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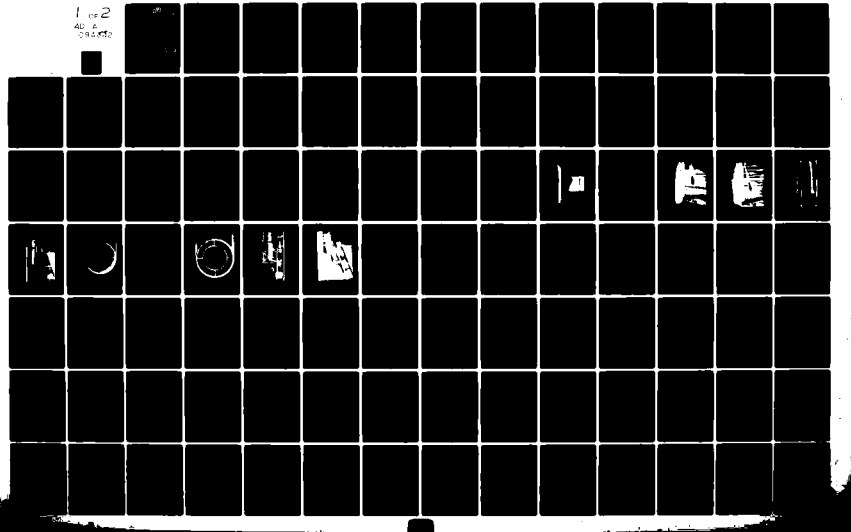

LEVEL II (12)

DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Maryland 20084

DTNSRDC/SPD-0833-06

AD A094342

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by

Rae B. Hurwitz and L. Bruce Crook

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Ship Performance Department
Departmental Report

JANUARY 1981

DTNSRDC/SPD-0833-06

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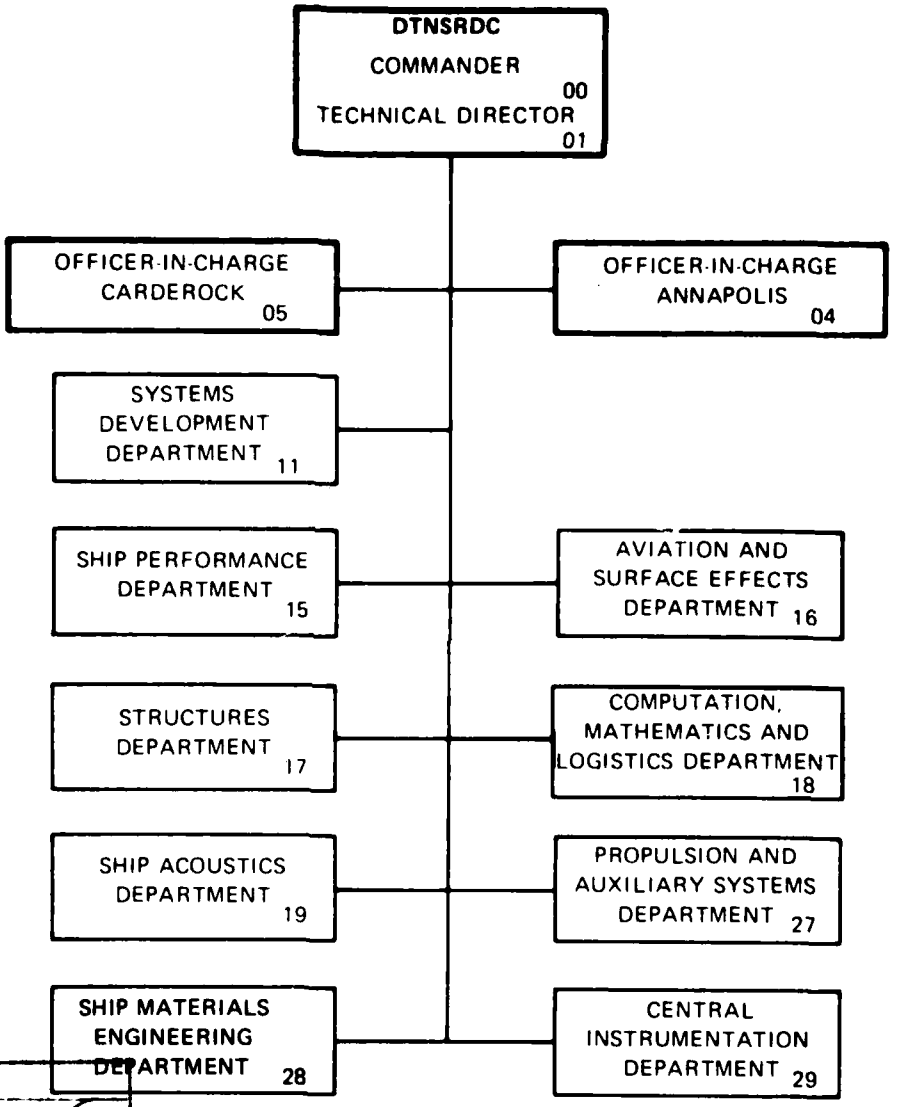

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SECURITY CLASSIFICATION OF THIS PAGE (When Date Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DTNSRDC/SPD-0833-06	2. GOVT ACCESSION NO. AD A094343	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ANALYSIS OF EXPERIMENTAL DATA FOR MODEL 5365 REPRESENTING THE R/V ATHENA WITH AND WITHOUT THE BASS DYNAMOMETER BOAT		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) RAE B. HURWITZ and L. BRUCE CROOK		8. CONTRACT OR GRANT NUMBER(s) N00167-78-C-0089
9. PERFORMING ORGANIZATION NAME AND ADDRESS DAVID TAYLOR NAVAL SHIP R & D CENTER BETHESDA, MARYLAND 20084		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PROGRAM ELEMENT 63508N TASK AREA S0379001 TASK 19977
11. CONTROLLING OFFICE NAME AND ADDRESS NAVAL SEA SYSTEMS COMMAND (NAVSEA 05R) WASHINGTON, D.C. 20362		12. REPORT DATE JANUARY 1981 13. NUMBER OF PAGES 171 + xvi
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release: Distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Wake survey; R/V ATHENA; Wake screen; Inclined flow ; Bass dynamometer boat

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes a series of model experiments conducted as part of the overall project of the David Taylor Naval Ship Research and Development Center (DTNSRDC) to adapt controllable pitch propellers to the needs of high speed combatant ships. The first set of experiments was conducted on a model of the R/V ATHENA with and without the port propeller operating. The second set repeated the first, except that the Bass Dynamometer Boat was mounted aft of the model. The third set was a series of idealized wake (over)

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distribution experiments, in which the model was removed and the pitot rake was mounted upstream of the Bass Boat. The effect of an operating port propeller on the mean starboard wake distribution and the harmonic content of the wake was small. The presence of the Bass Boat behind the ATHENA model, however, affects both the mean values and the harmonic content of the wake. Finally, one idealized mean wake distribution was shown to be weakly dependent on speed, and the harmonic content of wakes at two different speeds differed by less than three percent.

9. SHIP PERFORMANCE DEPARTMENT

10. Work Unit Number 1524-641

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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*
D	---	Propeller diameter
J_V	---	Apparent advance coefficient $J_V = \frac{V}{nD}$ (dimensionless)
N	N	Harmonic number
n	---	Propeller revolutions
r/R or x	Radius or RAD.	Distance (r) from the propeller axis expressed as a ratio of the propeller radius (R)
V	V	Actual model or ship velocity
$V_b(x,\theta)$	---	Resultant inflow velocity to blade for a given point
$\overline{V}_b(x)$	---	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)
$\overline{V}_r(x)$	---	Mean radial velocity component for a given radius
$V_r(x,\theta)/V$	VR/V	Radial velocity component ratio for a given point
$\overline{V}_r(x)/V$	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)

*See footnote on the following page

NOTATION (Continued)

$\bar{V}_t(x)$	---	Mean tangential velocity component for a given radius
$V_t(x,\vartheta)/V$	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*
$V_x(x,\vartheta)$	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
$\bar{V}_x(x)/V$	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*
Φ_N	PHASE ANGLE	Phase Angle of Nth harmonic*

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

$$f(\vartheta) = A_o + \sum_{N=1}^{N} A_N \cos(N\theta) + \sum_{N=1}^{N} B_N \sin(N\theta)$$

$$= A_o + \sum_{N=1}^{N} C_N \sin(N\theta + \Phi_N)$$

1-w(x)	1-WX	Volumetric mean velocity ratio from the hub to a given radius

$$1\text{-}w(r/R) = \left[\frac{2 \cdot \int_{r_{hub}/R}^{r/R} (\bar{V}_{x_c}(x)/V) \cdot x \cdot dx}{(r/R)^2 - (r_{hub}/R)^2} \right]$$

where $\bar{V}_{x_c}(x)/V = \int_0^{\pi} \left[\frac{V_{x_c}(x,\vartheta)}{2\pi V} \right] d\vartheta$

and $V_{x_c}(x,\vartheta)/V) = (V_x(x,\vartheta)/V) - (V_t(x,\vartheta)/V) \tan(\beta(x,\vartheta))$

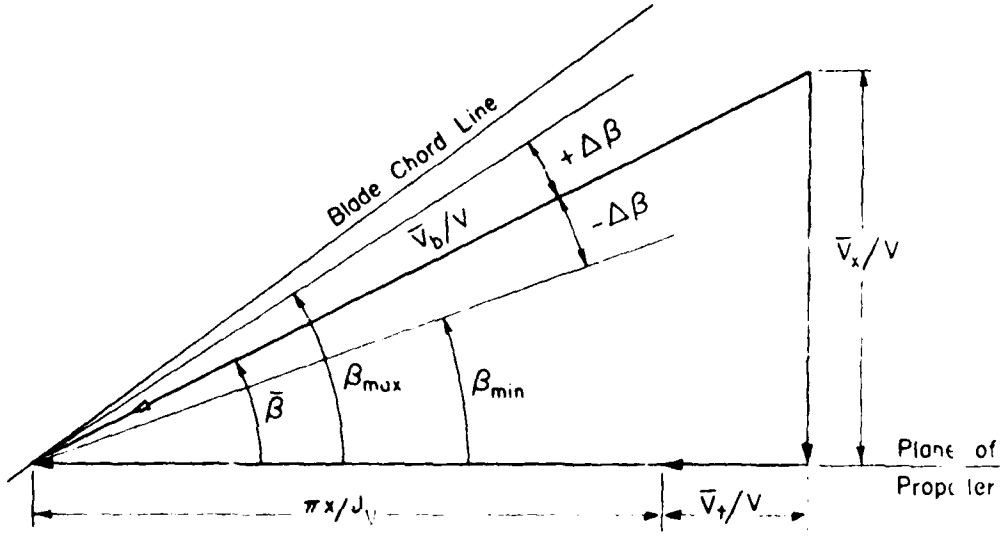
$1\text{-}w_V(x)$	1-WVX	Volumetric mean velocity ratio from the hub to a given radius (without the tangential velocity correction)

$$1\text{-}w(r/R) = \left[\frac{2 \cdot \int_{r_{hub}/R}^{r/R} (\bar{V}_x(x)/V) \cdot x \cdot dx}{(r/R)^2 - (r_{hub}/R)^2} \right]$$

$\beta(x,\vartheta)$	---	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 millimeters [0.0254 m (meters)]
1 foot	0.3048 m (meters)
1 foot per second	0.3048 m/sec (meters per second)
1 knot	0.5144 m/sec (meters per second)
1 pound (force)	4.4480 N (Newtons)
1 degree (angle)	0.01745 rad (radians)
1 horsepower	0.7457 kW (kilowatts)
1 long ton	1.016 metric tons or 1016 kilograms
1 inch water (60°F)	248.8 pa (pascals)

ABSTRACT

This report describes a series of model experiments conducted as part of the overall project of the David Taylor Naval Ship R&D Center (DTNSRDC) to adapt controllable pitch propellers to the needs of high speed combatant ships. The first set of experiments was conducted on a model of the R/V ATHENA, with and without the port propeller operating. The second set of experiments repeated the first, except that the Bass Dynamometer Boat was mounted aft of the model. The third set was a series of idealized wake distribution experiments, in which the model was removed and the pitot rake was mounted upstream of the Bass Boat. The effect of an operating port propeller on the mean starboard wake distribution was small. The presence of the Bass Boat behind the ATHENA model, however, affects both the mean values and the harmonic content of the wake. Finally, one idealized mean wake distribution was shown to be weakly dependent on speed, and the harmonic content of wakes at two different speeds differed by less than three percent.

ADMINISTRATIVE INFORMATION

The experimental program was initiated and funded by the Naval Sea Systems Command (NAVSEA 05R) under Task Area S0379001. This work was performed at the David Taylor Naval Ship R&D Center (DTNSRDC) under work unit number 1524-641. The preliminary data analysis was performed by Chi Associates, Inc. (CAI) under contract to DTNSRDC.

INTRODUCTION

As part of its overall project to adapt controllable pitch propellers to the needs of high speed combatant ships, the David Taylor Naval Ship Research and Development Center (DTNSRDC) conducted a full-scale wake survey aboard the R/V ATHENA in September 1977 as reported by Day et al[1]. The specific goal of this project was to obtain propeller disk velocity component ratios in the wake of a full-scale ship. In addition, propeller blade loading experiments have been completed for the R/V ATHENA.

Subsequent to the full-scale wake trials, a series of wake surveys were conducted on a model of the R/V ATHENA. These experiments were designed to evaluate the model wake at one propeller location, both with and without the other propeller operating. In addition, wake survey experiments were conducted with and without the Bass Dynamometer Boat mounted aft of the model. The Bass Dynamometer Boat was used in the blade loading experiments to drive the propeller and dynamometry systems from behind the model. The wake information was necessary to account for the effect of the Bass Boat on the flow into the propeller in the analysis of the blade loading experiments. Several idealized wake distributions were measured, and will be used for blade loading calculations for a propeller operating in an idealized wake. An idealized wake is the breaking down of a wake field into a purely longitudinally dominated wake by a wake screen or a purely tangentially dominated wake by inclining the flow angle. The blade loading calculations for the R/V ATHENA will be compared with experimental force measurements on a model propeller to help determine the validity of the load calculation method and will be reported later.

[1] References are listed on page 16.

EXPERIMENTAL PROCEDURE

The experiments described in this report measured the propeller disk velocity components under a variety of operating conditions. In the first set of experiments (Experiments 3, 9 and 10), wake measurements were obtained from the starboard propeller plane of the model with, and without the port propeller operating. In the second set (Experiments 11 and 12), measurements were taken with the model followed by the Bass Dynamometer Boat, with and without the port propeller operating. The third set of experiments (Experiments 13 through 16) consisted of idealized wake surveys. The ATHENA model was removed, and a pitot tube rake was mounted ahead of the Bass Dynamometer Boat. These experiments were run behind a screen which provided an idealized wake distribution.

DTNSRDC Model 5365, representing the R/V ATHENA (PG-94), was constructed to a linear ratio of 8.250, in accordance with model specifications of the Naval Sea Systems Command (NAVSEA 05R). Model and ship characteristics are presented in Table 1. The model was fitted with shafts and struts, a centerline skeg, and stabilizer fins. Model rudders were not included. DTNSRDC pitot tube rake number 7 was mounted in the model through the starboard shafting. Differential pressure gauges were used to measure the velocities in the plane of the propeller at four radial locations. A sketch of the pitot rake on the model is shown in Figure 1. The rake as fitted to Model 5365, including the five-hole spherical pitot tubes, is shown in Figure 2.

The DTNSRDC Bass Dynamometer Boat (Model 5271) was employed in all but the first three experiments. It was mounted in the same location in which it had previously been run to study unsteady propeller blade

forces behind a model, and was later mounted behind the pitot rake and wake screen.

The experimental program, as it pertains to this report, is described in Table 2. The experiments being discussed are 3 and 9 through 16. All the other experiments (1, 2, and 4 through 8) are discussed in another report by Hurwitz and Crook[2]. Experiment 3 was a conventional wake survey experiment which measured the Model 5365 starboard wake without the port propeller operating in the initial setup. Experiment 9 repeated this test to verify that the model conditions were essentially unchanged in the second setup from the original. For Experiment 10, with the port propeller operating, the model conditions from Experiments 3 and 9 were duplicated.

Experiments 11 and 12 were again conventional wake surveys, with the pitot tube rake mounted from inside the starboard shaft; but the Bass Dynamometer Boat was attached downstream of the ATHENA model. Experiment 11 was conducted without the port propeller, and Experiment 12 with the port propeller operating. A sketch of the experimental radii taken with the pitot tube arrangement behind the hull sections is shown in Figure 3. Figures 4 and 5 are profile and quartering photographs of the pitot tube rake and the ATHENA model. Figure 6 shows the experimental setup during Experiments 11 and 12.

Experiments 13 through 16 were conducted to create idealized wakes. Data from these wake surveys were required to perform calculations of unsteady blade loads for comparison with experimental results. Experiment 13 modeled an uniform flow with the rake inclined at 20 degrees (0.349 radian), as shown in Figure 7. Experiment 14 was performed to measure the flow behind a one-cycle wake screen with the bass dynamometer boat

and rake both at zero degree inclination. Figures 8 through 10 show the wake screen used, and Figures 11 and 12 show the experimental setups. Finally, Experiments 15 and 16 were uniform flow surveys at ten degrees (0.175 radian) inclination of the bass dynamometer boat and rake at model speeds corresponding to full-scale speeds of 17.2 and 8.6 knots (8.8 and 4.4 m/s), respectively. Also the single cycle wake screen was removed during Experiments 15 and 16.

The full-scale propeller disk was 6 feet (1.83 meters) in diameter. The radii at which measurements were made, expressed as ratios of the propeller radius (r/R), were 0.456, 0.633, 0.781, and 0.963. The plane in which the velocity measurements were taken was the starboard propeller plane located 146.2 feet (44.56 meters) aft of the forward perpendicular. The ATHENA displacement was 263 tons (267 metric tons), and the model trim was locked at a speed corresponding to a 20 knot (10.3 meter/second) ship speed, with the pitot rake in the zero degree position.

The wake measurement system consisted of a pitot tube rake and four differential pressure gages. The rake has five 5-hole spherical pitot tubes mounted in a common housing. Measurements were not made using the innermost pitot tube because of the flow interference between the pitot tube and the propeller hub. Figure 1 shows the arrangement of the rake and the pitot tubes. A description of the use and the calibration of 5-hole tubes is given by Hadler and Cheng.[3]

The carriage computer integrated the four pressure signals from each pitot tube, the model speed, and the angular position of the rake, over a 5-second period. Digital voltmeters and frequency counters monitored the computer values. The computer collected the pressure data for each of the

four pitot tubes. The rake was then rotated to a new angle, and the procedure was repeated until data were obtained throughout the entire rotation of the rake in the propeller disc.

Velocity component ratios were computed from the pressure data using established computer programs. The circumferential distributions of the longitudinal, tangential, and radial velocity component ratios were plotted for each radial location. Plots of the data were generated by a Control Data Corporation (CDC) Computer using a CALCOMP Plotter. Data were checked for random errors and agreement with previous experiments. Interpolation of the velocity component ratios in the radial and circumferential directions was made. This process yielded interpolated data every 2.5 degrees (0.044 radians) for four experimental radii, and for additional selected radii (interpolated radii). The mean longitudinal, tangential, and radial velocity component ratios; the volumetric mean wake; and the mean and extreme values of the advance angles were computed and are presented in this report. The advance angles were calculated using an advance coefficient, J_V, of 0.739. Explanation of this terminology and a diagram showing the relationship among the velocity vectors, the advance coefficient, and the advance angles are presented in the "Notation" section of this report.

Harmonic analyses of the circumferential distributions of the longitudinal and tangential velocity component ratios were computed for the experimental data. The harmonic content was determined by Fourier series analysis. The results of the harmonic analyses are presented as amplitudes and phase angles of a sine series.

ACCURACY ASSESSMENT

The instrumentation accuracy and the repeatability of wake survey experiments have been discussed in detail by Hadler and Cheng,[3] and Day[4]. The mean velocity component ratios and the harmonic amplitudes of these ratios all repeat within one percent of the model velocity. The accuracy of the entire velocity survey measurement system was also determined to be one percent of the model velocity, except in flow regions where steep velocity gradients occur, such as behind a shaft strut. In these high gradient regions, the accuracy was shown to be much less. These error bounds were derived for wake surveys calculated at model speeds of at least four knots, with the accuracy decreasing at lower speeds.

All data comparisons which follow will be referenced to the model velocity. Since the accuracy is on the order of one percent of the model velocity, highe order harmonics, whose amplitudes tend to be less than one percent of model velocity, cannot be considered to be as accurate as the mean values and lower order harmonics. The small higher order harmonics do not make a significant contribution to the reproduction of the velocity component ratios, though they do contribute to moments and forces calculated from the wake harmonics.

PRESENTATION AND DISCUSSION OF RESULTS

EXPERIMENTS 3, 9, AND 10 - EFFECT OF OPERATING PORT PROPELLER ON CONVENTIONAL WAKE SURVEYS

Experiments 3, 9, and 10 were conventional wake surveys of the starboard propeller plane of the R/V ATHENA (Model 5365). Experiment 3 was conducted without the port propeller operating, Experiment 9 was a check of

Experiment 3, and Experiment 10 was identical to Experiment 3, except that the port propeller was operating.

A listing of the input data for Experiment 3 (without the port propeller operating) is presented in Table A-1, of Appendix A. The circumferential distribution of the longitudinal, tangential, and radial velocity component ratios from Experiment 3 are shown in graphical form for each pitot tube radius in Figures A-1 through A-4. Included in these figures are the data from Experiment 9, which agree with the data for Experiment 3. The mean longitudinal (VXBAR), tangential (VTBAR), and radial (VRBAR) velocity component ratios, and the volumetric mean wake (1-WX) are presented in Table A-2. These quantities, except the radial mean, are presented graphically in Figure A-5.

The calculated mean values of the advance angle (BBAR), and the extreme variations (BPOS and BNEG) are shown in Figure A-6 and Table A-2. Tables A-3 through A-6 present the harmonic analyses of the circumferential distributions of the longitudinal and tangential velocity component ratios at the experimental and interpolated radii.

The results are presented in a similar form for Experiment 10 (with the port propeller operating). The circumferential distributions of the velocity component ratios are presented in Appendix B as Figures B-1 through B-4, the input data are listed in Table B-1, and mean values are presented in Figures B-5 and B-6, and Table B-2. The results of the harmonic analyses are presented in Tables B-3 through B-6.

When the results from Experiments 3 and 10 are compared, only small differences are seen. The mean values for the input radii of longitudinal,

tangential, and radial velocity listed in Tables A-2 and B-2 agree in most cases to within one percent of the freestream velocity. The circumferential mean values from Experiment 3 are not consistently higher or lower than those from Experiment 10.

The results of the harmonic analyses compare just as favorably. For example, at the input radii, the amplitudes of all harmonics of the longitudinal, tangential, and radial velocity component ratios differ by less than one percent of freestream. The phase angles, however, are different at several radii. The good agreement of the data, all within experimental accuracy, for Experiments 3 and 10, indicates only a small effect on the starboard wake is realized when the port propeller is operating.

EXPERIMENTS 11 AND 12 - EFFECT OF OPERATING PORT PROPELLER IN FRONT OF BASS DYNAMOMETER BOAT MOUNTED DOWNSTREAM

Experiments 11 and 12 were conventional wake surveys on the starboard propeller plane of the R/V ATHENA (Model 5365), with the Bass Dynamometer Boat (Model 5271) mounted downstream. This setup physically modeled the unsteady blade force experiments mentioned previously. Experiment 11 was conducted without the port propeller operating, and Experiment 12 was identical to Experiment 11, except that the port propeller was operating.

The circumferential distribution of the longitudinal, tangential, and radial velocity component ratios for Experiment 11 are shown graphically for each pitot tube radius in Appendix C as Figures C-1 through C-4. A listing of the input data is presented in Table C-1. The mean longitudinal, tangential, and radial velocity component ratios and the volumetric mean wake are presented in Figure C-5 and Table C-2.

The calculated mean and extreme values of the advance angles are also shown in Table C-2 and in Figure C-6. Tables C-3 through C-6 present the results of harmonic analyses of the circumferential distributions of the longitudinal and tangential velocity component ratios at the experimental and interpolated radii.

The results are presented in a similar form for Experiment 12. The circumferential distributions of the velocity component ratios are presented in Figures D-1 through D-4, the input data is listed in Table D-1, and the mean values are presented in Figures D-5 and D-6, and in Table D-2. The harmonic analyses are presented in Tables D-3 through D-6.

When the results from Experiments 11 and 12 are compared, only small differences are seen. The mean values of the longitudinal, tangential, and radial velocity component ratios for the input radii all agree to within one percent of freestream. At each radius, the longitudinal mean velocity component ratio is slightly higher with the port propeller operating (Experiment 12). However, the values are so nearly the same that no conclusions can be drawn regarding the trend.

