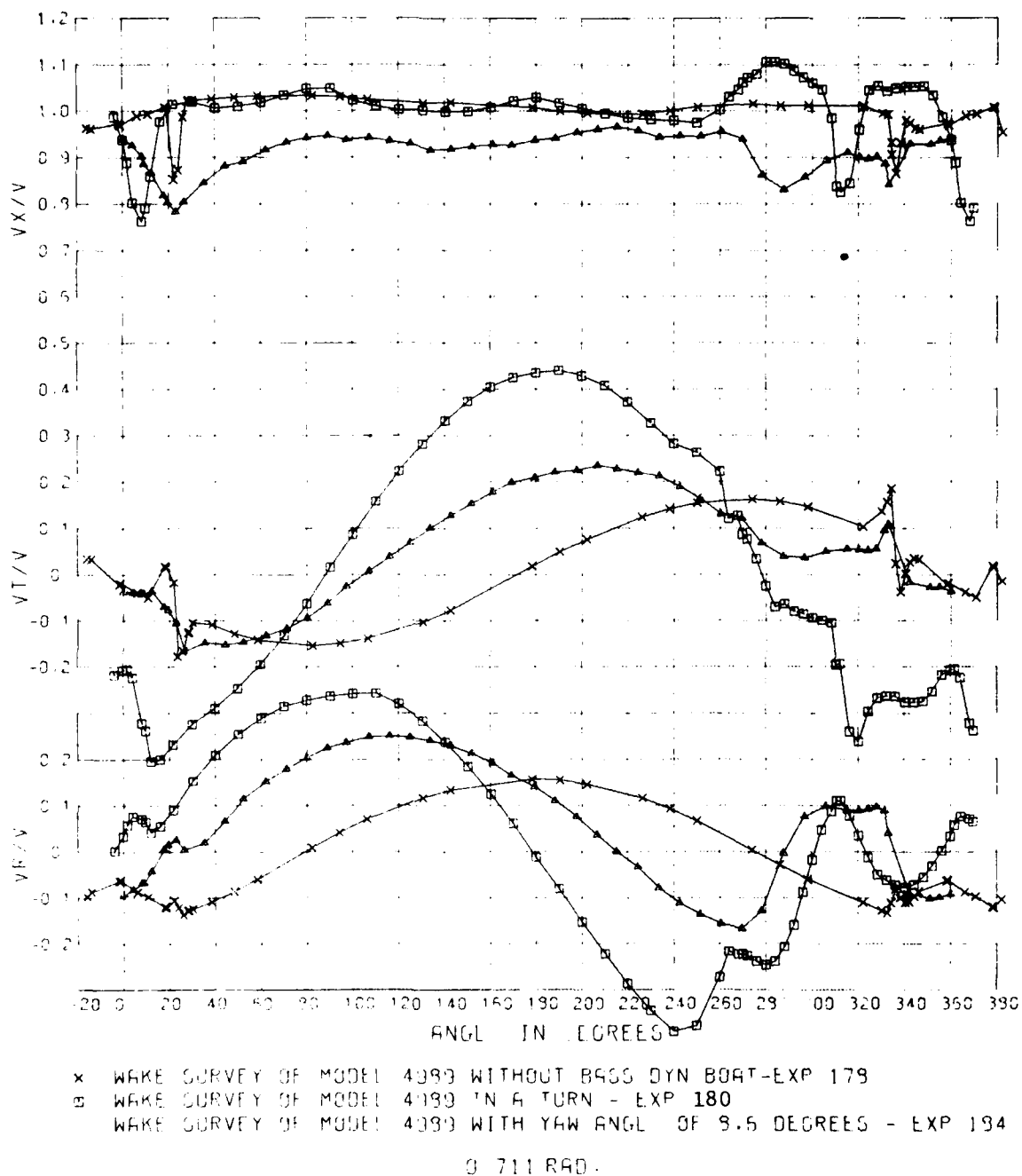
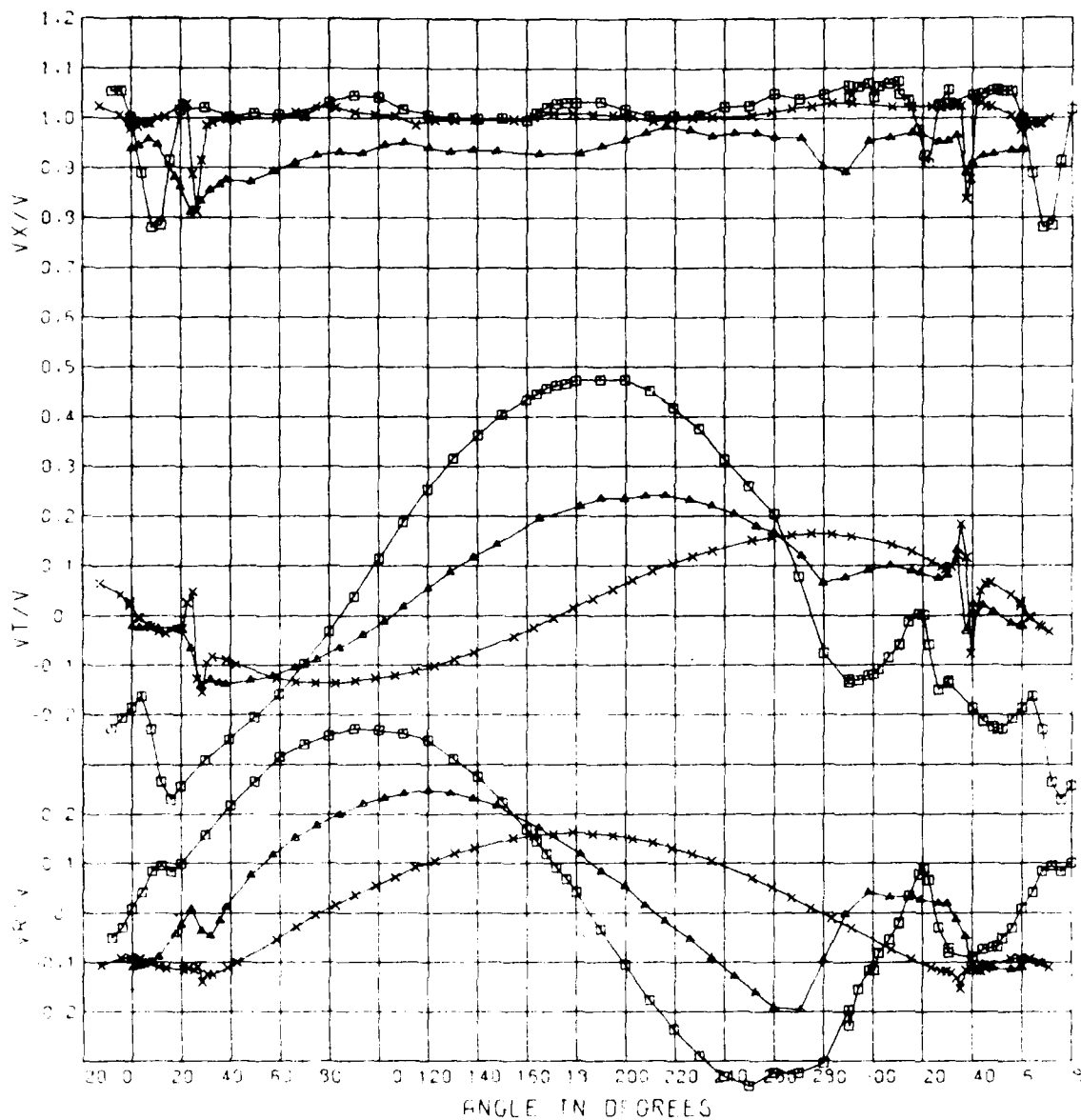


Figure 57 - Composite Plot of Velocity Component Ratios for Experiments 178, 180, and 184 for the 0.711 Radius



x WAKE SURVEY OF MODEL 4989 WITHOUT BASE DYN BOAT-EXP 178
 □ WAKE SURVEY OF MODEL 4989 IN A TURN - EXP 180
 ▲ WAKE SURVEY OF MODEL 4989 WITH YAW ANGLE OF 4.5 DEGREES - EXP 184

0.910 RAD.

Figure 58 - Composite Plot of Velocity Component Ratios for Experiments 178, 180, and 184 for the 0.910 Radius

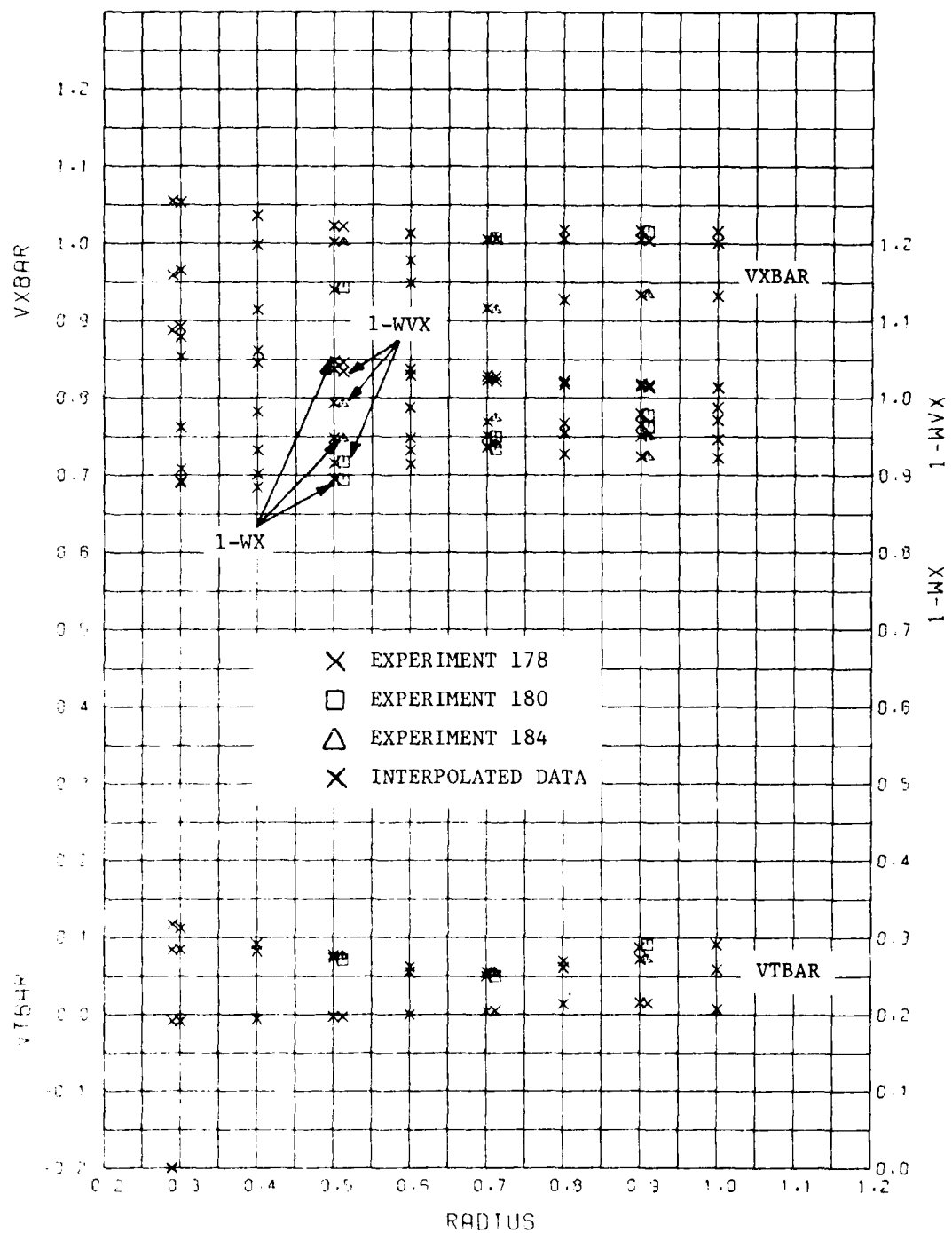


Figure 59 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake of Experiments, 178, 180, and 184

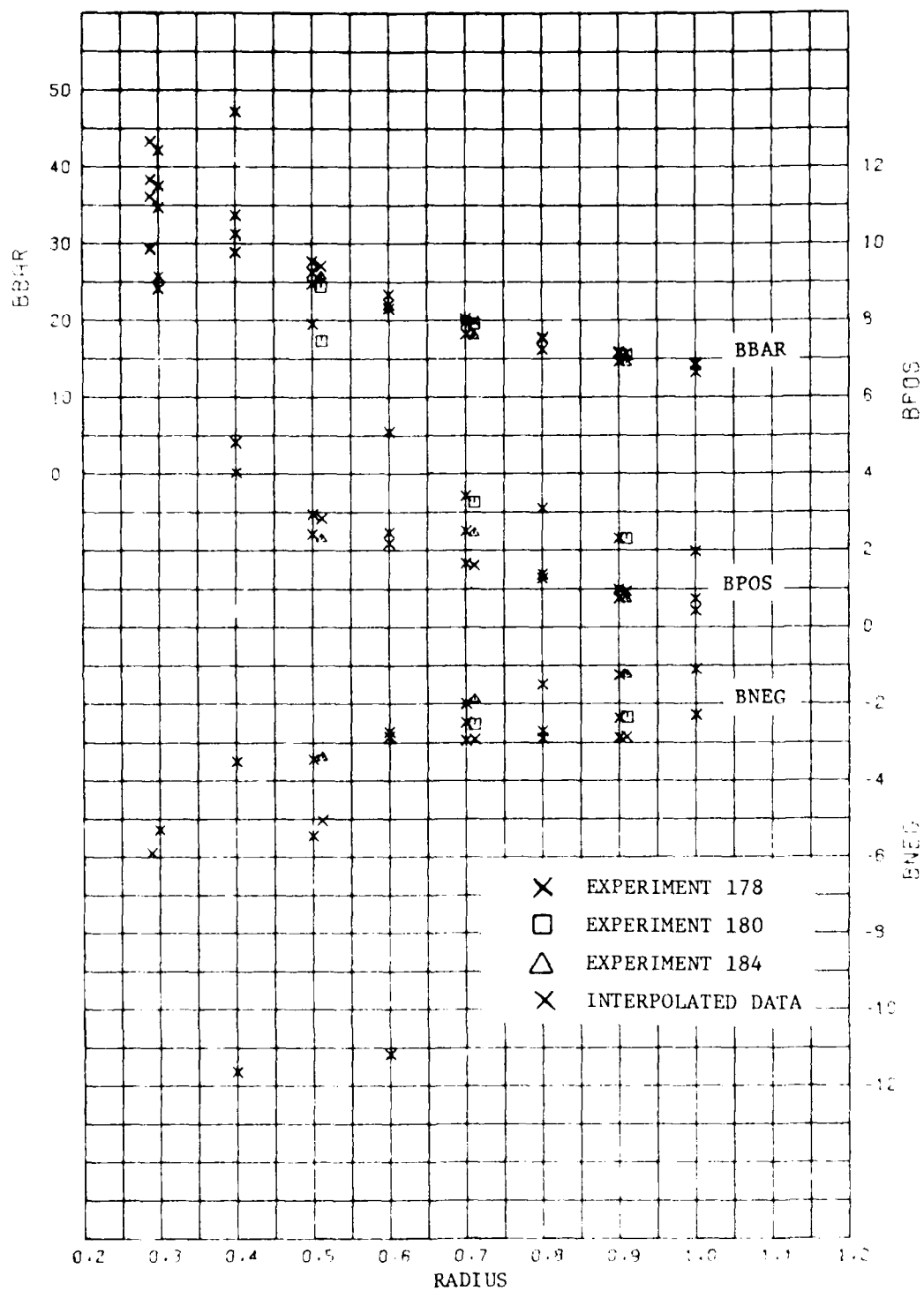


Figure 60 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle of Experiments 178, 180, and 184

TABLE 1 - LIST OF WAKE SURVEY EXPERIMENTS WITH MODEL 4989

Experiment Number	Description	Facility
178	Conventional Wake Survey - Model Speed Corresponding to 28.6 knots	Carriage 1 Tow Basin
179	Wake Survey with Bass Dynamometer Boat at Speed Corresponding to 28.6 knots	Carriage 1 Tow Basin
180	High Speed Approach, Maximum Rudder Angle Turning Wake Survey	Rotating Arm Basin
181	High Speed Approach, Moderate Rudder Angle Turning Wake Survey	Rotating Arm Basin
182	Low Speed Approach, Maximum Rudder Angle Turning Wake Survey	Rotating Arm Basin
183	Low Speed Approach, Moderate Rudder Angle Turning Wake Survey	Rotating Arm Basin
184	Yawed Model, Straight Motion Wake Survey corresponding to Experiment 180 (High Speed Approach, Maximum Rudder Angle)	Carriage 1 Tow Basin
185	Yawed Model, Straight Motion Wake Survey corresponding to Experiment 182 (Low Speed Approach, Maximum Rudder Angle)	Carriage 1 Tow Basin

TABLE 2a - CONDITIONS FOR WAKE SURVEYS IN A TURN

Experiment Number		180	181	182	183
Ship Speed Approaching the Turn	knots	28.6	28.6	20.0	20.0
	m/s	14.7	14.7	10.3	10.3
Ship Speed in the Steady Portion of the Turn	knots	18.9	24.5	12.3	15.8
	m/s	9.72	12-6	6.33	8.13
Rudder Angle in Degrees		35	20	35	20
Yaw Angle in Degrees		8.6	2.9	9.0	8.0
Steady Turning Radius of Ship	feet	759	1185	702	1095
	m	231	361	214	334

TABLE 2b - CONDITIONS FOR YAWED WAKE SURVEYS

Experiment Number		184	185
Simulated Ship Speed in Steady Portion of the Turn	knots	18.9	12.3
	m/s	9.72	6.33
Rudder Angle in Degrees		35	35
Yaw Angle in Degrees		8.6	9.0

TABLE 3

Comparison of Conventional Tow Tank Wake Survey Data with Data from
Rotating Arm Wake Survey and with Data from Yawed Model Wake Survey

Parameter (Values taken at $r/R = 0.7$)	Expt. 178 Conventional Wake Survey	Expt. 180 Rotating Arm Wake Survey	Expt. 184 Yawed Model Wake Survey
Mean Longitudinal Velocity Comparison $\bar{V}_x/V$	1.006	1.005	0.916
Mean Tangential Velocity Comparison $\bar{V}_t/V$	0.004	0.059	0.055
Mean Radial Velocity Comparison $\bar{V}_r/V$	0.019	0.030	0.064
Mean Hydrodynamic Pitch Angle $^\circ$	20.17 ⁰	19.74 ⁰	18.17 ⁰
Maximum Positive Variation of α $^\circ$	1.66 ⁰	3.42 ⁰	2.50 ⁰
Maximum Negative Variation of α $^\circ$	-2.95 ⁰	-2.48 ⁰	-1.99 ⁰
First Harmonic of Longitudinal	-0.0094	0.0109	0.0351
First Harmonic of Tangential	-0.1595	0.3953	0.1667
Second Harmonic of Tangential	-0.0059	0.0051	0.0408
$1-W_x$	1.029	0.936	0.936

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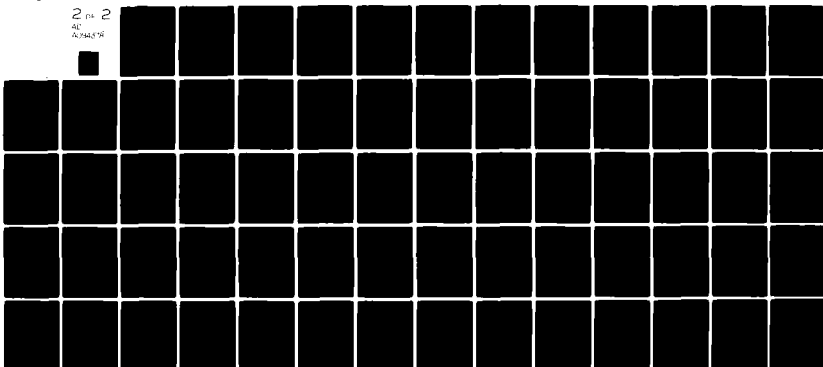
DAVID W TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CE--ETC F/G 13/10
PROPELLER-DISK WAKE SURVEY DATA FOR MODEL 4989 REPRESENTING THE--ETC(U)
DEC 80 W 8 DAY, R 8 HURWITZ
DTNSRDC/SPD-0011-21

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APPENDIX A

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS
FOR EXPERIMENTS WITH AND WITHOUT THE
BASS DYNAMOMETER BOAT -
EXPERIMENTS 178 AND 179

TABLE A-1
INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 178

INPUT DATA							
RADIUS = .512				RADIUS = .711			
ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V
-12.6	.935	-.006	-.021	-15.9	.962	.033	-.098
-10.4	.945	.012	-.019	-14.0	.960	.032	-.087
-6.2	.932	.018	-.016	-1.9	.972	-.023	-.064
1.0	.926	.011	-.013	-1.2	.968	-.020	-.063
4.8	.925	-.008	-.023	5.9	.988	-.040	-.088
6.8	.924	-.012	-.033	10.6	.992	-.051	-.098
14.8	.921	-.054	-.071	17.8	1.007	.017	-.121
16.9	.924	-.054	-.077	18.5	1.006	.015	-.122
18.8	.936	-.043	-.079	21.9	.851	-.018	-.107
20.8	.939	-.029	-.077	23.8	.872	-.179	-.122
22.8	.913	-.033	-.071	25.8	.986	-.167	-.138
24.8	.811	-.101	-.090	27.8	1.021	-.127	-.129
26.6	.857	-.202	-.124	28.4	1.022	-.126	-.128
28.8	.963	-.198	-.131	30.0	1.022	-.106	-.125
31.0	1.040	-.155	-.119	38.3	1.025	-.110	-.110
32.5	1.039	-.135	-.112	48.2	1.028	-.130	-.087
42.7	1.034	-.126	-.085	58.2	1.031	-.143	-.060
54.6	1.045	-.145	-.062	82.1	1.032	-.155	.008
66.9	1.041	-.163	-.035	94.2	1.030	-.150	.040
78.7	1.053	-.170	-.008	106.2	1.024	-.140	.059
90.7	1.048	-.171	.015	130.4	1.016	-.104	.116
102.8	1.041	-.166	.040	142.4	1.018	-.078	.133
114.8	1.040	-.154	.061	178.0	1.007	.017	.156
126.9	1.033	-.137	.081	190.1	.999	.048	.154
138.8	1.028	-.115	.097	202.0	.995	.075	.145
166.8	1.022	-.045	.118	226.0	.993	.123	.115
174.9	1.026	-.021	.119	237.9	1.000	.140	.092
191.0	1.020	.030	.118	249.9	1.008	.153	.065
199.0	1.022	.052	.113	273.9	1.015	.162	.003
207.0	1.025	.074	.106	285.9	1.011	.157	-.029
214.9	1.026	.094	.098	288.0	1.011	.145	-.060
230.9	1.033	.128	.076	302.0	1.010	.102	-.111
239.1	1.041	.142	.062	300.0	.993	.135	-.129
247.0	1.051	.152	.047	332.3	.991	.155	-.134
255.0	1.040	.163	.032	333.9	.931	.184	-.113
263.1	1.053	.166	.017	334.0	.905	.184	-.113
271.1	1.064	.168	.001	338.0	.864	.022	-.082
279.2	1.063	.166	-.015	338.0	.930	-.039	-.101
295.4	1.054	.154	-.047	340.2	.979	.001	-.111
303.5	1.051	.143	-.061	342.0	.973	.026	-.110
311.5	1.048	.128	-.075	344.1	.962	.033	-.098
321.6	1.041	.107	-.091	346.0	.960	.032	-.087
323.7	1.044	.103	-.094	358.1	.972	-.023	-.064
325.6	1.045	.100	-.097	358.8	.968	-.020	-.063
329.5	1.040	.097	-.101	365.9	.988	-.040	-.088
331.6	1.042	.100	-.101	370.6	.992	-.051	-.098
333.5	1.043	.110	-.103	377.8	1.007	.017	-.121
337.5	1.040	.149	-.112	378.5	1.000	.015	-.122
339.5	.975	.178	-.124	381.9	.953	-.016	-.105
341.5	.845	.107	-.090				
343.7	.844	-.002	-.050				
345.5	.893	-.021	-.030				
347.4	.935	-.006	-.021				
349.6	.945	.012	-.019				
353.8	.932	.018	-.016				
361.0	.926	.011	-.013				
364.8	.925	-.008	-.023				
366.8	.924	-.012	-.033				