The results of the harmonic analyses also compare favorably. For example, at the input radii, the amplitudes of the first harmonic of the longitudinal velocity component ratios differ less than one percent of freestream. The phase angles, however, are different for several of the radii. The harmonics of the tangential velocity component ratios also show good agreement, with the differences being very small compared to free-stream with good phase angle agreement. These results further verify the earlier conclusions that with the port propeller operating only a small effect on the starboard wake distribution is realized.

EXPERIMENTS 9 AND 11 - EFFECT OF BASS DYNAMOMETER BOAT MOUNTED DOWNSTREAM

The results already presented from Experiments 9 and 11 can be compared to determine the effect of the Bass Dynamometer Boat on the ATHENA model wake. The differences are very significant. The mean values of the longitudinal velocity component ratios in Tables A-2 and C-2 showed differences of 10 to 20 percent of the model velocity. The longitudinal velocity component ratios were always smaller with the Bass Dynamometer Boat behind the ATHENA model, as expected. The tangential and radial mean ratios also changed, though no consistent trend was evident.

The harmonics of the longitudinal velocity component ratios showed some differences. For example, the amplitude of the first harmonic is slightly less when the Bass Boat is present; however, the fifth harmonic shows the opposite trend, that is, slightly higher when the Bass Boat is present. The tangential harmonics differ only slightly. For example, the amplitudes of the first harmonic taken with the Bass Boat differed by about 2 percent of freestream when compared to the amplitudes of the first harmonic without the Bass Boat.

EXPERIMENT 13 - IDEALIZED WAKE SURVEY AT LARGE INFLOW ANGLE

Experiment 13 was an idealized wake survey conducted with the Bass Dynamometer Boat downstream of only the pitot tube rake, that is, no ATHENA model was present for this experiment or single cycle wake screen. The rake inclination to the direction of travel was 20 degrees (0.349 radians).

The circumferential distribution of the longitudinal, tangential, and radial component ratios for Experiment 13 are shown graphically for each pitot tube radius in Figures E-1 through E-4. A listing of the input data

is presented in Table E-1. The mean longitudinal, tangential, and radial velocity component ratios and the volumetric mean wake are presented in Table E-2 and Figure E-5.

The calculated mean and extreme values of the advance angles are shown in Figure E-6 and Table E-2. Tables E-2 through E-6 present the results of harmonic analyses of the circumferential distributions of the longitudinal and tangential velocity component ratios.

The mean values presented in Table E-2 are not uniform for all radii, though all differences are less than three percent of model velocity. The circumferential mean values of velocity components for this experiment indicate that the Bass Dynamometer Boat not only retards the flow, but also has a small effect on the radial distribution of the flow.

EXPERIMENT 14 - IDEALIZED WAKE SURVEY WITHOUT ANY INFLOW ANGLE BEHIND A WAKE SCREEN

Experiment 14 was an idealized wake survey conducted with the Bass Dynamometer Boat mounted at zero degree inclination downstream of a one-cycle wake screen. The results are presented in a form similar to Experiment 13. The circumferential velocity component distributions are presented in Figures F-1 through F-4, the input data are listed in Table F-1, and the mean values are presented in Figures F-5 and F-6 and Table F-2. The results of harmonic analyses are presented in Tables F-3 through F-6.

The circumferential distributions shown in Figures F-1 through F-4 indicate that the wake screen did indeed produce a one-cycle wake with a peak-to-peak variation to longitudinal velocity component ratio of about 0.3. Table F-2 indicates that the mean longitudinal velocity component

ratio is about 0.63. The longitudinal harmonics presented in Table F-3 indicate that even though the wake has only one cycle the higher harmonics are still significant.

EXPERIMENTS 15 AND 16 - EFFECT OF SPEED ON IDEALIZED WAKE SURVEY

Experiments 15 and 16 were idealized wake surveys conducted with only the Bass Dynamometer Boat downstream of the pitot tube rake. There was no single cycle wake screen during these experiments. The rake inclination to the direction of travel was ten degrees for both experiments. Experiment 16 was identical to Experiment 15, except that the towing speed of Experiment 16 was one-half that of Experiment 15.

The circumferential distribution of the longitudinal, tangential, and radial velocity component ratios for Experiment 15 are shown in Figures G-1 through G-4. A listing of the input data is presented in Table G-1. The mean longitudinal, tangential, and radial velocity component ratios and the volumetric mean wake are presented in Table G-2 and Figure G-5.

The calculated mean and extreme values of the advance angles are shown in Figure G-6 and Table G-2. Tables G-3 through G-6 present the results of harmonic analyses of the circumferential distributions of the longitudinal and tangential velocity component ratios at the experimental and interpolated radii.

The results are presented in similar form for Experiment 16. The circumferential velocity component distributions are presented in Figures H-1 through H-4, the input data are listed in Table H-1, and the mean values are presented in Figures H-5 and H-6 and in Table H-2. The results of harmonic analyses are presented in Tables H-3 through H-6.

When the results from Experiments 15 and 16 are compared, only small differences are noted. The differences between mean values presented in Tables G-2 and H-2 are not significant with a maximum difference of about one percent of model velocity in the longitudinal mean, and a maximum difference in the tangential and radial means of less than one percent. The harmonics do not compare as favorably as the mean values, although the amplitudes of the first harmonic of the tangential velocity component ratios at the input radii differ by less than three percent of model velocity. The amplitudes of the first harmonic for the longitudinal ratios are in better agreement with the maximum difference being less than one percent of model velocity. These small differences indicate this idealized wake is only weakly dependent on speed.

CONCLUSIONS

(1) The effect due to the port propeller operating on the starboard mean wake distribution is small. This effect was illustrated twice and established no noticeable trends in the mean velocity component ratios.

(2) The Bass Dynamometer Boat mounted aft of the R/V ATHENA very significantly affects the mean longitudinal velocity component ratios. These mean longitudinal velocity component ratios with and without the Bass Dynamometer Boat differ by 10 to 20 percent. The results of the harmonic analyses show smaller trends. The radial distribution of the flow is also slightly influenced.

(3) The Bass Dynamometer Boat affects each radius differently due to the bass dynamometer blunt bow causing greater flow obstruction when at a 20 degree inclination.

(4) When a single cycle wake screen is mounted upstream of the Bass Dynamometer Boat, both at zero inclined angle, the wake screen affects the peak to peak fluctuations in the longitudinal velocity component ratios. These peak to peak fluctuation ranges are half the total mean longitudinal velocity component ratio values. The single cycle wake screen affects the higher harmonics significantly.

(5) The idealized flow wake surveys show a weak dependence upon velocity when the Bass Dynamometer Boat and rake are mounted at a ten degree angle of inclination to the free surface without any single cycle wake screen present.

REFERENCES

1. Day, W. G., Jr., A. M. Reed, R. B. Hurwitz, "Full-Scale Propeller Disk Wake Survey and Boundary Layer Velocity Profile Measurements on the 154-Foot Ship R/V ATHENA," DTNSRDC Ship Performance Department Report DTNSRDC/SPD-0833-01 (Sep 1980).

2. Hurwitz, R. B. and L. B. Crook, "Analysis of Wake Survey Experimental Data for Model 5365 Representing the R/V ATHENA in the DTNSRDC Towing Tank," DTNSRDC Ship Performance Department Report DTNSRDC/SPD-0833-04 (Oct 1980).

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," Trans. Soc. Naval Arch. and Mar. Eng., Vol. 73, pp. 287-414 (1965).

4. Day, W. G., Jr., "Effect of Speed on the Wake in Way of the Propeller Plane for the DD 963 Class Destroyer Represented by Model 5265-1B," NSRDC Ship Performance Department Report SPD-311-37 (Jun 1975).

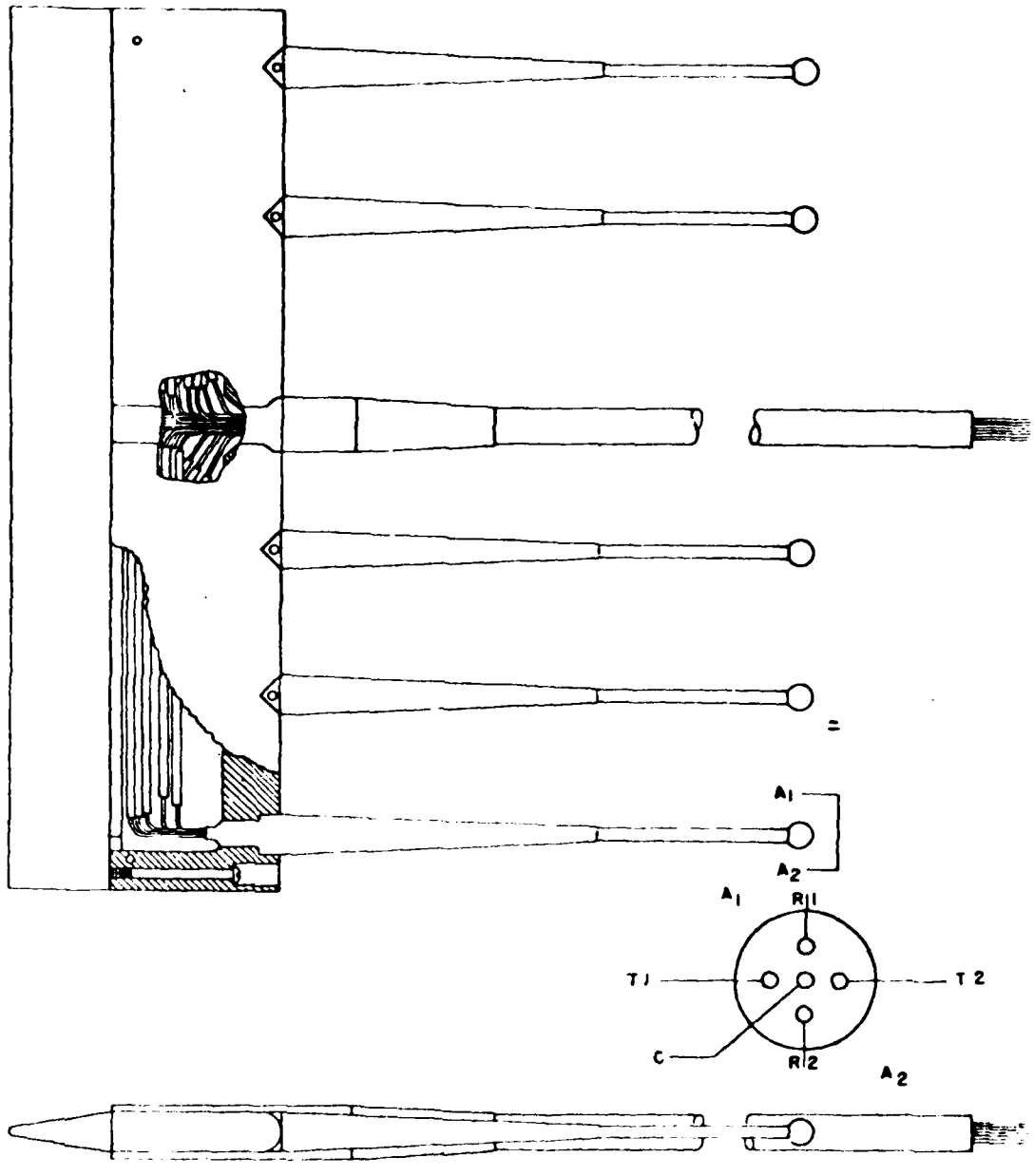
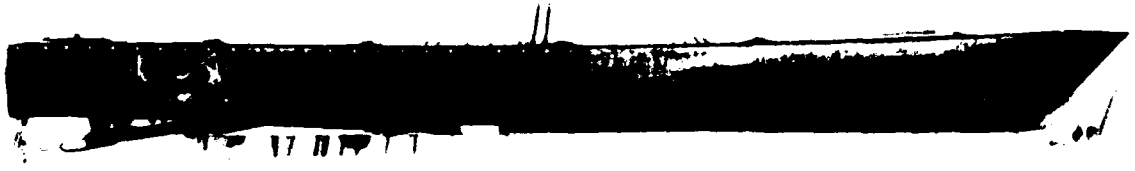


Figure 1 - Rake Arrangement Sketch Showing Five Spherical Head Pitot Tubes with Five Holes Each



PSD 0604-5-78-2

PSD 0605-5-78-5

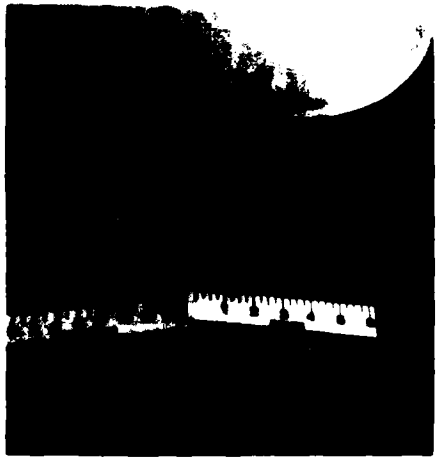


Figure 2 - Rake Arrangement Photographs Showing Installation in Starboard Shaft of Model 5365 During Experiments 3 and 9 Without Port Propeller

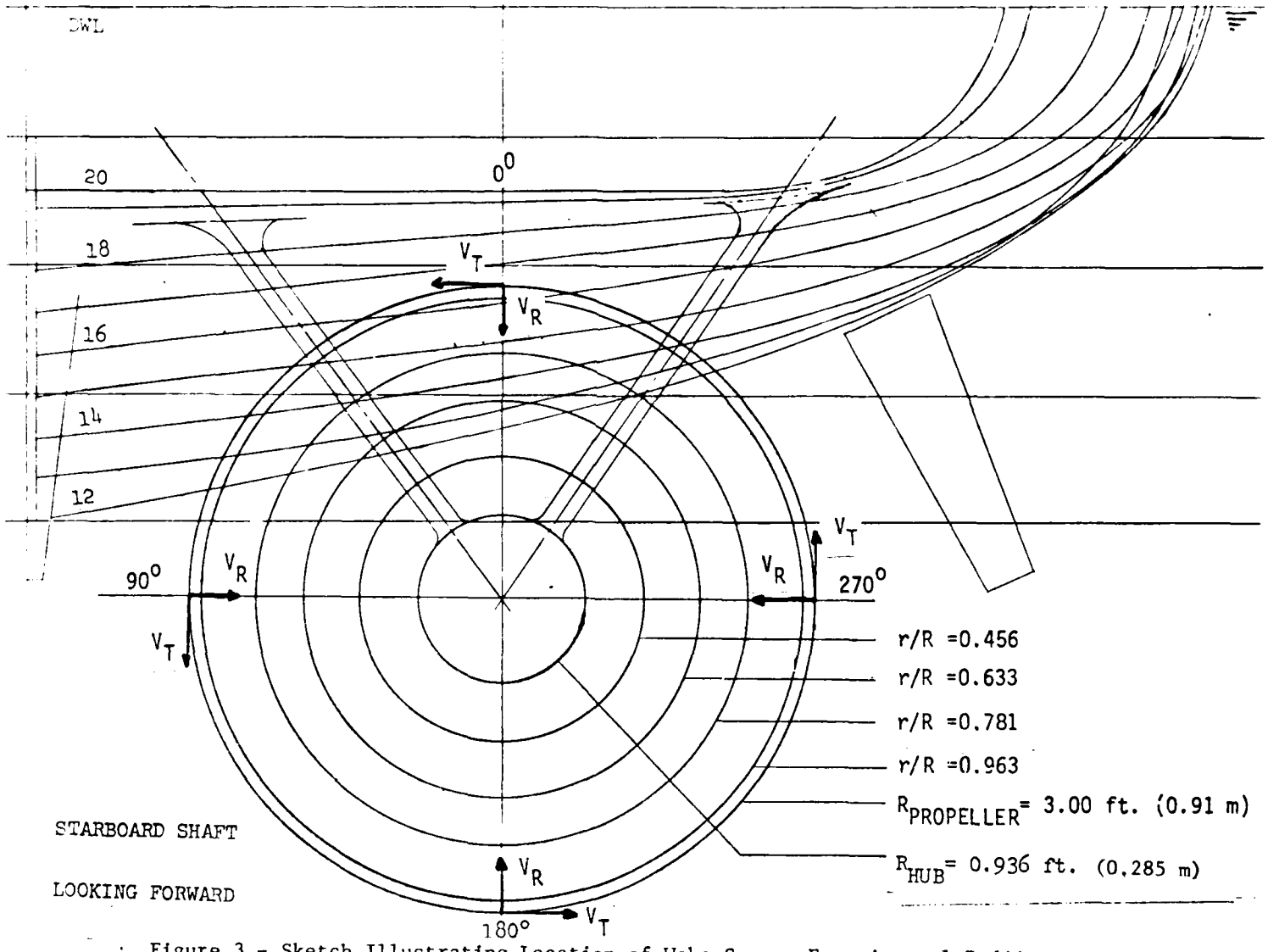


Figure 3 - Sketch Illustrating Location of Wake Survey Experimental Radii on Model 5365 Afterbody Sections Representing the R/V ATHENA

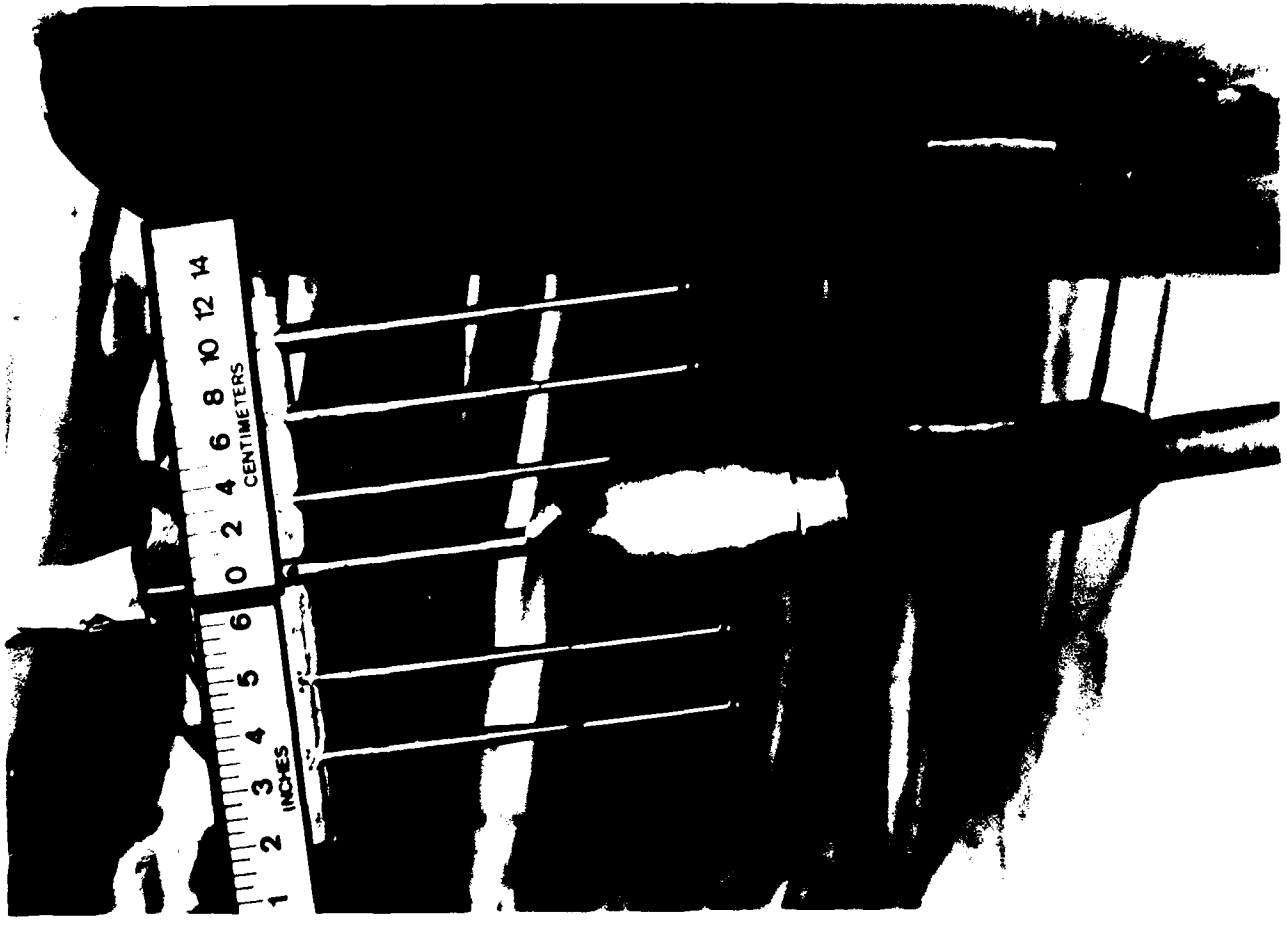


Figure 4 - Rake Arrangement Photograph Showing Closeup Profile View of Installation in Starboard Shaft of Model 5365 Without Port Propeller

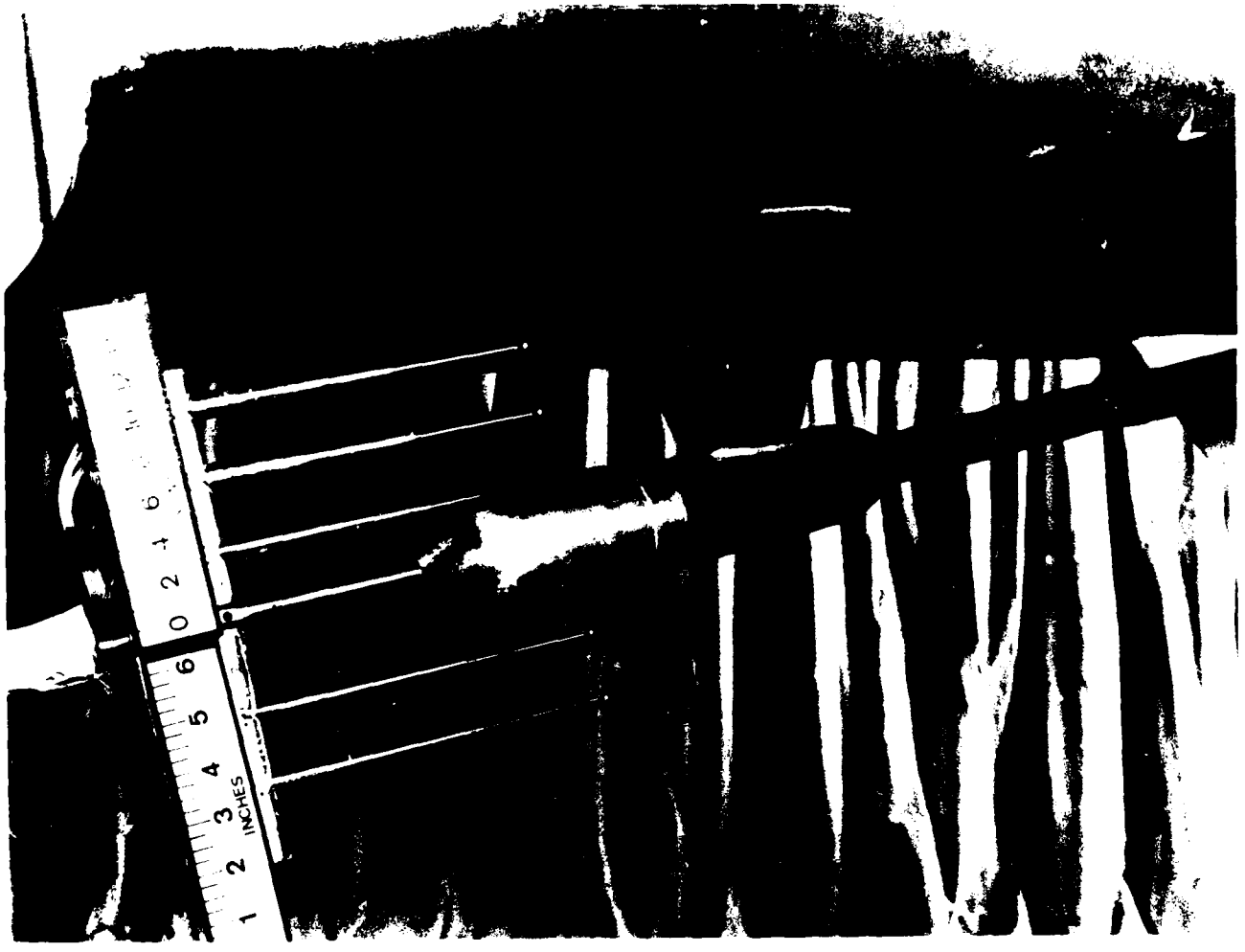
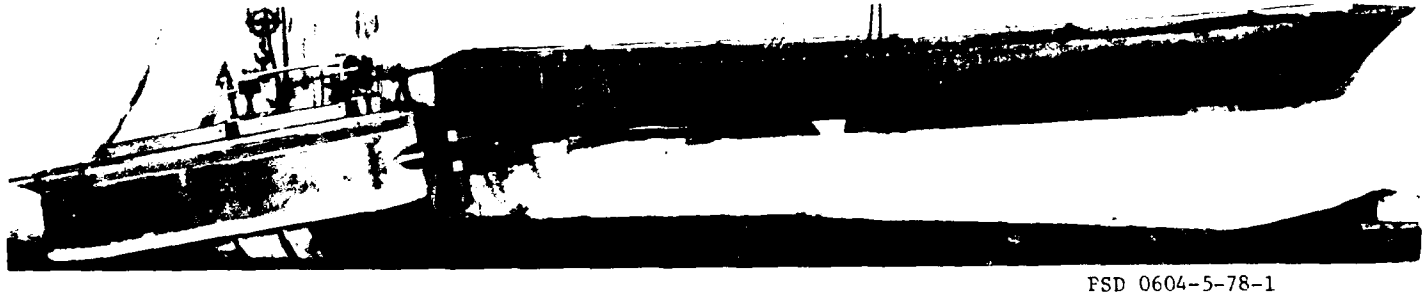