RADIUS = .910			
ANGLE	VX/V	VT/V	VR/V
-12.8	1.023	.065	-.106
-4.7	1.005	.042	-.091
-.9	.976	.020	-.091
-.7	.998	.027	-.090
2.5	.982	-.004	-.094
3.3	.990	-.004	-.092

TABLE A-1 CONTINUED

				RADIUS = 1.082			
				ANGLE	VX/V	VT/V	VR/V
				-16.3	1.008	.043	-.131
				-12.3	.999	.040	-.131
				-4.3	.980	.029	-.124
				-.3	.961	.004	-.119
				7.9	.987	-.045	-.128
				12.0	1.000	-.050	-.129
				19.7	.993	-.052	-.119
				20.0	1.000	-.050	-.118
				21.7	1.012	-.019	-.118
				23.6	.960	.050	-.111
				24.0	.916	.066	-.113
				25.5	.875	-.123	-.116
				25.9	.807	-.185	-.125
				28.0	.983	-.136	-.143
				29.9	.983	-.097	-.139
				31.9	.980	-.089	-.135
				39.9	.969	-.104	-.114
				45.9	.967	-.117	-.093
				53.8	.971	-.133	-.068
				53.8	.969	-.131	-.070
				61.9	.988	-.142	-.044
				69.8	1.008	-.148	-.018
				77.8	.940	-.152	.007
				77.9	1.024	-.149	.007
				85.7	.993	-.149	.027
				93.9	.995	-.145	.046
				101.9	.996	-.139	.065
				118.3	.994	-.121	.101
				126.2	.993	-.110	.117
				134.4	.999	-.098	.129
				142.5	.987	-.082	.145
				153.4	1.005	-.050	.160
				166.3	1.011	-.033	.165
				174.5	1.010	-.014	.170
				182.5	1.036	.004	.169
				190.6	1.002	.023	.166
				198.4	1.002	.039	.161
				214.5	.995	.069	.146
				222.5	.935	.082	.135
				230.6	1.001	.091	.120
				238.9	1.001	.106	.105
				246.7	1.003	.114	.090
				254.8	1.039	.120	.072
				263.0	1.010	.126	.051
				271.3	.997	.134	.027
				271.3	1.009	.132	.027
				279.2	1.011	.133	.008
				287.3	1.034	.131	-.016
				295.4	1.016	.128	-.040
				303.5	1.020	.121	-.062
				311.6	1.017	.109	-.087
				319.7	1.008	.093	-.110
				323.7	.997	.084	-.121
				325.6	.998	.080	-.126
				329.7	.989	.069	-.135
				331.6	1.001	.075	-.138
				333.6	1.015	.113	-.135
				335.6	.844	.194	-.100
				337.8	.887	-.109	-.082
				339.6	.983	-.011	-.130
				341.6	1.004	.036	-.130
				343.7	1.008	.043	-.131
				347.7	.999	.040	-.131
				355.7	.980	.029	-.124
				359.7	.961	.004	-.119
				367.9	.987	-.045	-.128
				372.0	1.000	-.050	-.129
6.5	.988	-.021	-.099				
7.5	.988	-.024	-.101				
10.6	.999	-.033	-.109				
13.5	1.001	-.037	-.112				
20.5	1.026	-.026	-.114				
22.5	1.029	.026	-.112				
24.7	.887	.048	-.115				
26.4	.812	-.128	-.110				
28.5	.914	-.155	-.140				
30.4	.985	-.096	-.125				
32.7	.990	-.083	-.124				
38.4	.997	-.089	-.111				
42.4	.995	-.098	-.100				
58.5	1.000	-.127	-.054				
66.4	1.011	-.134	-.028				
74.4	1.023	-.136	-.004				
82.5	1.021	-.137	.016				
90.4	1.012	-.132	.035				
98.5	1.007	-.127	.054				
106.5	1.005	-.121	.072				
114.7	.986	-.113	.092				
122.6	.996	-.101	.105				
130.6	.996	-.088	.120				
138.6	.997	-.074	.131				
154.5	.997	-.042	.151				
162.6	1.003	-.025	.156				
170.7	1.009	-.005	.160				
178.6	1.010	.015	.163				
186.6	1.008	.034	.160				
194.7	1.007	.052	.156				
202.7	1.003	.071	.150				
210.9	.995	.089	.142				
218.6	.999	.104	.131				
226.7	1.001	.118	.119				
234.8	1.002	.130	.105				
250.9	1.005	.150	.070				
258.9	1.013	.157	.051				
266.9	1.019	.161	.031				
274.9	1.024	.165	.010				
283.1	1.031	.163	-.010				
291.1	1.031	.159	-.030				
307.3	1.023	.142	-.073				
315.3	1.022	.128	-.093				
323.3	1.024	.108	-.110				
327.2	1.022	.097	-.117				
329.3	1.024	.094	-.118				
331.3	1.030	.098	-.121				
333.5	1.026	.121	-.132				
335.2	1.024	.183	-.152				
337.2	.837	.116	-.115				
339.2	.878	-.077	-.113				
341.5	1.036	.005	-.116				
343.2	1.031	.049	-.117				
345.2	1.024	.064	-.112				
347.2	1.023	.065	-.106				
355.3	1.005	.042	-.091				
359.1	.976	.020	-.091				
359.3	.998	.027	-.090				
362.5	.982	-.004	-.094				
363.3	.990	-.004	-.092				
366.5	.988	-.021	-.099				
367.5	.988	-.024	-.101				
370.6	.999	-.033	-.109				

TABLE A-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED $\Delta\beta$ FOR EXPERIMENT 178

RADIUS =	.512	.711	.910	1.082	.289	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.022	1.006	1.004	.996	1.055	1.053	1.036	1.023	1.013	1.006	1.006	1.005	1.001
VTBAR =	-.003	.005	.015	-.006	-.009	-.009	-.006	-.003	.000	.004	.014	.015	.007
VRBAR =	.013	.019	.022	.023	.001	.002	.008	.012	.016	.019	.021	.022	.023
1-WVX =	1.034	1.022	1.014	1.010	0.000	1.054	1.045	1.037	1.029	1.023	1.018	1.015	1.013
1-WX =	1.046	1.028	1.017	1.011	0.000	1.079	1.061	1.048	1.037	1.029	1.022	1.018	1.014
BBAR =	27.08	19.87	15.71	13.27	43.29	42.15	33.65	27.67	23.36	20.17	17.77	15.88	14.34
BPOS =	2.83	1.61	.95	.61	9.87	8.82	4.03	2.94	2.19	1.66	1.28	.98	.74
THETA =	80.00	77.50	77.50	72.50	20.00	20.00	80.00	80.00	80.00	77.50	77.50	77.50	75.00
BNEG =	-5.05	-2.92	-2.85	-1.84	-26.45	-24.58	-11.64	-5.46	-2.72	-2.95	-2.70	-2.88	-2.29
THETA =	342.50	335.00	337.50	335.00	25.00	25.00	25.00	342.50	22.50	335.00	337.50	337.50	337.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.

VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.

VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.

1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.

1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.

BBAR IS MEAN ANGLE OF ADVANCE.

BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).

BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).

THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE A-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 178

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .512									
AMPLITUDE	=	-.0247	-.0409	-.0246	-.0136	-.0089	-.0031	.0006	.0060
RADIUS = .711									
AMPLITUDE	=	-.0087	-.0189	-.0118	-.0030	-.0011	.0027	.0066	.0069
RADIUS = .910									
AMPLITUDE	=	-.0012	-.0095	-.0091	.0056	.0044	.0036	.0020	.0049
RADIUS = 1.082									
AMPLITUDE	=	-.0096	-.0082	-.0068	.0043	.0033	.0055	.0011	.0001
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .512									
AMPLITUDE	=	.0081	.0067	.0045	.0051	.0025	-.0005	-.0019	-.0023
RADIUS = .711									
AMPLITUDE	=	.0059	.0040	.0014	-.0010	-.0036	-.0054	-.0063	-.0062
RADIUS = .910									
AMPLITUDE	=	.0032	.0013	-.0007	-.0052	-.0059	-.0059	-.0062	-.0054
RADIUS = 1.082									
AMPLITUDE	=	.0018	.0011	-.0002	-.0060	-.0063	-.0047	-.0051	-.0046

TABLE A-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 178

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .289									
AMPLITUDE	=	-.0527	-.0805	-.0509	-.0279	-.0205	-.0153	-.0187	.0015
RADIUS = .300									
AMPLITUDE	=	-.0511	-.0781	-.0493	-.0271	-.0199	-.0145	-.0174	.0018
RADIUS = .400									
AMPLITUDE	=	-.0375	-.0588	-.0362	-.0205	-.0144	-.0084	-.0074	.0042
RADIUS = .500									
AMPLITUDE	=	-.0259	-.0426	-.0257	-.0143	-.0094	-.0036	-.0001	.0058
RADIUS = .600									
AMPLITUDE	=	-.0166	-.0296	-.0177	-.0087	-.0051	.0001	.0046	.0067
RADIUS = .700									
AMPLITUDE	=	-.0094	-.0198	-.0122	-.0035	-.0014	.0025	.0065	.0069
RADIUS = .800									
AMPLITUDE	=	-.0030	-.0137	-.0105	.0022	.0023	.0029	.0041	.0065
RADIUS = .900									
AMPLITUDE	=	-.0011	-.0098	-.0092	.0054	.0043	.0035	.0022	.0051
RADIUS = 1.000									
AMPLITUDE	=	-.0039	-.0080	-.0079	.0059	.0045	.0044	.0012	.0028
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .289									
AMPLITUDE	=	.0099	.0097	.0092	.0144	.0139	.0103	.0083	.0076
RADIUS = .300									
AMPLITUDE	=	.0098	.0095	.0090	.0139	.0132	.0096	.0077	.0070
RADIUS = .400									
AMPLITUDE	=	.0091	.0082	.0067	.0095	.0076	.0042	.0025	.0019
RADIUS = .500									
AMPLITUDE	=	.0082	.0068	.0047	.0056	.0030	-.0001	-.0015	-.0019
RADIUS = .600									
AMPLITUDE	=	.0072	.0055	.0030	.0022	-.0007	-.0033	-.0044	-.0046
RADIUS = .700									
AMPLITUDE	=	.0061	.0042	.0015	-.0008	-.0034	-.0053	-.0062	-.0061
RADIUS = .800									
AMPLITUDE	=	.0045	.0025	.0001	-.0034	-.0049	-.0059	-.0064	-.0059
RADIUS = .900									
AMPLITUDE	=	.0033	.0014	-.0007	-.0051	-.0059	-.0059	-.0062	-.0055
RADIUS = 1.000									
AMPLITUDE	=	.0024	.0010	-.0007	-.0060	-.0063	-.0055	-.0057	-.0050

TABLE A-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 178

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .512									
AMPLITUDE	=	-.1739	-.0071	-.0073	-.0044	-.0036	-.0003	.0022	.0049
RADIUS = .711									
AMPLITUDE	=	-.1588	-.0060	-.0017	.0000	.0008	.0020	.0043	.0059
RADIUS = .910									
AMPLITUDE	=	-.1502	-.0097	-.0018	.0011	.0004	.0002	.0001	.0003
RADIUS = 1.082									
AMPLITUDE	=	-.1409	-.0099	-.0017	.0010	-.0003	-.0008	-.0009	-.0006
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .512									
AMPLITUDE	=	.0066	.0071	.0056	.0038	.0013	-.0010	-.0030	-.0039
RADIUS = .711									
AMPLITUDE	=	.0059	.0043	.0013	-.0019	-.0049	-.0069	-.0077	-.0074
RADIUS = .910									
AMPLITUDE	=	-.0000	-.0010	-.0019	-.0030	-.0044	-.0053	-.0052	-.0045
RADIUS = 1.082									
AMPLITUDE	=	-.0011	-.0013	-.0018	-.0027	-.0038	-.0044	-.0043	-.0038

TABLE A-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 178

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .289									
AMPLITUDE	=	-.1984	-.0141	-.0203	-.0132	-.0140	-.0080	-.0077	-.0038
RADIUS = .300									
AMPLITUDE	=	-.1970	-.0136	-.0195	-.0127	-.0134	-.0075	-.0070	-.0032
RADIUS = .400									
AMPLITUDE	=	-.1852	-.0099	-.0129	-.0083	-.0081	-.0035	-.0018	.0016
RADIUS = .500									
AMPLITUDE	=	-.1750	-.0073	-.0078	-.0047	-.0040	-.0006	.0019	.0047
RADIUS = .600									
AMPLITUDE	=	-.1664	-.0060	-.0041	-.0020	-.0011	.0012	.0039	.0062
RADIUS = .700									
AMPLITUDE	=	-.1595	-.0059	-.0018	-.0001	.0007	.0020	.0044	.0060
RADIUS = .800									
AMPLITUDE	=	-.1553	-.0081	-.0017	.0007	.0007	.0011	.0020	.0027
RADIUS = .900									
AMPLITUDE	=	-.1507	-.0096	-.0018	.0011	.0005	.0003	.0002	.0004
RADIUS = 1.000									
AMPLITUDE	=	-.1455	-.0101	-.0017	.0012	.0001	-.0004	-.0007	-.0006
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .289									
AMPLITUDE	=	.0011	.0071	.0117	.0158	.0165	.0147	.0109	.0077
RADIUS = .300									
AMPLITUDE	=	.0016	.0072	.0114	.0150	.0156	.0137	.0100	.0069
RADIUS = .400									
AMPLITUDE	=	.0047	.0075	.0085	.0091	.0079	.0057	.0028	.0009
RADIUS = .500									
AMPLITUDE	=	.0064	.0072	.0059	.0043	.0019	-.0004	-.0025	-.0035
RADIUS = .600									
AMPLITUDE	=	.0069	.0062	.0036	.0007	-.0023	-.0046	-.0060	-.0062
RADIUS = .700									
AMPLITUDE	=	.0061	.0046	.0015	-.0017	-.0048	-.0068	-.0077	-.0074
RADIUS = .800									
AMPLITUDE	=	.0026	.0013	-.0006	-.0026	-.0047	-.0061	-.0064	-.0058
RADIUS = .900									
AMPLITUDE	=	.0002	-.0008	-.0018	-.0030	-.0044	-.0054	-.0053	-.0046
RADIUS = 1.000									
AMPLITUDE	=	-.0011	-.0016	-.0022	-.0030	-.0041	-.0048	-.0046	-.0039

TABLE A-7

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 179

INPUT DATA				RADIUS = .711			
ANGLE	RADIUS = .512			ANGLE	VX/V	VT/V	VR/V
	VX/V	VT/V	VR/V				
-14.0	.772	0.000	-.036	-17.5	.841	.014	-.113
-12.2	.784	.017	-.035	-13.6	.839	.014	-.094
-10.2	.788	.024	-.034	-9.5	.842	0.000	-.077
-6.1	.782	.030	-.028	-5.5	.848	-.016	-.069
-1.9	.772	.023	-.028	.5	.849	-.037	-.076
.3	.769	.013	-.032	1.8	.853	-.036	-.078
4.2	.778	.006	-.044	2.6	.858	-.041	-.077
8.3	.769	-.011	-.059	3.8	.856	-.045	-.088
12.2	.768	-.027	-.080	6.6	.862	-.045	-.091
16.3	.766	-.007	-.084	7.8	.861	-.052	-.103
18.2	.765	.003	-.083	10.0	.868	-.052	-.113
20.4	.730	-.016	-.087	10.5	.875	-.055	-.112
22.3	.655	-.105	-.100	12.0	.876	-.060	-.121
24.2	.701	-.214	-.136	13.9	.883	-.052	-.131
26.3	.826	-.184	-.153	16.0	.903	-.025	-.130
28.3	.888	-.138	-.142	18.1	.885	.014	-.126
32.3	.896	-.102	-.126	20.0	.799	.031	-.123
36.2	.899	-.098	-.119	22.0	.737	-.046	-.124
40.3	.897	-.105	-.112	24.0	.797	-.183	-.148
44.3	.898	-.112	-.107	26.0	.902	-.144	-.152
56.5	.892	-.135	-.086	28.0	.911	-.113	-.149
68.5	.904	-.149	-.062	30.0	.916	-.101	-.145
80.5	.907	-.156	-.036	32.0	.913	-.098	-.140
92.5	.909	-.157	-.013	42.1	.910	-.120	-.125
104.6	.834	-.153	.009	48.0	.909	-.131	-.112
116.5	.893	-.138	.028	60.1	.907	-.151	-.084
128.5	.886	-.120	.046	66.0	.908	-.157	-.069
140.6	.877	-.096	.060	72.1	.908	-.160	-.054
160.8	.865	-.045	.077	78.1	.907	-.163	-.037
164.7	.866	-.034	.078	84.0	.908	-.162	-.022
168.8	.869	-.022	.079	96.0	.904	-.158	.008
180.8	.868	.013	.081	102.2	.907	-.153	.022
186.7	.865	.031	.080	122.4	.892	-.128	.063
192.7	.867	.049	.077	130.4	.892	-.113	.075
204.6	.861	.085	.070	138.3	.877	-.098	.088
216.4	.880	.113	.057	146.3	.879	-.079	.096
228.1	.893	.137	.041	154.2	.884	-.058	.102
240.0	.905	.156	.022	162.2	.875	-.039	.107
252.1	.908	.172	.001	170.2	.878	-.015	.109
263.8	.920	.175	-.020	178.3	.877	.007	.108
275.9	.919	.173	-.043	194.3	.864	.047	.105
288.0	.918	.165	-.066	202.4	.867	.066	.098
312.0	.915	.127	-.105	218.3	.868	.098	.091
324.0	.920	.103	-.119	226.4	.874	.111	.069
332.0	.905	.123	-.121	234.3	.870	.125	.056
333.9	.902	.149	-.125	242.3	.881	.133	.039
335.8	.887	.177	-.134	258.0	.878	.148	.003
335.9	.857	.180	-.136	268.1	.888	.148	-.021
338.1	.655	.179	-.147	278.0	.892	.146	-.047
339.8	.645	.074	-.101	288.1	.892	.139	-.071
341.8	.686	-.010	-.060	306.1	.890	.114	-.112
343.8	.736	-.017	-.042	314.1	.892	.097	-.126
346.0	.772	0.000	-.036	322.2	.899	.082	-.136
347.8	.784	.017	-.035	330.2	.903	.101	-.152
349.8	.788	.024	-.034	332.3	.888	.142	-.158
353.9	.782	.030	-.028	334.3	.760	.139	-.135
358.1	.772	.023	-.028	336.2	.737	-.010	-.112
360.3	.769	.013	-.032	338.2	.797	-.047	-.112
364.2	.778	.006	-.044	340.3	.844	-.011	-.118
368.3	.769	-.011	-.059	342.5	.841	.014	-.113
				346.4	.839	.014	-.094
				350.5	.842	0.000	-.077
				354.5	.848	-.016	-.069
				360.5	.849	-.037	-.076
				361.8	.853	-.036	-.078
				362.6	.858	-.041	-.077
				363.8	.856	-.045	-.088

TABLE A-7 CONTINUED

RADIUS = .910				RADIUS = 1.082			
ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V
-7.8	.890	.046	-.104	-10.0	.879	.026	-.127
-3.8	.890	.032	-.102	0.0	.866	0.000	-.124
-.2	.892	.010	-.103	10.0	.879	-.026	-.127
-.1	.900	.017	-.103	17.8	.898	-.042	-.124
4.3	.892	-.007	-.109	21.2	.835	.047	-.123
8.2	.897	-.016	-.120	23.1	.696	-.181	-.150
12.3	.904	-.024	-.127	25.1	.766	-.137	-.176
16.0	.911	-.026	-.133	27.0	.882	-.089	-.156
17.8	.917	-.022	-.133	29.1	.885	-.084	-.154
20.2	.939	.007	-.133	29.4	.881	-.083	-.151
20.3	.939	.008	-.136	31.1	.881	-.087	-.149
21.8	.898	.066	-.134	32.9	.879	-.092	-.147
24.4	.742	.027	-.132	44.9	.873	-.121	-.119
28.4	.905	-.091	-.158	50.8	.876	-.135	-.103
32.3	.901	-.058	-.153	56.9	.881	-.143	-.085
36.3	.904	-.067	-.146	62.6	.886	-.152	-.069
40.3	.906	-.076	-.138	92.4	.898	-.152	.012
44.1	.905	-.087	-.131	104.8	.897	-.142	.038
48.4	.899	-.096	-.120	116.4	.894	-.128	.061
52.2	.906	-.104	-.109	128.6	.896	-.108	.080
56.3	.907	-.111	-.099	160.5	.893	-.047	.115
60.3	.907	-.116	-.085	172.6	.902	-.019	.118
66.1	.908	-.123	-.069	184.6	.897	.009	.117
78.0	.921	-.126	-.035	187.4	.902	.019	.118
81.3	.915	-.126	-.020	199.5	.893	.047	.115
90.1	.926	-.124	-.007	231.4	.896	.108	.080
96.2	.926	-.120	.006	243.6	.894	.128	.061
102.1	.918	-.115	.016	255.2	.897	.142	.038
108.2	.909	-.110	.030	267.6	.898	.152	.012
114.3	.897	-.104	.043	297.4	.886	.152	-.069
120.2	.900	-.094	.052	303.1	.881	.143	-.085
126.1	.895	-.086	.064	309.2	.876	.135	-.103
132.6	.883	-.076	.074	315.1	.873	.121	-.119
138.2	.894	-.065	.080	327.1	.879	.092	-.147
144.4	.887	-.053	.088	328.9	.881	.087	-.149
156.4	.888	-.028	.098	330.6	.881	.083	-.151
168.5	.894	0.000	.104	330.9	.885	.084	-.154
180.6	.879	.031	.107	333.0	.882	.089	-.156
192.5	.884	.060	.103	334.9	.766	.137	-.176
204.4	.890	.086	.093	336.9	.696	.161	-.150
216.1	.892	.109	.080	338.8	.835	-.047	-.123
239.9	.906	.148	.040	342.2	.898	.042	-.124
246.1	.909	.156	.027	350.0	.879	.026	-.127
251.7	.919	.161	.015	360.0	.866	0.000	-.124
257.9	.936	.165	.003	370.0	.879	-.026	-.127
263.6	.930	.167	-.009				
269.9	.934	.169	-.024				
282.3	.923	.168	-.058				
287.8	.923	.164	-.071				
294.2	.928	.157	-.086				
299.9	.928	.150	-.101				
306.2	.928	.140	-.114				
311.9	.931	.129	-.127				
316.4	.926	.118	-.135				
320.0	.932	.107	-.140				
324.0	.935	.096	-.143				
328.2	.930	.094	-.148				
332.0	.923	.174	-.180				
335.6	.884	-.056	-.121				
337.5	.655	-.033	-.122				
340.0	.884	.048	-.134				
343.7	.910	.063	-.119				
348.1	.891	.057	-.105				
352.2	.890	.046	-.104				
356.2	.890	.032	-.102				
359.8	.892	.010	-.103				
359.9	.900	.017	-.103				
364.3	.892	-.007	-.109				
368.2	.897	-.016	-.120				
372.3	.904	-.024	-.127				
376.0	.911	-.026	-.133				