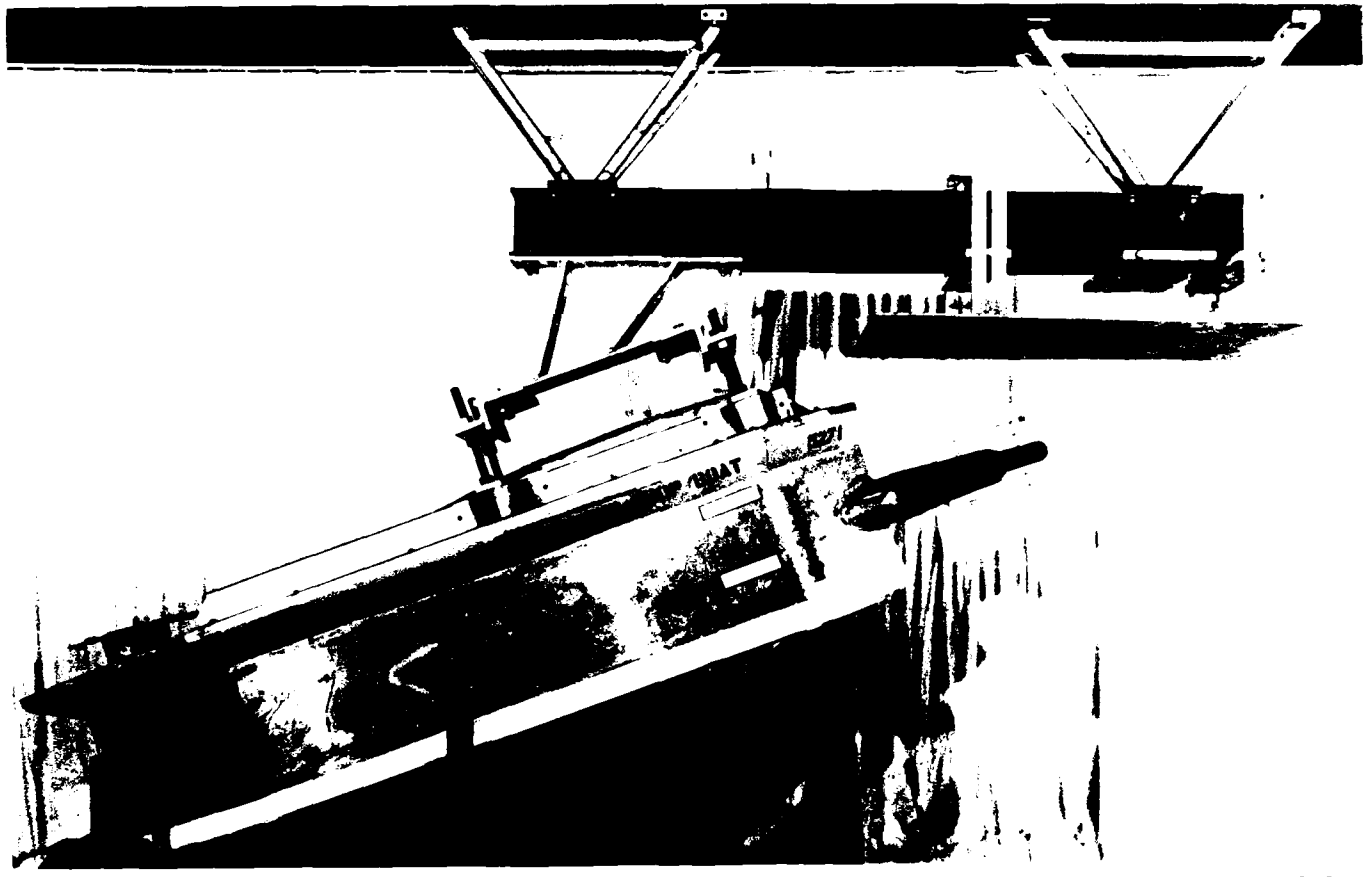
Figure 3 - Rake Arrangement Photograph Showing Closeup Quartering View of Installation in the Starboard Shaft of Model 5365 Without Port Propeller

PSD 0603-5-78-3



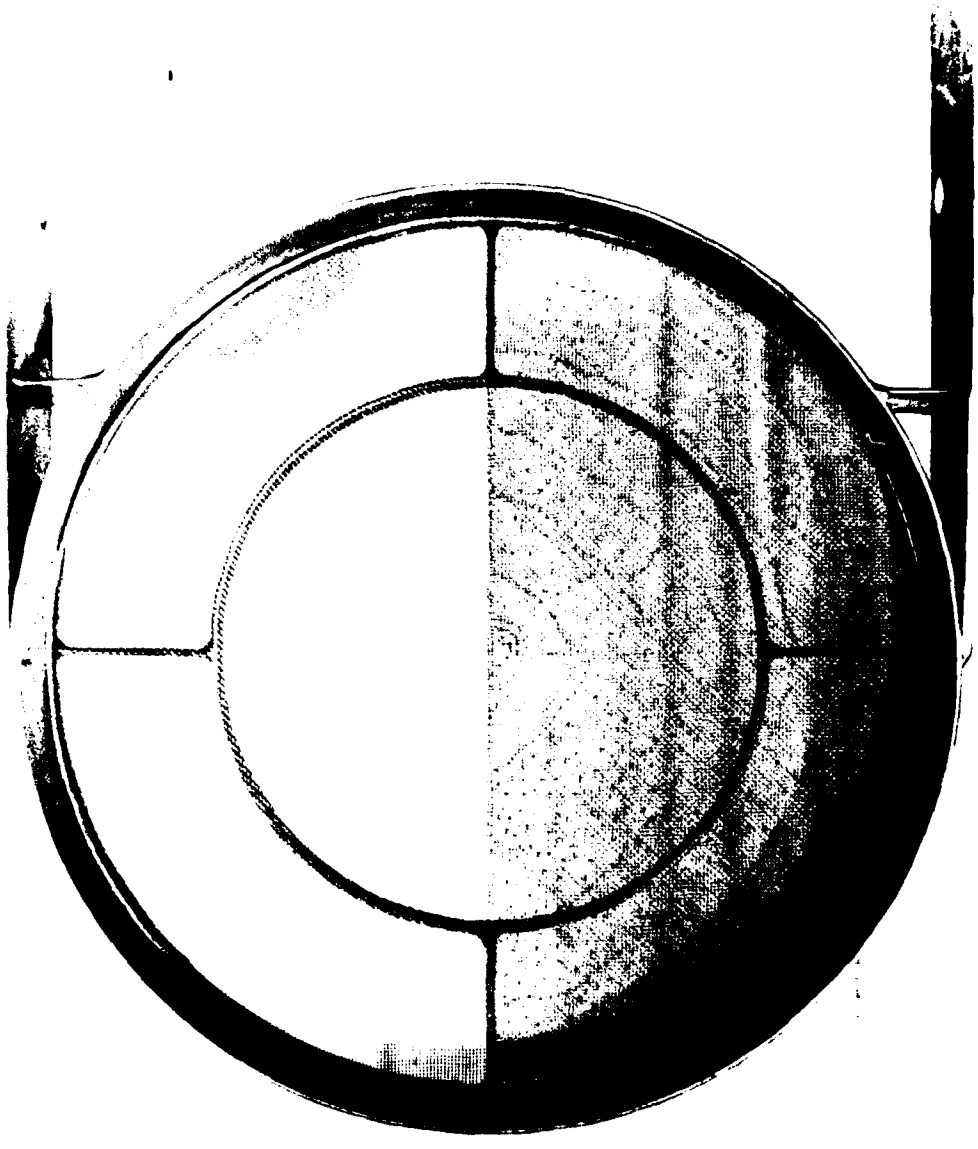
PSD 0604-5-78-1

Figure 6 - Rake Arrangement Photograph Showing Installation in Bass Dynamometer Boat, Model 5271, Mounted Behind Starboard Shaft of Model 5365 With and Without Port Propeller as During Experiments 11 and 12



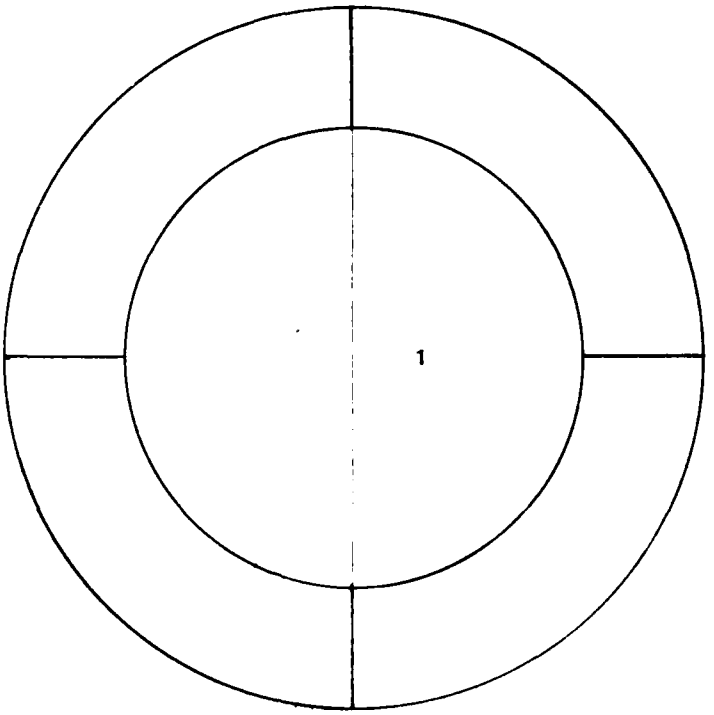
PSD 0606-5-78-3

Figure 7 - Rake Arrangement Photograph Showing Bass Dynamometer Boat Mounted for 20 Degree (0.349 radian) Inclined Idealized Flow Wake Experiment 13



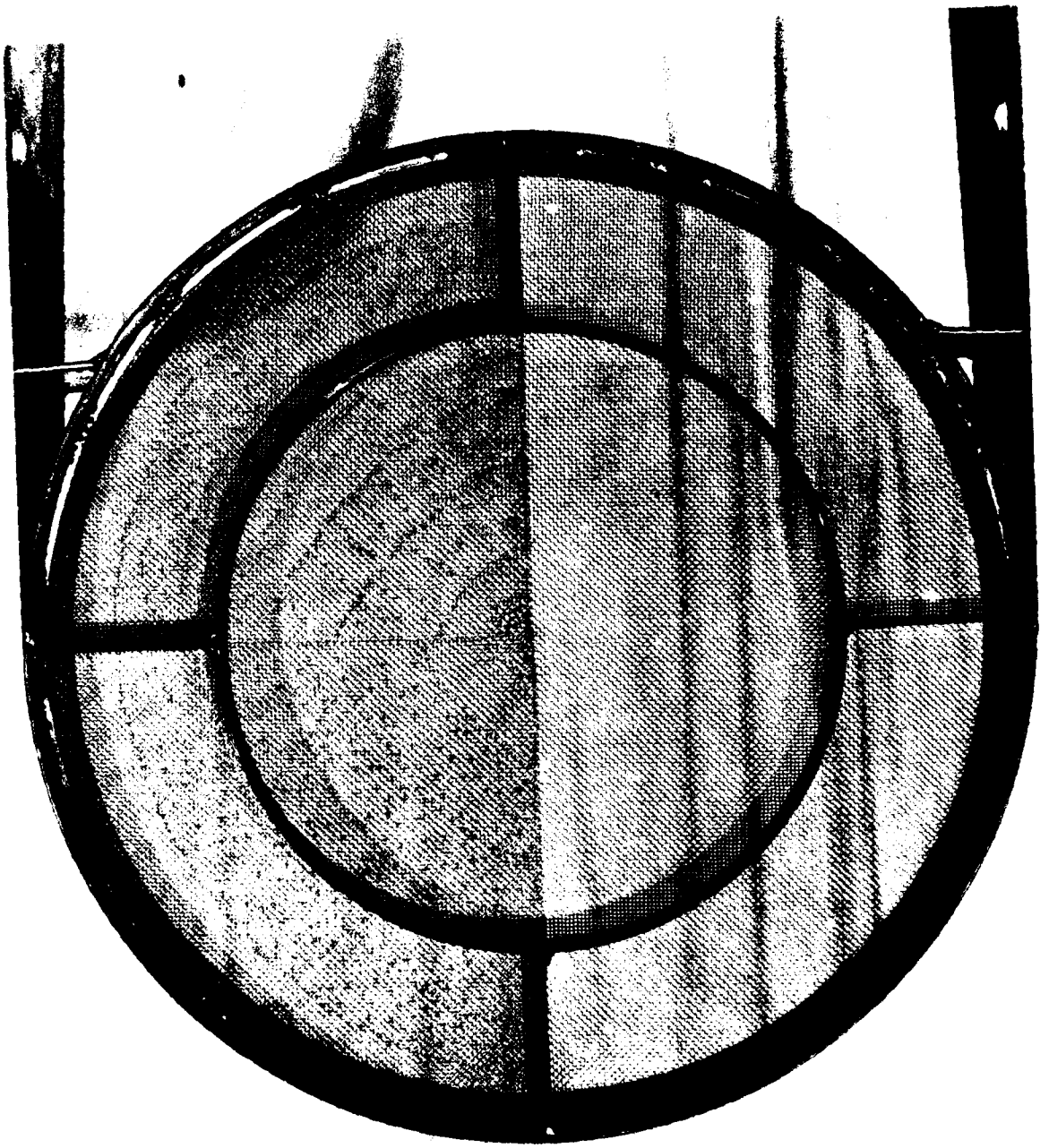
PSD 0607-5-78-1

Figure 8 - Wake Screen Photograph Showing Downstream View at Spherical Head Pitot Tubes Used for Idealized Flow Experiment 14



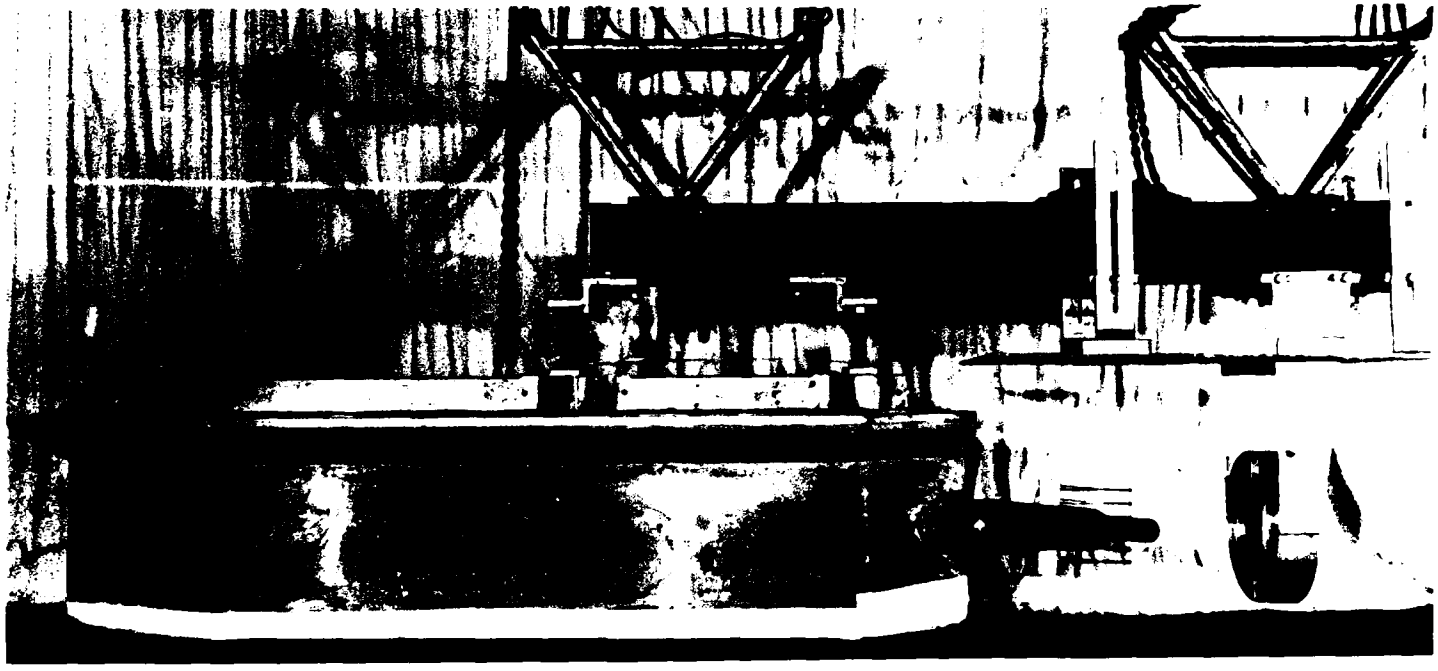
REGION	SCREEN SIZE	
	WIRES PER INCH	DIAMETER (inches)
SUPPORT (ALL)	16	0.009
1	20	0.011

Figure 9 - Schematic of Wake Screen Wire Sections and Sizes Used for Idealized Flow Experiment 14



PSD 0604-5-78-11

Figure 10 - Wake Screen Phototgraph Showing Upstream View Into the Flow for Idealized Flow Experiment 14



PSD 0606-5-78-7

Figure 11 - Bass Dynamometer Boat Mounted Behind the Wake Screen Photograph Showing Arrangement of Pitot Tubes for Idealized Flow Experiment 14

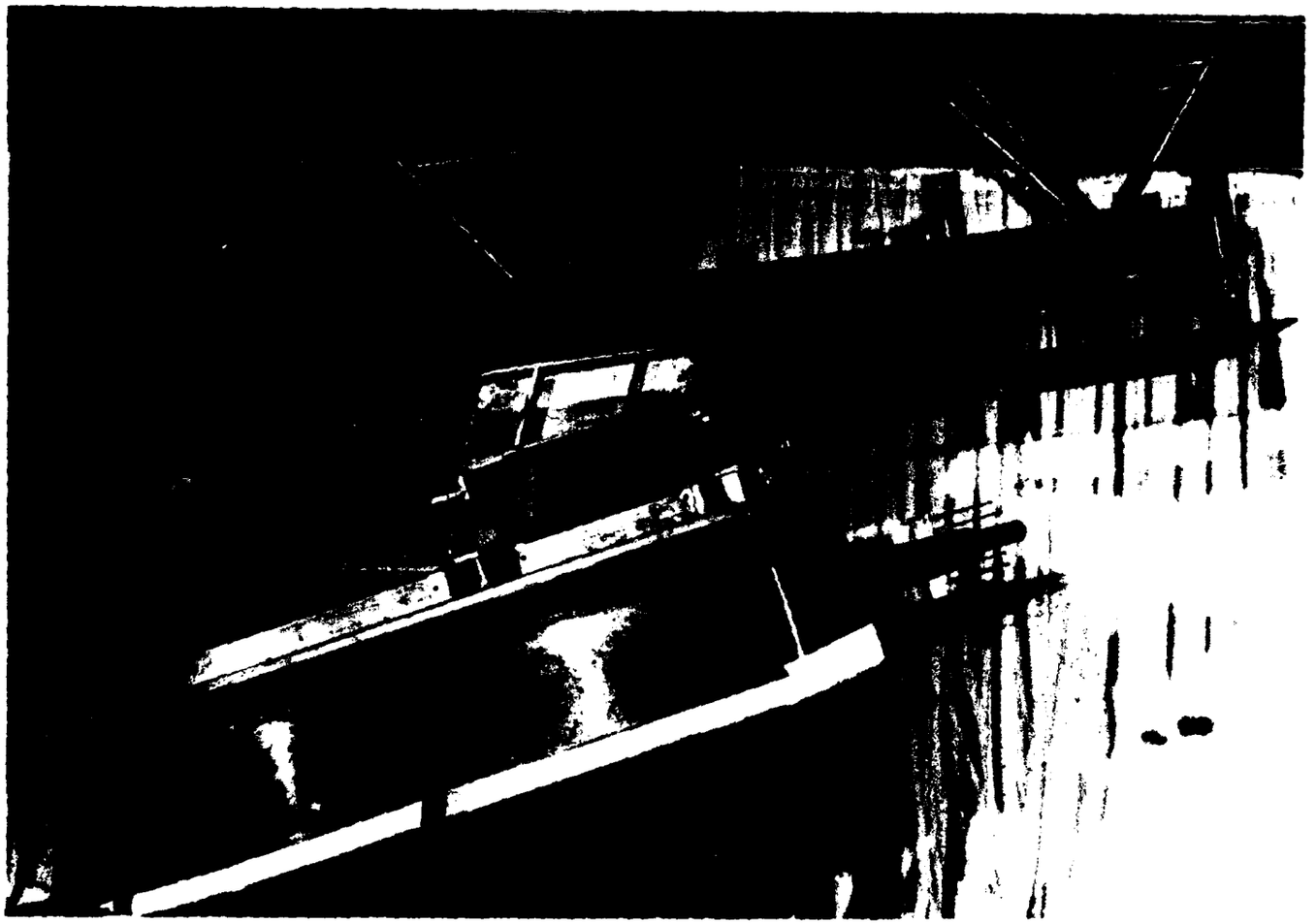


Figure 12 - Bass Dynamometer Boat Mounted for 10 Degree (0.174 radian) Inclined Idealized Flow Wake Photograph Showing Spacer Block Used for Experiments 15 and 16

TABLE I

Ship and Model Characteristics

R/V ATHENA Represented by Model 5365

	Ship	Model
Length Between Perpendiculars	154.0 ft (46.9m)	18.6 ft (5.7m)
Length Overall	164.5 ft (50.1m)	19.9 ft (6.1m)
Maximum Beam	24.0 ft (7.3 m)	2.9 ft (0.9m)
Displacement	263 tons (267.3 tonnes)	1020 lbs (462.6 kg)
Wetted Surface	3413 ft^2 (317.1 m^2)	50.15 ft^2 (4.659 m^2)
Draft	5.63 ft (1.72 m)	0.682 ft (0.208 m)
Trim by Stern	0.59 ft (0.18 m)	0.071 ft (0.022 m)
Propeller Diameter	6.0 ft (1.8 m)	8.73 in (22.2 cm)
Linear Scale Ratio	8.25	1.0

Propulsion: Twin screw, controllable pitch, 4 blades each

Appendages: Twin stabilizers, main shafts and V-struts, twin rudders, centerline skeg

APPENDIX A

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS

FOR EXPERIMENTS 3 AND 9

Table 2

EXPERIMENTAL PROGRAM

Experiment Number	Equivalent Ship Speed in Knots (m/s)	Shaft Inclination	Athena Model	Dynamometer Boat	Wake Screen	Port Propeller Operating
3,9	20.0 (10.3)	*	yes	no	no	no
10	20.0 (10.3)	*	yes	no	no	yes
11	20.0 (10.3)	*	yes	yes	no	no
12	20.0 (10.3)	*	yes	yes	no	yes
13	11.5 (5.9)	20^{o}	no	yes	no	no
14	12.9 (6.6)	0^{o}	no	yes	yes	no
15	17.2 (8.8)	10^{o}	no	yes	no	no
16	8.6 (4.4)	10^{o}	no	yes	no	no

*Model trim set at equivalent ship speed twenty knots (10.3 meters/second)

APPENDIX A

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENTS 3 AND 9

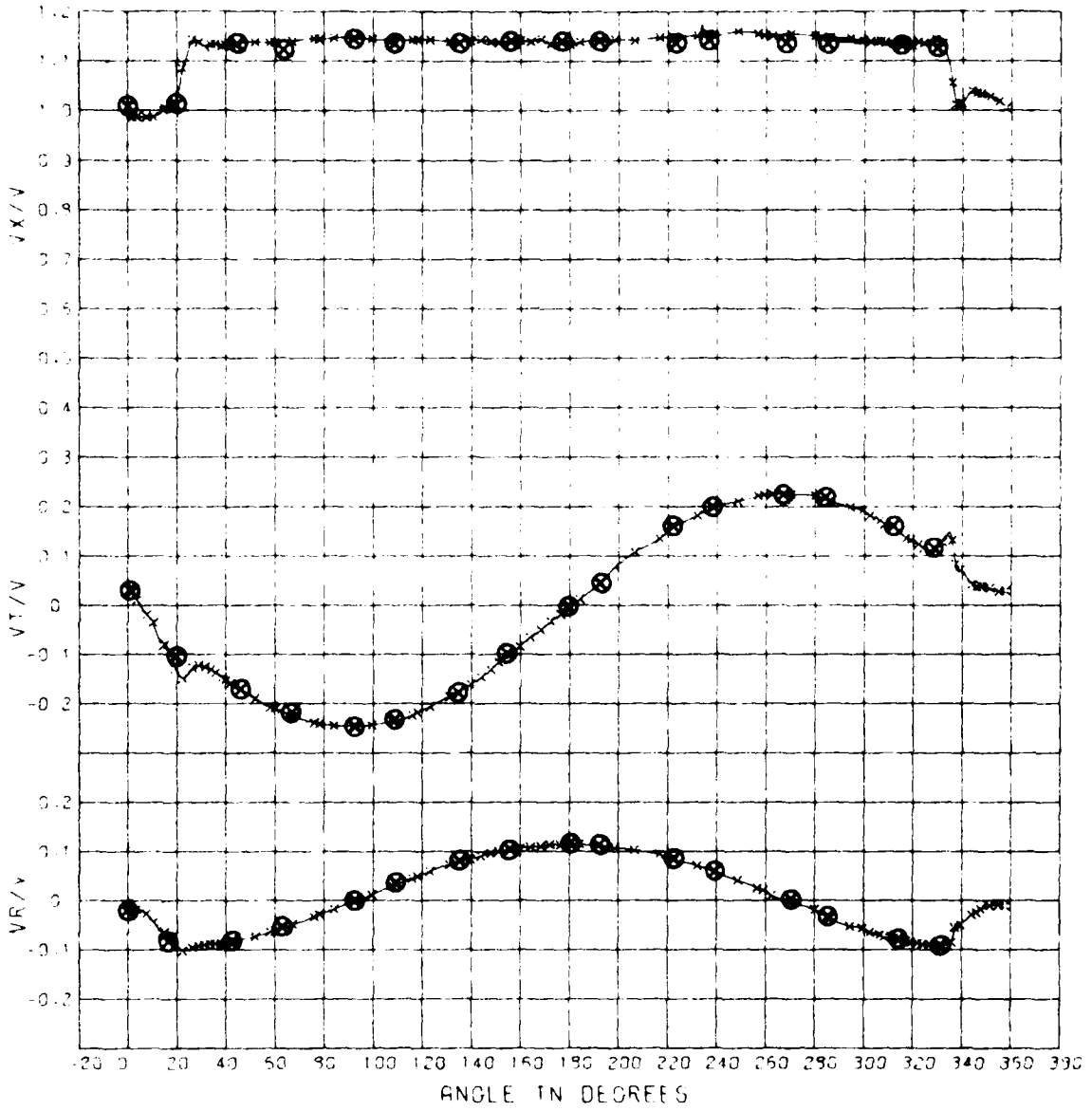


Figure A-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiments 3 and 9

x : Experiment 3
⊗ : Experiment 9

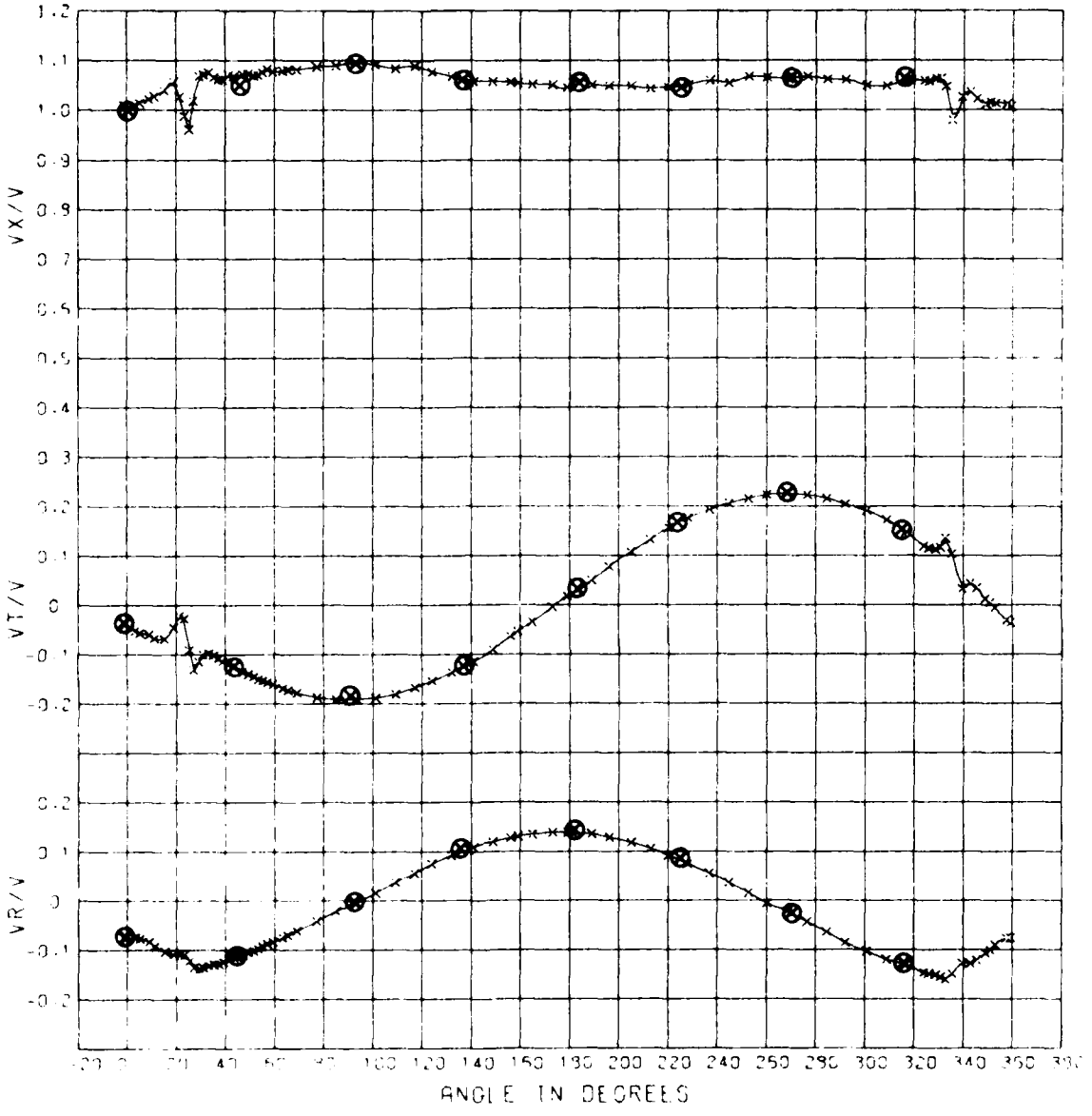


Figure A-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiments 3 and 9

x : Experiment 3
⊗ : Experiment 9

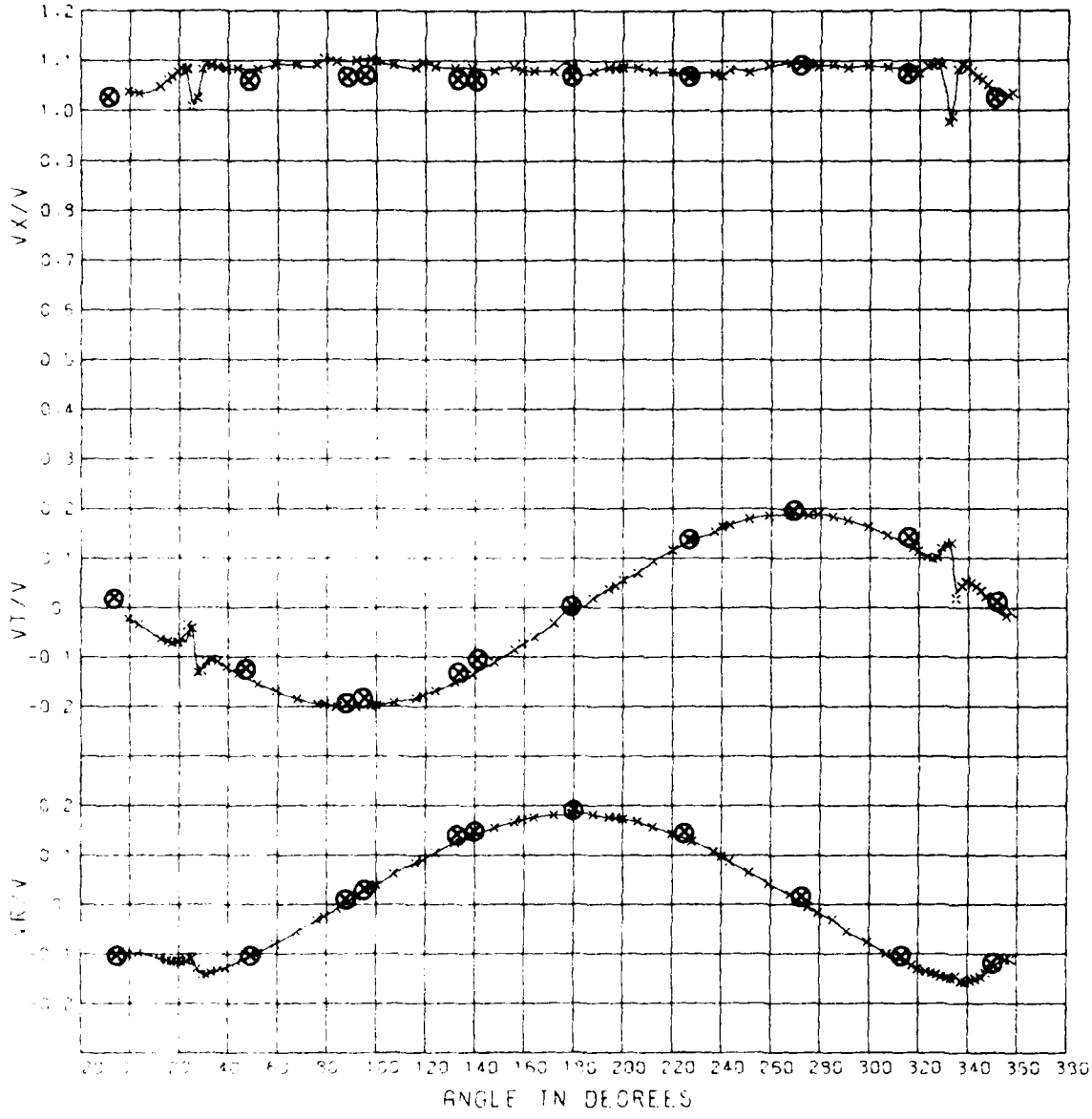


Figure A-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiments 3 and 9

x : Experiment 3
⊗ : Experiment 9

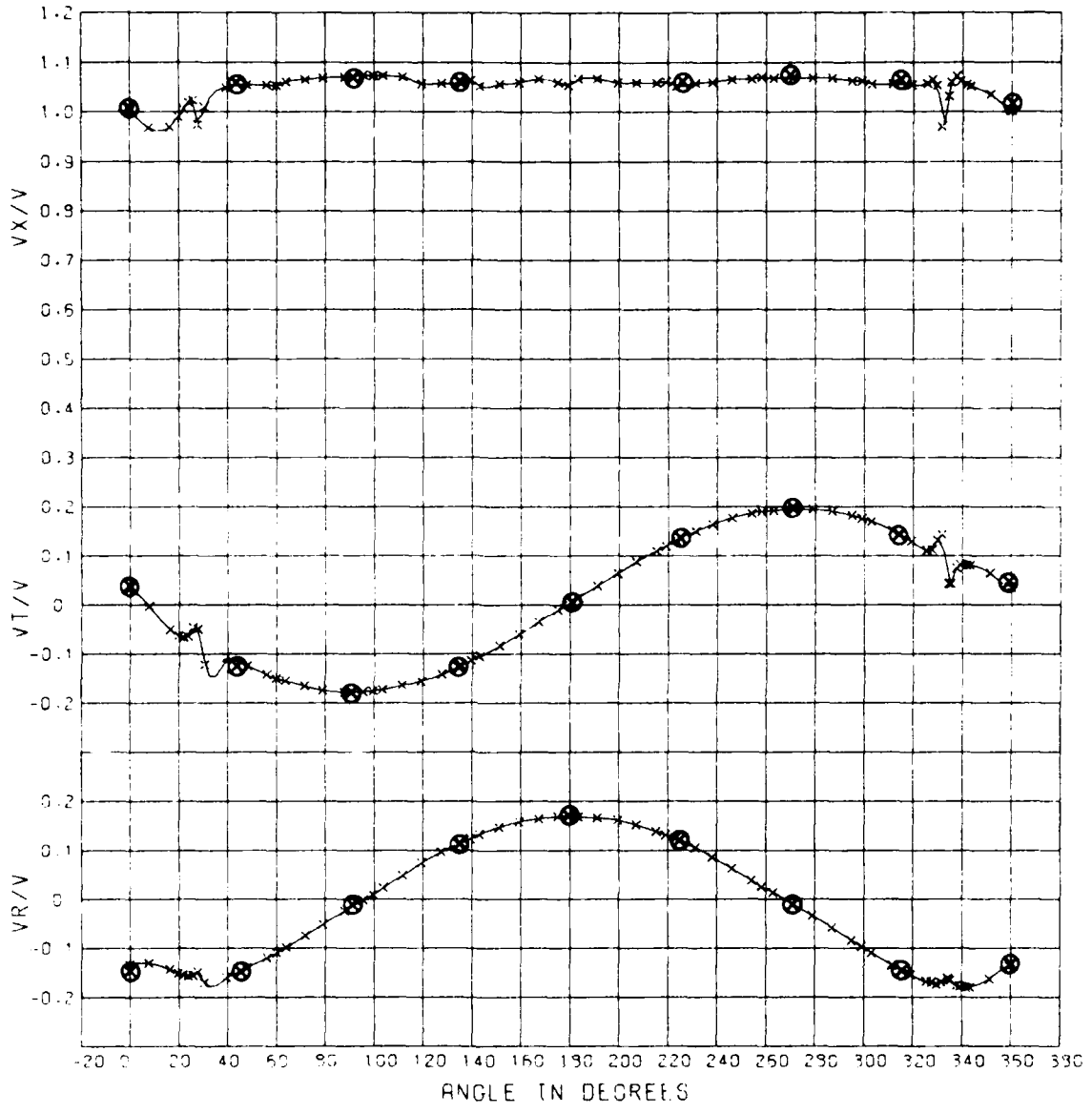


Figure A-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiments 3 and 9

x : Experiment 3
⊗ : Experiment 9

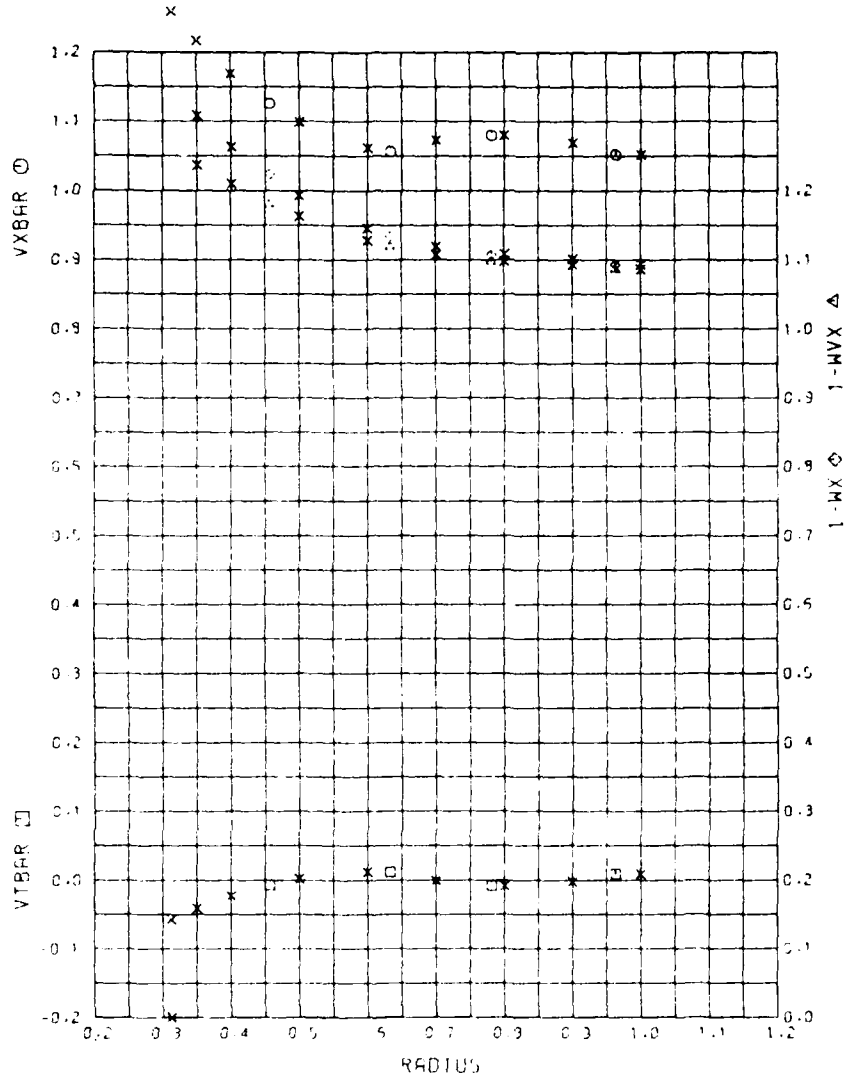


Figure A-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 3

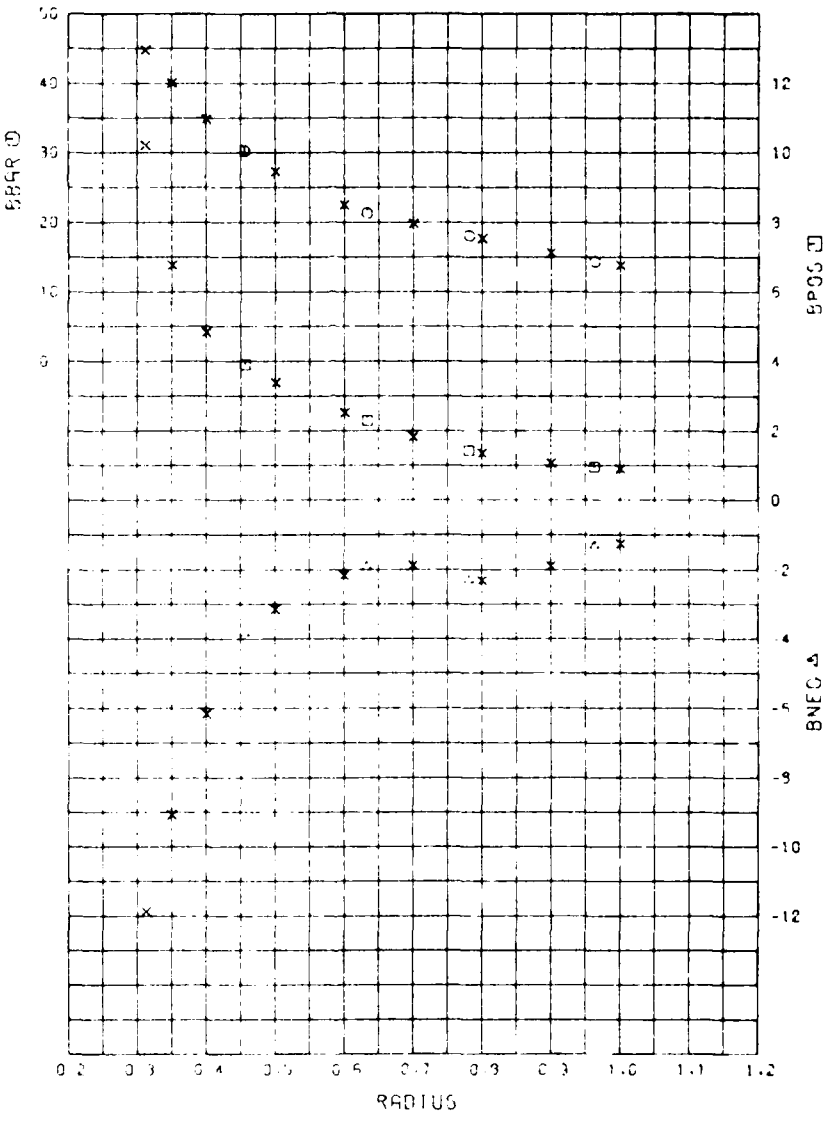


Figure A-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 3

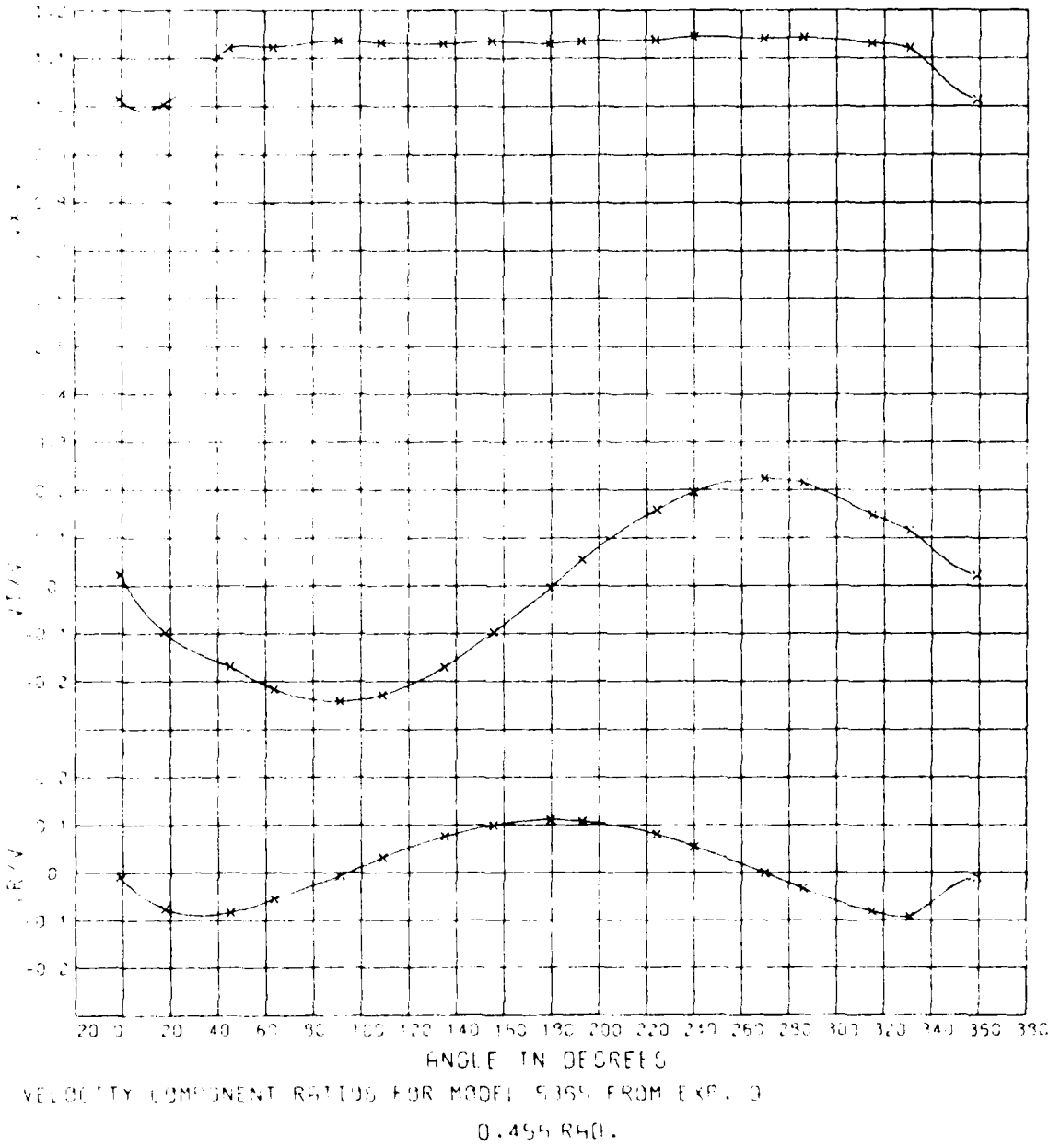


Figure A-7 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 9

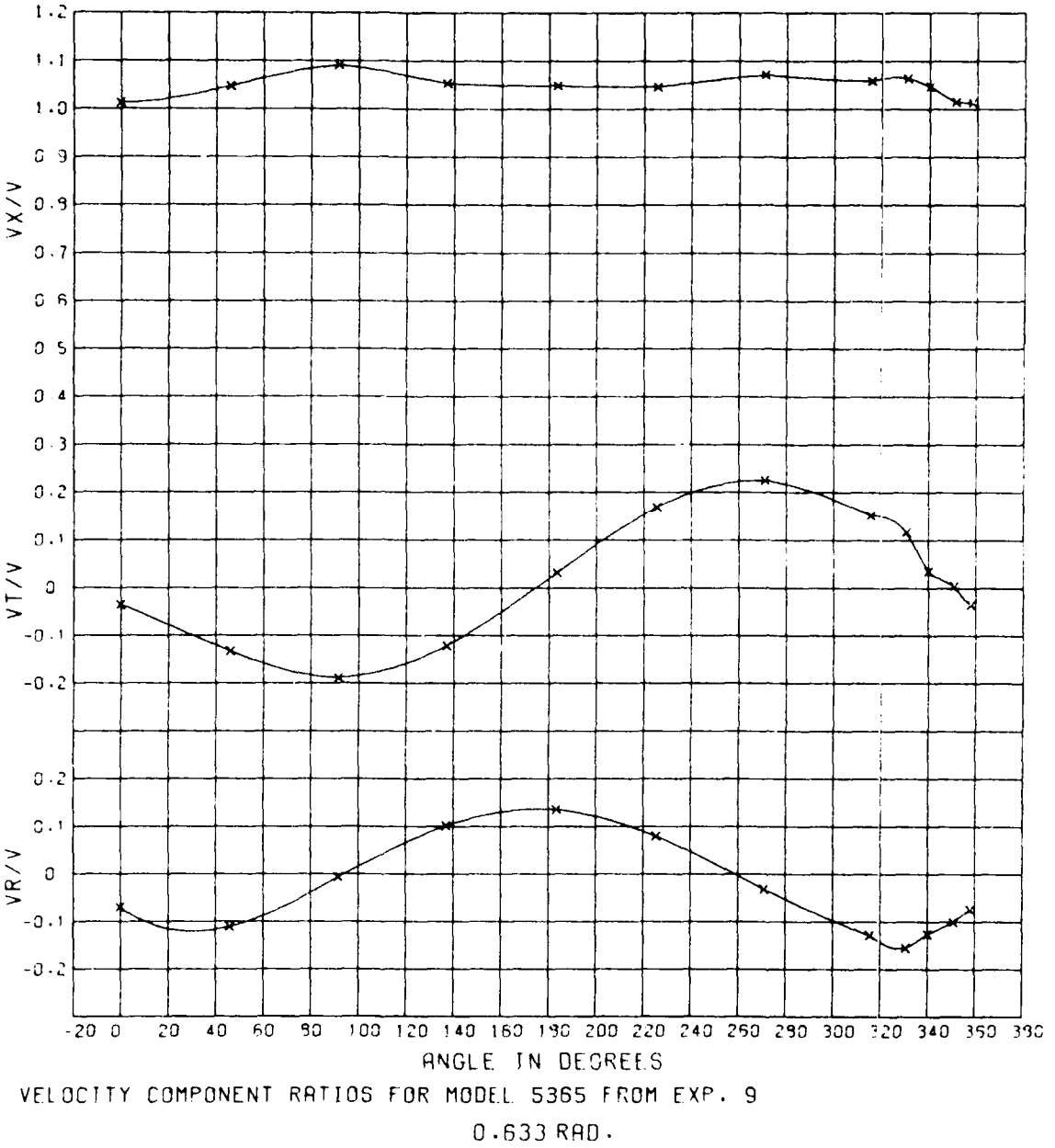


Figure A-8 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 9

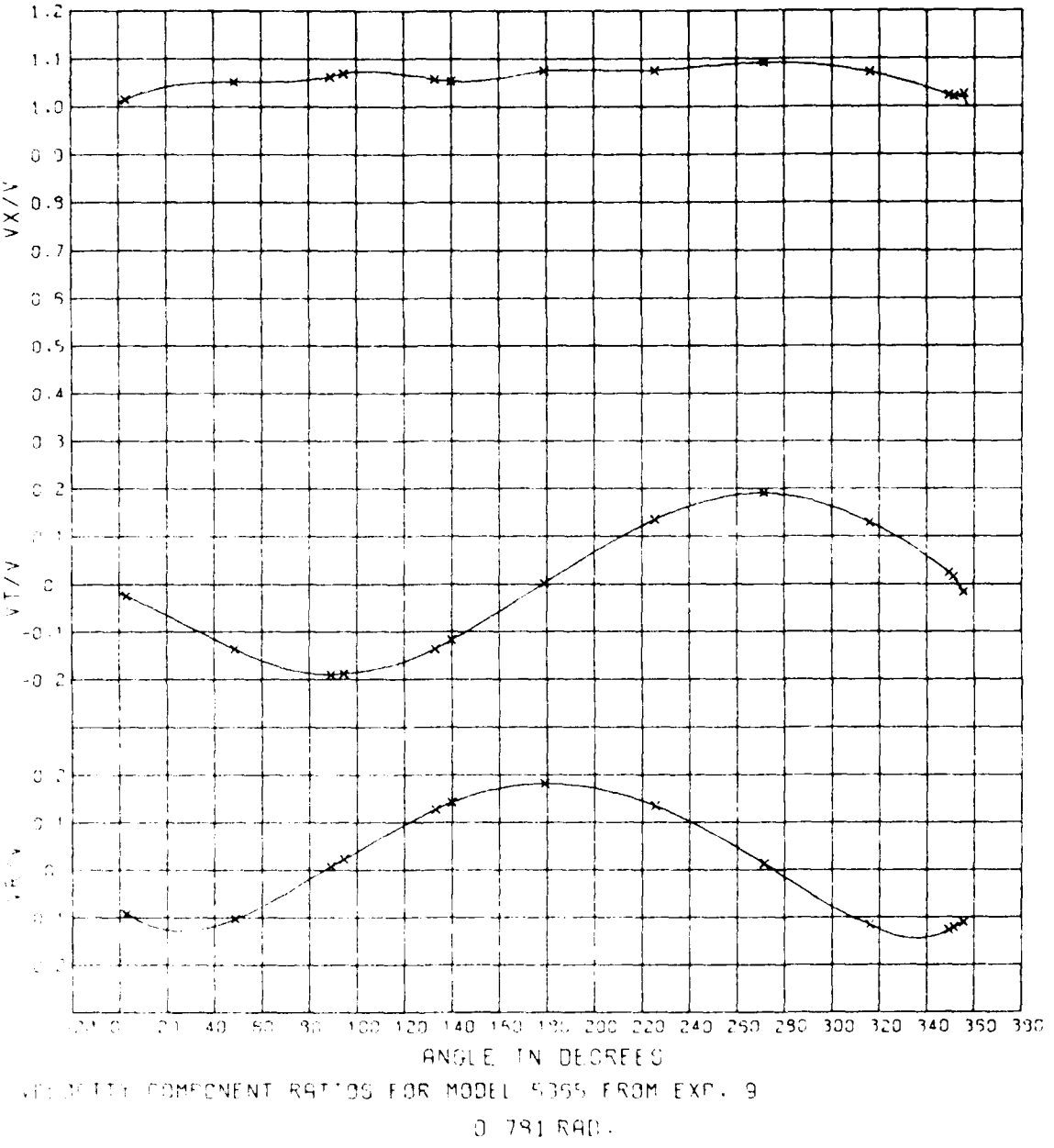


Figure A-9 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 9

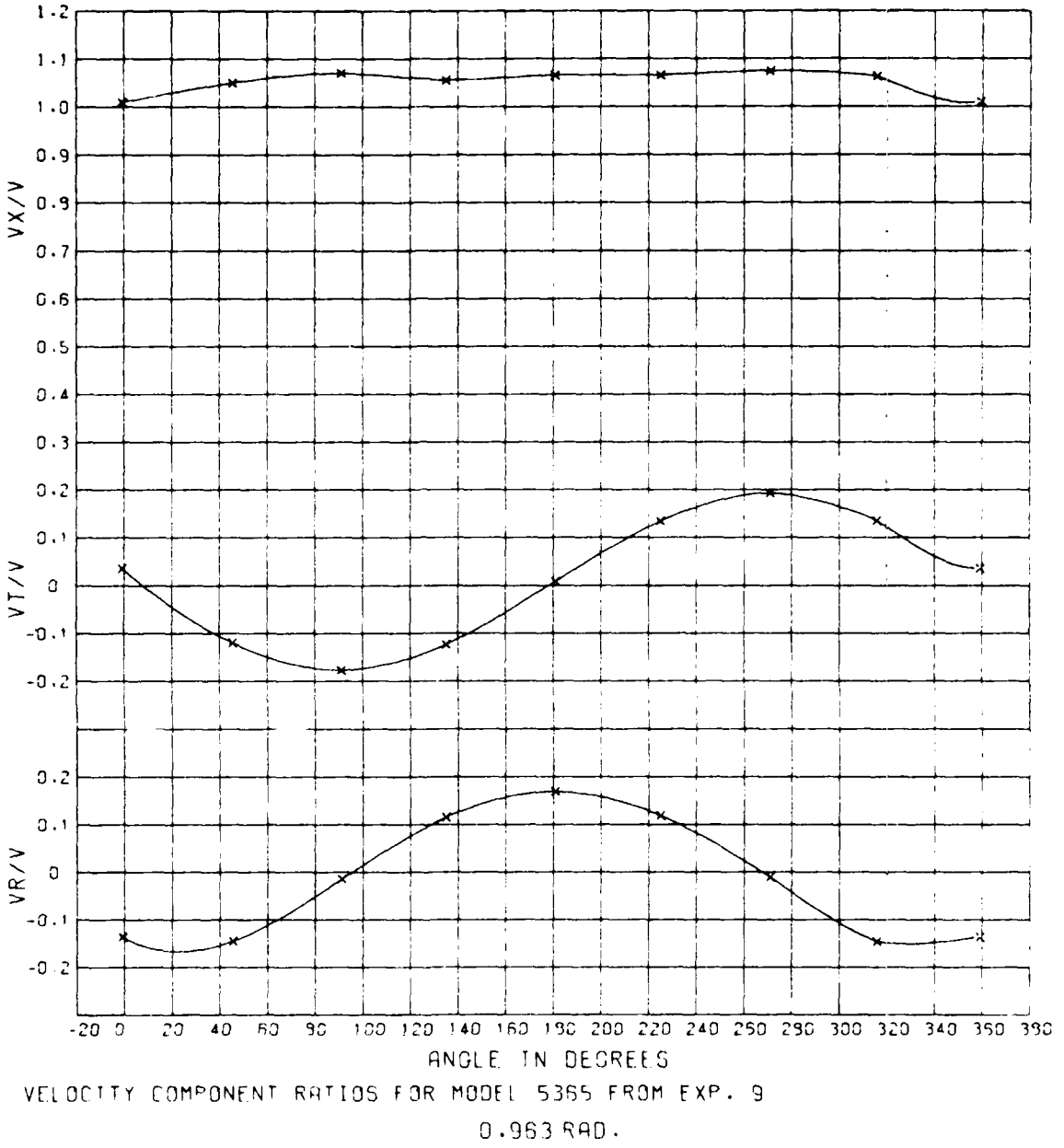


Figure A-10 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 9

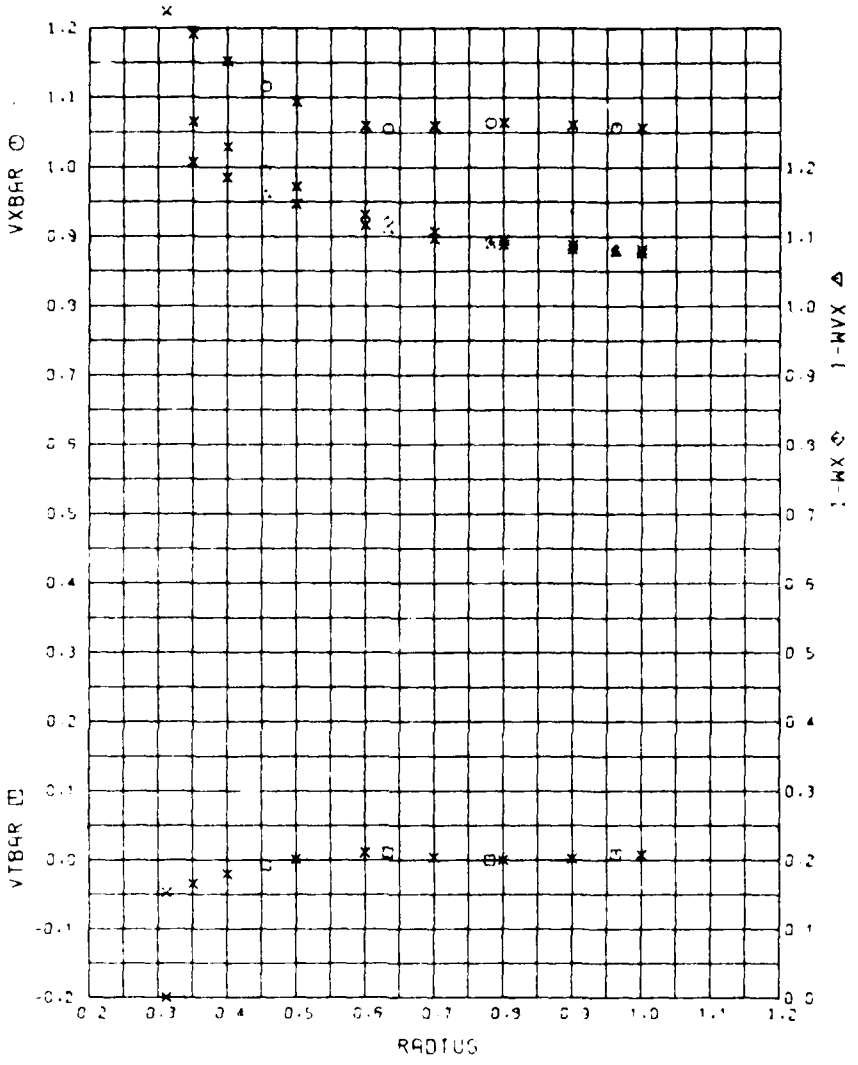


Figure A-11 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 9

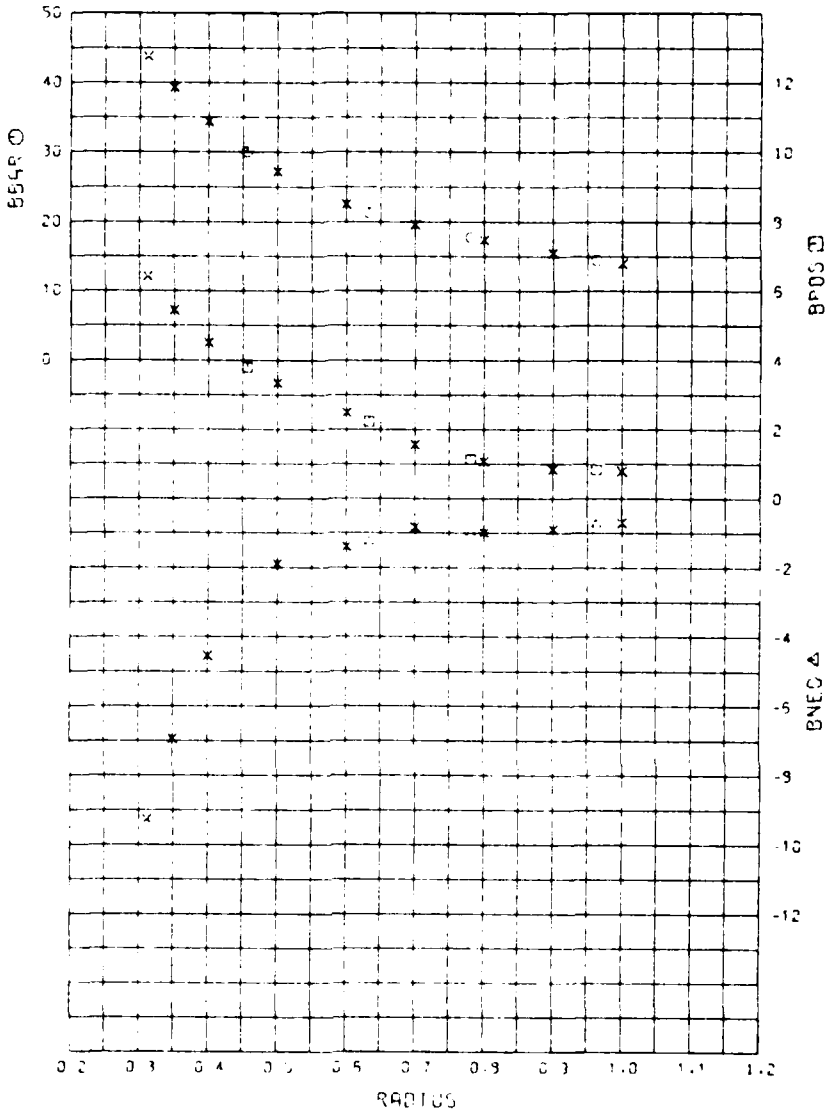


Figure A-12 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 9

TABLE A-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA,
MODEL 5365, EXPERIMENT 3

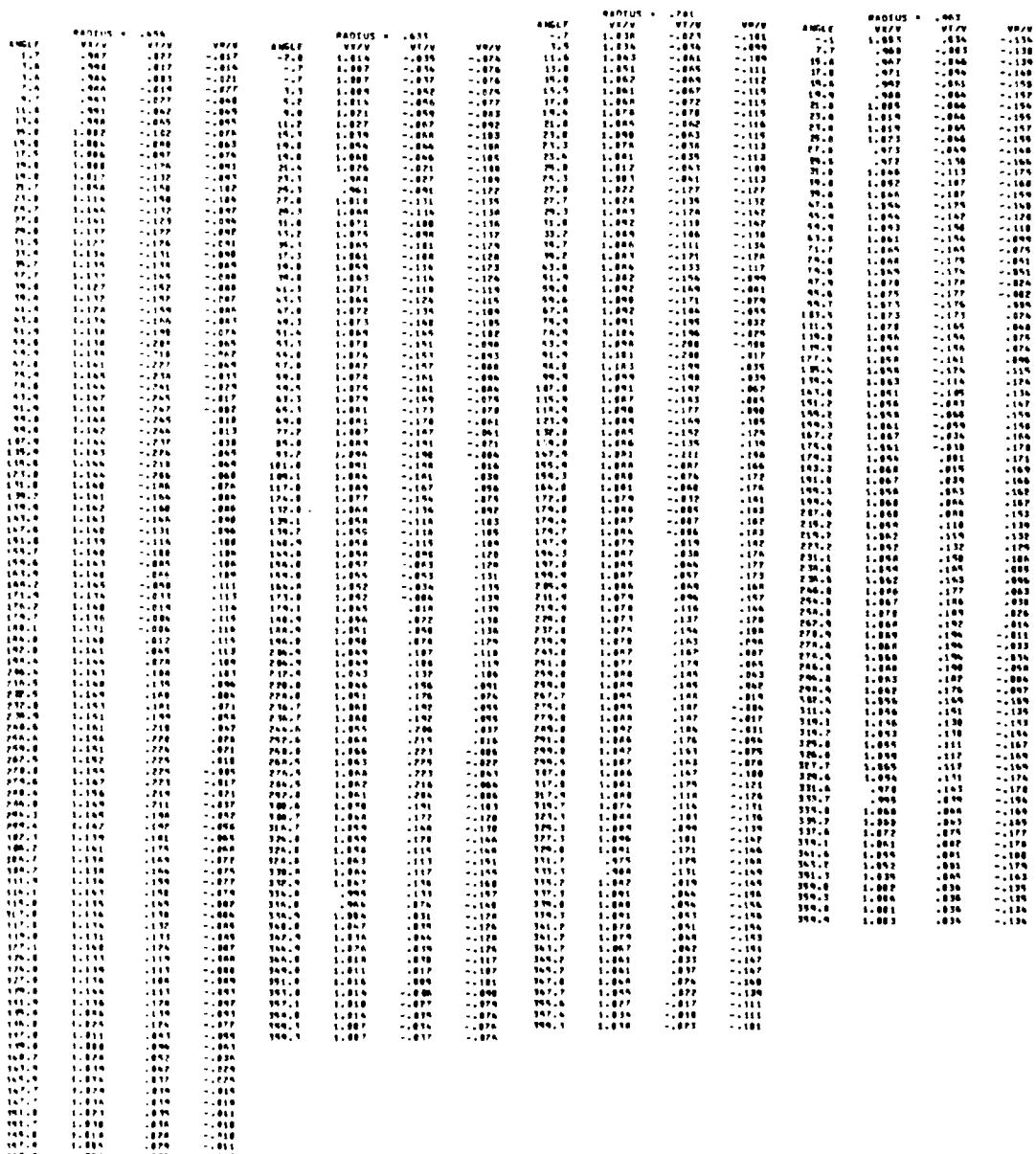


TABLE A-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 3

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER 6.00 FEET JA = .739

RADIUS =	.456	.623	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.126	1.057	1.080	1.052	1.259	1.217	1.169	1.099	1.062	1.073	1.080	1.069	1.052
VTBAR =	-.007	.012	-.008	.009	-.057	- 041	-.023	.002	.012	-.001	-.008	-.002	.009