TABLE A-8 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 179

RADIUS =	.512	.711	.910	1.082	.289	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.875	.882	.903	.886	.883	.882	.877	.875	.876	.881	.897	.903	.899
VTBAR =	.008	-.006	.022	-.000	.073	.069	.034	.010	-.003	-.006	.014	.022	.016
VRBAR =	-.018	-.014	-.020	-.007	-.033	-.032	-.024	-.019	-.015	-.014	-.020	-.020	-.015
1-WVX =	.878	.877	.884	.888	0.000	.883	.879	.877	.876	.877	.880	.885	.888
1-WX =	.861	.873	.881	.885	0.000	.840	.852	.861	.867	.872	.877	.881	.885
BBAR =	23.53	17.65	14.17	11.84	36.30	35.42	28.76	24.01	20.52	17.89	15.94	14.32	12.90
BPOS =	2.74	1.49	.94	.59	11.15	10.41	4.17	2.86	2.08	1.54	1.19	.96	.76
THETA =	87.50	82.50	92.50	87.50	335.00	335.00	92.50	90.00	85.00	82.50	92.50	92.50	92.50
BNEG =	-6.12	-3.14	-3.64	-2.32	-26.32	-24.72	-13.49	-6.71	-3.28	-3.21	-3.20	-3.65	-3.20
THETA =	340.00	335.00	337.50	337.50	340.00	340.00	340.00	340.00	22.50	335.00	337.50	337.50	337.50

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VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE A-9 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 179

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (Vx/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .512									
AMPLITUDE	=	-.0231	-.0499	-.0274	-.0192	-.0120	-.0026	.0019	.0125
RADIUS = .711									
AMPLITUDE	=	-.0016	-.0199	-.0115	-.0058	-.0041	.0012	.0038	.0063
RADIUS = .910									
AMPLITUDE	=	.0054	-.0193	-.0051	.0021	-.0008	.0003	.0068	.0060
RADIUS = 1.082									
AMPLITUDE	=	-.0156	-.0081	-.0011	.0052	.0034	.0045	.0035	.0050
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .512									
AMPLITUDE	=	.0137	.0128	.0112	.0079	.0023	-.0030	-.0046	-.0060
RADIUS = .711									
AMPLITUDE	=	.0076	.0065	.0033	.0012	-.0027	-.0046	-.0076	-.0066
RADIUS = .910									
AMPLITUDE	=	.0041	.0023	.0024	-.0022	-.0045	-.0061	-.0058	-.0069
RADIUS = 1.082									
AMPLITUDE	=	.0034	.0017	.0002	-.0039	-.0055	-.0083	-.0083	-.0087

TABLE A-10 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 179

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .289									
AMPLITUDE	=	-.0644	-.1185	-.0563	-.0410	-.0263	-.0124	.0012	.0263
RADIUS = .300									
AMPLITUDE	=	-.0619	-.1142	-.0546	-.0398	-.0255	-.0118	.0012	.0254
RADIUS = .400									
AMPLITUDE	=	-.0416	-.0797	-.0404	-.0293	-.0185	-.0068	.0014	.0185
RADIUS = .500									
AMPLITUDE	=	-.0249	-.0526	-.0286	-.0202	-.0126	-.0030	.0019	.0131
RADIUS = .600									
AMPLITUDE	=	-.0118	-.0330	-.0192	-.0126	-.0080	-.0003	.0026	.0091
RADIUS = .700									
AMPLITUDE	=	-.0024	-.0208	-.0121	-.0063	-.0044	.0011	.0037	.0065
RADIUS = .800									
AMPLITUDE	=	.0057	-.0213	-.0084	-.0017	-.0028	.0000	.0060	.0063
RADIUS = .900									
AMPLITUDE	=	.0058	-.0196	-.0054	.0018	-.0010	.0002	.0068	.0060
RADIUS = 1.000									
AMPLITUDE	=	-.0025	-.0147	-.0028	.0042	.0013	.0019	.0057	.0056
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .289									
AMPLITUDE	=	.0237	.0225	.0283	.0194	.0118	-.0011	.0044	-.0116
RADIUS = .300									
AMPLITUDE	=	.0231	.0219	.0273	.0187	.0112	-.0012	.0038	-.0114
RADIUS = .400									
AMPLITUDE	=	.0183	.0173	.0187	.0131	.0065	-.0020	-.0008	-.0096
RADIUS = .500									
AMPLITUDE	=	.0141	.0133	.0119	.0084	.0027	-.0029	-.0043	-.0082
RADIUS = .600									
AMPLITUDE	=	.0107	.0097	.0068	.0045	-.0003	-.0037	-.0065	-.0072
RADIUS = .700									
AMPLITUDE	=	.0078	.0068	.0036	.0014	-.0025	-.0045	-.0075	-.0067
RADIUS = .800									
AMPLITUDE	=	.0057	.0041	.0031	-.0005	-.0036	-.0051	-.0061	-.0065
RADIUS = .900									
AMPLITUDE	=	.0042	.0024	.0024	-.0021	-.0044	-.0060	-.0057	-.0068
RADIUS = 1.000									
AMPLITUDE	=	.0035	.0017	.0014	-.0032	-.0051	-.0071	-.0066	-.0076

TABLE A-11 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 179

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .512									
AMPLITUDE	=	-.1698	-.0033	-.0060	-.0046	-.0032	.0002	.0031	.0059
RADIUS = .711									
AMPLITUDE	=	-.1549	-.0023	.0005	.0017	.0017	.0024	.0030	.0036
RADIUS = .910									
AMPLITUDE	=	-.1447	-.0016	.0046	.0055	.0031	.0019	.0000	-.0006
RADIUS = 1.082									
AMPLITUDE	=	-.1558	-.0129	-.0005	.0025	.0002	.0005	-.0001	-.0016
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .512									
AMPLITUDE	=	.0087	.0090	.0077	.0052	.0020	-.0021	-.0054	-.0076
RADIUS = .711									
AMPLITUDE	=	.0038	.0028	.0011	-.0012	-.0032	-.0052	-.0063	-.0063
RADIUS = .910									
AMPLITUDE	=	-.0021	-.0035	-.0047	-.0054	-.0058	-.0054	-.0038	-.0018
RADIUS = 1.082									
AMPLITUDE	=	.0017	.0014	.0008	.0003	-.0007	-.0018	-.0027	-.0033

TABLE A-12 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 179

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .289									
AMPLITUDE	=	-.1921	-.0048	-.0163	-.0145	-.0127	-.0054	-.0003	.0061
RADIUS = .300									
AMPLITUDE	=	-.1909	-.0047	-.0157	-.0139	-.0121	-.0051	-.0000	.0062
RADIUS = .400									
AMPLITUDE	=	-.1803	-.0040	-.0108	-.0092	-.0074	-.0022	.0019	.0063
RADIUS = .500									
AMPLITUDE	=	-.1708	-.0034	-.0065	-.0050	-.0036	.0000	.0030	.0060
RADIUS = .600									
AMPLITUDE	=	-.1626	-.0028	-.0028	-.0015	-.0006	.0015	.0034	.0051
RADIUS = .700									
AMPLITUDE	=	-.1556	-.0024	.0002	.0014	.0015	.0024	.0031	.0038
RADIUS = .800									
AMPLITUDE	=	-.1473	-.0002	.0036	.0044	.0030	.0023	.0013	.0008
RADIUS = .900									
AMPLITUDE	=	-.1446	-.0013	.0046	.0055	.0032	.0019	.0001	-.0006
RADIUS = 1.000									
AMPLITUDE	=	-.1482	-.0061	.0029	.0047	.0021	.0012	-.0003	-.0002
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .289									
AMPLITUDE	=	.0133	.0157	.0160	.0150	.0110	.0048	-.0004	-.0051
RADIUS = .300									
AMPLITUDE	=	.0131	.0153	.0156	.0144	.0105	.0043	-.0008	-.0053
RADIUS = .400									
AMPLITUDE	=	.0112	.0124	.0117	.0098	.0061	.0009	-.0034	-.0069
RADIUS = .500									
AMPLITUDE	=	.0090	.0093	.0081	.0057	.0024	-.0018	-.0052	-.0076
RADIUS = .600									
AMPLITUDE	=	.0066	.0063	.0047	.0021	-.0007	-.0038	-.0062	-.0075
RADIUS = .700									
AMPLITUDE	=	.0041	.0032	.0014	-.0009	-.0030	-.0051	-.0063	-.0065
RADIUS = .800									
AMPLITUDE	=	-.0002	-.0016	-.0031	-.0045	-.0055	-.0059	-.0050	-.0035
RADIUS = .900									
AMPLITUDE	=	-.0020	-.0035	-.0048	-.0054	-.0059	-.0055	-.0039	-.0019
RADIUS = 1.000									
AMPLITUDE	=	-.0011	-.0021	-.0031	-.0035	-.0040	-.0039	-.0031	-.0020

APPENDIX B

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS
FOR ROTATING ARM WAKE SURVEYS -
EXPERIMENTS 180, 181, 182, AND 183

TABLE B-1

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 180

INPUT DATA

RADIUS = .330				RADIUS = .512			
ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V
-4.3	.735	-.469	-.004	-8.3	.910	-.195	.074
0.0	.839	-.567	-.028	-4.4	.829	-.227	.078
3.6	.965	-.501	-.034	-4.4	.757	-.310	.044
7.6	1.036	-.487	-.045	3.7	.770	-.395	-.025
11.6	1.075	-.464	-.056	7.6	.860	-.431	-.060
19.7	1.035	-.450	-.072	11.6	.955	-.415	-.032
29.5	1.020	-.416	-.059	15.5	1.009	-.378	.016
39.6	1.024	-.379	-.040	19.4	1.031	-.348	.047
49.6	1.010	-.318	-.029	29.4	1.021	-.312	.104
59.7	.989	-.245	-.019	39.3	1.008	-.280	.147
69.7	.970	-.155	-.007	49.4	1.003	-.240	.193
79.8	.950	-.054	-.004	59.5	.996	-.190	.227
89.7	.954	.051	-.002	69.6	.994	-.127	.252
89.7	.931	.052	-.003	79.5	1.002	-.057	.270
99.8	.956	.152	0.000	89.6	1.006	.024	.282
110.1	1.021	.254	.004	99.5	.985	.107	.293
120.0	1.064	.351	-.001	109.6	.979	.190	.290
130.2	1.104	.451	-.003	119.8	.982	.274	.276
140.1	1.118	.531	-.012	130.0	1.001	.352	.245
150.2	1.126	.582	-.024	139.9	1.015	.406	.203
160.1	1.135	.617	-.036	149.8	1.024	.454	.157
170.2	1.150	.632	-.048	159.9	1.039	.492	.100
180.0	1.119	.619	-.060	169.7	1.055	.512	.044
189.8	1.105	.609	-.073	179.6	1.057	.520	-.010
199.8	1.116	.585	-.080	180.0	1.052	.527	-.007
209.8	1.158	.554	-.044	189.7	1.026	.529	-.068
219.6	1.058	.500	.059	199.7	1.011	.522	-.135
229.7	.979	.356	.087	209.8	1.003	.489	-.196
239.7	.850	.124	.031	219.7	.995	.448	-.258
239.7	.849	.132	.034	229.8	.995	.388	-.318
249.9	.930	.093	.017	239.8	1.007	.312	-.349
259.7	.999	.110	.017	249.8	.966	.146	-.277
263.8	.975	.104	.009	259.7	.991	-.011	-.124
267.8	.920	.142	.013	263.7	1.019	-.044	-.075
271.8	.870	.174	.004	267.8	1.024	-.025	-.032
275.8	.802	.183	.024	269.8	1.038	-.013	-.027
279.8	.727	.190	.024	271.7	1.031	.020	-.020
283.8	.639	.190	.025	275.7	1.011	.040	-.013
287.8	.532	.186	.037	279.8	.953	.068	.014
291.9	.446	.175	.010	283.8	.861	.092	.030
295.9	.345	.166	.016	287.9	.780	.106	.041
299.9	.275	.132	.006	291.9	.639	.088	.026
303.9	.199	.121	.008	295.9	.544	.026	.071
308.0	.174	.040	-.009	296.1	.424	-.021	.111
312.0	0.000	0.000	0.000	299.9	.376	-.081	.128
316.1	0.000	0.000	0.000	302.1	.388	-.216	.170
320.0	0.000	0.000	0.000	304.0	.363	-.286	.218
324.0	.461	-.456	.034	306.1	.390	-.304	.215
327.9	.609	-.295	.036	308.1	.369	-.358	.222
331.9	.648	-.276	.051	310.0	.300	-.296	.223
335.8	.619	-.282	.068	311.8	0.000	0.000	0.000
340.0	.624	-.279	.069	312.0	0.000	0.000	0.000
343.9	.629	-.296	.058	316.0	.333	-.168	.081
347.9	.643	-.326	.047	320.0	.845	-.453	-.029
351.7	.695	-.361	.018	323.9	.933	-.417	-.096
355.7	.735	-.469	-.004	327.8	1.010	-.361	-.116
360.0	.839	-.567	-.028	331.8	1.042	-.312	-.107
363.6	.965	-.501	-.034	335.8	1.058	-.287	-.085
367.6	1.036	-.487	-.045	339.8	1.069	-.256	-.045
				343.9	1.062	-.221	-.004
				347.7	1.005	-.198	.034
				351.7	.910	-.195	.074

TABLE B-1 CONTINUED

355.6	.829	-.227	.078	355.9	.988	-.219	.001
359.6	.757	-.310	.044	359.7	.937	-.209	.032
363.7	.770	-.395	-.025	361.5	.887	-.207	.056
367.6	.860	-.431	-.060	363.9	.801	-.225	.075
371.6	.955	-.415	-.032	367.9	.761	-.323	.070
375.5	1.009	-.378	.016	369.5	.790	-.339	.063
379.4	1.031	-.348	.047				

RADIUS = .711				RADIUS = .911			
ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V
-4.1	.986	-.219	.001	-8.2	1.054	-.228	-.050
-1.3	.937	-.209	.032	-4.2	1.054	-.208	-.030
1.5	.887	-.207	.056	-1.2	1.000	-.186	.009
3.9	.801	-.225	.075	3.9	.889	-.163	.041
7.9	.761	-.323	.070	7.9	.780	-.230	.084
9.5	.790	-.339	.063	11.8	.784	-.336	.095
11.8	.858	-.406	.040	15.6	.914	-.372	.083
15.9	.976	-.402	.054	19.7	1.016	-.344	.100
21.4	1.013	-.370	.089	29.6	1.021	-.292	.158
29.9	1.018	-.325	.152	39.6	1.002	-.250	.217
39.8	1.005	-.291	.208	49.6	1.009	-.206	.266
49.8	1.008	-.248	.253	59.6	1.007	-.159	.316
59.8	1.017	-.196	.288	69.7	1.004	-.097	.341
69.8	1.033	-.133	.314	79.7	1.032	-.033	.358
79.7	1.047	-.064	.327	89.8	1.046	.038	.372
89.9	1.048	.015	.336	99.8	1.042	.113	.369
99.8	1.022	.085	.341	109.8	1.018	.187	.362
110.0	1.009	.157	.342	119.9	1.006	.254	.349
114.9	1.001	.222	.319	130.0	1.001	.316	.311
130.2	1.000	.281	.283	139.9	.999	.363	.276
140.1	.997	.331	.237	149.8	1.000	.404	.224
150.0	.998	.373	.184	159.8	.996	.434	.170
154.9	1.007	.404	.124	163.7	1.011	.445	.144
164.8	1.021	.424	.060	167.7	1.022	.456	.119
174.7	1.029	.434	-.013	171.7	1.030	.463	.092
184.7	1.017	.439	-.081	175.7	1.032	.466	.068
194.7	1.005	.428	-.153	179.7	1.032	.472	.042
204.7	.994	.407	-.223	189.5	1.034	.474	-.033
219.5	.985	.371	-.288	194.5	1.018	.473	-.105
229.6	.981	.326	-.346	204.5	1.006	.452	-.176
239.6	.978	.281	-.391	214.4	1.005	.417	-.235
249.6	.974	.262	-.379	224.6	1.007	.375	-.290
259.5	1.002	.221	-.274	234.7	1.024	.314	-.331
263.5	1.050	.119	-.218	249.7	1.025	.259	-.350
267.5	1.045	.126	-.223	259.8	1.050	.204	-.324
271.6	1.061	.086	-.223	269.9	1.038	.078	-.324
271.6	1.071	.076	-.227	279.9	1.048	-.076	-.304
275.5	1.079	.033	-.239	289.9	1.066	-.135	-.196
279.7	1.105	-.026	-.247	290.1	1.043	-.129	-.228
284.6	1.105	-.071	-.239	293.9	1.063	-.131	-.154
287.7	1.101	-.065	-.208	297.9	1.070	-.121	-.116
291.8	1.085	-.081	-.161	300.1	1.042	-.119	-.115
295.8	1.071	-.086	-.088	302.1	1.063	-.108	-.080
299.8	1.060	-.095	-.019	306.2	1.069	-.084	-.053
303.9	1.046	-.100	.046	310.2	1.074	-.059	-.022
308.0	.984	-.106	.086	310.3	1.048	-.060	-.020
310.2	.837	-.197	.109	314.1	1.036	-.014	.034
312.0	.824	-.195	.109	318.2	.976	.002	.077
				320.3	.925	.001	.090
316.0	.843	-.341	.076	322.2	.909	-.059	.066
319.9	.959	-.363	.033	326.1	1.028	-.150	-.029
324.1	1.044	-.298	-.014	330.2	1.057	-.132	

TABLE B-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 180

RADIUS =	.330	.512	.711	.911	.280	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.898	.943	1.007	1.016	.888	.892	.914	.940	.978	1.005	1.018	1.017	1.016
VTBAR =	.105	.071	.050	.091	.117	.112	.091	.073	.055	.050	.061	.087	.091
VRBAR =	-.007	.044	.030	.041	-.032	-.021	.020	.042	.035	.030	.032	.040	.041
1-WVX =	.893	.917	.950	.978	0.000	.890	.901	.915	.932	.951	.967	.979	.987
1-WX =	.889	.894	.933	.962	0.000	.892	.884	.895	.914	.936	.954	.965	.971
BBAR =	32.65	24.36	19.50	15.48	36.12	34.65	28.81	24.76	22.08	19.74	17.63	15.68	14.19
BPOS =	19.63	7.46	3.26	2.31	27.91	22.89	13.44	7.90	.510	3.42	3.10	2.31	1.97
THETA =	10.00	17.50	325.00	22.50	0.00	0.00	12.50	17.50	17.50	325.00	297.50	22.50	22.50
BNEG =	-33.67	-24.84	-2.53	-2.34	-51.27	-43.68	-32.31	-25.89	-11.18	-2.48	-2.89	-2.37	-2.28
THETA =	317.50	312.50	5.00	10.00	320.00	320.00	312.50	312.50	312.50	5.00	7.50	7.50	10.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
 VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
 VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
 1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
 1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
 BBAR IS MEAN ANGLE OF ADVANCE.
 BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
 BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
 THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 180

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .330									
AMPLITUDE	=	.2867	.1884	.1346	.0706	.0646	.0445	.0343	.0220
PHASE ANGLE	=	311.5	21.9	40.9	90.1	164.2	255.4	324.1	292.9
RADIUS = .512									
AMPLITUDE	=	.1231	.0995	.0717	.0847	.0830	.0893	.0772	.0463
PHASE ANGLE	=	316.3	20.5	67.0	139.6	198.6	242.2	280.4	318.5
RADIUS = .711									
AMPLITUDE	=	.0075	.0266	.0255	.0135	.0213	.0334	.0349	.0203
PHASE ANGLE	=	263.7	252.1	271.7	99.5	176.3	212.6	238.0	246.8
RADIUS = .911									
AMPLITUDE	=	.0150	.0227	.0184	.0057	.0141	.0171	.0248	.0200
PHASE ANGLE	=	210.9	246.7	241.6	137.7	229.2	197.2	197.0	196.5
HARMONIC	=	9	10	11	12	13	14	15	
RADIUS = .330									
AMPLITUDE	=	.0407	.0354	.0265	.0156	.0129	.0143	.0177	
PHASE ANGLE	=	332.1	8.7	33.8	68.2	91.2	146.9	208.9	
RADIUS = .512									
AMPLITUDE	=	.0260	.0085	.0047	.0140	.0186	.0195	.0196	
PHASE ANGLE	=	344.9	3.4	81.1	156.1	197.1	227.4	252.9	
RADIUS = .711									
AMPLITUDE	=	.0118	.0048	.0072	.0154	.0173	.0159	.0125	
PHASE ANGLE	=	257.2	232.9	146.2	148.6	167.1	185.8	206.5	
RADIUS = .911									
AMPLITUDE	=	.0175	.0130	.0091	.0108	.0122	.0138	.0140	
PHASE ANGLE	=	215.5	204.0	174.8	145.4	124.3	124.9	127.3	

TABLE B-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 180

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	*	1	2	3	4	5	6	7	8
RADIUS = .280									
AMPLITUDE	*	.3412	.2099	.1549	.0806	.0619	.0184	.0313	.0168
PHASE ANGLE	*	310.3	21.4	32.8	62.0	138.1	283.5	21.9	235.6
RADIUS = .300									
AMPLITUDE	*	.3189	.2015	.1464	.0743	.0616	.0289	.0287	.0167
PHASE ANGLE	*	310.8	21.6	36.0	73.1	149.6	265.5	356.2	264.2
RADIUS = .400									
AMPLITUDE	*	.2173	.1562	.1100	.0774	.0767	.0728	.0580	.0373
PHASE ANGLE	*	313.3	22.1	51.9	120.0	185.4	247.5	294.7	314.2
RADIUS = .500									
AMPLITUDE	*	.1323	.1059	.0761	.0853	.0837	.0892	.0767	.0464
PHASE ANGLE	*	316.0	20.9	65.6	138.5	197.9	242.7	281.5	318.7
RADIUS = .600									
AMPLITUDE	*	.0572	.0360	.0191	.0436	.0486	.0581	.0527	.0281
PHASE ANGLE	*	314.0	.5	43.8	131.8	191.0	232.4	265.9	295.0
RADIUS = .700									
AMPLITUDE	*	.0100	.0242	.0231	.0153	.0233	.0351	.0360	.0204
PHASE ANGLE	*	282.2	257.6	274.5	105.2	177.9	214.9	241.1	251.5
RADIUS = .800									
AMPLITUDE	*	.0160	.0378	.0344	.0070	.0103	.0235	.0294	.0213
PHASE ANGLE	*	172.5	236.1	260.5	46.2	174.6	195.4	214.6	217.5
RADIUS = .900									
AMPLITUDE	*	.0153	.0256	.0212	.0043	.0125	.0175	.0254	.0204
PHASE ANGLE	*	201.7	243.0	245.8	124.7	225.9	194.9	198.0	198.3
RADIUS = 1.000									
AMPLITUDE	*	.0150	.0227	.0184	.0057	.0141	.0171	.0248	.0200
PHASE ANGLE	*	210.9	246.7	241.6	137.7	229.2	197.2	197.0	196.5