VRBAR =	.008	-.008	.015	-.008	.056	.041	.023	-.000	-.009	.007	.015	.006	-.008
1-WX* =	1.180	1.119	1.097	1.086	0.000	1.237	1.219	1.163	1.128	1.107	1.098	1.093	1.086
1-WX =	1.224	1.135	1.107	1.093	0.000	1.308	1.263	1.194	1.146	1.119	1.108	1.101	1.093
BBAR =	33.23	21.26	18.05	14.38	44.74	40.05	34.87	27.48	22.51	19.82	17.65	15.61	13.87
BPOS =	3.91	2.29	1.42	.95	10.21	6.77	4.83	3.32	2.52	1.82	1.35	1.06	.90
THETA =	90.00	92.50	95.00	95.00	22.50	22.50	85.00	9 .50	92.50	95.00	95.00	95.00	95.00
BNEG =	-3.83	-1.91	-2.31	-1.31	-11.67	-9.07	-6.17	- .11	-2.17	-1.88	-2.32	-1.90	-1.26
THETA	0.00	335.00	332.50	332.50	0.00	0.00	0.00	33 .50	335.00	332.50	332.50	332.50	332.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WX* 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 (D LTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (D LTA 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 3

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0367	.0358	.0284	.0190	.0143	.0099	.0050	.0026
PHASE ANGLE =	264.2	273.4	271.3	267.3	269.3	263.6	244.1	195.5
RADIUS = .633								
AMPLITUDE =	.0150	.0224	.0098	.0030	.0050	.0013	.0010	.0027
PHASE ANGLE =	323.3	268.9	255.5	290.1	202.2	282.8	13.3	31.2
RADIUS = .781								
AMPLITUDE =	.0103	.0147	.0073	.0025	.0029	.0040	.0007	.0012
PHASE ANGLE =	269.9	264.1	248.3	309.2	258.5	278.0	205.2	183.8
RADIUS = .963								
AMPLITUDE =	.0187	.0193	.0152	.0067	.0083	.0070	.0058	.0038
PHASE ANGLE =	261.6	254.1	234.9	191.4	213.7	193.4	175.5	174.1

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0044	.0058	.0048	.0057	.0054	.0030	.0009	.0019
PHASE ANGLE =	130.7	130.5	140.9	128.8	126.8	154.0	179.1	290.1
RADIUS = .633								
AMPLITUDE =	.0034	.0021	.0012	.0028	.0033	.0032	.0030	.0034
PHASE ANGLE =	73.2	40.2	136.1	298.0	279.1	261.3	242.6	271.8
RADIUS = .781								
AMPLITUDE =	.0007	.0027	.0019	.0016	.0018	.0027	.0028	.0003
PHASE ANGLE =	267.1	254.2	285.2	293.3	296.9	274.4	319.3	240.7
RADIUS = .963								
AMPLITUDE =	.0027	.0026	.0012	.0026	.0020	.0017	.0010	.0014
PHASE ANGLE =	165.9	169.4	190.8	260.4	205.3	298.0	133.4	43.5