TABLE B-4 CONTINUED

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC	=	9	10	11	12	13	14	15
RADIUS = .280								
AMPLITUDE	=	.0444	.0455	.0359	.0234	.0237	.0229	.0207
PHASE ANGLE	=	325.5	8.6	32.1	53.3	71.3	121.2	185.7
RADIUS = .300								
AMPLITUDE	=	.0429	.0413	.0319	.0200	.0189	.0188	.0191
PHASE ANGLE	=	328.2	8.7	32.6	58.1	76.8	129.2	194.7
RADIUS = .400								
AMPLITUDE	=	.0357	.0232	.0156	.0104	.0095	.0132	.0180
PHASE ANGLE	=	339.6	8.4	38.9	109.0	162.7	200.3	236.0
RADIUS = .500								
AMPLITUDE	=	.0272	.0098	.0053	.0135	.0179	.0191	.0196
PHASE ANGLE	=	344.9	4.6	71.5	153.9	196.3	226.7	252.3
RADIUS = .600								
AMPLITUDE	=	.0145	.0036	.0054	.0153	.0185	.0179	.0161
PHASE ANGLE	=	318.5	330.8	120.0	151.8	183.0	209.2	235.6
RADIUS = .700								
AMPLITUDE	=	.0115	.0043	.0071	.0154	.0174	.0161	.0128
PHASE ANGLE	=	262.5	237.6	144.3	148.8	168.7	188.3	209.9
RADIUS = .800								
AMPLITUDE	=	.0153	.0087	.0084	.0141	.0152	.0142	.0111
PHASE ANGLE	=	230.0	213.8	159.6	146.9	152.6	163.1	172.5
RADIUS = .900								
AMPLITUDE	=	.0175	.0126	.0091	.0113	.0124	.0137	.0135
PHASE ANGLE	=	216.6	204.7	173.3	145.5	127.9	129.1	131.1
RADIUS = 1.000								
AMPLITUDE	=	.0175	.0130	.0091	.0108	.0122	.0138	.0140
PHASE ANGLE	=	215.5	204.0	174.8	145.4	124.3	124.9	127.3

TABLE B-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 180

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	*	1	2	3	4	5	6	7	8
RADIUS = .330									
AMPLITUDE	*	.4975	.1084	.0723	.0506	.0328	.0209	.0024	.0168
PHASE ANGLE	*	263.5	180.5	261.8	341.3	88.6	207.5	263.7	170.4
RADIUS = .512									
AMPLITUDE	*	.4365	.0335	.0112	.0193	.0383	.0470	.0371	.0125
PHASE ANGLE	*	267.7	112.4	201.0	358.5	99.5	159.7	212.5	261.6
RADIUS = .711									
AMPLITUDE	*	.3935	.0053	.0225	.0193	.0115	.0152	.0236	.0171
PHASE ANGLE	*	264.3	102.1	93.2	121.8	135.9	106.2	132.6	175.2
RADIUS = .911									
AMPLITUDE	*	.3735	.0362	.0413	.0291	.0169	.0161	.0222	.0189
PHASE ANGLE	*	264.0	118.8	151.3	207.1	263.7	10.3	69.9	107.8
HARMONIC	*	9	10	11	12	13	14	15	
RADIUS = .330									
AMPLITUDE	*	.0207	.0131	.0134	.0173	.0110	.0060	.0064	
PHASE ANGLE	*	232.5	256.4	249.0	283.6	327.8	326.6	343.9	
RADIUS = .512									
AMPLITUDE	*	.0105	.0197	.0171	.0119	.0078	.0075	.0119	
PHASE ANGLE	*	130.8	178.2	209.8	244.0	282.5	2.7	65.8	
RADIUS = .711									
AMPLITUDE	*	.0045	.0076	.0107	.0133	.0147	.0114	.0055	
PHASE ANGLE	*	245.1	26.8	56.1	63.7	83.7	114.3	144.7	
RADIUS = .911									
AMPLITUDE	*	.0103	.0067	.0070	.0031	.0058	.0088	.0093	
PHASE ANGLE	*	119.8	91.2	81.8	70.4	13.3	26.6	37.8	

TABLE B-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 180

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .280									
AMPLITUDE =		.5189	.1500	.0978	.0598	.0263	.0214	.0193	.0280
PHASE ANGLE =		261.4	187.3	264.8	339.9	82.1	266.8	35.0	155.5
RADIUS = .300									
AMPLITUDE =		.5101	.1324	.0872	.0561	.0292	.0186	.0104	.0231
PHASE ANGLE =		262.3	184.9	263.8	340.4	85.2	242.2	30.2	160.1
RADIUS = .400									
AMPLITUDE =		.4712	.0645	.0422	.0381	.0384	.0355	.0229	.0098
PHASE ANGLE =		265.7	164.2	254.5	344.6	93.8	174.5	220.9	218.8
RADIUS = .500									
AMPLITUDE =		.4398	.0347	.0129	.0212	.0389	.0468	.0367	.0123
PHASE ANGLE =		267.6	118.6	214.0	355.8	98.9	160.8	213.6	260.9
RADIUS = .600									
AMPLITUDE =		.4145	.0138	.0113	.0135	.0254	.0293	.0255	.0135
PHASE ANGLE =		265.9	107.7	94.9	70.2	108.9	145.1	178.4	209.1
RADIUS = .700									
AMPLITUDE =		.3953	.0054	.0218	.0189	.0127	.0161	.0235	.0169
PHASE ANGLE =		264.4	101.1	91.6	118.1	131.3	111.7	136.5	177.9
RADIUS = .800									
AMPLITUDE =		.3818	.0116	.0274	.0209	.0074	.0128	.0240	.0175
PHASE ANGLE =		263.7	115.0	114.5	154.6	209.4	56.0	105.6	151.1
RADIUS = .900									
AMPLITUDE =		.3740	.0329	.0391	.0275	.0157	.0157	.0224	.0184
PHASE ANGLE =		263.9	118.7	148.0	202.3	261.2	13.9	74.1	112.6
RADIUS = 1.000									
AMPLITUDE =		.3735	.0362	.0413	.0291	.0169	.0161	.0222	.0189
PHASE ANGLE =		264.0	118.8	151.3	207.1	263.7	10.3	69.9	107.8

TABLE B-6 CONTINUED

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC	=	9	10	11	12	13	14	15
RADIUS = .280								
AMPLITUDE	=	.0323	.0200	.0119	.0189	.0128	.0040	.0101
PHASE ANGLE	=	243.7	294.5	283.8	301.5	352.4	301.7	301.9
RADIUS = .300								
AMPLITUDE	=	.0273	.0163	.0121	.0181	.0118	.0048	.0081
PHASE ANGLE	=	240.0	282.0	267.8	294.1	342.5	314.8	315.3
RADIUS = .400								
AMPLITUDE	=	.0107	.0154	.0171	.0162	.0106	.0079	.0084
PHASE ANGLE	=	196.5	204.4	225.8	264.0	301.5	341.4	39.2
RADIUS = .500								
AMPLITUDE	=	.0103	.0198	.0176	.0126	.0084	.0077	.0118
PHASE ANGLE	=	134.3	179.8	211.2	245.8	283.6	359.6	64.0
RADIUS = .600								
AMPLITUDE	=	.0037	.0043	.0029	.0036	.0066	.0069	.0065
PHASE ANGLE	=	186.8	155.1	147.0	62.7	80.1	97.9	106.6
RADIUS = .700								
AMPLITUDE	=	.0045	.0070	.0101	.0128	.0143	.0113	.0056
PHASE ANGLE	=	244.3	27.8	56.9	63.7	84.0	114.4	143.5
RADIUS = .800								
AMPLITUDE	=	.0027	.0092	.0126	.0131	.0134	.0098	.0036
PHASE ANGLE	=	210.9	31.5	56.2	64.3	77.5	102.8	121.2
RADIUS = .900								
AMPLITUDE	=	.0089	.0066	.0078	.0045	.0061	.0080	.0081
PHASE ANGLE	=	122.0	80.3	75.5	67.9	29.2	35.9	40.8
RADIUS = 1.000								
AMPLITUDE	=	.0103	.0067	.0070	.0031	.0058	.0088	.0093
PHASE ANGLE	=	119.8	91.2	81.8	70.4	13.3	26.6	37.8

TABLE B-7

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 181

INPUT DATA							
ANGLE	RADIUS = .330			VR/V	363.3	.793	-.349
	VX/V	VT/V	VT/V				
-.7	.756	-.312	.031		367.4	.900	-.347
-.7	.748	-.318	.039		369.3	.941	-.355
3.3	.793	-.349	.031		371.3	.974	-.350
7.4	.900	-.347	.015		375.2	1.028	-.330
9.3	.941	-.355	.002				
11.3	.974	-.350	-.002				
15.2	1.028	-.330	-.011				
19.2	1.057	-.313	-.027				
23.3	1.066	-.292	-.034				
29.2	1.058	-.265	-.045				
39.2	1.037	-.245	-.045				
49.2	1.014	-.202	-.038				
59.2	1.011	-.158	-.031				
69.3	.994	-.090	-.024				
79.4	.990	-.025	-.021				
89.4	.988	.051	-.021				
99.2	.999	.117	-.021				
109.3	1.022	.186	-.018				
119.2	1.053	.255	-.013				
129.1	1.094	.320	-.011				
139.3	1.116	.394	-.016				
149.4	1.126	.445	-.018				
159.4	1.136	.491	-.025				
169.2	1.127	.521	-.032				
179.2	1.135	.539	-.040				
189.0	1.135	.534	-.045				
199.0	1.143	.521	-.044				
209.0	1.152	.490	-.039				
219.0	1.188	.441	-.008				
223.0	1.214	.414	.019				
227.0	1.226	.398	.052				
228.9	1.215	.394	.065				
231.0	1.199	.378	.084				
235.0	1.138	.343	.123				
239.0	1.099	.288	.133				
243.1	1.062	.248	.114				
247.0	1.013	.220	.077				
249.1	.966	.191	.051				
251.1	.954	.155	.046				
255.0	.941	.080	.026				
259.1	.952	.056	.014				
263.0	.980	.066	.020				
267.0	.973	.096	.020				
271.0	.962	.131	.021				
274.9	.942	.161	.032				
278.9	.878	.176	.029				
282.9	.812	.176	.035				
286.9	.693	.152	.040				
290.9	.579	.084	.051				
295.0	.507	.008	.047				
299.1	.471	-.100	.060				
303.0	.453	-.169	.087				
307.0	.448	-.174	.115				
311.0	.466	-.192	.149				
315.1	.498	-.162	.130				
319.2	.546	-.179	.107				
323.3	.583	-.228	.099				
327.3	.672	-.247	.089				
331.4	.719	-.238	.096				
335.4	.756	-.227	.087				
339.4	.735	-.219	.079				
343.4	.727	-.222	.079				
347.4	.715	-.232	.072				
351.4	.694	-.261	.062				
355.4	.703	-.292	.055				
359.3	.756	-.312	.031				
359.5	.764	-.313	.029				

ANGLE	RADIUS = .512			VR/V
	VX/V	VT/V	VT/V	
-16.4	1.042	-.145	-.041	
-12.4	1.051	-.144	-.021	
-8.5	1.040	-.131	.009	
-4.5	1.037	-.101	.042	
-.3	.959	-.076	.072	
3.5	.845	-.095	.089	
7.5	.786	-.168	.077	
11.4	.810	-.291	.041	
15.4	.937	-.302	.025	
19.4	1.019	-.260	.030	
29.4	1.030	-.202	.070	
39.3	1.010	-.181	.102	
49.3	1.011	-.157	.134	
59.3	.997	-.124	.155	
69.2	1.001	-.083	.183	
79.4	.999	-.034	.201	
89.4	1.024	.019	.208	
99.2	.994	.074	.220	
109.2	.994	.128	.223	
119.3	1.002	.184	.213	
129.3	1.020	.240	.197	
139.3	1.025	.295	.175	
149.3	1.039	.339	.142	
159.5	1.058	.364	.103	
169.4	1.065	.391	.065	
179.4	1.058	.405	.027	
189.2	1.061	.413	-.017	
219.0	1.024	.367	-.155	
229.1	1.027	.324	-.200	
239.2	1.020	.269	-.229	
249.3	1.016	.219	-.215	
259.3	1.010	.100	-.108	
263.4	1.010	.070	-.079	
267.4	1.026	.042	-.070	
269.3	1.010	.035	-.085	
271.3	1.006	.024	-.086	
275.2	.970	-.007	-.107	
279.3	.959	-.023	-.126	
283.3	.967	-.029	-.128	
287.2	.965	-.019	-.082	
289.3	.970	.008	-.073	
291.4	.941	.006	-.050	
295.3	.868	.008	-.012	
299.4	.812	-.004	.027	
303.4	.761	-.060	.097	
307.5	.778	-.099	.144	
311.6	.778	-.104	.166	
315.5	.768	-.156	.126	
319.6	.830	-.226	.068	
323.6	.922	-.229	.021	
327.5	1.004	-.194	-.026	
331.7	1.029	-.167	-.048	
335.7	1.032	-.149	-.055	
339.7	1.039	-.146	-.051	
343.6	1.042	-.145	-.041	
347.6	1.051	-.144	-.021	
351.5	1.040	-.131	.009	
355.5	1.037	-.101	.042	
359.7	.959	-.076	.072	
363.5	.845	-.095	.089	
367.5	.786	-.168	.077	

TABLE B-7 CONTINUED

TABLE 2 - CONTINUED				RADIUS = .911			
				ANGLE	VX/V	VT/V	VR/V
371.4	.810	-.291	.041				
375.4	.937	-.302	.025				
379.4	1.019	-.260	.030				
	RADIUS = .711						
ANGLE	VX/V	VT/V	VR/V				
-4.8	1.036	-.164	-.044				
-.6	1.035	-.158	-.027				
3.0	1.036	-.120	.003				
7.0	.965	-.079	.040				
9.5	.884	-.085	.058				
11.1	.836	-.129	.061				
15.0	.822	-.248	.057				
19.4	.952	-.287	.062				
22.9	1.020	-.247	.076				
26.8	1.024	-.217	.085				
29.2	1.008	-.208	.094				
39.3	1.003	-.193	.131				
49.3	1.005	-.169	.162				
59.3	1.002	-.136	.195				
69.5	1.008	-.103	.228				
79.3	1.019	-.054	.247				
89.3	1.025	-.003	.261				
99.2	1.008	.044	.263				
109.3	.998	.092	.267				
119.2	.987	.140	.263				
129.3	.982	.189	.251				
139.3	.988	.233	.219				
149.4	.993	.268	.181				
159.3	1.009	.293	.142				
169.4	1.012	.312	.092				
179.3	1.029	.325	.043				
189.2	1.019	.330	-.013				
199.0	1.017	.330	-.070				
209.1	1.005	.321	-.126				
219.0	.988	.302	-.181				
229.1	.991	.269	-.240				
239.1	.990	.221	-.293				
249.1	.998	.164	-.325				
255.1	.977	.105	-.318				
259.0	1.003	.061	-.281				
263.0	1.016	.014	-.269				
267.0	1.021	-.023	-.253				
271.1	1.022	-.071	-.255				
274.9	1.019	-.092	-.247				
278.9	1.006	-.112	-.238				
282.9	.995	-.139	-.205				
287.0	.995	-.153	-.175				
290.9	1.002	-.168	-.138				
294.9	1.006	-.167	-.089				
299.0	1.029	-.162	-.048				
303.0	1.032	-.149	.001				
307.0	1.038	-.138	.040				
311.0	1.036	-.116	.071				
315.1	1.042	-.065	.109				
319.2	.933	-.010	.165				
323.3	.802	-.103	.114				
327.3	.933	-.170	-.012				
331.3	.968	-.125	-.070				
335.3	.985	-.127	-.085				
339.2	1.014	-.141	-.086				</

TABLE B-7 CONTINUED

149.6	1.021	.214	.229
159.6	1.029	.245	.186
169.6	1.038	.260	.136
179.5	1.052	.276	.079
189.3	1.053	.276	.029
199.4	1.056	.288	-.027
209.4	1.045	.287	-.083
219.3	1.029	.280	-.145
229.4	1.016	.262	-.208
238.6	1.001	.247	-.275
249.4	.999	.211	-.343
258.8	.984	.187	-.396
265.0	.975	.170	-.412
269.3	.971	.082	-.393
274.8	1.006	-.014	-.393
278.6	1.004	-.092	-.383
284.7	.997	-.149	-.373
289.2	.965	-.226	-.320
294.8	.953	-.309	-.190
299.4	1.000	-.322	-.060
304.8	.996	-.281	.081
309.4	1.014	-.241	.143
315.0	1.042	-.169	.188
319.5	1.048	-.108	.191
320.1	1.035	-.088	.176
325.0	.928	.017	.101
330.0	.980	-.059	-.059
335.1	.971	-.035	-.113
340.1	.936	-.040	-.131
345.0	.921	-.066	-.126
349.5	.930	-.110	-.127
355.0	.935	-.172	-.119
360.0	.959	-.195	-.088
369.5	.967	-.141	-.005

TABLE B-8 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 181

RADIUS =	.330	.512	.711	.911	1.082	.280	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.961	.994	.998	1.011	1.004	.946	.952	.977	.993	.995	.998	1.007	1.011	1.010
VTBAR =	.097	.078	.038	.070	.021	.099	.098	.091	.079	.052	.039	.064	.071	.053
VRBAR =	.011	.038	.026	.045	.027	-.003	.003	.026	.038	.029	.026	.039	.045	.040
1-WVX =	.954	.976	.988	.995	.999	0.000	.950	.963	.975	.983	.987	.991	.995	.998
1-WX =	.906	.934	.960	.974	.981	0.000	.901	.916	.933	.948	.959	.968	.973	.978
BBAR =	34.60	25.45	19.43	15.49	13.24	38.30	36.73	30.44	25.92	22.45	19.69	17.43	15.66	14.23
BPOS =	12.45	5.02	2.44	2.18	2.35	16.82	14.55	8.65	5.30	3.70	2.55	2.30	2.22	1.68
THETA =	20.00	22.50	25.00	297.50	5.00	10.00	20.00	20.00	22.50	22.50	25.00	297.50	297.50	300.00
BNEG =	-13.35	-4.07	-2.68	-1.11	-2.55	-19.62	-16.83	-8.87	-4.52	-2.00	-2.73	-1.37	-1.14	-1.11
THETA =	295.00	302.50	322.50	230.00	17.50	295.00	295.00	302.50	302.50	217.50	322.50	227.50	230.00	17.50

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VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-9 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 181

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .330									
AMPLITUDE	=	.2212	.1472	.0746	.0062	.0174	.0435	.0481	.0226
PHASE ANGLE	=	299.4	13.6	47.5	153.6	195.1	255.2	304.5	2.6
RADIUS = .512									
AMPLITUDE	=	.0569	.0354	.0153	.0324	.0348	.0380	.0319	.0170
PHASE ANGLE	=	297.4	28.7	67.1	149.9	197.6	224.0	239.0	249.3
RADIUS = .711									
AMPLITUDE	=	.0097	.0070	.0134	.0112	.0072	.0136	.0200	.0204
PHASE ANGLE	=	274.2	284.5	257.8	99.0	144.0	152.3	158.4	164.9
RADIUS = .911									
AMPLITUDE	=	.0120	.0137	.0260	.0069	.0036	.0041	.0103	.0055
PHASE ANGLE	=	214.1	196.7	227.5	394.4	312.7	137.9	146.5	114.2
RADIUS = 1.082									
AMPLITUDE	=	.0351	.0037	.0189	.0044	.0034	.0032	.0094	.0134
PHASE ANGLE	=	284.7	316.6	232.6	329.2	313.6	39.9	86.5	85.0
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .330									
AMPLITUDE	=	.0052	.0138	.0076	.0049	.0026	.0017	.0024	.0027
PHASE ANGLE	=	229.0	284.0	326.4	332.3	26.8	133.0	228.9	191.5
RADIUS = .512									
AMPLITUDE	=	.0054	.0071	.0156	.0156	.0115	.0085	.0106	.0103
PHASE ANGLE	=	244.0	183.6	155.0	184.7	168.1	157.4	142.3	147.8
RADIUS = .711									
AMPLITUDE	=	.0173	.0099	.0005	.0087	.0111	.0133	.0129	.0117
PHASE ANGLE	=	182.5	209.7	2.8	74.7	74.6	73.3	80.4	90.4
RADIUS = .911									
AMPLITUDE	=	.0041	.0082	.0106	.0065	.0043	.0006	.0014	.0017
PHASE ANGLE	=	84.8	77.0	98.7	105.4	138.8	80.9	87.5	127.9
RADIUS = 1.082									
AMPLITUDE	=	.0129	.0093	.0063	.0123	.0163	.0139	.0114	.0122
PHASE ANGLE	=	96.2	105.3	57.7	37.1	41.2	41.7	24.4	19.1

TABLE B-10 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 181

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/VI)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .200									
AMPLITUDE =		.2864	.1920	.0973	.0093	.0053	.0440	.0610	.0352
PHASE ANGLE =		299.5	11.7	45.1	334.5	176.0	267.9	319.3	19.6
RADIUS = .300									
AMPLITUDE =		.2593	.1733	.0879	.0026	.0104	.0437	.0553	.0297
PHASE ANGLE =		299.5	12.4	46.0	334.7	189.7	262.6	313.9	14.0
RADIUS = .400									
AMPLITUDE =		.1444	.0947	.0475	.0219	.0292	.0430	.0375	.0137
PHASE ANGLE =		299.1	17.4	52.1	192.7	198.0	241.1	278.8	315.6
RADIUS = .500									
AMPLITUDE =		.0642	.0403	.0181	.0321	.0350	.0388	.0323	.0165
PHASE ANGLE =		297.8	26.9	64.4	150.3	197.8	225.7	242.7	253.9
RADIUS = .600									
AMPLITUDE =		.0307	.0166	.0029	.0205	.0188	.0211	.0203	.0164
PHASE ANGLE =		295.2	11.0	349.9	134.0	184.1	200.7	201.7	193.7
RADIUS = .700									
AMPLITUDE =		.0111	.0069	.0123	.0110	.0079	.0138	.0198	.0203
PHASE ANGLE =		278.9	295.9	259.8	103.4	149.8	156.8	161.3	166.6
RADIUS = .800									
AMPLITUDE =		.0092	.0107	.0212	.0058	.0011	.0088	.0153	.0108
PHASE ANGLE =		204.0	210.0	234.5	90.4	167.6	150.5	157.8	159.3
RADIUS = .900									
AMPLITUDE =		.0118	.0138	.0259	.0068	.0033	.0045	.0107	.0055
PHASE ANGLE =		209.9	197.1	227.7	357.4	312.0	140.4	148.6	120.9
RADIUS = 1.000									
AMPLITUDE =		.0178	.0087	.0245	.0069	.0045	.0021	.0080	.0084
PHASE ANGLE =		259.2	200.8	227.5	339.1	314.7	87.8	119.0	84.1

TABLE B-10 CONTINUED

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .200									
AMPLITUDE =		.0068	.0212	.0202	.0162	.0107	.0040	.0054	.0026
PHASE ANGLE =		205.3	291.4	330.5	344.0	10.5	26.6	303.9	301.1
RADIUS = .300									
AMPLITUDE =		.0060	.0181	.0148	.0114	.0072	.0022	.0036	.0016
PHASE ANGLE =		214.2	289.1	329.6	341.6	12.7	44.4	287.0	257.0
RADIUS = .400									
AMPLITUDE =		.0050	.0067	.0057	.0071	.0059	.0058	.0063	.0068
PHASE ANGLE =		254.3	255.2	168.9	176.3	171.1	167.5	164.6	164.4
RADIUS = .500									
AMPLITUDE =		.0053	.0068	.0152	.0153	.0113	.0084	.0103	.0101
PHASE ANGLE =		247.9	186.8	155.1	165.7	169.3	159.7	144.5	149.6
RADIUS = .600									
AMPLITUDE =		.0133	.0103	.0058	.0083	.0084	.0101	.0116	.0109
PHASE ANGLE =		193.6	206.2	164.1	124.8	107.0	94.4	100.7	109.9
RADIUS = .700									
AMPLITUDE =		.0173	.0102	.0001	.0086	.0110	.0133	.0138	.0117
PHASE ANGLE =		183.3	210.0	333.7	77.2	75.8	74.3	81.6	91.5
RADIUS = .800									
AMPLITUDE =		.0068	.0030	.0070	.0072	.0058	.0044	.0057	.0059
PHASE ANGLE =		174.1	128.8	102.3	104.7	121.8	89.1	96.6	116.2
RADIUS = .900									
AMPLITUDE =		.0037	.0078	.0105	.0066	.0046	.0006	.0016	.0021
PHASE ANGLE =		90.7	77.4	99.4	107.7	142.1	103.0	97.8	133.2
RADIUS = 1.000									
AMPLITUDE =		.0082	.0097	.0094	.0070	.0058	.0048	.0043	.0042
PHASE ANGLE =		80.3	83.4	88.7	68.5	65.5	36.7	21.9	19.1