TABLE A-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 3

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0400	.0499	.0135	.0042	.0238	.0265	.0155	.0101
PHASE ANGLE =	245.6	275.9	249.9	264.5	272.0	262.5	235.2	201.9
RADIUS = .350								
AMPLITUDE =	.0730	.0459	.0341	.0176	.0224	.0213	.0122	.0108
PHASE ANGLE =	248.7	275.3	275.1	268.0	271.4	262.6	236.5	201.4
RADIUS = .400								
AMPLITUDE =	.0537	.0409	.0333	.0261	.0183	.0153	.0085	.0064
PHASE ANGLE =	254.3	274.5	273.6	268.3	270.5	262.9	239.1	200.1
RADIUS = .500								
AMPLITUDE =	.0269	.0320	.0172	.0136	.0116	.0095	.0029	.0035
PHASE ANGLE =	276.0	272.4	268.5	269.4	268.0	264.9	252.4	156.0
RADIUS = .600								
AMPLITUDE =	.0162	.0246	.0082	.0048	.0048	.0019	.0009	.0025
PHASE ANGLE =	313.7	269.9	258.7	264.2	263.9	277.8	346.3	31.6
RADIUS = .700								
AMPLITUDE =	.0116	.0177	.0080	.0026	.0039	.0032	.0006	.0008
PHASE ANGLE =	312.2	267.7	268.3	307.6	268.6	291.2	348.1	41.7
RADIUS = .800								
AMPLITUDE =	.0106	.0144	.0045	.0023	.0029	.0040	.0010	.0015
PHASE ANGLE =	284.5	262.9	266.6	303.6	251.8	272.5	195.9	185.4
RADIUS = .900								
AMPLITUDE =	.0145	.0159	.0112	.0029	.0051	.0046	.0036	.0031
PHASE ANGLE =	265.7	256.7	249.5	218.3	220.8	223.6	179.6	180.9
RADIUS = 1.000								
AMPLITUDE =	.0187	.0193	.0152	.0067	.0083	.0070	.0058	.0038
PHASE ANGLE =	261.9	254.1	254.9	231.4	213.7	198.4	175.5	174.1

TABLE A-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0100	.0157	.0131	.0156	.0185	.0107	.0082	.0044
PHASE ANGLE =	152.6	159.9	150.7	128.5	116.5	122.3	71.5	65.5
RADIUS = .350								
AMPLITUDE =	.0078	.0125	.0113	.0126	.0145	.0082	.0055	.0026
PHASE ANGLE =	173.7	154.2	140.7	128.4	117.9	126.0	75.5	33.8
RADIUS = .400								
AMPLITUDE =	.0057	.0069	.0091	.0091	.0098	.0054	.0025	.0012
PHASE ANGLE =	166.6	145.5	130.7	129.5	120.6	134.1	88.2	.9
RADIUS = .500								
AMPLITUDE =	.0040	.0042	.0052	.0055	.0027	.0020	.0021	.0028
PHASE ANGLE =	110.0	113.0	131.5	129.8	140.7	188.2	226.7	262.9
RADIUS = .600								
AMPLITUDE =	.0037	.0024	.0021	.0002	.0025	.0028	.0038	.0036
PHASE ANGLE =	79.3	58.5	137.6	218.2	270.4	254.0	247.3	273.4
RADIUS = .700								
AMPLITUDE =	.0011	.0012	.0009	.0012	.0039	.0030	.0030	.0017
PHASE ANGLE =	53.8	290.5	206.4	289.2	292.8	267.2	288.6	265.6
RADIUS = .800								
AMPLITUDE =	.0009	.0029	.0020	.0017	.0036	.0026	.0027	.0001
PHASE ANGLE =	255.3	250.0	284.9	281.3	295.9	276.1	324.1	172.1
RADIUS = .900								
AMPLITUDE =	.0017	.0026	.0014	.0022	.0020	.0021	.0012	.0010
PHASE ANGLE =	201.1	217.8	264.6	268.9	270.9	287.4	349.4	64.1
RADIUS = 1.000								
AMPLITUDE =	.0027	.0026	.0012	.0026	.0029	.0017	.0010	.0014
PHASE ANGLE =	165.9	169.4	196.8	260.4	205.3	298.0	133.4	43.5

TABLE A-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 3

VELOCITY COMPONENT RATIOS FO MODEL 5368 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2359	.0054	.0027	.0040	.0046	.0036	.0034	.0031
PHASE ANGLE =	180.6	66.7	131.0	150.6	141.6	146.5	106.7	84.2
RADIUS = .633								
AMPLITUDE =	.2069	.0088	.0072	.0059	.0047	.0041	.0037	.0026
PHASE ANGLE =	183.6	289.5	2[illegible].4	279.2	279.7	272.4	290.2	282.0
RADIUS = .781								
AMPLITUDE =	.1932	.0037	.0042	.0027	.0036	.0020	.0022	.0013
PHASE ANGLE =	180.5	283.4	296.2	263.2	279.0	256.9	294.7	312.0
RADIUS = .963								
AMPLITUDE =	.1868	.0031	.0026	.0042	.0044	.0044	.0027	.0012
PHASE ANGLE =	178.5	154.7	127.2	125.1	106.3	104.2	89.7	62.6

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0050	.0045	.0062	.0051	.0042	.0026	.0012	.0010
PHASE ANGLE =	62.1	43.5	46.2	49.6	43.0	69.2	60.2	164.8
RADIUS = .633								
AMPLITUDE =	.0025	.0024	.0008	.0008	.0016	.0030	.0030	.0034
PHASE ANGLE =	297.0	287.0	268.2	211.6	167.1	163.9	163.1	156.5
RADIUS = .781								
AMPLITUDE =	.0010	.0008	.0002	.0006	.0013	.0018	.0014	.0015
PHASE ANGLE =	330.4	31.0	48.6	124.8	135.3	158.7	147.9	168.7
RADIUS = .963								
AMPLITUDE =	.0002	.0008	.0014	.0023	.0025	.0022	.0016	.0014
PHASE ANGLE =	21.0	212.2	266.4	191.3	172.3	153.9	124.6	46.0

TABLE A-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 3

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2717	.0308	.0212	.0213	.0196	.0165	.0161	.0137
PHASE ANGLE =	174.5	92.2	111.6	1[illegible].0	124.1	122.3	108.9	88.8
RADIUS = .450								
AMPLITUDE =	.2610	.0226	.0154	.0157	.0149	.0124	.0121	.0104
PHASE ANGLE =	176.3	90.2	112.8	126.2	125.6	124.5	108.7	88.5
RADIUS = .400								
AMPLITUDE =	.2483	.0134	.0087	.0095	.0095	.0077	.0076	.0066
PHASE ANGLE =	178.5	85.2	115.9	131.5	129.8	129.9	108.2	87.5
RADIUS = .500								
AMPLITUDE =	.2273	.0027	.0015	.0021	.0020	.0019	.0008	.0010
PHASE ANGLE =	181.9	354.3	259.7	[illegible]	177.9	192.1	97.2	69.3
RADIUS = .600								
AMPLITUDE =	.2112	.0080	.0056	.0051	.0040	.0037	.0031	.0021
PHASE ANGLE =	183.6	292.5	280.6	276.5	275.2	268.4	292.6	283.0
RADIUS = .700								
AMPLITUDE =	.1997	.0065	.0061	.0047	.0047	.0034	.0033	.0020
PHASE ANGLE =	182.1	289.0	291.0	275.1	279.9	268.0	291.7	292.5
RADIUS = .800								
AMPLITUDE =	.1920	.0031	.0047	.0023	.0029	.0015	.0019	.0012
PHASE ANGLE =	180.2	280.0	297.1	296.8	278.3	250.4	296.8	318.9
RADIUS = .900								
AMPLITUDE =	.1878	.0014	.0002	.0019	.0010	.0019	.0008	.0008
PHASE ANGLE =	178.3	191.9	280.3	148.6	117.2	117.5	60.7	24.0
RADIUS = 1.000								
AMPLITUDE =	.1868	.0031	.0026	.0040	.0041	.0044	.0027	.0012
PHASE ANGLE =	179.5	154.7	127.2	125.1	106.3	104.2	89.7	62.6

TABLE A-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R V ATHENA 3
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0169	.0162	.0160	.0154	.0136	.0096	.0079	.0047
PHASE ANGLE =	73.7	62.7	50.3	49.3	33.5	30.8	6.5	328.1
RADIUS = .350								
AMPLITUDE =	.0132	.0124	.0143	.0122	.0107	.0073	.0057	.0029
PHASE ANGLE =	72.4	60.4	49.7	49.3	34.6	35.0	11.6	326.4
RADIUS = .400								
AMPLITUDE =	.0089	.0082	.0101	.0085	.0073	.0047	.0031	.0009
PHASE ANGLE =	69.5	55.4	48.5	49.3	37.1	44.6	20.3	315.5
RADIUS = .500								
AMPLITUDE =	.0027	.0025	.0037	.0030	.0024	.0020	.0013	.0020
PHASE ANGLE =	46.4	20.5	42.5	50.4	54.5	106.1	129.8	159.0
RADIUS = .600								
AMPLITUDE =	.0020	.0022	.0005	.0001	.0013	.0028	.0028	.0033
PHASE ANGLE =	306.2	295.7	323.2	186.6	153.7	158.7	161.4	156.2
RADIUS = .700								
AMPLITUDE =	.0022	.0011	.0003	.0004	.0013	.0023	.0021	.0025
PHASE ANGLE =	314.3	321.7	324.7	154.9	146.1	162.1	159.0	164.1
RADIUS = .800								
AMPLITUDE =	.0018	.0009	.0002	.0006	.0013	.0018	.0013	.0013
PHASE ANGLE =	333.5	40.8	63.7	135.2	136.4	157.8	144.2	168.0
RADIUS = .900								
AMPLITUDE =	.0010	.0004	.0006	.0013	.0017	.0019	.0013	.0005
PHASE ANGLE =	348.9	94.4	140.3	176.1	157.3	154.4	127.1	84.8
RADIUS = 1.000								
AMPLITUDE =	.0002	.0006	.0014	.0023	.0025	.0022	.0016	.0014
PHASE ANGLE =	21.6	212.2	206.4	191.5	172.3	153.9	124.6	46.0

TABLE A-7

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 9

INPUT DATA

RADIUS = .456

ANGLE	VX/V	VT/V	VR/V
-1.0	1.014	.023	-.010
17.6	1.003	-.098	-.076
45.2	1.122	-.168	-.084
63.6	1.121	-.217	-.053
63.6	1.124	-.216	-.058
91.1	1.137	-.241	-.007
109.0	1.132	-.228	.031
135.0	1.129	-.170	.076
155.6	1.136	-.097	.099
179.7	1.131	-.003	.111
193.0	1.136	.055	.108
224.2	1.138	.159	.081
240.0	1.145	.196	.055
269.6	1.137	.225	.002
269.7	1.145	.224	-.002
286.1	1.143	.215	-.034
315.0	1.131	.148	-.081
331.0	1.121	.116	-.093
359.0	1.014	.023	-.010
361.0	1.014	.023	-.010

RADIUS = .633

ANGLE	VX/V	VT/V	VR/V
-.3	1.013	-.035	-.070
46.0	1.048	-.133	-.111
91.7	1.091	-.189	-.007
137.0	1.053	-.122	.102
137.0	1.056	-.121	.101
183.4	1.049	.032	.136
225.5	1.047	.168	.080
271.5	1.021	.225	-.032
315.7	1.059	.152	-.129
330.8	1.064	.117	-.155
340.0	1.047	.035	-.126
351.0	1.016	.005	-.101
358.0	1.014	-.035	-.074
359.7	1.013	-.035	-.070

RADIUS = .781

ANGLE	VX/V	VT/V	VR/V
2.9	1.015	-.025	-.092
48.7	1.052	-.137	-.104
89.1	1.063	-.190	.007
94.6	1.070	-.188	.023
133.2	1.058	-.136	.127
140.0	1.054	-.117	.142
179.0	1.075	.002	.182
179.0	1.076	.002	.182
225.5	1.075	.134	.135
271.4	1.092	.191	.013
316.0	1.072	.128	-.116
349.3	1.024	.025	-.127
351.3	1.020	.016	-.121
355.6	1.027	-.017	-.111
362.9	1.015	-.025	-.092

RADIUS = .963

ANGLE	VX/V	VT/V	VR/V
-.5	1.011	.036	-.135
-1.0	1.009	.036	-.137
45.5	1.050	-.120	-.145
91.2	1.071	-.177	-.014
135.1	1.056	-.124	.115
180.9	1.066	.009	.169
225.1	1.066	.133	.119
271.0	1.074	.193	-.011
316.0	1.063	.135	-.146
359.0	1.009	.036	-.137
359.5	1.011	.036	-.135
360.5	1.011	.036	-.135

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 9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.116	1.055	1.064	1.057	1.224	1.191	1.152	1.094	1.060	1.060	1.064	1.061	1.057
VTBAR =	-.007	.011	-.000	.008	-.047	-.034	-.020	.001	.011	.004	-.000	.002	.008
VRBAR =	.006	-.009	.016	-.008	.054	.038	.021	-.002	-.010	.007	.016	.007	-.008
1-WVX =	1.160	1.109	1.088	1.077	0.000	1.207	1.185	1.147	1.117	1.097	1.088	1.082	1.077
1-WX =	1.196	1.122	1.095	1.082	0.000	1.265	1.229	1.172	1.132	1.107	1.095	1.088	1.082
BBAR =	30.01	21.31	17.76	14.44	43.73	39.31	34.42	27.20	22.48	19.58	17.37	15.49	13.93
BPOS =	3.79	2.23	1.13	.84	6.42	5.44	4.50	3.34	2.49	1.57	1.07	.84	.79
THETA =	90.00	92.50	102.50	90.00	105.00	102.50	95.00	90.00	92.50	97.50	102.50	100.00	90.00
BNEG =	-2.69	-1.26	-.98	-.74	-9.28	-6.94	-4.55	-1.89	-1.40	-.84	-.99	-.90	-.71
THETA =	0.00	242.50	357.50	352.50	357.50	357.50	357.50	267.50	247.50	245.00	357.50	357.50	352.50

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

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0379	.0328	.0226	.0159	.0098	.0063	.0031	.0006
PHASE ANGLE =	254.5	256.8	247.0	237.5	236.2	221.4	179.6	24.2
RADIUS = .633								
AMPLITUDE =	.0079	.0222	.0093	.0027	.0042	.0033	.0019	.0016
PHASE ANGLE =	298.9	252.9	219.8	161.2	257.3	270.6	302.0	329.7
RADIUS = .781								
AMPLITUDE =	.0196	.0151	.0069	.0056	.0063	.0014	.0014	.0012
PHASE ANGLE =	228.3	267.9	289.9	345.6	274.0	258.9	296.3	292.3
RADIUS = .963								
AMPLITUDE =	.0165	.0167	.0095	.0029	.0033	.0015	.0009	.0005
PHASE ANGLE =	256.5	273.1	269.1	325.0	319.7	344.8	19.9	39.5

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0021	.0014	.0006	.0005	.0007	.0008	.0008	.0004
PHASE ANGLE =	47.3	17.2	44.4	92.3	135.5	133.8	128.7	132.9
RADIUS = .633								
AMPLITUDE =	.0013	.0010	.0006	.0008	.0002	.0001	.0002	.0001
PHASE ANGLE =	350.1	353.7	29.4	60.0	68.2	105.1	87.1	68.8
RADIUS = .781								
AMPLITUDE =	.0013	.0007	.0007	.0005	.0008	.0004	.0005	.0004
PHASE ANGLE =	278.3	255.3	282.7	291.9	267.3	268.9	279.7	275.9
RADIUS = .963								
AMPLITUDE =	.0002	.0001	.0003	.0001	.0003	.0002	.0001	.0001
PHASE ANGLE =	77.8	200.9	242.7	318.7	310.6	340.6	25.4	44.0

TABLE A-10 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.1039	.0435	.0460	.0400	.0203	.0132	.0106	.0022
PHASE ANGLE =	242.0	265.5	264.1	254.7	235.6	196.2	163.4	134.3
RADIUS = .350								
AMPLITUDE =	.0828	.0404	.0386	.0324	.0170	.0109	.0083	.0015
PHASE ANGLE =	244.1	263.0	260.6	251.5	235.4	200.9	165.3	125.8
RADIUS = .400								
AMPLITUDE =	.0590	.0367	.0302	.0238	.0133	.0084	.0056	.0007
PHASE ANGLE =	247.9	259.9	255.0	246.1	235.3	209.0	169.5	97.8
RADIUS = .500								
AMPLITUDE =	.0254	.0300	.0180	.0110	.0076	.0051	.0017	.0009
PHASE ANGLE =	262.8	254.7	239.5	227.7	238.0	233.6	200.4	356.1
RADIUS = .600								
AMPLITUDE =	.0101	.0240	.0109	.0040	.0046	.0036	.0016	.0015
PHASE ANGLE =	293.6	252.6	222.7	185.7	250.5	263.1	292.8	334.6
RADIUS = .700								
AMPLITUDE =	.0129	.0179	.0070	.0023	.0057	.0023	.0018	.0014
PHASE ANGLE =	239.7	259.4	243.6	350.2	266.6	262.7	296.4	307.4
RADIUS = .800								
AMPLITUDE =	.0204	.0147	.0071	.0060	.0063	.0012	.0013	.0012
PHASE ANGLE =	228.1	269.6	273.5	345.0	275.9	260.6	297.9	290.6
RADIUS = .900								
AMPLITUDE =	.0197	.0150	.0085	.0054	.0048	.0008	.0008	.0005
PHASE ANGLE =	237.0	274.3	276.8	339.5	291.6	317.4	330.6	304.0
RADIUS = 1.000								
AMPLITUDE =	.0165	.0167	.0095	.0029	.0033	.0015	.0009	.0005
PHASE ANGLE =	256.5	273.1	269.1	325.0	319.7	344.8	19.9	39.5

TABLE A-10 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0035	.0012	.0003	.0014	.0016	.0016	.0015	.0008
PHASE ANGLE =	77.5	37.5	258.2	230.6	179.7	149.1	148.3	176.8
RADIUS = .350								
AMPLITUDE =	.0021	.0013	.0001	.0009	.0013	.0014	.0013	.0007
PHASE ANGLE =	70.7	30.2	334.7	222.6	171.0	145.7	143.7	167.3
RADIUS = .400								
AMPLITUDE =	.0026	.0014	.0004	.0003	.0010	.0011	.0010	.0005
PHASE ANGLE =	60.6	23.3	38.5	181.1	156.1	140.5	137.0	152.2
RADIUS = .500								
AMPLITUDE =	.0018	.0014	.0007	.0007	.0006	.0006	.0006	.0003
PHASE ANGLE =	35.5	12.8	44.4	77.3	118.6	128.0	121.5	117.7
RADIUS = .600								
AMPLITUDE =	.0014	.0011	.0007	.0009	.0004	.0002	.0003	.0002
PHASE ANGLE =	3.1	.4	36.4	64.3	83.6	112.1	100.6	84.8
RADIUS = .700								
AMPLITUDE =	.0012	.0006	.0005	.0003	.0004	.0002	.0002	.0002
PHASE ANGLE =	304.5	301.3	318.5	357.5	269.7	259.5	280.4	281.4
RADIUS = .800								
AMPLITUDE =	.0013	.0007	.0008	.0006	.0008	.0004	.0005	.0004
PHASE ANGLE =	275.1	250.4	279.2	288.2	267.7	270.4	280.3	275.9
RADIUS = .900								
AMPLITUDE =	.0007	.0005	.0006	.0005	.0006	.0003	.0003	.0002
PHASE ANGLE =	265.9	235.5	265.5	282.7	275.8	286.5	292.9	283.9
RADIUS = 1.000								
AMPLITUDE =	.0002	.0001	.0003	.0001	.0003	.0002	.0001	.0001
PHASE ANGLE =	77.8	200.9	242.7	318.7	310.6	340.6	25.4	44.0

TABLE A-11 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2333	.0027	.0030	.0039	.0046	.0028	.0022	.0014
PHASE ANGLE =	181.0	95.4	170.2	161.9	161.4	166.2	127.5	69.0
RADIUS = .633								
AMPLITUDE =	.2047	.0105	.0074	.0063	.0048	.0039	.0037	.0024
PHASE ANGLE =	184.2	281.9	271.3	263.9	275.6	303.8	334.7	.8
RADIUS = .781								
AMPLITUDE =	.1873	.0015	.0044	.0021	.0022	.0020	.0011	.0012
PHASE ANGLE =	181.3	305.1	304.3	273.6	269.7	259.4	286.7	294.9
RADIUS = .963								
AMPLITUDE =	.1813	.0025	.0037	.0032	.0023	.0022	.0022	.0017
PHASE ANGLE =	178.8	39.5	26.5	51.8	53.6	58.4	60.3	82.4

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0022	.0016	.0014	.0011	.0011	.0010	.0009	.0006
PHASE ANGLE =	70.0	63.1	83.8	95.8	109.8	114.9	115.2	119.4
RADIUS = .633								
AMPLITUDE =	.0017	.0015	.0013	.0013	.0014	.0014	.0013	.0012
PHASE ANGLE =	39.3	65.1	102.0	143.2	175.7	205.6	237.0	255.4
RADIUS = .781								
AMPLITUDE =	.0010	.0008	.0008	.0006	.0006	.0005	.0005	.0005
PHASE ANGLE =	277.9	293.1	304.5	305.1	304.1	302.0	316.8	320.9
RADIUS = .963								
AMPLITUDE =	.0013	.0008	.0005	.0004	.0004	.0004	.0004	.0004
PHASE ANGLE =	103.3	101.2	98.6	93.3	88.0	78.8	71.7	89.7

TABLE A-12 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2652	.0329	.0179	.0191	.0190	.0154	.0139	.0050
PHASE ANGLE =	174.9	99.5	108.7	114.2	132.1	147.7	147.3	152.0
RADIUS = .350								
AMPLITUDE =	.2558	.0232	.0128	.0139	.0144	.0113	.0101	.0035
PHASE ANGLE =	176.8	99.4	112.9	118.2	135.1	149.0	145.8	143.6
RADIUS = .400								
AMPLITUDE =	.2446	.0124	.0071	.0082	.0091	.0068	.0059	.0020
PHASE ANGLE =	178.9	99.0	124.3	128.5	142.1	152.5	142.0	121.1
RADIUS = .500								
AMPLITUDE =	.2253	.0031	.0035	.0033	.0028	.0011	.0008	.0017
PHASE ANGLE =	182.3	284.2	232.2	215.3	201.5	232.4	36.6	35.7
RADIUS = .600								
AMPLITUDE =	.2094	.0101	.0070	.0060	.0044	.0035	.0034	.0024
PHASE ANGLE =	184.1	281.7	266.9	259.9	270.2	302.9	337.8	6.6
RADIUS = .700								
AMPLITUDE =	.1954	.0056	.0059	.0043	.0037	.0030	.0022	.0016
PHASE ANGLE =	182.8	283.7	283.5	264.9	271.2	281.8	315.2	327.9
RADIUS = .800								
AMPLITUDE =	.1859	.0010	.0041	.0016	.0019	.0018	.0009	.0011
PHASE ANGLE =	180.9	329.6	310.3	280.2	270.9	255.0	281.0	290.0
RADIUS = .900								
AMPLITUDE =	.1815	.0021	.0032	.0016	.0007	.0003	.0006	.0002
PHASE ANGLE =	179.5	53.7	355.4	39.6	25.8	79.8	65.6	71.5
RADIUS = 1.000								
AMPLITUDE =	.1813	.0025	.0037	.0032	.0023	.0022	.0022	.0017
PHASE ANGLE =	178.8	39.5	26.5	51.8	53.6	58.4	60.3	82.4

TABLE A-12 (Continued)

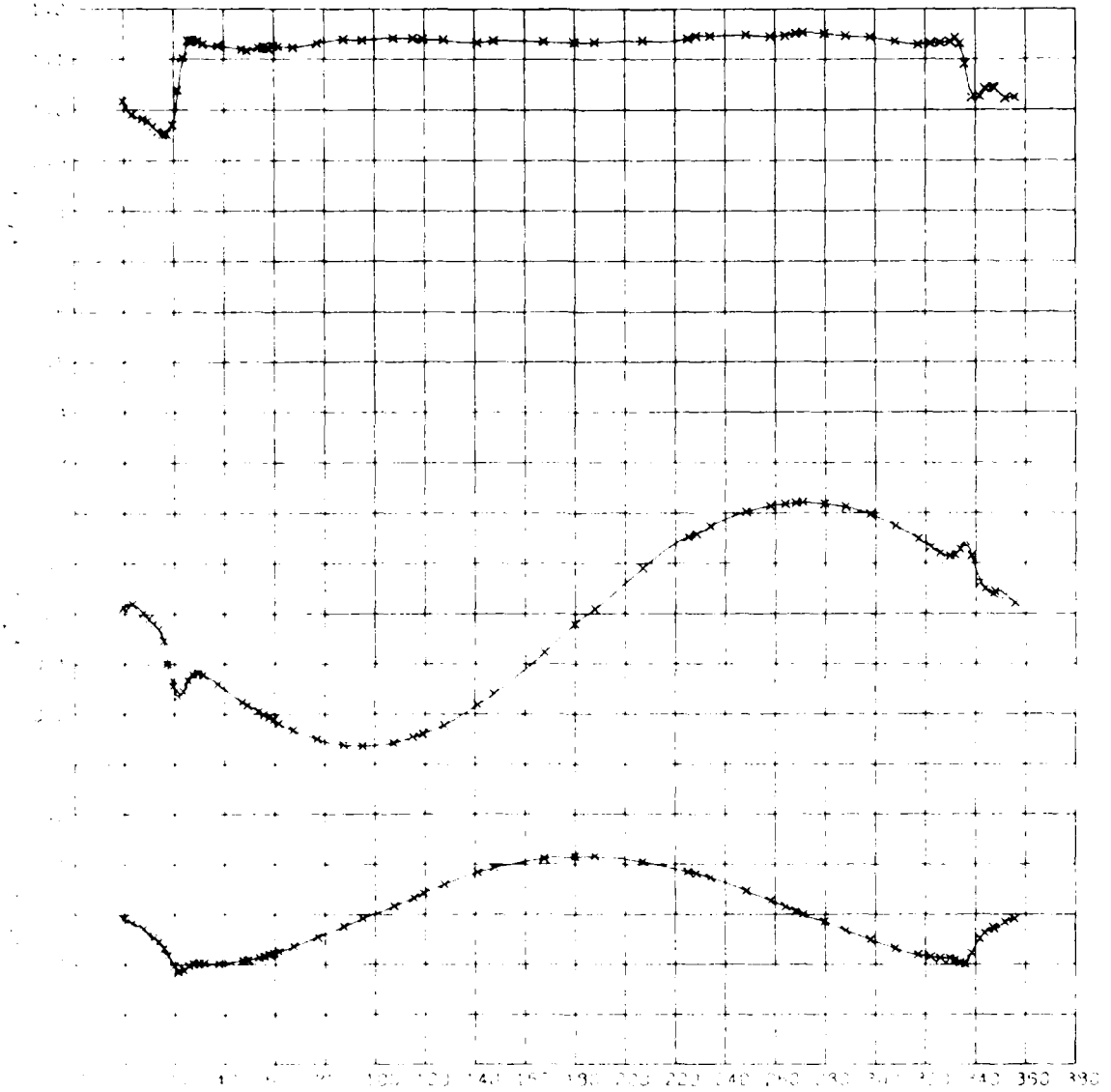
VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0020	.0008	.0015	.0028	.0036	.0041	.0047	.0042
PHASE ANGLE =	130.7	320.3	350.3	6.3	33.8	55.9	78.0	84.8
RADIUS = .350								
AMPLITUDE =	.0019	.0007	.0011	.0019	.0025	.0030	.0034	.0030
PHASE ANGLE =	109.9	18.0	17.2	18.1	42.6	61.8	79.5	87.4
RADIUS = .400								
AMPLITUDE =	.0020	.0012	.0011	.0012	.0015	.0018	.0020	.0017
PHASE ANGLE =	87.0	52.6	58.6	48.5	64.6	76.3	88.0	93.8
RADIUS = .500								
AMPLITUDE =	.0022	.0019	.0016	.0013	.0012	.0010	.0006	.0004
PHASE ANGLE =	61.0	66.2	93.0	118.3	140.4	157.5	173.4	203.0
RADIUS = .600								
AMPLITUDE =	.0019	.0018	.0015	.0015	.0015	.0014	.0012	.0012
PHASE ANGLE =	45.2	66.8	101.3	139.2	170.0	199.0	230.9	250.9
RADIUS = .700								
AMPLITUDE =	.0008	.0005	.0002	.0002	.0005	.0007	.0007	.0008
PHASE ANGLE =	335.8	6.7	33.2	185.9	215.9	239.2	264.7	279.4
RADIUS = .800								
AMPLITUDE =	.0010	.0008	.0008	.0007	.0006	.0006	.0005	.0005
PHASE ANGLE =	272.4	288.7	303.0	308.3	311.6	312.3	328.0	331.3
RADIUS = .900								
AMPLITUDE =	.0003	.0003	.0004	.0004	.0004	.0004	.0004	.0004
PHASE ANGLE =	207.9	273.0	309.8	331.2	343.7	359.0	20.2	33.2
RADIUS = 1.000								
AMPLITUDE =	.0013	.0008	.0005	.0004	.0004	.0004	.0004	.0004
PHASE ANGLE =	103.3	101.2	98.6	93.3	88.0	78.8	71.7	89.7

APPENDIX B

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 10



0.456 RHO.

Figure 8-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 10

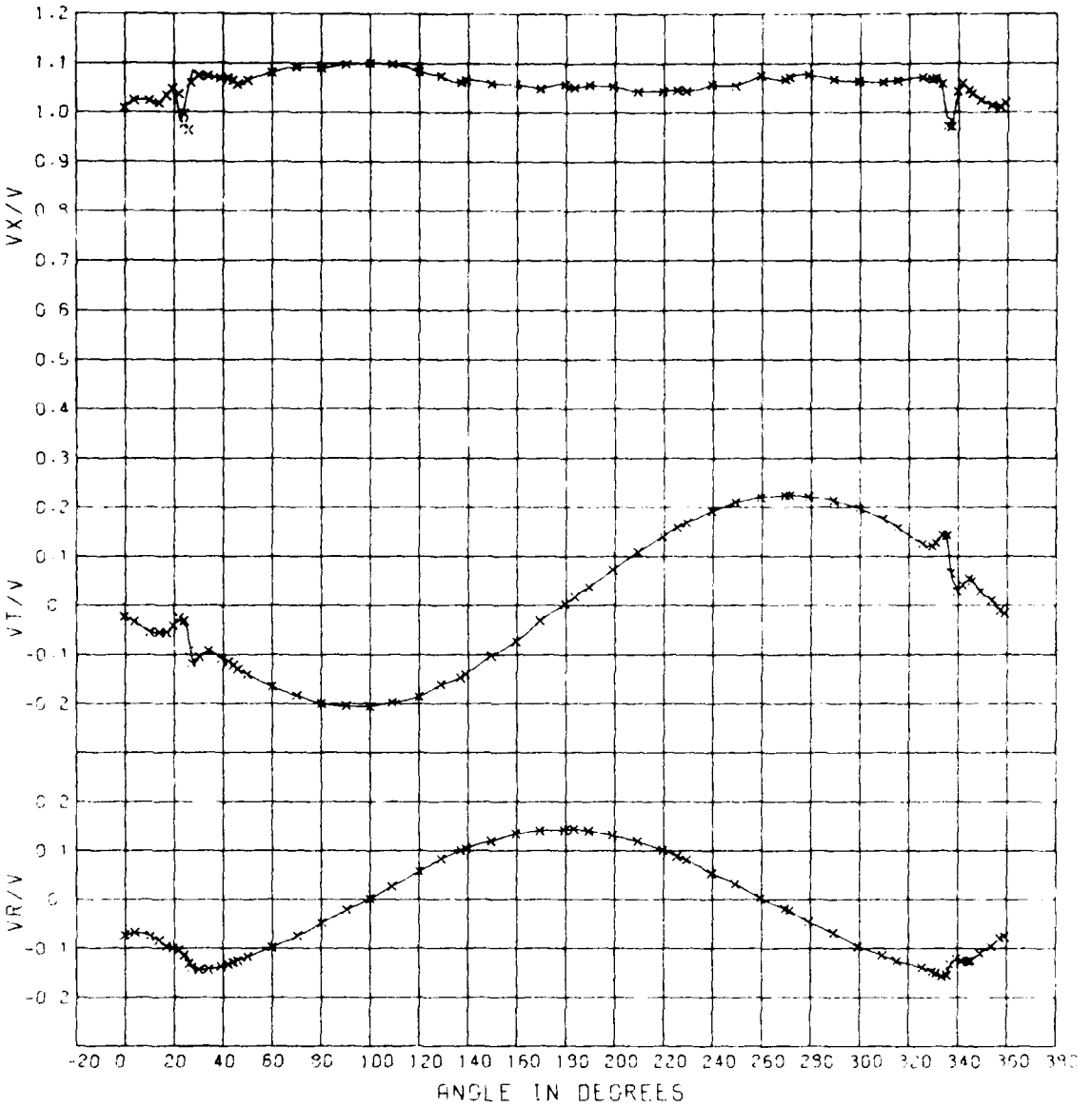


Figure B-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 10

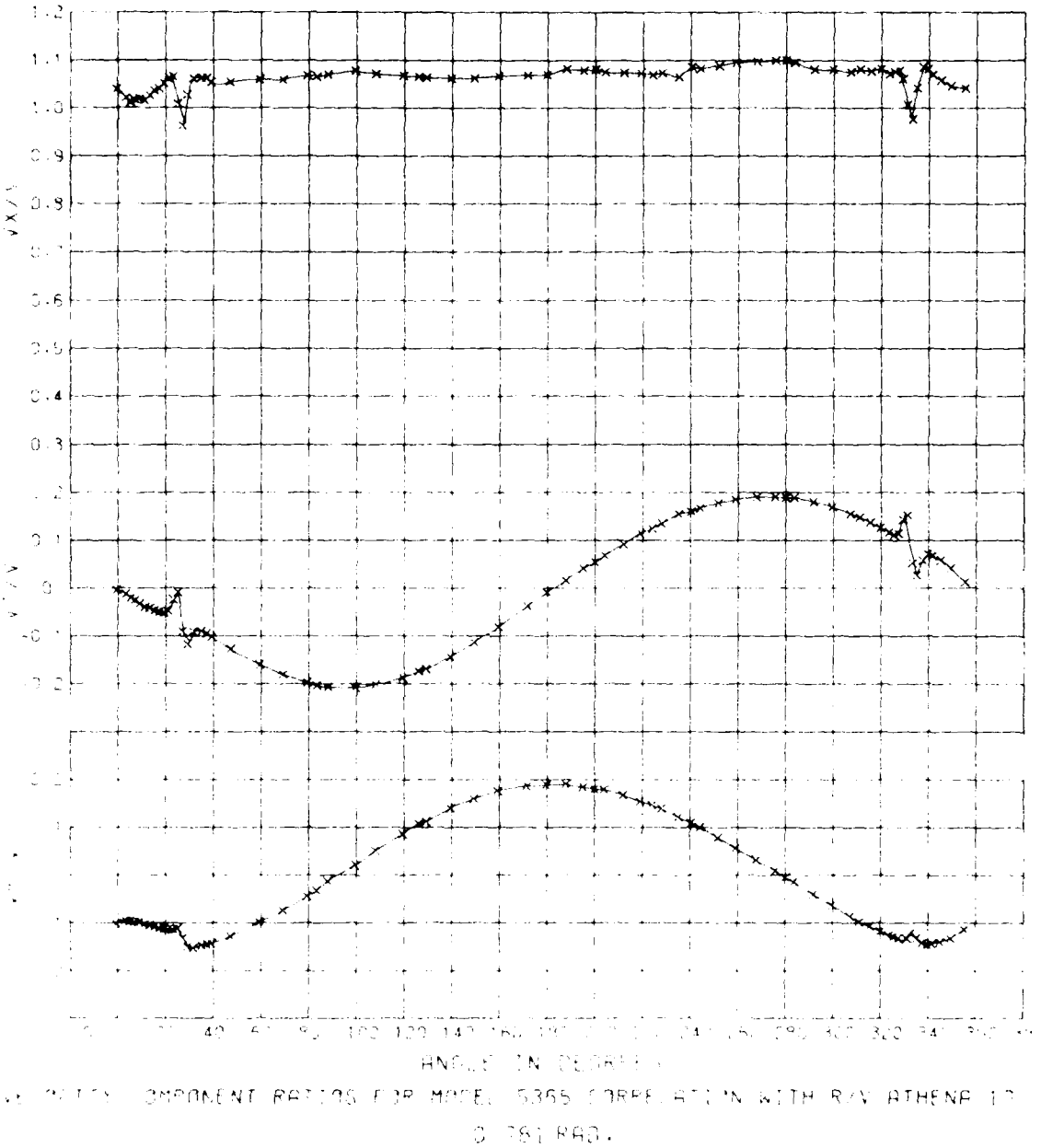


Figure B-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 10

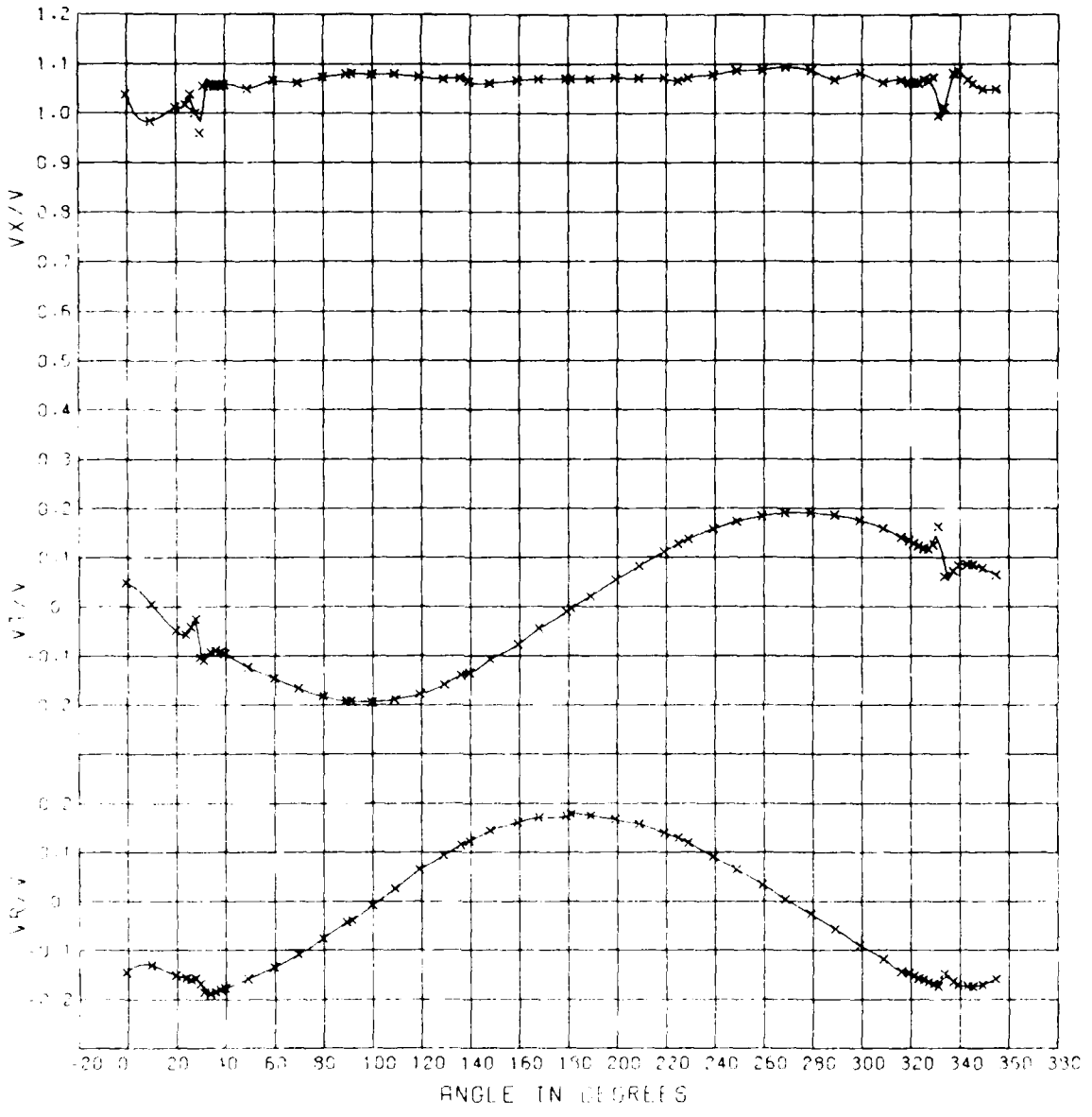


Figure B-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 10

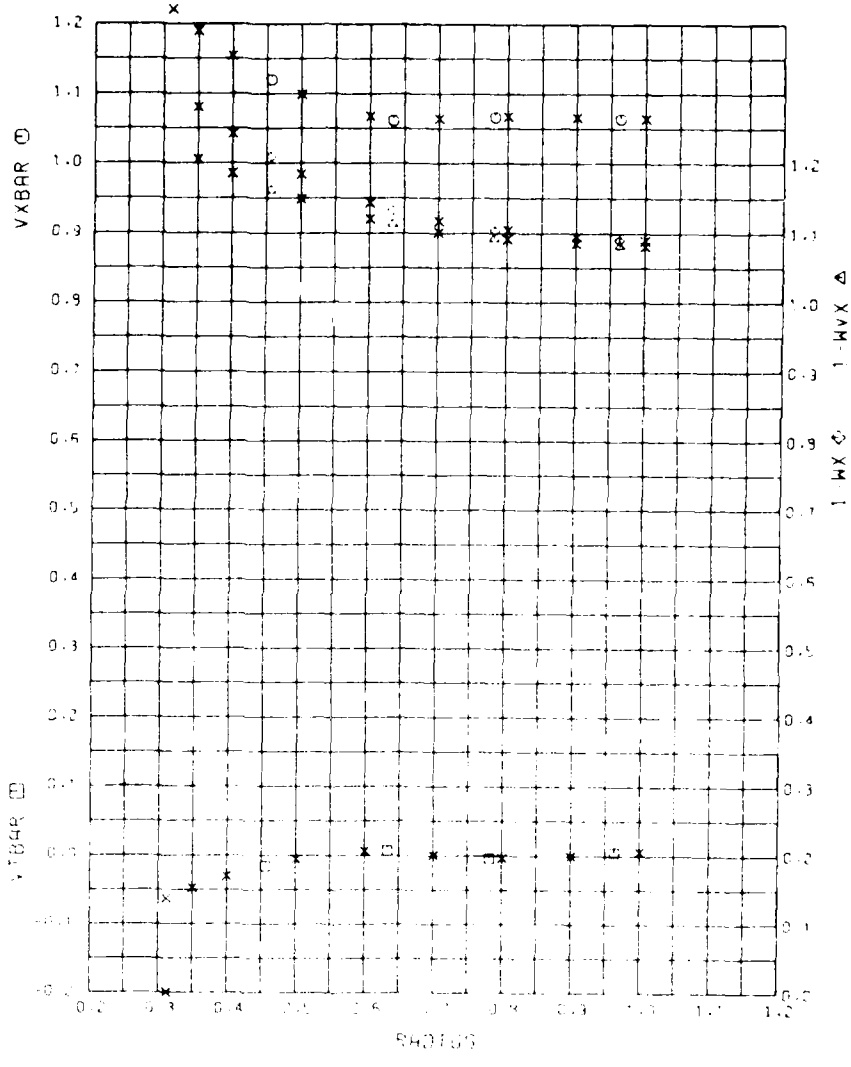


Figure B-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 10

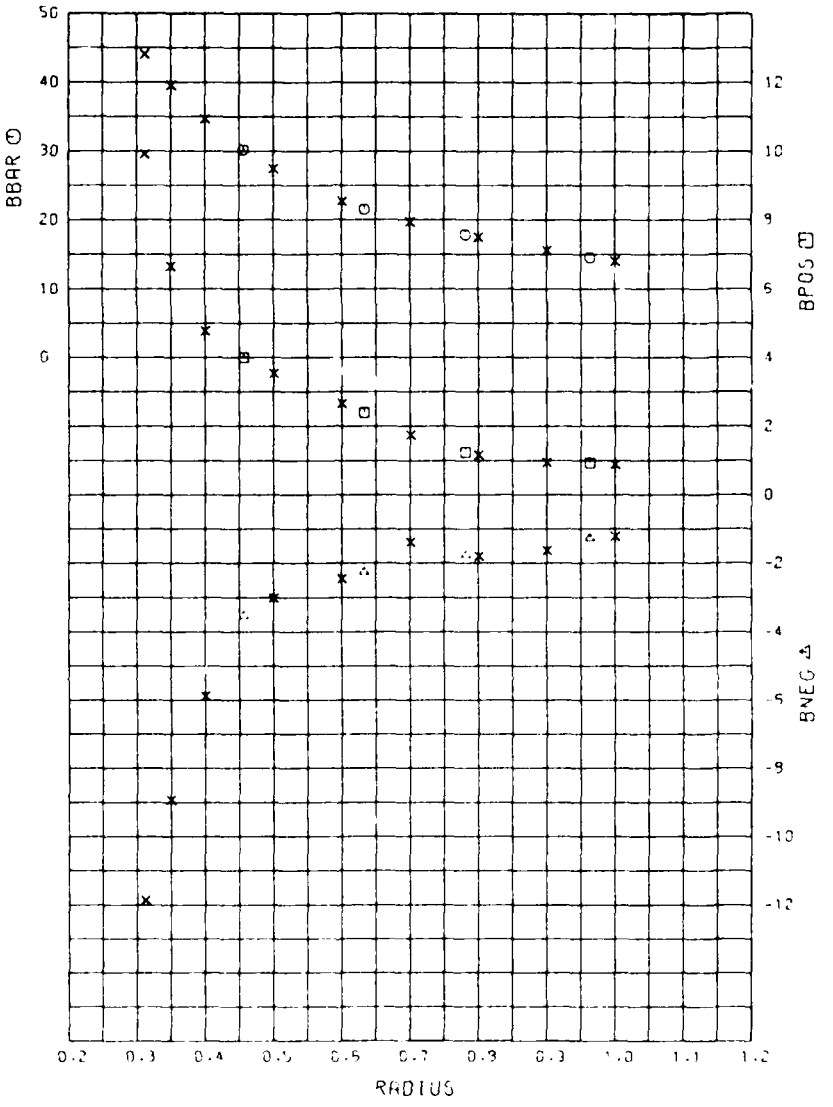


Figure B-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 10

TABLE B-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA,
MODEL 5365, EXPERIMENT 10

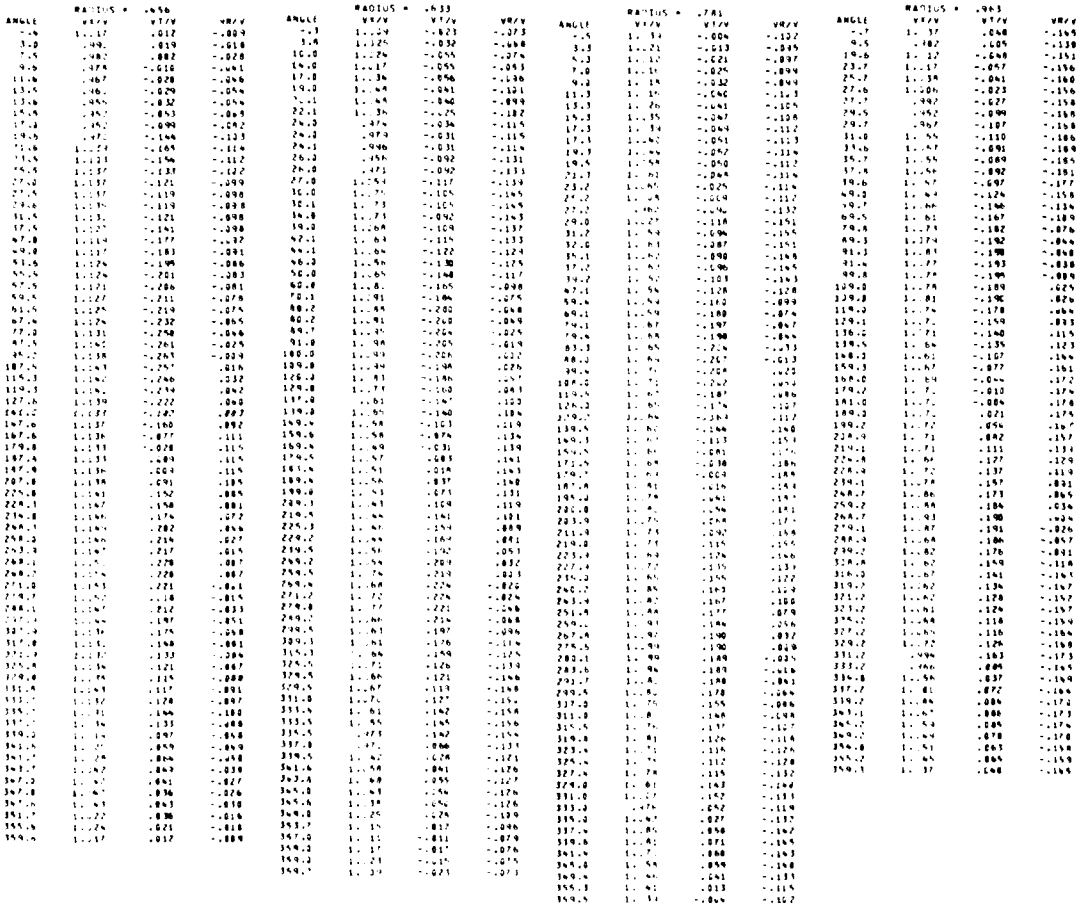


TABLE B-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 10

[illegible] ION OF [illegible] VELOCITY COMPONENT RATI[illegible] [illegible] 5315 CORRELATION WITH R / ATHENA 10
PROPELLER DIA [illegible] [illegible] FEET VA = .739