TABLE B-11 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 181

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .330									
AMPLITUDE =		.4117	.0232	.0213	.0164	.0245	.0328	.0269	.0135
PHASE ANGLE =		265.3	130.9	261.4	22.4	116.7	193.8	255.1	341.0
RADIUS = .512									
AMPLITUDE =		.3095	.0371	.0189	.0038	.0175	.0241	.0244	.0119
PHASE ANGLE =		264.3	85.1	140.0	148.4	90.5	123.7	155.7	182.2
RADIUS = .711									
AMPLITUDE =		.2666	.0516	.0426	.0231	.0097	.0117	.0127	.0113
PHASE ANGLE =		267.0	84.7	141.5	210.5	314.2	33.7	74.4	74.4
RADIUS = .911									
AMPLITUDE =		.2656	.0592	.0560	.0445	.0242	.0171	.0132	.0082
PHASE ANGLE =		263.3	72.5	127.0	190.1	253.6	332.6	39.4	67.6
RADIUS = 1.082									
AMPLITUDE =		.2537	.0501	.0636	.0575	.0404	.0278	.0178	.0097
PHASE ANGLE =		260.0	63.1	113.0	171.6	225.5	285.4	352.3	37.0
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .330									
AMPLITUDE =		.0114	.0139	.0097	.0054	.0038	.0037	.0042	.0051
PHASE ANGLE =		97.9	171.4	226.3	258.1	295.6	330.0	26.5	76.5
RADIUS = .512									
AMPLITUDE =		.0019	.0073	.0089	.0105	.0093	.0064	.0084	.0078
PHASE ANGLE =		148.0	76.7	70.4	75.2	80.7	71.6	57.0	76.9
RADIUS = .711									
AMPLITUDE =		.0102	.0070	.0017	.0064	.0094	.0100	.0099	.0077
PHASE ANGLE =		73.5	88.3	38.0	345.9	351.5	350.5	352.0	.7
RADIUS = .911									
AMPLITUDE =		.0068	.0081	.0071	.0061	.0074	.0082	.0073	.0051
PHASE ANGLE =		36.2	26.1	19.9	.3	342.0	330.3	337.7	327.6
RADIUS = 1.082									
AMPLITUDE =		.0046	.0047	.0030	.0024	.0090	.0084	.0045	.0071
PHASE ANGLE =		37.7	20.3	27.6	282.3	302.2	316.9	308.7	280.3

TABLE B-12 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 181

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .280									
AMPLITUDE =		.4504	.0256	.0335	.0216	.0250	.0428	.0418	.0263
PHASE ANGLE =		265.9	154.2	268.2	16.2	126.2	211.3	275.1	350.4
RADIUS = .300									
AMPLITUDE =		.4344	.0241	.0284	.0195	.0248	.0383	.0351	.0208
PHASE ANGLE =		265.6	145.1	266.3	18.5	122.2	204.9	268.6	347.7
RADIUS = .400									
AMPLITUDE =		.3653	.0265	.0091	.0095	.0231	.0262	.0191	.0038
PHASE ANGLE =		264.6	103.5	221.4	35.8	105.9	163.5	205.8	253.2
RADIUS = .500									
AMPLITUDE =		.3144	.0360	.0171	.0033	.0183	.0243	.0239	.0115
PHASE ANGLE =		264.2	86.0	142.2	130.3	92.3	127.2	158.8	184.5
RADIUS = .600									
AMPLITUDE =		.2853	.0445	.0309	.0115	.0078	.0142	.0145	.0073
PHASE ANGLE =		266.2	86.8	144.3	212.6	46.4	93.9	126.1	118.5
RADIUS = .700									
AMPLITUDE =		.2679	.0510	.0416	.0220	.0090	.0115	.0125	.0110
PHASE ANGLE =		267.0	85.1	142.0	211.3	319.9	39.2	78.5	76.3
RADIUS = .800									
AMPLITUDE =		.2679	.0573	.0494	.0339	.0156	.0141	.0132	.0096
PHASE ANGLE =		265.4	78.4	135.0	280.7	278.2	4.7	62.1	75.6
RADIUS = .900									
AMPLITUDE =		.2661	.0593	.0554	.0436	.0233	.0167	.0132	.0083
PHASE ANGLE =		263.5	73.0	127.8	191.2	255.7	335.8	42.1	69.0
RADIUS = 1.000									
AMPLITUDE =		.2607	.0563	.0602	.0515	.0319	.0211	.0144	.0082
PHASE ANGLE =		261.6	68.0	120.1	180.9	238.1	306.5	14.7	52.6

TABLE B-12 CONTINUED

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .200									
AMPLITUDE	=	.0171	.0208	.0186	.0141	.0110	.0082	.0046	.0032
PHASE ANGLE	=	92.9	180.4	233.0	260.8	285.2	306.9	338.8	55.3
RADIUS = .300									
AMPLITUDE	=	.0147	.0178	.0148	.0104	.0079	.0051	.0040	.0040
PHASE ANGLE	=	94.6	177.4	231.1	260.0	287.1	312.5	358.2	67.2
RADIUS = .400									
AMPLITUDE	=	.0056	.0075	.0022	.0036	.0040	.0034	.0064	.0071
PHASE ANGLE	=	111.4	142.3	140.3	83.4	79.1	58.3	55.7	82.9
RADIUS = .500									
AMPLITUDE	=	.0021	.0070	.0084	.0102	.0091	.0063	.0083	.0079
PHASE ANGLE	=	146.5	80.5	71.5	76.1	81.8	72.8	58.2	78.3
RADIUS = .600									
AMPLITUDE	=	.0067	.0074	.0043	.0057	.0070	.0071	.0083	.0066
PHASE ANGLE	=	84.7	90.2	71.0	35.7	28.4	16.5	17.2	34.0
RADIUS = .700									
AMPLITUDE	=	.0100	.0071	.0018	.0062	.0092	.0098	.0098	.0076
PHASE ANGLE	=	74.4	89.5	44.4	348.4	353.4	352.0	353.6	2.9
RADIUS = .800									
AMPLITUDE	=	.0081	.0071	.0054	.0070	.0084	.0089	.0089	.0062
PHASE ANGLE	=	54.7	48.2	21.8	357.8	352.6	341.7	346.6	352.0
RADIUS = .900									
AMPLITUDE	=	.0069	.0081	.0071	.0063	.0075	.0082	.0074	.0051
PHASE ANGLE	=	37.5	27.4	19.9	.6	343.8	331.4	338.8	330.8
RADIUS = 1.000									
AMPLITUDE	=	.0058	.0072	.0060	.0039	.0075	.0081	.0058	.0055
PHASE ANGLE	=	30.7	19.7	21.0	348.8	322.5	322.4	326.5	300.1

TABLE B-13

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 182

INPUT DATA				RADIUS = .512			
ANGLE	RADIUS = .330			ANGLE	VX/V	VT/V	VR/V
	VX/V	VT/V	VR/V				
-0.4	.915	-.502	-.034	-8.9	.846	-.224	.058
5.0	.965	-.527	-.051	-4.9	.748	-.290	.069
10.7	.999	-.513	-.065	-1.0	.685	-.349	.017
14.8	.994	-.492	-.067	3.0	.711	-.422	-.061
24.7	.992	-.470	-.049	7.0	.776	-.459	-.091
34.7	.975	-.440	-.039	9.4	.891	-.465	-.052
44.7	.979	-.380	-.021	14.8	.961	-.440	-.005
54.8	.965	-.385	-.008	18.9	1.009	-.399	.036
58.9	.969	-.273	-.003	22.9	1.007	-.377	.058
64.8	.957	-.211	-0.000	26.8	1.022	-.355	.089
75.0	.948	-.091	.011	30.9	1.004	-.346	.113
78.9	.934	-.046	.011	38.8	.978	-.327	.159
84.9	.944	.031	.006	58.9	.968	-.212	.247
94.9	.958	.139	.008	69.3	.986	-.125	.282
99.0	.979	.185	.013	78.9	.972	-.059	.289
105.0	1.012	.258	.010	89.4	.989	.049	.305
109.5	1.032	.307	.015	98.8	.966	.130	.310
114.9	1.060	.347	.012	109.3	.958	.237	.312
119.2	1.077	.392	.014	119.1	.968	.310	.290
125.2	1.098	.454	.010	129.5	.972	.399	.265
135.1	1.115	.545	.004	139.0	.991	.464	.223
139.2	1.140	.567	.006	151.5	1.004	.522	.163
145.0	1.128	.612	-.001	158.8	1.025	.540	.118
149.5	1.091	.641	-.004	171.3	1.046	.571	.045
154.9	1.154	.650	-.008	179.4	1.145	.582	-.003
158.9	1.153	.659	-.008	187.4	1.034	.572	-.059
164.8	1.148	.675	-.020	190.9	1.029	.575	-.076
175.0	1.112	.696	-.038	198.9	1.020	.561	-.124
179.0	1.108	.693	-.040	209.4	1.013	.531	-.188
189.3	1.087	.719	-.051	218.7	.988	.508	-.232
198.7	1.064	.693	-.066	229.4	.997	.432	-.287
204.7	1.105	.651	-.056	238.9	.983	.384	-.307
209.3	1.107	.608	-.084	249.4	.966	.301	-.239
214.7	1.127	.622	.025	255.2	.970	.281	-.165
218.7	.966	.711	.076	259.0	.968	.278	-.109
224.7	.867	.485	.081	263.0	.964	.216	-.046
229.2	.843	.399	.065	271.1	.941	.211	-.051
234.8	1.008	.307	-.005	275.0	.883	.203	-.095
238.8	1.023	.318	-.007	279.0	.852	.181	-.109
244.8	.944	.256	-.011	283.1	.763	.186	-.114
249.1	.902	.166	-.002	287.1	.700	.145	-.089
254.9	.943	.103	-.011	291.2	.552	.162	-.057
258.9	.988	.073	-.009	295.1	.411	.157	-.047
264.8	.969	.121	-.008	299.0	.346	.087	-.033
269.1	.912	.133	-.001	299.1	.237	.112	-.004
274.9	.907	.182	.004	303.1	0.000	0.000	0.000
278.9	.839	.213	.043	307.2	0.000	0.000	0.000
284.7	.724	.240	.041	309.8	0.000	0.000	0.000
289.3	.469	.313	.052	311.2	0.000	0.000	0.000
294.9	.386	.347	.018	315.0	0.000	0.000	0.000
299.0	.385	.178	.019	317.1	0.000	0.000	0.000
304.9	.253	.331	-.029	319.2	0.000	0.000	0.000
309.4	0.000	0.000	0.000	321.3	0.000	0.000	0.000
314.9	0.000	0.000	0.000	323.3	.675	-.533	-.132
319.0	0.000	0.000	0.000	327.0	.884	-.448	-.144
324.9	.284	.030	-.002	329.6	.939	-.481	-.195
334.8	.565	-.283	.056	331.0	.945	-.383	-.139
338.8	.596	-.295	.059	335.0	1.014	-.321	-.117
344.7	.603	-.389	.032	339.0	1.013	-.275	-.068
349.2	.668	-.351	.011	343.0	1.085	-.242	-.016
358.8	.719	-.792	-.037	347.0	.921	-.216	.023
359.6	.915	-.582	-.034	351.1	.846	-.224	.058
365.0	.965	-.527	-.051	355.1	.748	-.290	.069
370.7	.999	-.513	-.065	359.0	.885	-.349	.017
374.8	.994	-.492	-.067	363.0	.711	-.422	-.061
				367.0	.776	-.459	-.091
				369.4	.891	-.465	-.052
				374.8	.961	-.440	-.005

TABLE B-13 CONTINUED

ANGLE	RADIUS =	.711	350.9	.987	-.283	-.047
	VX/V	VT/V	VR/V			
-6.6	.977	-.280	-.044	351.2	.977	-.280
-6.6	.954	-.255	-.022	353.4	.954	-.255
-2.6	.872	-.226	.016	357.4	.872	-.226
-.6	.822	-.231	.034	359.4	.822	-.231
1.4	.746	-.242	.053	361.4	.746	-.242
5.3	.699	-.298	.067	365.3	.699	-.298
9.4	.773	-.385	.029	369.4	.773	-.385
10.8	.813	-.426	.025	370.8	.813	-.426
13.3	.884	-.436	.027			
17.3	.994	-.424	.064	ANGLE	RADIUS =	.911
21.3	.995	-.389	.094	-9.3	1.007	-.266
25.2	.993	-.377	.123	-5.2	.999	-.252
29.2	.991	-.359	.147	-1.2	.983	-.219
31.6	.990	-.344	.154	-.7	.908	-.216
33.1	.980	-.356	.176	1.2	.887	-.212
38.8	.975	-.341	.198	2.6	.874	-.190
51.4	.993	-.261	.271	3.2	.859	-.190
71.3	1.011	-.124	.330	6.8	.764	-.220
78.9	1.005	-.080	.341	10.5	.729	-.337
91.5	1.018	.039	.356	11.2	.732	-.335
99.0	.994	.095	.361	14.5	.793	-.407
111.4	.971	.193	.355	18.6	.930	-.395
118.9	.953	.243	.340	22.5	.960	-.346
131.6	.945	.329	.296	26.6	.971	-.325
138.9	.941	.376	.258	30.6	.976	-.318
151.4	.950	.436	.185	34.5	.978	-.308
158.7	.957	.467	.139	41.1	.964	-.287
171.4	.972	.490	.048	51.2	.978	-.239
178.5	.978	.501	-.009	61.2	.978	-.173
181.2	.972	.498	-.028	71.2	.966	-.105
191.2	.956	.495	-.105	81.2	1.002	-.029
198.7	.942	.494	-.155	91.2	1.005	.052
211.2	.936	.444	-.249	101.2	.967	.133
218.6	.933	.425	-.291	111.5	.960	.212
231.2	.949	.324	-.358	121.5	.974	.280
238.6	.952	.277	-.376	131.5	.939	.351
249.4	.972	.169	-.371	141.5	.951	.405
253.3	.991	.130	-.328	151.3	.956	.452
257.4	1.012	.063	-.287	161.3	.974	.485
258.7	1.024	.051	-.269	171.2	.992	.504
261.4	1.042	.006	-.246	179.8	1.022	.515
265.3	1.048	-.047	-.227	191.7	1.016	.520
269.3	1.046	-.089	-.237	201.6	1.007	.498
271.1	1.031	-.103	-.258	211.6	.989	.483
273.4	1.020	-.112	-.269	221.4	.984	.438
277.4	1.019	-.114	-.268	231.4	.977	.369
281.6	1.036	-.122	-.263	241.5	.966	.287
285.6	.997	-.104	-.217	251.5	.995	.168
289.5	.968	-.084	-.141	255.2	1.005	.102
291.4	.935	-.071	-.106	259.0	1.021	.052
293.5	.909	-.059	-.079	262.9	1.027	.011
297.5	.856	-.085	.020	266.8	1.026	-.057
301.7	.780	-.110	.077	270.9	1.009	-.087
305.6	.739	-.138	.128	274.8	.988	-.126
309.6	.679	-.259	.150	278.9	1.009	-.143
313.6	.724	-.351	.111	282.8	1.012	-.160
317.6	.866	-.433	.034	286.9	1.005	-.160
319.0	.879	-.427	-.022	291.7	1.031	-.160
321.8	.993	-.398	-.064	294.8	1.039	-.145
325.7	1.008	-.345	-.103	298.8	1.033	-.133
329.6	1.017	-.333	-.114	302.9	1.037	-.117
333.6	1.016	-.323	-.120	306.9	1.045	-.097
337.7	1.023	-.319	-.114	310.9	1.031	-.099
341.6	1.026	-.318	-.098	314.9	.964	-.032
345.6	1.025	-.310	-.079	319.0	.873	-.105
349.5	1.016	-.290	-.049	321.6	.869	-.210
				322.9	.897	-.215
						.001

TABLE B-13 CONTINUED

326.9	1.000	-.211	-.064	333.3	.966	-.216	-.210
331.5	1.008	-.207	-.102	337.2	.957	-.252	-.202
334.8	1.006	-.210	-.112	341.2	.942	-.282	-.179
338.8	1.015	-.237	-.107	345.3	.963	-.310	-.154
342.7	1.009	-.257	-.106	348.8	.973	-.322	-.138
346.7	1.015	-.267	-.099	353.1	.976	-.324	-.112
350.7	1.007	-.266	-.075	357.0	.965	-.318	-.081
354.8	.999	-.252	-.044	359.6	.942	-.296	-.046
358.8	.983	-.219	0.000	363.6	.860	-.274	.005
359.3	.908	-.216	.001	367.4	.762	-.342	.065
361.2	.887	-.212	.024				
362.6	.874	-.190	.038				
363.2	.859	-.190	.046				
366.8	.764	-.220	.068				

RADIUS = 1.082

ANGLE	VX/V	VT/V	VR/V
-3.0	.965	-.318	-.081
-.4	.942	-.296	-.046
3.6	.860	-.274	.005
7.4	.762	-.342	.065
11.5	.733	-.391	.119
13.5	.795	-.426	.132
17.3	.908	-.451	.115
21.5	.958	-.415	.118
25.4	.986	-.384	.148
33.3	.966	-.369	.205
38.6	.961	-.363	.236
48.7	.964	-.324	.304
58.8	.970	-.266	.347
69.3	.999	-.166	.383
78.8	1.003	-.122	.397
89.3	1.038	-.015	.408
98.7	1.031	.038	.406
109.5	1.031	.134	.393
118.9	.991	.183	.408
129.7	.991	.266	.360
139.0	.987	.316	.330
149.5	1.008	.362	.251
158.9	1.006	.396	.203
169.6	1.017	.419	.107
179.6	1.024	.439	.028
189.3	1.021	.446	-.053
198.6	.996	.436	-.129
209.3	.990	.416	-.223
218.5	1.004	.377	-.285
229.3	.968	.320	-.374
238.7	.964	.267	-.424
249.3	.955	.141	-.465
253.3	.973	.102	-.457
258.7	.991	.038	-.437
261.2	1.027	-.018	-.415
265.3	1.021	-.068	-.403
269.2	.985	-.128	-.422
273.2	.962	-.169	-.402
277.3	.962	-.218	-.368
281.3	.933	-.243	-.327
285.4	.935	-.267	-.265
289.4	.956	-.267	-.197
293.4	.969	-.242	-.143
298.9	.970	-.227	-.100
301.6	.969	-.199	-.060
305.5	.936	-.163	-.053
309.5	.949	-.132	-.042
313.4	.967	-.096	-.040
317.5	.925	-.064	-.053
321.6	.930	-.034	-.034
325.3	.908	-.110	-.075
328.9	.972	-.203	-.183

TABLE B-14 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 182

RADIUS =	.330	.512	.711	.911	1.082	.280	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.886	.887	.956	.977	.976	.896	.891	.879	.885	.923	.953	.968	.977	.979
VTBAR =	.148	.122	.039	.074	.013	.147	.148	.144	.125	.071	.040	.069	.075	.053
VRBAR =	-.005	.037	.033	.041	.025	-.024	-.016	.016	.036	.034	.033	.040	.041	.035
1-WVX =	.890	.884	.905	.933	.947	0.000	.893	.885	.883	.891	.906	.921	.933	.942
1-WX =	.879	.846	.878	.915	.932	0.000	.892	.855	.848	.859	.882	.902	.915	.926
BBAR =	31.53	22.59	18.65	14.98	12.90	35.70	33.91	27.16	22.97	20.83	18.86	16.79	15.14	13.82
BPOS =	20.44	9.38	4.14	2.05	1.40	30.84	25.07	14.94	9.81	6.68	4.36	2.94	2.13	1.53
THETA =	10.00	20.00	17.50	347.50	25.00	357.50	357.50	12.50	20.00	17.50	17.50	340.00	347.50	295.00
BNEG =	-32.40	-23.71	-3.58	-2.39	-2.31	-33.80	-32.13	-30.82	-24.79	-11.96	-4.19	-2.33	-2.36	-2.49
THETA =	312.50	320.00	310.00	10.00	10.00	325.00	312.50	320.00	320.00	310.00	310.00	7.50	10.00	10.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.

VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.

VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.

1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.

1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.

BBAR IS MEAN ANGLE OF ADVANCE.

BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).

BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).

THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-15 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 182

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .330									
AMPLITUDE =		.2935	.1671	.1543	.0910	.0646	.0287	.0157	.0265
PHASE ANGLE =		309.3	14.2	36.9	86.9	153.8	227.0	295.0	289.8
RADIUS = .512									
AMPLITUDE =		.1981	.1618	.1111	.1092	.0978	.1011	.0919	.0670
PHASE ANGLE =		314.0	15.8	64.3	128.3	187.7	232.4	267.4	295.8
RADIUS = .711									
AMPLITUDE =		.0240	.0349	.0064	.0386	.0441	.0485	.0393	.0219
PHASE ANGLE =		325.0	310.0	357.9	142.3	207.8	237.4	265.9	282.9
RADIUS = .911									
AMPLITUDE =		.0259	.0193	.0299	.0065	.0184	.0177	.0249	.0250
PHASE ANGLE =		220.6	258.3	244.6	142.3	209.6	195.7	193.8	193.2
RADIUS = 1.082									
AMPLITUDE =		.0421	.0170	.0181	.0083	.0144	.0174	.0119	.0177
PHASE ANGLE =		293.3	256.6	228.4	145.2	237.4	223.1	187.1	182.6
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .330									
AMPLITUDE =		.0256	.0102	.0314	.0306	.0139	.0087	.0202	.0184
PHASE ANGLE =		353.2	334.1	.7	67.1	141.4	66.9	170.9	278.3
RADIUS = .512									
AMPLITUDE =		.0460	.0262	.0156	.0106	.0079	.0115	.0148	.0133
PHASE ANGLE =		324.0	351.0	40.0	106.2	158.8	187.7	202.6	230.1
RADIUS = .711									
AMPLITUDE =		.0116	.0061	.0164	.0207	.0175	.0125	.0094	.0048
PHASE ANGLE =		283.3	183.7	171.1	188.5	214.0	221.2	222.2	228.6
RADIUS = .911									
AMPLITUDE =		.0174	.0079	.0089	.0121	.0102	.0123	.0120	.0082
PHASE ANGLE =		219.2	242.6	169.8	125.4	107.3	123.6	138.5	154.3
RADIUS = 1.082									
AMPLITUDE =		.0190	.0066	.0116	.0128	.0105	.0068	.0104	.0095
PHASE ANGLE =		211.3	169.0	144.8	145.1	153.8	122.3	117.2	131.5

TABLE B-16 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 182

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .200									
AMPLITUDE	=	.3094	.1472	.1675	.0939	.0558	.0120	.0304	.0050
PHASE ANGLE	=	307.7	11.3	26.2	62.9	124.8	67.9	67.5	222.9
RADIUS = .300									
AMPLITUDE	=	.3036	.1562	.1617	.0909	.0579	.0063	.0138	.0128
PHASE ANGLE	=	308.4	12.7	30.6	72.9	138.2	203.9	46.5	278.1
RADIUS = .400									
AMPLITUDE	=	.2639	.1797	.1398	.1010	.0838	.0702	.0583	.0513
PHASE ANGLE	=	311.3	16.1	49.7	110.3	174.2	230.9	271.2	294.8
RADIUS = .500									
AMPLITUDE	=	.2063	.1660	.1150	.1097	.0977	.0999	.0904	.0668
PHASE ANGLE	=	313.7	16.0	63.0	127.1	186.7	232.3	267.6	295.9
RADIUS = .600									
AMPLITUDE	=	.1027	.0837	.0539	.0728	.0696	.0756	.0662	.0445
PHASE ANGLE	=	317.5	2.1	60.0	133.2	195.6	235.6	269.3	295.4
RADIUS = .700									
AMPLITUDE	=	.0298	.0367	.0088	.0414	.0461	.0509	.0417	.0238
PHASE ANGLE	=	324.1	317.4	22.5	141.2	206.5	237.4	266.8	285.6
RADIUS = .800									
AMPLITUDE	=	.0150	.0237	.0185	.0198	.0301	.0286	.0268	.0184
PHASE ANGLE	=	234.3	287.6	254.9	142.1	206.5	221.2	230.4	225.1
RADIUS = .900									
AMPLITUDE	=	.0255	.0195	.0295	.0073	.0192	.0183	.0250	.0246
PHASE ANGLE	=	219.0	260.5	245.3	142.2	208.9	197.6	196.2	194.8
RADIUS = 1.000									
AMPLITUDE	=	.0274	.0184	.0282	.0041	.0138	.0150	.0213	.0246
PHASE ANGLE	=	251.3	249.2	239.3	144.7	221.5	196.0	182.3	185.1

TABLE B-16 CONTINUED

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .280									
AMPLITUDE =		.0180	.0051	.0360	.0376	.0164	.0152	.0228	.0224
PHASE ANGLE =		33.8	233.6	352.0	85.1	145.5	47.4	162.1	292.1
RADIUS = .300									
AMPLITUDE =		.0200	.0048	.0341	.0347	.0153	.0123	.0217	.0206
PHASE ANGLE =		12.8	298.2	355.4	65.8	143.7	53.2	165.5	286.9
RADIUS = .400									
AMPLITUDE =		.0387	.0213	.0254	.0215	.0110	.0058	.0175	.0153
PHASE ANGLE =		334.5	347.3	13.6	73.0	139.9	136.7	183.8	256.9
RADIUS = .500									
AMPLITUDE =		.0462	.0264	.0167	.0114	.0081	.0110	.0150	.0135
PHASE ANGLE =		324.8	350.8	36.4	99.9	155.0	185.3	200.8	232.2
RADIUS = .600									
AMPLITUDE =		.0268	.0076	.0077	.0145	.0144	.0130	.0124	.0089
PHASE ANGLE =		317.2	350.9	129.5	175.5	207.5	215.6	219.0	235.8
RADIUS = .700									
AMPLITUDE =		.0125	.0052	.0159	.0205	.0176	.0128	.0097	.0052
PHASE ANGLE =		289.2	183.6	169.8	188.4	214.2	221.8	223.2	231.0
RADIUS = .800									
AMPLITUDE =		.0129	.0069	.0118	.0130	.0072	.0090	.0089	.0058
PHASE ANGLE =		241.1	232.6	174.3	198.4	161.6	159.3	168.9	180.2
RADIUS = .900									
AMPLITUDE =		.0170	.0079	.0090	.0120	.0099	.0122	.0118	.0080
PHASE ANGLE =		220.4	243.1	170.9	127.1	108.5	125.2	140.3	156.1
RADIUS = 1.000									
AMPLITUDE =		.0193	.0062	.0090	.0123	.0106	.0115	.0124	.0093
PHASE ANGLE =		213.0	223.2	156.8	125.1	115.1	117.3	127.1	142.2

TABLE B-17 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 182

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .330									
AMPLITUDE	=	.5392	.1321	.0944	.0649	.0276	.0155	.0168	.0113
PHASE ANGLE	=	260.3	182.2	243.0	323.0	57.5	201.0	249.9	286.6
RADIUS = .512									
AMPLITUDE	=	.4754	.0515	.0208	.0191	.0214	.0225	.0240	.0244
PHASE ANGLE	=	259.7	204.7	286.2	356.8	84.2	129.5	155.0	170.6
RADIUS = .711									
AMPLITUDE	=	.4393	.0408	.0249	.0058	.0286	.0348	.0267	.0162
PHASE ANGLE	=	270.2	98.7	148.6	51.9	78.5	122.3	161.1	219.6
RADIUS = .911									
AMPLITUDE	=	.4131	.0621	.0531	.0269	.0179	.0199	.0181	.0128
PHASE ANGLE	=	268.9	109.6	165.2	245.2	356.5	65.1	102.0	114.5
RADIUS = 1.082									
AMPLITUDE	=	.3975	.0657	.0676	.0414	.0266	.0218	.0151	.0126
PHASE ANGLE	=	267.5	114.1	165.5	232.1	307.4	10.4	63.9	85.9
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .330									
AMPLITUDE	=	.0122	.0083	.0056	.0002	.0158	.0216	.0114	.0089
PHASE ANGLE	=	313.4	37.9	192.4	36.2	176.2	256.0	328.6	253.1
RADIUS = .512									
AMPLITUDE	=	.0252	.0232	.0201	.0162	.0129	.0118	.0120	.0131
PHASE ANGLE	=	189.7	197.5	223.9	256.2	300.1	342.7	33.6	76.6
RADIUS = .711									
AMPLITUDE	=	.0069	.0083	.0129	.0135	.0131	.0087	.0045	.0017
PHASE ANGLE	=	298.8	51.2	79.2	86.0	99.8	128.5	137.7	132.5
RADIUS = .911									
AMPLITUDE	=	.0098	.0071	.0025	.0046	.0100	.0117	.0107	.0074
PHASE ANGLE	=	119.5	120.7	64.6	24.8	38.1	37.9	54.6	70.7
RADIUS = 1.082									
AMPLITUDE	=	.0118	.0109	.0077	.0037	.0026	.0058	.0043	.0073
PHASE ANGLE	=	105.8	113.9	106.4	91.7	8.1	5.3	14.6	26.7

TABLE B-18 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 182

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .280									
AMPLITUDE =		.5610	.1639	.1274	.0843	.0328	.0205	.0274	.0260
PHASE ANGLE =		261.7	176.0	237.5	319.2	50.1	222.4	270.9	311.1
RADIUS = .300									
AMPLITUDE =		.5520	.1505	.1135	.0762	.0305	.0181	.0226	.0194
PHASE ANGLE =		261.1	178.4	239.5	320.6	52.9	215.1	264.5	305.3
RADIUS = .400									
AMPLITUDE =		.5119	.0959	.0579	.0425	.0231	.0147	.0135	.0117
PHASE ANGLE =		259.1	191.8	254.1	330.8	69.3	161.7	192.0	189.6
RADIUS = .500									
AMPLITUDE =		.4789	.0558	.0237	.0209	.0213	.0216	.0230	.0237
PHASE ANGLE =		259.5	203.9	281.6	352.9	83.2	131.3	156.3	170.7
RADIUS = .600									
AMPLITUDE =		.4562	.0248	.0060	.0134	.0288	.0325	.0290	.0196
PHASE ANGLE =		265.6	153.0	193.7	25.0	84.7	128.1	162.6	200.2
RADIUS = .700									
AMPLITUDE =		.4408	.0387	.0231	.0068	.0291	.0351	.0291	.0167
PHASE ANGLE =		269.9	100.4	148.6	49.4	79.5	123.2	161.7	218.9
RADIUS = .800									
AMPLITUDE =		.4266	.0524	.0386	.0113	.0193	.0255	.0212	.0095
PHASE ANGLE =		269.7	105.2	160.6	255.5	47.8	101.4	135.9	166.6
RADIUS = .900									
AMPLITUDE =		.4144	.0613	.0518	.0256	.0176	.0201	.0182	.0124
PHASE ANGLE =		269.0	109.3	165.0	246.0	1.1	69.0	105.1	117.4
RADIUS = 1.000									
AMPLITUDE =		.4042	.0657	.0618	.0358	.0220	.0198	.0171	.0143
PHASE ANGLE =		268.2	112.1	166.0	238.9	326.6	34.4	80.7	98.3

TABLE B-18 CONTINUED

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	9	10	11	12	13	14	15	16
RADIUS = .280									
AMPLITUDE =		.0296	.0265	.0085	.0120	.0287	.0310	.0142	.0205
PHASE ANGLE =		337.7	28.0	83.0	76.8	159.4	240.8	302.2	253.8
RADIUS = .300									
AMPLITUDE =		.0218	.0187	.0046	.0069	.0230	.0268	.0127	.0156
PHASE ANGLE =		332.0	29.9	112.6	76.2	164.4	246.1	312.1	253.6
RADIUS = .400									
AMPLITUDE =		.0127	.0108	.0156	.0110	.0084	.0141	.0113	.0033
PHASE ANGLE =		210.1	192.3	221.3	257.9	243.3	289.5	3.5	79.0
RADIUS = .500									
AMPLITUDE =		.0247	.0229	.0203	.0164	.0128	.0128	.0121	.0127
PHASE ANGLE =		190.1	197.5	224.2	256.5	297.4	338.3	31.2	76.6
RADIUS = .600									
AMPLITUDE =		.0106	.0057	.0053	.0028	.0033	.0023	.0041	.0056
PHASE ANGLE =		221.6	173.5	153.3	135.5	84.5	87.9	71.2	87.6
RADIUS = .700									
AMPLITUDE =		.0069	.0076	.0123	.0129	.0126	.0083	.0043	.0018
PHASE ANGLE =		293.0	52.7	80.8	87.3	100.2	129.2	136.8	127.8
RADIUS = .800									
AMPLITUDE =		.0026	.0057	.0062	.0099	.0109	.0088	.0079	.0052
PHASE ANGLE =		130.1	88.0	69.9	51.5	65.9	65.9	71.3	86.6
RADIUS = .900									
AMPLITUDE =		.0093	.0069	.0026	.0088	.0102	.0116	.0107	.0073
PHASE ANGLE =		120.1	119.4	62.8	26.1	40.1	39.6	55.7	72.3
RADIUS = 1.000									
AMPLITUDE =		.0122	.0091	.0033	.0059	.0074	.0103	.0088	.0076
PHASE ANGLE =		114.2	122.2	96.7	26.9	25.1	26.1	44.5	53.7

TABLE B-19

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 183

INPUT DATA				RADIUS = .512			
ANGLE	RADIUS = .330			ANGLE	VX/V	VT/V	VR/V
	VX/V	VT/V	VR/V				
-14.5	.698	-.190	.118	-10.6	.982	-.183	0.000
-10.9	.728	-.191	.095	-5.6	.947	-.140	.039
-4.4	.710	-.250	.057	-.9	.826	-.140	.062
-1.0	.715	-.317	.021	4.5	.767	-.217	.052
3.7	.863	-.374	0.000	9.2	.769	-.323	.003
5.3	.891	-.393	-.002	14.5	.901	-.331	-.026
8.7	.944	-.414	-.011	18.5	.989	-.307	.012
15.3	1.045	-.365	-.024	24.5	.991	-.270	.057
18.7	1.028	-.360	-.033	29.1	1.010	-.245	.074
25.3	1.033	-.331	-.041	34.4	1.001	-.236	.094
29.6	1.025	-.309	-.039	38.4	.986	-.231	.108
35.2	1.007	-.306	-.038	58.6	.971	-.158	.173
38.5	.935	-.299	-.034	68.9	.976	-.103	.207
44.9	.986	-.278	-.030	78.6	.984	-.053	.218
56.6	.973	-.202	-.019	89.0	.997	.019	.234
69.3	.988	-.109	-.009	98.5	.977	.079	.235
75.4	.974	-.057	-.005	109.1	.976	.155	.241
89.3	.966	.056	-.008	118.7	.979	.213	.229
95.4	.968	.103	-.010	129.4	.980	.278	.212
96.5	.957	.124	-.009	138.9	.995	.328	.183
109.2	1.019	.217	-.006	149.3	1.007	.375	.149
115.5	1.020	.266	-.003	158.8	1.036	.405	.107
118.6	1.044	.281	-.003	169.2	1.044	.426	.064
129.4	1.054	.364	-.010	169.2	1.043	.427	.065
138.7	1.089	.420	-.010	178.7	1.055	.446	.020
149.3	1.071	.500	-.019	179.3	1.052	.448	.018
158.6	1.117	.521	-.020	179.6	1.051	.444	.015
169.3	1.098	.557	-.032	188.6	1.046	.450	-.020
178.7	1.112	.561	-.041	199.0	1.041	.441	-.072
189.1	1.115	.559	-.050	209.5	1.020	.415	-.125
198.5	1.094	.544	-.059	218.8	1.014	.391	-.167
209.1	1.101	.502	-.066	229.3	1.009	.332	-.205
218.4	1.132	.485	-.011	238.7	.997	.292	-.233
225.3	1.144	.438	-.021	249.2	.983	.221	-.209
229.0	1.142	.420	.013	258.7	.973	.162	-.100
235.3	1.056	.394	.081	269.3	.948	.091	-.050
238.5	.997	.342	.121	271.2	.924	.075	-.062
245.3	.948	.256	.085	275.2	.912	.055	-.109
248.9	.899	.202	.044	278.5	.909	.019	-.129
255.3	.897	.080	.010	279.2	.899	.040	-.131
258.5	.959	.008	-.005	283.2	.897	.017	-.131
265.2	.929	.040	-.007	287.1	.861	.022	-.102
269.0	.887	.090	-.008	289.2	.822	.025	-.077
275.3	.822	.148	.018	291.2	.810	.025	-.045
285.3	.648	.203	.054	294.6	.790	.032	-.040
289.1	.522	.195	.053	295.2	.745	.024	-.005
295.4	.432	.062	.071	299.2	.673	.020	.013
305.4	.342	-.063	.116	303.3	.599	-.090	.093
315.6	.425	-.137	.108	307.3	.611	-.175	.171
325.6	.628	-.271	.087	309.4	.650	-.179	.161
329.4	.684	-.291	.094	311.3	.666	-.222	.180
335.6	.769	-.256	.122	314.7	.691	-.252	.156
338.8	.707	-.235	.136	318.7	.785	-.298	.119
345.5	.698	-.190	.118	319.0	.790	-.321	.116
355.6	.710	-.250	.057	324.8	.933	-.283	.022
358.7	.719	-.314	.031	329.3	.992	-.236	-.036
359.0	.715	-.317	.021	334.6	.983	-.216	-.054
363.7	.863	-.374	0.000	338.7	.987	-.206	-.057
365.3	.891	-.393	-.002	349.4	.982	-.183	0.000
368.7	.944	-.414	-.011	354.4	.947	-.140	.039
375.3	1.045	-.365	-.024	359.1	.826	-.140	.062
378.7	1.028	-.360	-.033	364.5	.767	-.217	.052
				369.2	.769	-.323	.003
				374.5	.901	-.331	-.026
				378.5	.989	-.307	.012

TABLE B-19 CONTINUED

ANGLE	RADIUS = .711			ANGLE	RADIUS = .911		
	VX/V	VT/V	VR/V		VX/V	VT/V	VR/V
-1.2	.996	-.183	-.032	-15.5	.989	-.143	-.106
4.8	.930	-.145	.017	-10.8	.995	-.161	-.087
5.5	.866	-.145	.015	-5.6	1.003	-.177	-.074
8.7	.792	-.185	.051	-2.9	1.003	-.175	-.061
9.5	.807	-.191	.060	-1.4	1.000	-.172	-.061
14.9	.863	-.316	.044	1.0	.981	-.164	-.040
18.8	.964	-.309	.036	5.2	.927	-.137	-.006
29.4	1.003	-.254	.098	9.2	.847	-.129	.055
34.7	.990	-.251	.123	12.6	.786	-.186	.075
38.8	.983	-.243	.139	16.5	.810	-.289	.093
49.3	.993	-.203	.179	18.5	.903	-.292	.089
58.8	.983	-.176	.214	20.6	.924	-.279	.086
69.3	1.000	-.120	.242	24.5	.973	-.246	.097
78.7	1.003	-.076	.258	29.2	.980	-.220	.118
89.2	1.015	-.002	.273	34.4	.971	-.208	.140
98.7	.999	.044	.275	38.5	.962	-.204	.156
109.2	.981	.111	.276	44.4	.966	-.189	.185
118.7	.977	.153	.268	49.0	.978	-.170	.204
129.3	.966	.214	.247	58.5	.959	-.141	.235
138.8	.970	.249	.219	68.9	.977	-.094	.272
149.3	.967	.296	.176	78.5	.987	-.052	.291
158.7	.971	.319	.135	88.9	1.016	.009	.310
169.2	.981	.346	.079	98.5	.997	.059	.315
178.6	.994	.357	.027	109.2	.983	.123	.317
189.2	.978	.361	-.037	118.8	.970	.173	.304
198.5	.979	.360	-.086	129.4	.958	.232	.282
209.1	.964	.345	-.155	138.9	.967	.276	.258
218.4	.957	.319	-.203	149.3	.973	.319	.214
229.1	.962	.271	-.256	158.8	.977	.344	.167
238.6	.971	.222	-.297	169.3	.989	.370	.108
248.9	.990	.139	-.299	178.9	1.005	.387	.059
255.3	1.000	.091	-.277	189.5	1.026	.392	.001
259.2	1.016	.041	-.259	198.8	1.008	.396	-.052
265.0	1.036	-.021	-.258	209.3	.977	.385	-.123
268.9	1.045	-.067	-.251	218.7	.970	.369	-.186
274.9	1.035	-.109	-.259	229.3	.963	.325	-.247
278.6	1.040	-.126	-.251	238.7	.960	.279	-.296
284.8	1.023	-.151	-.241	249.3	.972	.191	-.329
289.1	1.000	-.157	-.202	254.8	.978	.130	-.319
294.9	.999	-.151	-.154	258.7	.987	.115	-.310
304.9	.981	-.129	-.052	264.7	.997	.010	-.309
309.4	.967	-.122	-.003	269.3	.973	-.050	-.304
312.9	.970	-.065	.019	274.6	.943	-.097	-.287
315.0	.944	-.043	.046	278.6	.961	-.141	-.256
317.0	.878	-.021	.062	284.7	.976	-.192	-.205
318.9	.824	-.040	.073	289.2	1.005	-.204	-.138
319.0	.763	-.051	.102	294.6	.999	-.196	-.076
321.1	.736	-.118	.086	304.7	.993	-.138	.029
323.0	.730	-.176	.087	309.4	.977	-.110	.070
325.1	.842	-.235	.029	312.6	.964	-.088	.079
327.0	.928	-.245	-.025	316.7	.950	-.058	.094
329.1	.973	-.214	-.064	318.7	.931	-.044	.112
334.9	1.004	-.172	-.090	320.7	.924	-.028	.129
337.1	1.010	-.179	-.088	324.6	.859	.018	.111
338.8	1.003	-.179	-.091	328.7	.870	-.122	-.062
341.0	1.008	-.189	-.086	332.7	.911	-.096	-.128
344.9	1.009	-.198	-.081	336.5	.960	-.108	-.130
344.9	1.013	-.199	-.081	340.6	.977	-.126	-.119
354.9	1.028	-.208	-.048	344.5	.989	-.143	-.106
358.8	.996	-.183	-.032	349.2	.995	-.161	-.087
364.8	.930	-.145	.017	354.4	1.003	-.177	-.074
365.5	.866	-.145	.015	357.1	1.003	-.175	-.061
368.7	.792	-.185	.051	358.6	1.000	-.172	-.061
369.5	.807	-.191	.060	361.0	.981	-.164	-.040
374.9	.863	-.316	.044	365.2	.927	-.137	-.006
				369.2	.847	-.129	.055

TABLE B-19 CONTINUED

ANGLE	RADIUS = 1.082		
	VX/V	VT/V	VR/V
-1.3	.969	-.221	-.105
1.6	.970	-.218	-.088
5.6	.953	-.201	-.053
9.6	.898	-.197	-.005
13.5	.834	-.230	.061
17.6	.892	-.318	.126
18.9	.901	-.335	.130
21.6	.950	-.308	.135
25.5	.968	-.268	.125
29.5	.962	-.253	.129
40.3	.972	-.223	.207
58.8	.951	-.197	.246
69.2	.979	-.142	.275
78.7	.977	-.101	.300
89.2	1.019	-.039	.310
98.6	1.002	.012	.324
100.1	1.002	.071	.312
116.7	.984	.117	.314
129.4	.997	.169	.277
138.8	.988	.209	.270
140.3	.949	.249	.214
158.7	.994	.276	.181
169.2	1.004	.297	.111
179.2	1.018	.307	.053
189.1	1.038	.317	-.005
198.5	1.008	.322	-.058
209.1	.998	.311	-.134
218.4	.984	.297	-.187
229.0	.984	.266	-.262
238.5	.973	.232	-.316
248.9	.967	.172	-.382
252.8	.942	.143	-.390
256.9	.925	.104	-.387
256.6	.942	.097	-.333
265.0	.953	-.012	-.386
268.9	.940	-.090	-.389
273.0	.947	-.151	-.390
277.0	.936	-.208	-.372
281.0	.929	-.276	-.337
285.1	.935	-.324	-.272
289.1	.956	-.344	-.180
293.2	.985	-.341	-.087
298.7	1.008	-.294	.020
301.4	1.006	-.271	.062
305.3	1.008	-.225	.102
313.3	1.003	-.135	.130
317.5	.969	-.100	.126
321.4	.933	-.071	.131
325.3	.873	.006	.102
329.3	.804	-.104	-.076
333.3	.856	-.068	-.139
337.2	.867	-.083	-.157
338.8	.874	-.099	-.170
341.3	.880	-.118	-.171
345.2	.901	-.153	-.172
351.3	.936	-.201	-.151
355.2	.942	-.217	-.125
358.7	.969	-.221	-.105
361.6	.970	-.218	-.088
365.6	.953	-.201	-.053
369.6	.898	-.197	-.005
373.5	.834	-.230	.061
377.6	.892	-.318	.126

TABLE B-20 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 183

RADIUS =	.330	.512	.711	.911	1.082	.280	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.921	.955	.979	.971	.970	.910	.915	.935	.953	.969	.978	.974	.971	.970
VTBAR =	.107	.076	.031	.061	.006	.114	.112	.096	.078	.046	.031	.057	.062	.042
VRBAR =	.011	.042	.016	.037	.026	-.007	.000	.029	.042	.025	.016	.030	.037	.035
1-WVX =	.916	.936	.954	.964	.966	0.000	.913	.924	.935	.945	.954	.960	.963	.965
1-WX =	.876	.898	.929	.946	.951	0.000	.874	.882	.897	.915	.931	.941	.945	.948
BBAR =	33.23	24.59	19.12	14.94	12.84	36.87	35.35	29.30	25.02	21.97	19.38	16.94	15.11	13.73
BPOS =	15.03	5.63	2.80	1.67	1.47	20.49	18.12	9.96	5.96	4.05	2.90	2.16	1.69	1.47
THETA =	15.00	20.00	25.00	290.00	297.50	10.00	12.50	17.50	20.00	22.50	25.00	352.50	290.00	292.50
BNEG =	-17.78	-7.20	-3.73	-1.88	-1.80	-22.14	-20.10	-13.14	-7.79	-2.57	-3.70	-2.04	-1.91	-1.54
THETA =	305.00	302.50	322.50	12.50	330.00	310.00	307.50	302.50	302.50	320.00	322.50	322.50	12.50	12.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.

VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.

VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.

1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.

1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.

BBAR IS MEAN ANGLE OF ADVANCE.

BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).

BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).

THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-21 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 183

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .330									
AMPLITUDE =		.2284	.1519	.0787	.0207	.0245	.0420	.0522	.0204
PHASE ANGLE =		306.3	20.9	56.0	125.5	199.8	264.8	314.8	1.2
RADIUS = .512									
AMPLITUDE =		.0859	.0559	.0220	.0398	.0432	.0466	.0370	.0191
PHASE ANGLE =		302.3	25.4	90.0	154.8	213.3	239.4	262.3	279.2
RADIUS = .711									
AMPLITUDE =		.0065	.0225	.0113	.0213	.0180	.0208	.0235	.0209
PHASE ANGLE =		279.5	286.4	325.4	101.2	166.6	187.6	194.8	195.3
RADIUS = .911									
AMPLITUDE =		.0220	.0101	.0159	.0116	.0074	.0128	.0258	.0191
PHASE ANGLE =		277.9	270.7	244.2	83.4	175.4	150.5	165.4	170.7
RADIUS = 1.082									
AMPLITUDE =		.0415	.0077	.0165	.0151	.0128	.0131	.0181	.0161
PHASE ANGLE =		290.0	284.6	257.0	352.8	7.9	83.0	136.7	131.8
HARMONIC	=	9	10	11	12	13	14	15	
RADIUS = .330									
AMPLITUDE =		.0071	.0164	.0070	.0027	.0027	.0019	.0067	
PHASE ANGLE =		292.6	336.4	37.7	300.7	335.3	22.4	196.2	
RADIUS = .512									
AMPLITUDE =		.0038	.0068	.0150	.0161	.0096	.0064	.0057	
PHASE ANGLE =		303.4	156.6	165.6	187.3	207.3	210.3	186.6	
RADIUS = .711									
AMPLITUDE =		.0172	.0107	.0008	.0088	.0130	.0159	.0152	
PHASE ANGLE =		213.8	228.4	275.8	88.5	91.6	109.2	119.4	
RADIUS = .911									
AMPLITUDE =		.0138	.0058	.0097	.0056	.0053	.0088	.0110	
PHASE ANGLE =		188.2	172.2	147.2	136.8	76.7	58.3	71.9	
RADIUS = 1.082									
AMPLITUDE =		.0129	.0060	.0039	.0041	.0024	.0039	.0075	
PHASE ANGLE =		164.7	174.9	152.7	89.3	124.8	22.5	51.1	

TABLE B-22 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 183

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .280									
AMPLITUDE	=	.2792	.1858	.1031	.0177	.0147	.0373	.0618	.0269
PHASE ANGLE	=	307.0	19.0	51.0	78.7	169.0	278.4	328.3	24.1
RADIUS = .300									
AMPLITUDE	=	.2583	.1718	.0929	.0174	.0182	.0392	.0576	.0238
PHASE ANGLE	=	306.7	19.7	52.8	100.5	186.3	272.3	323.1	15.8
RADIUS = .400									
AMPLITUDE	=	.1657	.1101	.0512	.0319	.0367	.0470	.0439	.0177
PHASE ANGLE	=	305.2	23.5	65.6	148.8	211.0	252.6	294.1	323.3
RADIUS = .500									
AMPLITUDE	=	.0933	.0610	.0244	.0398	.0434	.0472	.0376	.0190
PHASE ANGLE	=	302.7	25.6	86.8	154.9	213.5	240.7	265.5	283.2
RADIUS = .600									
AMPLITUDE	=	.0390	.0265	.0100	.0276	.0279	.0307	.0255	.0161
PHASE ANGLE	=	301.4	353.1	43.8	132.6	195.7	221.0	234.8	230.4
RADIUS = .700									
AMPLITUDE	=	.0083	.0220	.0108	.0217	.0187	.0214	.0233	.0205
PHASE ANGLE	=	286.4	290.8	330.4	103.9	169.4	191.0	198.0	197.5
RADIUS = .800									
AMPLITUDE	=	.0126	.0156	.0107	.0178	.0149	.0172	.0258	.0208
PHASE ANGLE	=	272.1	279.1	266.9	100.1	172.6	175.2	179.3	185.4
RADIUS = .900									
AMPLITUDE	=	.0210	.0105	.0155	.0122	.0084	.0132	.0259	.0193
PHASE ANGLE	=	277.1	271.2	244.9	86.6	175.5	153.7	166.8	172.4
RADIUS = 1.000									
AMPLITUDE	=	.0312	.0079	.0174	.0090	.0019	.0111	.0228	.0172
PHASE ANGLE	=	284.3	271.7	245.5	34.7	22.5	116.9	153.6	153.9

TABLE B-22 CONTINUED

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)								
HARMONIC	=	9	10	11	12	13	14	15
RADIUS = .280								
AMPLITUDE	=	.0091	.0273	.0171	.0116	.0091	.0073	.0070
PHASE ANGLE	=	273.3	333.2	12.9	355.9	18.9	46.4	192.2
RADIUS = .300								
AMPLITUDE	=	.0081	.0227	.0126	.0074	.0061	.0049	.0068
PHASE ANGLE	=	280.9	334.3	18.7	348.0	10.8	41.9	188.5
RADIUS = .400								
AMPLITUDE	=	.0059	.0046	.0075	.0095	.0060	.0037	.0064
PHASE ANGLE	=	314.3	349.4	143.2	200.5	229.9	238.6	204.8
RADIUS = .500								
AMPLITUDE	=	.0040	.0061	.0147	.0159	.0096	.0064	.0057
PHASE ANGLE	=	309.3	154.1	164.8	188.5	299.6	214.1	190.7
RADIUS = .600								
AMPLITUDE	=	.0106	.0082	.0053	.0078	.0076	.0104	.0110
PHASE ANGLE	=	226.7	212.6	175.4	143.4	122.7	129.4	136.7
RADIUS = .700								
AMPLITUDE	=	.0168	.0107	.0008	.0086	.0127	.0157	.0150
PHASE ANGLE	=	214.7	228.1	260.7	90.8	92.9	110.5	120.8
RADIUS = .800								
AMPLITUDE	=	.0153	.0069	.0063	.0066	.0090	.0116	.0124
PHASE ANGLE	=	203.0	204.8	149.0	116.4	83.9	87.0	96.4
RADIUS = .900								
AMPLITUDE	=	.0139	.0058	.0096	.0057	.0056	.0090	.0111
PHASE ANGLE	=	189.7	174.5	147.2	136.0	77.0	60.9	73.9
RADIUS = 1.000								
AMPLITUDE	=	.0131	.0059	.0084	.0045	.0031	.0067	.0097
PHASE ANGLE	=	175.8	164.7	147.8	129.3	84.0	39.7	58.9

TABLE B-23 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 183

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .330									
AMPLITUDE	=	.4375	.0451	.0269	.0224	.0371	.0407	.0318	.0077
PHASE ANGLE	=	263.7	161.0	237.7	359.0	82.8	164.0	224.3	290.7
RADIUS = .512									
AMPLITUDE	=	.3607	.0192	.0129	.0163	.0245	.0268	.0238	.0155
PHASE ANGLE	=	264.3	88.5	81.1	82.6	114.4	143.9	172.4	203.9
RADIUS = .711									
AMPLITUDE	=	.3042	.0486	.0401	.0169	.0110	.0148	.0162	.0118
PHASE ANGLE	=	267.5	97.6	154.1	229.1	346.4	57.3	92.7	106.9
RADIUS = .911									
AMPLITUDE	=	.3013	.0624	.0564	.0372	.0182	.0136	.0131	.0107
PHASE ANGLE	=	267.0	86.1	147.8	215.3	285.1	4.5	56.2	73.8
RADIUS = 1.082									
AMPLITUDE	=	.2849	.0685	.0733	.0549	.0374	.0228	.0140	.0072
PHASE ANGLE	=	267.8	81.8	138.1	203.0	266.1	329.0	43.8	89.2
HARMONIC	=	9	10	11	12	13	14	15	
RADIUS = .330									
AMPLITUDE	=	.0152	.0188	.0148	.0058	.0024	.0031	.0026	
PHASE ANGLE	=	137.1	182.3	230.5	257.3	258.7	265.3	35.8	
RADIUS = .512									
AMPLITUDE	=	.0048	.0062	.0118	.0127	.0087	.0043	.0042	
PHASE ANGLE	=	246.7	58.2	82.3	107.3	122.0	130.0	86.2	
RADIUS = .711									
AMPLITUDE	=	.0082	.0051	.0003	.0056	.0101	.0114	.0106	
PHASE ANGLE	=	105.6	118.9	21.8	343.6	359.4	17.5	29.8	
RADIUS = .911									
AMPLITUDE	=	.0077	.0068	.0046	.0033	.0047	.0059	.0069	
PHASE ANGLE	=	71.4	70.1	56.5	29.7	346.5	336.3	330.8	
RADIUS = 1.082									
AMPLITUDE	=	.0035	.0057	.0063	.0048	.0046	.0039	.0042	
PHASE ANGLE	=	69.9	32.7	34.9	10.5	354.0	333.7	315.2	

TABLE B-24 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 183

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .280									
AMPLITUDE	=	.4628	.0651	.0466	.0317	.0419	.0432	.0367	.0128
PHASE ANGLE	=	263.7	164.8	234.0	337.5	70.1	168.4	239.0	337.4
RADIUS = .300									
AMPLITUDE	=	.4525	.0566	.0382	.0274	.0398	.0423	.0345	.0100
PHASE ANGLE	=	263.7	163.7	235.3	345.1	75.2	166.7	233.2	323.1
RADIUS = .400									
AMPLITUDE	=	.4052	.0247	.0060	.0174	.0325	.0362	.0278	.0110
PHASE ANGLE	=	263.7	145.8	247.6	38.5	98.6	157.6	203.2	231.6
RADIUS = .500									
AMPLITUDE	=	.3650	.0182	.0116	.0167	.0256	.0279	.0242	.0154
PHASE ANGLE	=	264.2	92.7	78.0	78.9	113.3	145.8	175.6	206.2
RADIUS = .600									
AMPLITUDE	=	.3289	.0341	.0228	.0031	.0103	.0163	.0162	.0097
PHASE ANGLE	=	266.0	98.0	142.4	163.1	76.8	110.1	136.2	157.0
RADIUS = .700									
AMPLITUDE	=	.3059	.0474	.0386	.0155	.0103	.0146	.0160	.0115
PHASE ANGLE	=	267.4	97.9	153.8	228.9	351.9	61.5	95.9	109.9
RADIUS = .800									
AMPLITUDE	=	.3051	.0555	.0471	.0261	.0117	.0129	.0137	.0112
PHASE ANGLE	=	267.1	91.2	152.4	223.0	315.8	37.4	75.5	86.3
RADIUS = .900									
AMPLITUDE	=	.3020	.0619	.0555	.0362	.0173	.0134	.0131	.0108
PHASE ANGLE	=	267.0	86.5	148.4	216.1	287.3	7.7	57.8	74.4
RADIUS = 1.000									
AMPLITUDE	=	.2944	.0664	.0647	.0462	.0271	.0174	.0135	.0092
PHASE ANGLE	=	267.3	83.5	143.0	208.9	272.6	342.4	47.0	74.7

TABLE B-24 CONTINUED

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)								
HARMONIC	=	9	10	11	12	13	14	15
RADIUS = .280								
AMPLITUDE	=	.0242	.0296	.0276	.0157	.0085	.0066	.0043
PHASE ANGLE	=	129.1	186.9	236.3	274.5	295.0	296.6	6.7
RADIUS = .300								
AMPLITUDE	=	.0203	.0250	.0221	.0114	.0057	.0050	.0034
PHASE ANGLE	=	131.7	185.5	236.0	270.6	288.6	288.1	15.5
RADIUS = .400								
AMPLITUDE	=	.0067	.0076	.0040	.0057	.0052	.0029	.0027
PHASE ANGLE	=	165.2	162.0	161.9	127.0	141.1	178.1	84.7
RADIUS = .500								
AMPLITUDE	=	.0048	.0057	.0112	.0125	.0087	.0043	.0040
PHASE ANGLE	=	242.1	62.7	83.8	108.3	123.9	134.8	88.6
RADIUS = .600								
AMPLITUDE	=	.0037	.0046	.0047	.0043	.0055	.0069	.0082
PHASE ANGLE	=	135.5	96.8	83.0	66.5	36.3	36.2	45.6
RADIUS = .700								
AMPLITUDE	=	.0079	.0051	.0005	.0053	.0099	.0112	.0106
PHASE ANGLE	=	107.0	118.6	52.5	346.2	.8	18.6	31.2
RADIUS = .800								
AMPLITUDE	=	.0082	.0061	.0026	.0036	.0069	.0080	.0078
PHASE ANGLE	=	85.2	90.9	62.7	6.0	353.6	359.7	1.6
RADIUS = .900								
AMPLITUDE	=	.0078	.0068	.0045	.0032	.0048	.0061	.0069
PHASE ANGLE	=	72.4	71.9	57.4	28.7	347.0	338.3	333.2
RADIUS = 1.000								
AMPLITUDE	=	.0061	.0065	.0057	.0037	.0041	.0049	.0060
PHASE ANGLE	=	66.8	54.0	47.0	26.1	346.8	326.8	317.8

APPENDIX C

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS
FOR YAWED MODEL STRAIGHT WAKE SURVEYS -
EXPERIMENTS 184 AND 185

TABLE C-1

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989 EXPERIMENT 184

INPUT DATA				74.2	1.015	-.060	.136
RADIUS = .330				92.0	1.016	-.012	.126
ANGLE	VX V	VT V	VR V	101.0	1.016	.012	.168
0.0	.802	-.042	.082	110.0	1.000	.049	.192
1.3	.806	-.047	.079	119.0	.939	.075	.191
3.3	.811	-.059	.074	137.9	.940	.138	.181
8.5	.821	-.085	.044	146.9	.990	.167	.171
10.4	.827	-.100	.027	161.0	1.018	.216	.166
13.9	.844	-.130	.027	179.3	1.043	.238	.082
17.0	.860	-.158	.024	190.1	1.050	.251	.049
21.1	.873	-.173	.019	200.0	1.056	.262	.040
24.5	.881	-.185	.013	218.4	1.043	.257	-.029
28.1	.870	-.194	.014	236.0	1.035	.224	-.087
31.6	1.006	-.183	.011	254.1	1.031	.167	-.135
35.1	1.024	-.181	.007	269.9	1.022	.141	-.154
44.1	1.000	-.164	-.015	271.9	.954	.121	-.113
52.9	.995	-.156	-.016	282.7	.926	.044	-.056
61.9	.981	-.144	-.008	300.0	.942	-.019	.010
70.8	.982	-.124	-.001	307.8	.959	-.008	.024
79.9	.989	-.094	.008	318.0	.976	.015	.023
106.9	.984	.028	.030	325.5	.967	.037	.028
115.9	.986	.077	.031	332.0	.919	.105	.033
124.7	.999	.109	.029	336.5	.853	.079	.026
123.8	1.006	.173	.027	341.0	1.006	-.052	-.032
132.7	1.026	.207	.024	343.9	1.042	-.022	-.050
151.0	1.046	.246	.019	354.9	1.045	.014	-.065
160.9	1.049	.269	.016	360.0	1.040	.014	-.069
169.9	1.078	.301	.011	RADIUS = .711			
179.0	1.085	.324	.005	ANGLE	VX V	VT V	VR V
192.5	1.046	.332	-.004	0.0	.939	-.038	-.093
215.3	1.068	.322	-.010	4.0	.925	-.040	-.083
224.2	1.102	.306	-.011	8.0	.901	-.043	-.068
233.3	1.109	.279	-.026	8.8	.885	-.042	-.064
242.3	1.124	.249	.004	12.1	.866	-.037	-.044
251.2	1.123	.210	.048	17.6	.817	-.071	.005
260.0	1.047	.165	.074	19.3	.801	-.078	.014
269.4	.916	.133	.012	22.8	.782	-.107	.025
279.0	.837	.045	.036	26.4	.803	-.156	.003
289.9	.847	.043	.076	30.2	.845	-.149	.018
319.0	.852	.063	.077	44.1	.880	-.154	.064
341.7	.849	.073	.071	52.0	.869	-.148	.113
360.3	.846	.082	.062	61.9	.915	-.133	.151
369.0	.841	.080	.063	70.9	.932	-.119	.179
378.6	.835	.033	.103	79.8	.941	-.095	.203
427.0	.857	.023	.120	88.8	.946	-.064	.224
432.9	.849	.047	.095	97.0	.937	-.028	.235
439.3	.846	.025	.045	106.9	.941	.006	.248
443.7	.835	-.021	.056	115.9	.935	.037	.250
446.9	.863	-.024	.074	124.8	.928	.067	.247
450.0	.842	-.008	.079	133.6	.914	.100	.240
454.3	.893	-.002	.080	142.6	.917	.126	.229
457.8	.828	-.012	.084	151.7	.923	.152	.212
459.0	.801	-.039	.084	160.8	.928	.177	.192
460.0	.802	-.042	.082	169.0	.926	.198	.164
RADIUS = .512				179.1	.936	.208	.139
ANGLE	VX V	VT V	VR V	188.0	.941	.220	.109
0.0	1.040	.014	-.059	197.5	.953	.224	.075
2.3	1.022	.014	-.047	206.5	.960	.234	.035
4.1	1.024	.011	-.027	215.0	.966	.227	-.001
13.0	.932	-.011	.012	224.2	.958	.218	-.034
15.2	.892	-.026	.018	233.3	.943	.211	-.079
20.5	.910	-.068	.022	242.3	.946	.188	-.113
25.8	.956	-.130	-.009	251.3	.945	.163	-.137
38.5	1.036	-.096	.006	260.3	.955	.129	-.157
47.5	1.005	-.092	.038	269.4	.939	.120	-.167
56.3	1.018	-.088	.077	278.0	.861	.067	-.130
				287.5	.829	.033	-.005

TABLE C-1 CONTINUED

RADIUS	VR/V	VT/V	VR/V	ANGLE	RADIUS = 1.082		
					VX/V	VT/V	VR/V
285.8	.887	.076	.076	0.0	.835	-.028	-.110
305.8	.842	.074	.074	3.4	.836	-.041	-.115
314.9	.910	.069	.069	7.0	.858	-.047	-.116
320.2	.849	.083	.088	10.5	.887	-.049	-.094
324.0	.896	.051	.090	14.0	.903	-.058	-.083
327.6	.901	.054	.095	17.6	.911	-.057	-.064
337.2	.895	.093	.087	21.1	.848	-.054	-.044
333.0	.840	.107	.036	24.5	.846	-.027	-.017
342.0	.894	-.019	-.002	27.0	.834	-.137	-.108
350.0	.928	-.029	-.103	31.7	.807	-.159	-.091
354.0	.896	-.029	-.100	35.2	.807	-.166	.015
357.1	.939	-.039	-.043	38.7	.827	-.136	.040
RADIUS					45.9	.845	.103
ANGLE	VR/V	VT/V	VR/V		53.0	.869	.137
0.0	.928	-.023	-.110	50.7	.847	-.149	.117
3.0	.934	-.025	-.108	70.8	.906	-.132	.103
6.8	.938	-.020	-.100	81.5	.916	-.108	.100
10.5	.946	-.026	-.089	92.3	.924	-.078	.212
17.5	.879	-.026	-.042	97.0	.927	-.057	.214
19.8	.861	-.028	-.014	104.9	.932	-.018	.214
24.0	.811	-.066	.016	116.9	.938	.008	.223
26.0	.845	-.143	-.037	124.3	.953	.029	.271
27.8	.875	-.130	-.046	131.4	.932	.051	.214
31.5	.965	-.135	-.015	133.2	.932	.059	.214
38.0	.876	-.138	.011	138.4	.937	.068	.240
39.1	.871	-.131	.075	138.5	.945	.089	.240
42.1	.843	-.122	.117	152.7	.927	.100	.232
44.1	.910	-.105	.152	167.3	.938	.145	.122
47.0	.926	-.089	.176	174.6	.949	.160	.170
49.1	.931	-.066	.199	181.6	.949	.173	.143
49.3	.930	-.040	.210	191.5	.957	.168	.096
102.1	.946	-.013	.242	203.0	.973	.148	.077
110.0	.952	.018	.241	211.1	.978	.140	.020
120.0	.941	.055	.240	226.2	.994	.163	-.042
134.0	.933	.087	.242	233.3	.983	.175	-.046
138.0	.937	.117	.242	240.6	.982	.166	-.095
147.6	.935	.143	.246	252.8	.963	.151	-.145
161.0	.929	.195	.172	259.0	.939	.144	-.181
164.6	.931	.219	.178	262.3	.913	.137	-.180
190.0	.945	.235	.083	269.5	.886	.097	-.132
194.5	.957	.234	.083	271.0	.884	.063	-.166
208.0	.972	.241	.016	276.6	.906	.013	-.030
210.0	.984	.240	-.017	283.9	.937	.010	-.023
225.0	.977	.232	-.052	289.7	.959	.040	.034
231.8	.964	.220	-.080	294.0	.947	.062	.072
233.8	.971	.204	-.125	298.0	.943	.071	.063
247.7	.971	.180	-.160	307.7	.944	.076	.074
254.0	.963	.167	-.192	310.0	.939	.063	.073
270.7	.960	.120	-.190	320.4	.942	.063	.010
279.8	.903	.064	-.097	327.6	.947	.057	-.007
283.8	.891	.077	-.003	330.6	.936	-.031	-.008
292.9	.954	.090	.041	345.6	.919	.032	-.101
306.6	.961	.100	.031	357.8	.886	.008	-.007
313.5	.970	.089	.033	367.0	.854	-.015	-.103
319.1	.968	.085	.077	360.0	.835	-.028	-.110
326.3	.953	.074	.020				
329.9	.954	.081	.019				
334.5	.965	.131	-.013				
337.1	.949	-.033	-.047				
340.0	.910	.023	-.111				
344.0	.925	.021	-.104				
348.1	.928	.037	-.112				
353.5	.925	-.016	-.114				
359.2	.936	-.021	-.110				
360.0	.938	-.023	-.110				

TABLE C-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 184

RADIUS =	.330	.512	.711	.910	1.109	.269	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.978	1.001	.914	.934	.924	.959	.905	.948	1.002	.949	.916	.927	.933	.932
VTBAR =	.084	.076	.055	.072	.038	.084	.084	.082	.077	.062	.055	.070	.072	.059
VRBAR =	.029	.038	.064	.045	.063	.029	.059	.031	.037	.055	.064	.050	.045	.051
1-WVX =	.969	.992	.974	.950	.944	0.000	.902	.982	.923	.987	.969	.955	.950	.946
1-WX =	.916	.947	.940	.924	.921	0.000	.908	.932	.948	.948	.936	.927	.923	.922
BBAR =	35.45	25.72	17.88	14.43	12.23	38.33	37.52	31.24	26.26	21.52	18.17	16.17	14.58	13.22
BPCS =	7.53	2.30	2.45	.72	.48	9.85	9.15	4.81	2.42	2.47	2.50	1.39	.75	.43
THETA =	35.00	57.50	357.50	7.50	225.00	37.50	37.50	35.00	35.00	357.50	357.50	357.50	7.50	332.50
BNEG =	-3.88	-3.40	-1.89	-1.25	-1.12	-5.90	-5.30	-3.51	-3.45	-2.85	-1.99	-1.50	-1.26	-1.11
THETA =	305.00	335.00	335.00	25.00	27.50	305.00	305.00	335.00	335.00	335.00	335.00	22.50	25.00	25.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.

VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.

VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.

1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.

1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.

BBAR IS MEAN ANGLE OF ADVANCE.

BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).

BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).

THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE C-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 184

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)										
HARMONIC	1	2	3	4	5	6	7	8	9	10
RADIUS = .330										
AMPLITUDE =	.1135	.0253	.0001	.0209	.0269	.0006	.0168	.0145	.0013	.0028
PHASE ANGLE =	278.9	3	62.9	215.8	275.3	205.8	107.2	201.2	149.2	93.5
RADIUS = .512										
AMPLITUDE =	.0297	.0269	.0178	.0165	.0070	.0113	.0193	.0176	.0101	.0089
PHASE ANGLE =	282.8	17.3	150.0	149.4	189.5	96.2	113.4	133.0	104.2	134.5
RADIUS = .711										
AMPLITUDE =	.0349	.0076	.0284	.0200	.0078	.0094	.0201	.0163	.0035	.0031
PHASE ANGLE =	270.6	320.5	151.6	149.0	150.6	60.9	81.5	120.1	133.5	63.9
RADIUS = .910										
AMPLITUDE =	.0302	.0104	.0243	.0061	.0036	.0099	.0153	.0072	.0021	.0007
PHASE ANGLE =	223.8	215.0	143.8	135.0	46.7	28.7	63.5	96.8	84.4	22.3
RADIUS = 1.082										
AMPLITUDE =	.0457	.0116	.0267	.0092	.0075	.0064	.0053	.0108	.0109	.0029
PHASE ANGLE =	206.1	213.7	170.7	234.4	21.3	57.0	294.8	297.1	312.8	286.0

TABLE C-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 184

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (Vx/V)										
HARMONIC	1	2	3	4	5	6	7	8	9	10
RADIUS = .269										
AMPLITUDE =	.1442	.0772	.0101	.0387	.0359	.0048	.0268	.0178	.0021	.0070
PHASE ANGLE =	278.2	357.1	34.7	223.3	280.0	274.4	181.8	220.3	325.2	68.5
RADIUS = .300										
AMPLITUDE =	.1356	.0736	.0088	.0361	.0314	.0035	.0202	.0167	.0011	.0069
PHASE ANGLE =	278.4	357.9	45.1	221.6	279.1	271.5	178.0	215.7	323.6	75.5
RADIUS = .400										
AMPLITUDE =	.0713	.0479	.0082	.0196	.0147	.0060	.0180	.0136	.0059	.0031
PHASE ANGLE =	280.3	6.6	141.3	194.1	262.0	104.5	142.4	164.5	146.4	120.5
RADIUS = .500										
AMPLITUDE =	.0326	.0288	.0168	.0164	.0069	.0110	.0196	.0172	.0099	.0090
PHASE ANGLE =	262.7	16.2	153.6	152.9	198.8	97.1	115.8	135.0	144.5	133.9
RADIUS = .600										
AMPLITUDE =	.0346	.0164	.0242	.0204	.0082	.0101	.0200	.0180	.0100	.0050
PHASE ANGLE =	279.7	2.8	151.5	147.9	167.2	81.2	95.3	126.7	139.3	120.4
RADIUS = .700										
AMPLITUDE =	.0351	.0083	.0242	.0203	.0080	.0094	.0201	.0166	.0087	.0030
PHASE ANGLE =	271.9	326.8	151.8	148.7	152.1	62.9	82.7	120.8	134.2	70.7
RADIUS = .800										
AMPLITUDE =	.0270	.0059	.0263	.0122	.0038	.0099	.0200	.0136	.0063	.0060
PHASE ANGLE =	243.6	247.5	147.4	154.3	124.2	38.2	72.8	110.9	122.8	34.6
RADIUS = .900										
AMPLITUDE =	.0296	.0101	.0243	.0064	.0034	.0100	.0160	.0079	.0025	.0068
PHASE ANGLE =	224.5	215.1	143.2	160.5	51.5	28.9	64.5	98.8	93.6	23.4
RADIUS = 1.000										
AMPLITUDE =	.0368	.0122	.0248	.0065	.0058	.0084	.0077	.0023	.0044	.0045
PHASE ANGLE =	226.0	210.9	153.6	223.5	25.9	33.8	46.0	350.4	327.0	4.5

TABLE C-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 184

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS										
	1	2	3	4	5	6	7	8	9	10
RADIUS = 1.340										
AMPLITUDE =	105.0	107.1	101.2	100.5	100.5	100.5	100.5	100.5	100.5	100.5
PHASE ANGLE =	115.6	115.9	114.4	114.5	114.5	114.5	117.4	134.5	190.2	6.8
RADIUS = 1.512										
AMPLITUDE =	104.6	101.4	101.7	100.9	100.8	100.8	101.9	101.8	100.9	100.7
PHASE ANGLE =	87.3	111.2	152.6	182.1	310.5	310.5	13.0	28.4	30.0	3.1
RADIUS = .711										
AMPLITUDE =	101.0	100.4	100.5	100.5	100.5	100.5	100.7	100.7	100.6	100.6
PHASE ANGLE =	121.2	111.2	182.4	182.4	182.4	182.4	6.1	2.6	342.5	330.1
RADIUS = .910										
AMPLITUDE =	103.4	101.4	100.7	100.8	100.8	101.3	100.7	100.2	100.9	100.6
PHASE ANGLE =	119.2	140.8	212.5	339.7	339.7	13.2	20.6	320.6	303.3	320.7
RADIUS = 1.082										
AMPLITUDE =	103.4	101.3	100.9	101.4	101.4	101.9	100.6	100.6	100.7	100.6
PHASE ANGLE =	114.7	130.1	210.4	323.7	323.7	29.7	81.0	171.9	260.3	311.8

TABLE C-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 184

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)										
HARMONIC	1	2	3	4	5	6	7	8	9	10
RADIUS = .289										
AMPLITUDE =	.2522	.0606	.0277	.0128	.0026	.0144	.0142	.0090	.0069	.0048
PHASE ANGLE =	241.3	124.3	167.4	217.8	29.4	91.2	135.9	162.9	161.6	3.4
RADIUS = .300										
AMPLITUDE =	.2452	.0583	.0271	.0124	.0019	.0130	.0128	.0078	.0058	.0050
PHASE ANGLE =	241.6	122.0	163.7	211.4	43.2	90.6	132.2	157.6	166.4	5.3
RADIUS = .400										
AMPLITUDE =	.1935	.0452	.0204	.0142	.0048	.0032	.0069	.0058	.0044	.0066
PHASE ANGLE =	243.7	100.7	135.1	167.3	168.7	62.5	55.1	57.7	13.3	12.0
RADIUS = .500										
AMPLITUDE =	.1625	.0404	.0283	.0166	.0069	.0043	.0115	.0104	.0081	.0072
PHASE ANGLE =	244.0	88.3	121.8	153.2	180.7	312.6	14.8	29.9	30.1	9.0
RADIUS = .600										
AMPLITUDE =	.1638	.0392	.0273	.0128	.0042	.0050	.0103	.0093	.0071	.0067
PHASE ANGLE =	239.3	107.4	129.7	164.4	222.6	319.2	8.4	16.3	8.4	348.0
RADIUS = .700										
AMPLITUDE =	.1662	.0408	.0257	.0097	.0045	.0057	.0088	.0075	.0066	.0066
PHASE ANGLE =	235.5	120.4	136.6	180.5	281.7	337.9	6.1	3.9	343.9	331.4
RADIUS = .800										
AMPLITUDE =	.1663	.0394	.0216	.0073	.0059	.0087	.0083	.0053	.0062	.0063
PHASE ANGLE =	233.3	120.8	140.5	196.7	328.9	.6	5.3	349.4	326.6	325.6
RADIUS = .900										
AMPLITUDE =	.1628	.0384	.0195	.0058	.0083	.0111	.0073	.0024	.0059	.0057
PHASE ANGLE =	231.3	119.4	141.0	211.4	339.7	12.3	18.2	325.7	305.6	321.1
RADIUS = 1.000										
AMPLITUDE =	.1557	.0385	.0195	.0047	.0097	.0125	.0070	.0021	.0060	.0048
PHASE ANGLE =	229.4	117.1	136.8	217.6	335.0	21.5	51.6	196.9	280.9	316.5

TABLE C-7

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 185

INPUT DATA				108.0	.976	.048	.193
RADIUS = .330				127.0	.964	.113	.192
ANGLE	VX/V	VT/V	VR/V	144.0	.975	.183	.169
0.0	.709	-.100	.075	163.0	1.010	.224	.131
3.9	.704	-.118	.060	180.0	1.021	.258	.089
6.2	.712	-.143	.057	188.0	1.038	.263	.067
11.5	.763	-.164	.040	198.6	1.049	.271	.051
16.8	.809	-.196	.025	216.3	1.040	.265	-.028
22.1	.870	-.220	.026	234.2	1.017	.235	-.034
27.5	.969	-.219	.018	252.2	1.002	.185	-.141
32.7	1.007	-.199	.009	287.0	.931	-.007	.001
37.0	1.005	-.137	-.002	296.1	.934	-.033	.010
43.4	.997	-.174	-.008	305.9	.932	-.011	.057
48.8	.997	-.173	-.007	314.5	.929	.001	.047
54.1	.933	-.163	-.012	323.7	.917	.026	.036
68.4	.981	-.130	.004	332.5	.848	.091	.030
77.0	.972	-.090	.014	337.0	.777	.003	-.012
86.2	.957	-.051	.025	341.7	.888	-.057	-.041
104.2	.972	.042	.035	350.6	.924	-.004	-.101
113.0	.977	.092	.036	355.0	.921	-.010	-.080
121.0	.984	.141	.033	360.0	.907	-.014	-.050
131.1	.948	.181	.028	RADIUS = .711			
139.0	1.016	.212	.029	ANGLE	VX/V	VT/V	VR/V
146.0	1.037	.250	.026	0.0	.873	-.057	-.115
160.0	1.062	.315	.018	5.0	.866	-.076	-.103
175.9	1.073	.334	.011	15.0	.852	-.087	.015
183.1	1.077	.350	.005	18.0	.791	-.122	.149
203.5	1.075	.358	-.005	23.9	.727	-.182	.104
212.6	1.084	.346	-.010	32.8	.798	-.159	.054
221.7	1.084	.322	-.010	36.0	.830	-.153	.066
230.7	1.104	.268	.005	41.0	.862	-.15	.091
239.9	1.107	.247	.042	71.0	.907	-.153	.191
245.2	1.098	.233	.051	89.0	.925	-.046	.229
250.7	1.086	.206	.067	107.0	.923	.026	.246
257.9	.840	.180	.061	126.1	.921	.086	.241
261.5	.871	.141	.064	143.8	.904	.145	.224
266.7	.854	.075	.050	161.7	.923	.186	.185
277.0	.970	-.005	.048	179.9	.928	.218	.131
282.0	.864	.014	.042	198.3	.951	.238	.060
288.6	.867	.034	.046	216.6	.948	.236	-.020
293.9	.848	.049	.046	252.8	.950	.167	-.163
299.3	.848	.053	.043	261.9	.933	.144	-.185
304.7	.855	.063	.039	270.8	.917	.114	-.160
310.0	.849	.090	.037	279.9	.821	.054	-.116
315.6	.830	.083	.074	290.8	.828	.005	.016
320.9	.791	.072	.095	294.0	.830	-.001	.058
326.0	.732	.037	.087	301.6	.865	-.004	.096
331.7	.614	.020	.087	312.0	.886	.041	.078
337.2	.648	-.015	.057	324.0	.871	.039	.082
347.9	.733	-.030	.091	330.4	.822	.081	.097
353.2	.753	-.036	.050	334.0	.784	.083	.023
358.6	.711	-.087	.078	339.4	.853	-.028	-.092
360.0	.709	-.100	.075	348.4	.853	-.016	-.111
RADIUS = .512				357.0	.875	-.036	-.114
ANGLE	VX/V	VT/V	VR/V	360.0	.873	-.057	-.115
0.0	.907	-.014	-.050				
4.6	.854	-.052	.027				
10.9	.821	-.088	.116				
18.4	.767	-.126	.061				
25.8	.899	-.145	.031				
36.0	.939	-.117	.019				
47.4	.970	-.107	.066				
58.0	.977	-.093	.107				
79.0	.997	-.051	.160				
90.7	.999	-.015	.175				

TABLE C-7 CONTINUED

RADIUS = .910				RADIUS = 1.082			
ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V
0.0	.900	-.011	-.117	0.0	.843	-.013	-.119
1.6	.894	-.012	-.112	2.4	.843	-.021	-.110
7.0	.862	-.008	-.103	7.8	.886	-.028	-.093
12.6	.843	-.015	-.072	14.9	.877	-.045	-.049
23.7	.816	-.030	.066	21.0	.875	-.066	.002
29.1	.841	-.121	.012	29.2	.873	-.136	.014
34.0	.851	-.116	.012	36.3	.846	-.112	.044
39.0	.859	-.106	.061	43.4	.878	-.148	.084
51.0	.898	-.125	.104	61.3	.894	-.149	.170
59.8	.902	-.112	.134	79.2	.918	-.110	.236
70.7	.911	-.095	.167	97.1	.934	-.051	.272
90.5	.925	-.040	.220	115.1	.928	.019	.284
99.0	.936	-.014	.231	132.0	.914	.073	.267
110.4	.933	.024	.237	150.8	.906	.131	.240
118.5	.924	.059	.248	169.0	.935	.165	.164
130.0	.916	.099	.258	187.1	.941	.194	.117
139.0	.916	.133	.224	205.7	.957	.200	.042
150.1	.927	.167	.207	223.6	.975	.195	-.036
160.9	.934	.193	.180	241.7	.961	.171	-.118
169.8	.934	.214	.152	259.8	.938	.137	-.152
180.0	.930	.238	.108	265.3	.934	.110	-.189
198.7	.936	.253	.041	276.1	.868	.069	-.132
216.0	.956	.250	-.025	281.5	.893	.040	-.027
234.2	.947	.231	-.105	287.1	.905	.047	.019
252.0	.956	.188	-.169	292.4	.904	.071	.040
270.0	.950	.146	-.212	297.9	.914	.077	.047
275.0	.912	.120	-.177	303.3	.932	.073	.032
280.7	.864	.086	-.103	308.7	.923	.070	.040
291.7	.853	.069	.010	314.0	.919	.069	.025
302.2	.921	.089	.042	319.0	.910	.065	.016
307.7	.940	.097	.027	324.8	.889	.054	.011
313.4	.949	.085	.025	330.0	.821	.050	.015
323.0	.941	.072	.024	335.7	.802	-.014	-.031
328.0	.936	.076	.022	341.0	.824	.019	-.117
334.4	.844	.129	-.010	346.0	.839	.022	-.108
339.8	.911	.014	-.112	351.8	.843	.004	-.115
350.0	.922	.009	-.124	357.1	.844	-.004	-.122
359.0	.915	-.002	-.122	360.0	.843	-.013	-.119
360.0	.900	-.011	-.117				

TABLE C-8 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 185

RADIUS =	.830	.842	.855	.868	.880	.892	.904	.916	.928	.940	.952	.964	.976	.988	1.000
VXBAR =	.947	.903	.869	.835	.801	.767	.733	.699	.665	.631	.597	.563	.529	.495	.461
VYBAR =	.083	.070	.055	.042	.028	.014	.000	.000	.000	.000	.000	.000	.000	.000	.000
VRBAR =	.032	.021	.010	.004	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
1-WX =	.940	.937	.933	.929	.925	.921	.917	.913	.909	.905	.901	.897	.893	.889	.885
1-WY =	.839	.835	.831	.827	.823	.819	.815	.811	.807	.803	.799	.795	.791	.787	.783
BBAR =	34.59	24.94	17.55	14.13	10.72	8.15	5.68	3.21	0.74	.00	.00	.00	.00	.00	.00
BPOS =	5.13	2.02	1.35	.88	.41	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
THETA =	32.50	70.00	97.50	97.50	97.50	97.50	97.50	97.50	97.50	97.50	97.50	97.50	97.50	97.50	97.50
BNEG =	-6.67	-3.65	-2.00	-1.14	-.77	-.45	-.15	.00	.00	.00	.00	.00	.00	.00	.00
THETA =	332.50	335.00	335.00	20.00	394.50	330.00	332.50	332.50	332.50	332.50	332.50	332.50	332.50	332.50	332.50

XBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
 YBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
 VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
 1-WX IS VOLUTEtric MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
 1-WY IS VOLUTEtric MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
 BBAR IS MEAN ANGLE OF ADVANCE.
 BPOS IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
 BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
 THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE C-9 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 185

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX:V)										
HARMONIC	1	2	3	4	5	6	7	8	9	10
RADIUS = .330										
AMPLITUDE =	.1342	.0752	.0260	.0387	.0259	.0118	.0196	.0070	.0115	.0172
PHASE ANGLE =	283.6	345.9	207.9	271.6	323.9	125.4	190.2	225.3	130.1	155.4
RADIUS = .512										
AMPLITUDE =	.0666	.0297	.0246	.0030	.0049	.0079	.0166	.0148	.0136	.0106
PHASE ANGLE =	271.7	321.9	228.3	201.9	183.4	144.3	129.6	137.6	129.9	136.7
RADIUS = .711										
AMPLITUDE =	.0524	.0180	.0217	.0167	.0039	.0154	.0213	.0137	.0057	.0056
PHASE ANGLE =	270.1	310.7	159.9	172.3	186.6	63.5	78.5	94.2	77.7	322.8
RADIUS = .910										
AMPLITUDE =	.0327	.0105	.0199	.0174	.0077	.0044	.0177	.0133	.0078	.0028
PHASE ANGLE =	247.5	249.8	103.6	182.5	247.5	29.0	75.1	126.1	175.4	210.9
RADIUS = 1.082										
AMPLITUDE =	.0435	.0208	.0056	.0093	.0154	.0112	.0065	.0040	.0017	.0016
PHASE ANGLE =	258.7	307.9	159.2	327.1	351.4	47.6	58.7	119.2	284.1	237.0

TABLE C-10 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 185

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS										
HARMONIC	1	2	3	4	5	6	7	8	9	10
RADIUS = .250										
AMPLITUDE =	10.00	10.00	10.00	10.00	10.00	10.00	10.222	.0161	.0065	.0045
PHASE ANGLE =	10.00	10.00	10.00	10.00	10.00	10.00	20.215	261.5	126.5	173.8
RADIUS = .300										
AMPLITUDE =	10.00	10.00	10.00	10.00	10.00	10.00	10.214	.0069	.0101	.0161
PHASE ANGLE =	10.00	10.00	10.00	10.00	10.00	10.00	149.0	254.0	126.0	171.5
RADIUS = .400										
AMPLITUDE =	10.00	10.00	10.00	10.00	10.00	10.00	10.101	.0092	.0137	.0151
PHASE ANGLE =	10.00	10.00	10.00	10.00	10.00	10.00	167.0	166.9	101.9	153.8
RADIUS = .500										
AMPLITUDE =	10.00	10.00	10.00	10.00	10.00	10.00	10.082	.0144	.0140	.0112
PHASE ANGLE =	10.00	10.00	10.00	10.00	10.00	10.00	133.3	139.6	130.4	138.3
RADIUS = .600										
AMPLITUDE =	10.00	10.00	10.00	10.00	10.00	10.00	10.180	.0132	.0066	.0010
PHASE ANGLE =	10.00	10.00	10.00	10.00	10.00	10.00	97.2	109.8	103.8	90.9
RADIUS = .700										
AMPLITUDE =	10.00	10.00	10.00	10.00	10.00	10.00	10.153	.0137	.0059	.0053
PHASE ANGLE =	10.00	10.00	10.00	10.00	10.00	10.00	79.6	94.7	78.8	323.9
RADIUS = .800										
AMPLITUDE =	10.00	10.00	10.00	10.00	10.00	10.00	10.207	.0143	.0061	.0022
PHASE ANGLE =	10.00	10.00	10.00	10.00	10.00	10.00	77.6	114.1	150.0	276.7
RADIUS = .900										
AMPLITUDE =	10.00	10.00	10.00	10.00	10.00	10.00	10.181	.0135	.0079	.0027
PHASE ANGLE =	10.00	10.00	10.00	10.00	10.00	10.00	75.5	125.4	174.0	213.2
RADIUS = 1.000										
AMPLITUDE =	10.00	10.00	10.00	10.00	10.00	10.00	10.135	.0097	.0054	.0027
PHASE ANGLE =	10.00	10.00	10.00	10.00	10.00	10.00	70.5	129.2	159.2	206.2

TABLE C-11 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 185

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (V _T /V)										
HARMONIC	1	2	3	4	5	6	7	8	9	10
RADIUS = .330										
AMPLITUDE =	.2441	.0578	.0399	.0218	.0086	.0106	.0134	.0086	.0022	.0050
PHASE ANGLE =	248.0	125.1	172.5	232.7	292.1	64.6	114.4	166.7	48.1	63.5
RADIUS = .512										
AMPLITUDE =	.1795	.0376	.0299	.0226	.0056	.0034	.0057	.0069	.0063	.0077
PHASE ANGLE =	248.9	94.4	138.0	189.1	229.3	329.0	51.3	47.3	49.8	65.7
RADIUS = .711										
AMPLITUDE =	.1750	.0333	.0292	.0161	.0093	.0059	.0086	.0074	.0039	.0042
PHASE ANGLE =	240.6	122.2	138.6	178.4	227.0	312.7	26.2	43.8	41.3	16.6
RADIUS = .910										
AMPLITUDE =	.1626	.0404	.0173	.0038	.0077	.0113	.0072	.0041	.0050	.0064
PHASE ANGLE =	231.7	111.6	129.6	196.6	314.4	342.8	357.5	4.4	299.1	320.3
RADIUS = 1.082										
AMPLITUDE =	.1515	.0427	.0200	.0011	.0078	.0083	.0056	.0028	.0013	.0024
PHASE ANGLE =	229.3	120.3	118.8	234.6	340.6	27.8	87.2	160.4	239.2	21.2

TABLE C-12 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII FOR EXPERIMENT 185

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS									
	1	2	3	4	5	6	7	8	9
RADIUS = .200									
APPROX. USE =	20.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
PHASE ANGLE =	24.12	132.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RADIUS = .300									
APPROX. USE =	30.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
PHASE ANGLE =	24.14	132.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RADIUS = .400									
APPROX. USE =	40.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
PHASE ANGLE =	24.16	132.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RADIUS = .500									
APPROX. USE =	50.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
PHASE ANGLE =	24.18	132.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RADIUS = .600									
APPROX. USE =	60.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
PHASE ANGLE =	24.20	132.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RADIUS = .700									
APPROX. USE =	70.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
PHASE ANGLE =	24.22	132.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RADIUS = .800									
APPROX. USE =	80.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
PHASE ANGLE =	24.24	132.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RADIUS = .900									
APPROX. USE =	90.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
PHASE ANGLE =	24.26	132.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00
RADIUS = 1.000									
APPROX. USE =	100.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
PHASE ANGLE =	24.28	132.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00

DTNSRDC ISSUES THREE TYPES OF REPORTS

1. DTNSRDC REPORTS, A FORMAL SERIES, CONTAIN INFORMATION OF PERMANENT TECHNICAL VALUE. THEY CARRY A CONSECUTIVE NUMERICAL IDENTIFICATION REGARDLESS OF THEIR CLASSIFICATION OR THE ORIGINATING DEPARTMENT.
2. DEPARTMENTAL REPORTS, A SEMIFORMAL SERIES, CONTAIN INFORMATION OF A PRELIMINARY, TEMPORARY, OR PROPRIETARY NATURE OR OF LIMITED INTEREST OR SIGNIFICANCE. THEY CARRY A DEPARTMENTAL ALPHANUMERICAL IDENTIFICATION.
3. TECHNICAL MEMORANDA, AN INFORMAL SERIES, CONTAIN TECHNICAL DOCUMENTATION OF LIMITED USE AND INTEREST. THEY ARE PRIMARILY WORKING PAPERS INTENDED FOR INTERNAL USE. THEY CARRY AN IDENTIFYING NUMBER WHICH INDICATES THEIR TYPE AND THE NUMERICAL CODE OF THE ORIGINATING DEPARTMENT. ANY DISTRIBUTION OUTSIDE DTNSRDC MUST BE APPROVED BY THE HEAD OF THE ORIGINATING DEPARTMENT ON A CASE-BY-CASE BASIS.

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