[illegible]	[illegible]	[illegible]	.781	.963	[illegible]12	.350	.400	[illegible]	.600	.700	.800	.900	1.000
[illegible]	[illegible]20	[illegible]	1.066	1.063	[illegible]	1.190	[illegible]	[illegible]	1.067	1.064	1.067	1.066	1.064
[illegible]	-[illegible]16	.007	-.004	.005	-[illegible]3	-.048	-.0[illegible]	[illegible]	.000	-.000	-.004	-.001	.005
[illegible]	[illegible]	-.0[illegible]	.016	-.010	[illegible]	.035	.01[illegible]	[illegible]2	-.009	.008	.016	.005	-.010
[illegible]	[illegible]61	1.1[illegible]	1.092	1.082	0.[illegible]	1.205	1.1[illegible]	[illegible]	1.120	1.101	1.091	1.055	1.081
[illegible]	[illegible]09	1.133	1.104	1.096	0.000	1.290	1.242	[illegible]	1.143	1.117	1.104	1.095	1.089
[illegible]	[illegible]21	21.46	17.62	14.54	44.01	39.56	34.[illegible]	[illegible]	22.64	19.67	17.43	15.56	14.02
[illegible]	[illegible]00	2.39	1.24	.93	[illegible]	6.65	4.[illegible]	[illegible]	2.1[illegible]	1.74	1.16	.94	.88
[illegible]	[illegible]50	100.00	97.50	95.00	[illegible]	22.50	90.[illegible]	[illegible]	100.00	100.00	97.50	97.50	95.00
[illegible]	[illegible]54	-2.[illegible]6	-1.77	-1.27	-11.[illegible]	-8.93	-5.8[illegible]	[illegible]	-2.46	-1.39	-1.80	-1.63	-1.22
[illegible]	[illegible]00	335.00	332.50	332.50	[illegible]	5.00	5.0[illegible]	[illegible]	335.00	332.50	332.50	332.50	332.50

[illegible] IS [illegible]RCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
[illegible] IS [illegible]RCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
[illegible] IS [illegible]RCUMFERENTIAL MEAN RADIAL VELOCITY.
[illegible] WAKE [illegible]CITY [illegible] TANGENTIAL [illegible]
[illegible] WITH TANGENTIAL [illegible]
[illegible] ANGLE OF ADVANCE.
[illegible] BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES [illegible] BETA [illegible]
[illegible] BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES [illegible] BETA MINUS.
[illegible] ANGLE IN DEGREES AT WHICH CORRESPONDING [illegible]

TABLE B-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 10

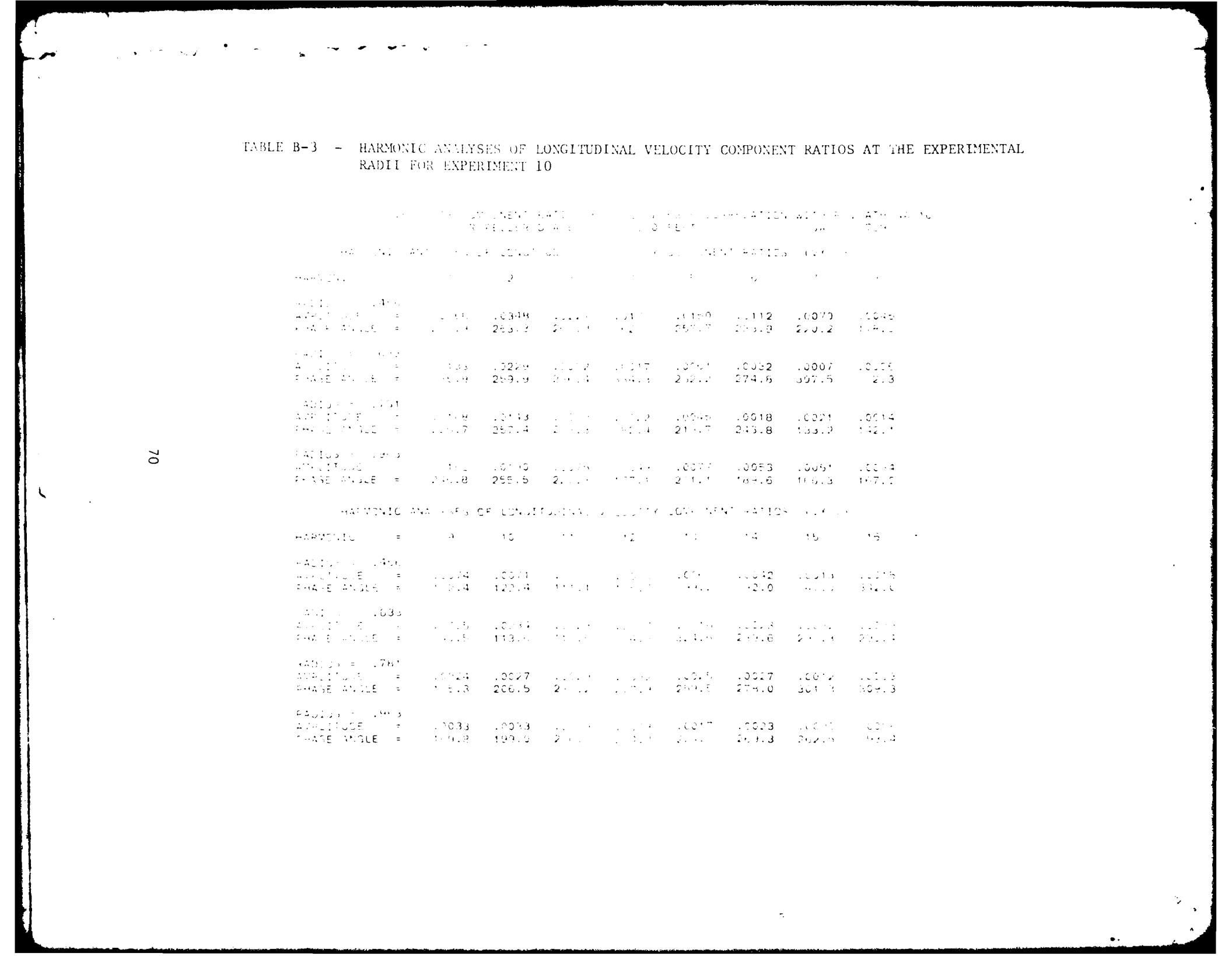


TABLE B-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 10

VELOCITY COMPONENT RATIOS FO[R] MODEL 5365 CORRELATION WITH R/V ATHENA 10
PROPELLER DIAMETER 9.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.1100	.0458	.0428	.0435	.0272	.0248	.0187	.0143
PHASE ANGLE =	246.3	265.9	2[illegible].5	2[illegible].3	249.4	228.0	208.4	175.8
RADIUS = .350								
AMPLITUDE =	.0959	.0428	.0385	.0357	.0235	.0206	.0151	.0112
PHASE ANGLE =	259.6	265.2	268.8	257.[illegible]	251.4	230.0	210.[illegible]	176.1
RADIUS = .400								
AMPLITUDE =	.0593	.0380	.0342	.0268	.0192	.0157	.0109	.0077
PHASE ANGLE =	246.2	264.3	267.8	259.[illegible]	251.3	233.5	214.2	176.9
RADIUS = .500								
AMPLITUDE =	.0246	.0316	.0275	.0122	.0122	.0083	.0046	.0025
PHASE ANGLE =	276.0	262.5	264.1	260.1	260.4	244.8	227.5	180.1
RADIUS = .600								
AMPLITUDE =	.0138	.0250	.0214	.0031	.0073	.0040	.0012	.0003
PHASE ANGLE =	327.5	260.5	260.5	294.[illegible]	263.7	266.4	270.4	349.8
RADIUS = .700								
AMPLITUDE =	.0089	.0176	.0[illegible]	.0017	.0047	.0024	.0007	.0005
PHASE ANGLE =	358.7	259.0	2[illegible].2	[illegible].1	243.9	271.6	116.0	85.3
RADIUS = .800								
AMPLITUDE =	.0142	.0140	.0[illegible]	.0022	.0047	.0019	.0024	.0017
PHASE ANGLE =	24.3	257.0	2[illegible].4	[illegible].7	215.7	233.5	130.[illegible]	147.1
RADIUS = .900								
AMPLITUDE =	.0204	.0155	.00[illegible].2	.0031	.0063	.0035	.0030	.0037
PHASE ANGLE =	350.2	255.[illegible]	2[illegible].4	[illegible].[illegible]	208.3	196.8	154.8	161.9
RADIUS = 1.000								
AMPLITUDE =	.0165	.0190	.0[illegible]	.00[illegible].4	.0027	.0052	.0033	.0054
PHASE ANGLE =	346.8	255.5	2[illegible].3	[illegible].1	211.1	189.6	166.[illegible]	167.0

TABLE B-4 (Continued)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0122	.0108	.0150	.0[illegible]	.0087	.0141	.0042	.0035
PHASE ANGLE =	142.3	143.8	120.5	[illegible]	110.4	98.1	40.4	68.1
RADIUS = .[illegible]								
AMPLITUDE =	.0108	.0097	.0[illegible]91	.0[illegible]91	.0[illegible]80	.0111	.00[illegible]9	.0052
PHASE ANGLE =	142.2	138.0	11[illegible].1	[illegible]0[illegible].1	106.9	97.3	87.9	[illegible]0.8
RADIUS = .400								
AMPLITUDE =	.0091	.0083	.0108	.0114	.0104	.0075	.0038	.0035
PHASE ANGLE =	142.1	130.4	114.8	107.7	105.5	95.7	81.0	60.[illegible]
RADIUS = .500								
AMPLITUDE =	.002	.0062	.[illegible]068	.0074	.0069	.0021	.0019	.0015
PHASE ANGLE =	[illegible]3.1	117.1	103.[illegible]	100.7	9[illegible].[illegible]	83.9	32[illegible].[illegible]	306.1
RADIUS = .600								
AMPLITUDE =	.0045	.0042	.0048	.0018	.0012	.0016	.0030	.0039
PHASE ANGLE =	137.6	111.5	10[illegible].4	[illegible]3.1	354.9	296.3	292.1	292.1
RADIUS = .700								
AMPLITUDE =	.0027	.0020	.[illegible]016	.0015	.0019	.0025	.0020	.0019
PHASE ANGLE =	[illegible]31.2	160.4	1[illegible].9	2[illegible].[illegible]	2[illegible].6	283.3	296.[illegible]	291.9
RADIUS = .800								
AMPLITUDE =	.0021	.0029	.0030	.[illegible]0[illegible]3	.0025	.0027	.0011	.0001
PHASE ANGLE =	[illegible]7.[illegible]	210.3	2[illegible].3	2[illegible].[illegible]	250.3	277.0	2[illegible].[illegible]	6.2
RADIUS = .900								
AMPLITUDE =	.0027	.0034	.[illegible]038	.0023	.0023	.0026	.0012	.0018
PHASE ANGLE =	[illegible]72.[illegible]	211.5	2[illegible].[illegible]	2[illegible].[illegible]	240.[illegible]	272.3	273.[illegible]	97.2
RADIUS = 1.000								
AMPLITUDE =	.0038	.0038	.[illegible]0[illegible]9	.0009	.0017	.0023	.0020	.0002
PHASE ANGLE =	[illegible]0[illegible].[illegible]	199.0	20[illegible].[illegible]	2[illegible].[illegible]	224.6	269.3	2[illegible].5	93.4

TABLE B-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 10

[illegible] COMPONENT RAT[illegible] [illegible] 5845 CORRELATION WITH R V ATHENA 10
PROPELLER DIAM[illegible] [illegible].0 FEET JA = .737

HARMONIC ANALYSES OF TANGENTIAL [illegible] COMPONENT RATIOS (VT /

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	[illegible]	.0044	[illegible]	[illegible]	.0038	.0037	.0026	.0013
PHASE ANGLE =	[illegible]	54.8	[illegible]	[illegible]	139.7	134.3	83.4	72.1
RADIUS = .633								
AMPLITUDE =	[illegible]	.0031	[illegible]	[illegible]	.0041	.0029	.0027	.0019
PHASE ANGLE =	[illegible]	306.2	[illegible]	[illegible]	281.8	273.5	288.2	242.1
RADIUS = .781								
AMPLITUDE =	.1056	.0059	[illegible]	[illegible]	.0019	.0007	.0014	[illegible]
PHASE ANGLE =	[illegible]	21.7	[illegible]	[illegible]	281.0	255.3	287.9	257.7
RADIUS = .963								
AMPLITUDE =	.1065	.0071	[illegible]	[illegible]	.0037	.0035	.0029	.0020
PHASE ANGLE =	194.2	68.4	[illegible]	[illegible]	99.0	105.7	105.4	96.6

HARMONIC ANALYSES OF TANGENTIAL [illegible] COMPONENT RATIOS (VT /

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0046	.0057	[illegible]	[illegible]	.0059	.0036	.0022	.0014
PHASE ANGLE =	30.1	35.0	[illegible]	[illegible]	11.1	359.3	340.3	275.2
RADIUS = .633								
AMPLITUDE =	.0019	.0026	[illegible]	.0012	.0020	.0035	.0030	.0033
PHASE ANGLE =	149.4	292.8	[illegible]	158.5	168.1	160.2	154.0	163.7
RADIUS = .781								
AMPLITUDE =	.0007	.0011	[illegible]	[illegible]	.0004	.0020	.0012	.0006
PHASE ANGLE =	108.5	181.6	[illegible]	[illegible]	196.9	192.2	191.5	247.2
RADIUS = .963								
AMPLITUDE =	.0013	.0013	[illegible]	[illegible]	.0011	.0010	[illegible]	.0005
PHASE ANGLE =	303.7	117.7	[illegible]	[illegible]	184.3	180.0	221.4	245.0

TABLE B-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 10

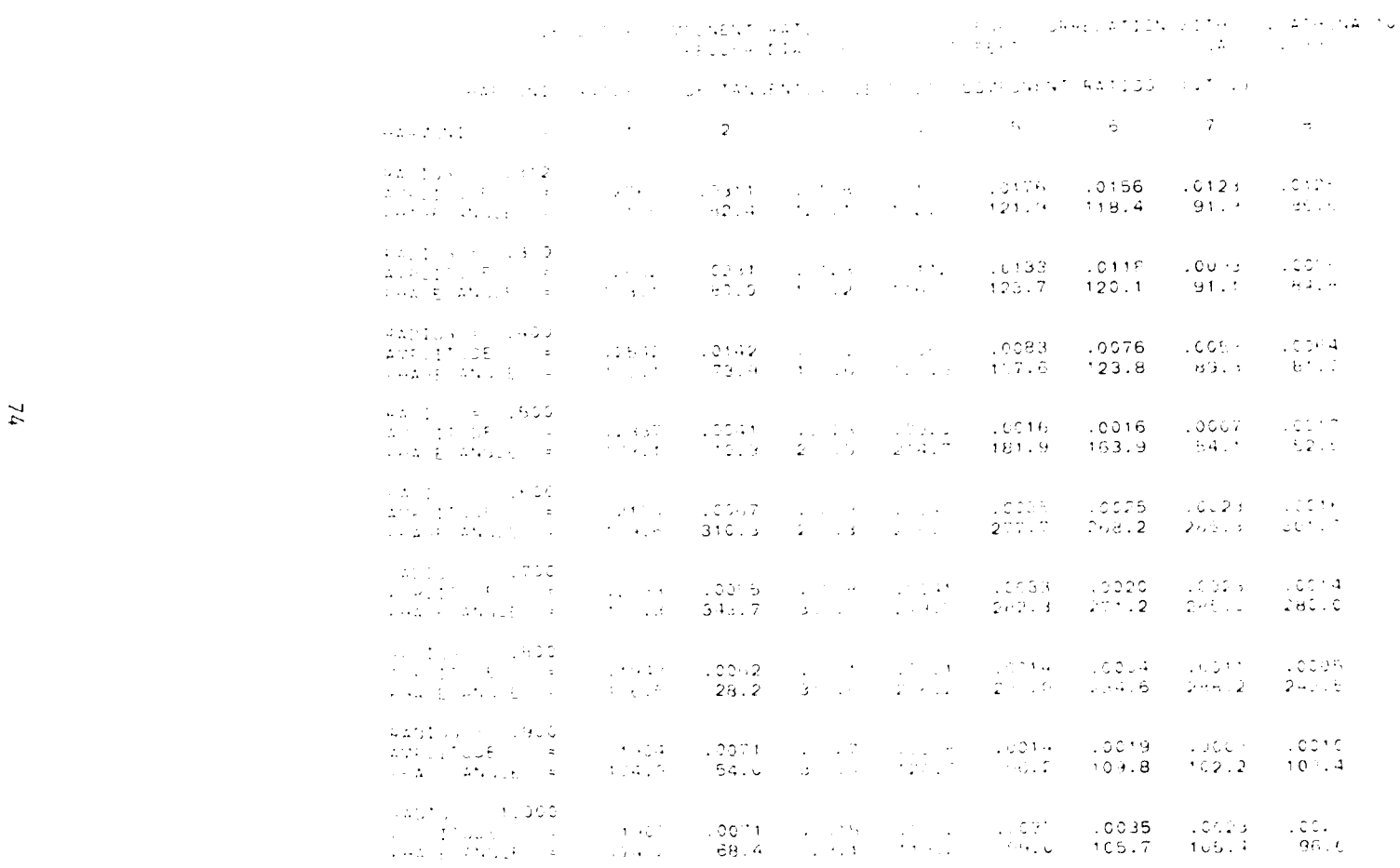


TABLE B-6 (Continued)

[illegible]

APPENDIX C

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 11

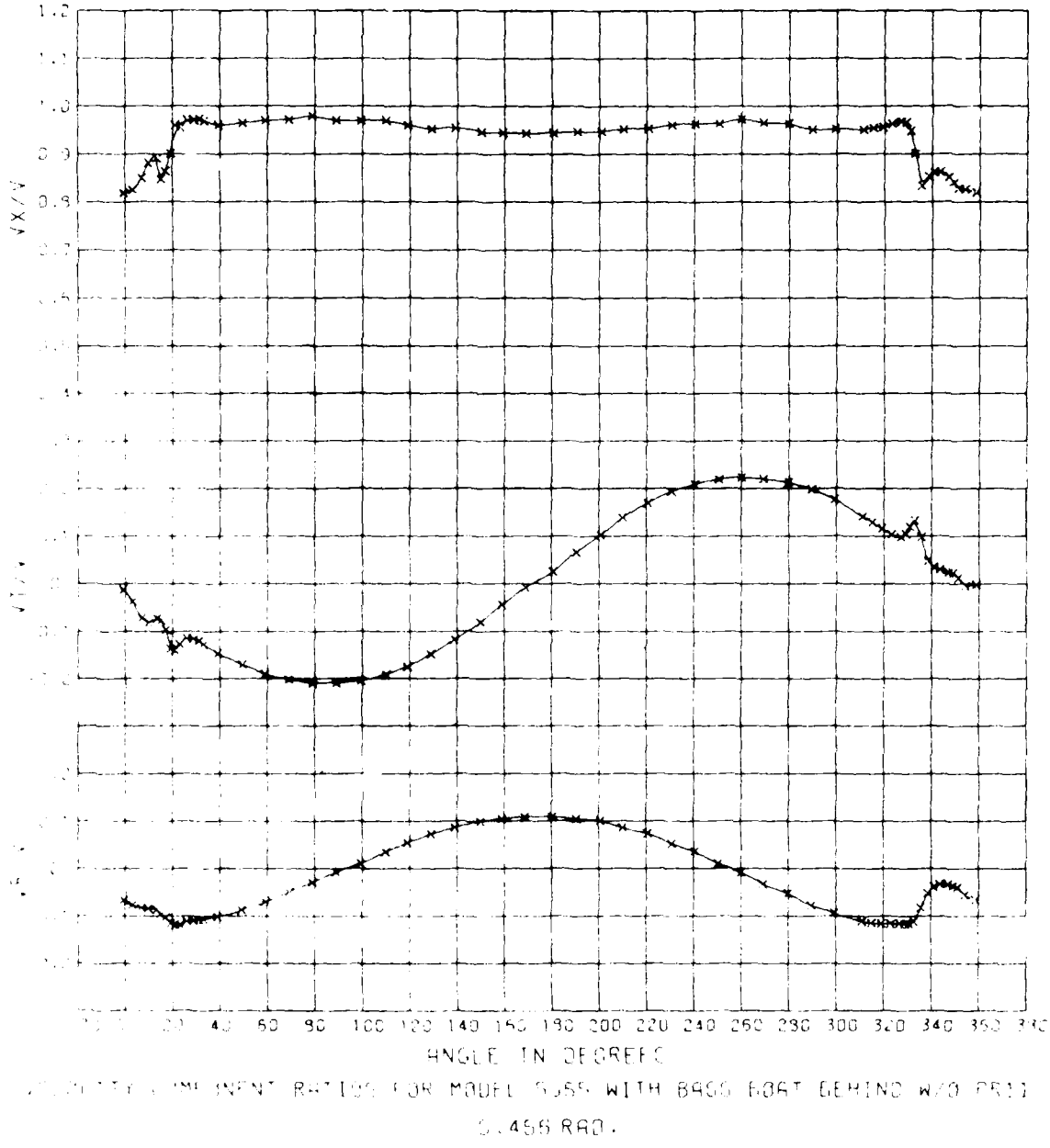


Figure C-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 11

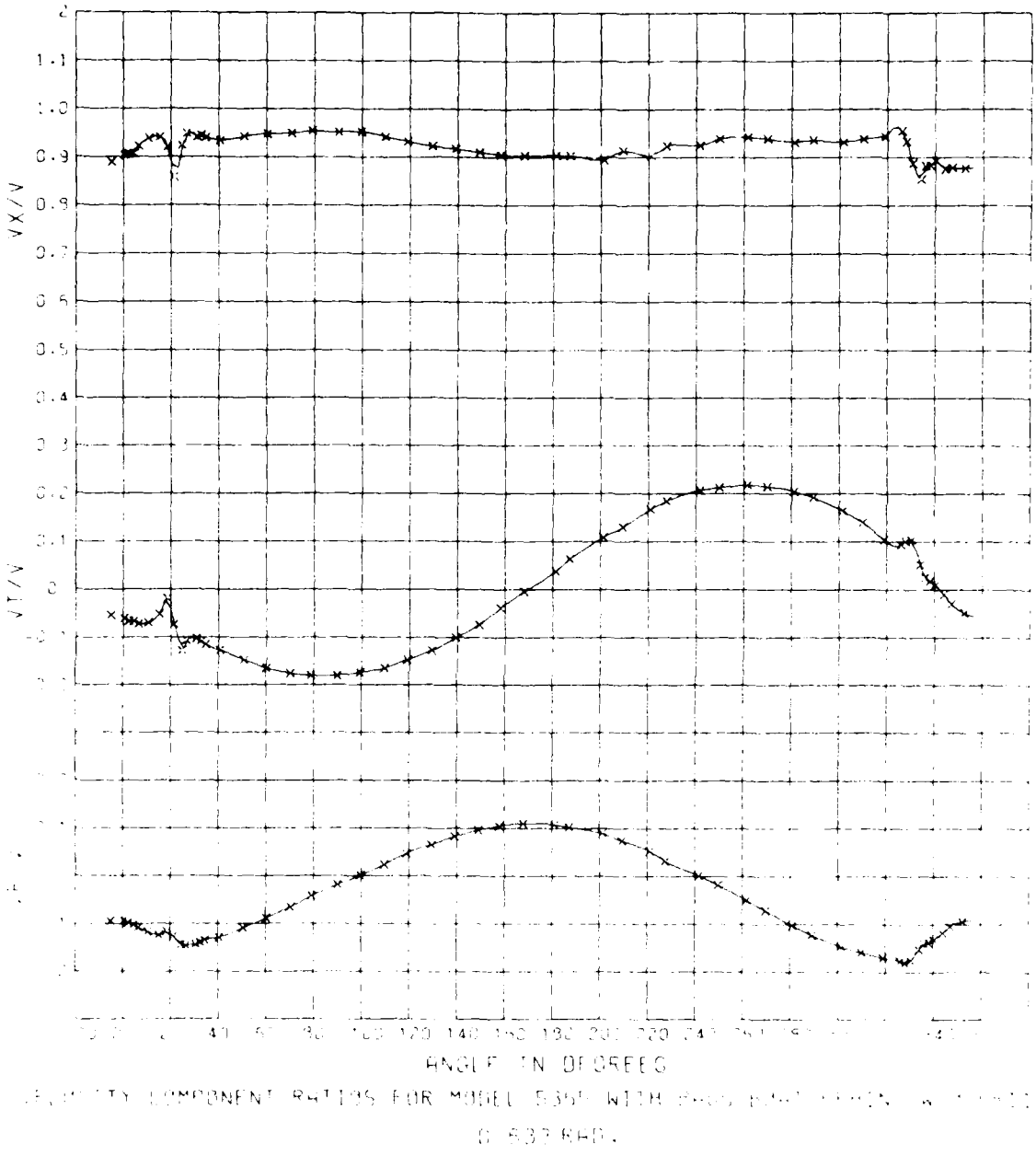


Figure C-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 11

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ANALYSIS OF WAKE SURVEY EXPERIMENTAL DATA FOR MODEL 5365 REPRES--ETC(U)
JAN 81 R B HURWITZ, L B CROOK
UNCLASSIFIED DTNSRDC/SPD-0833-06 NL

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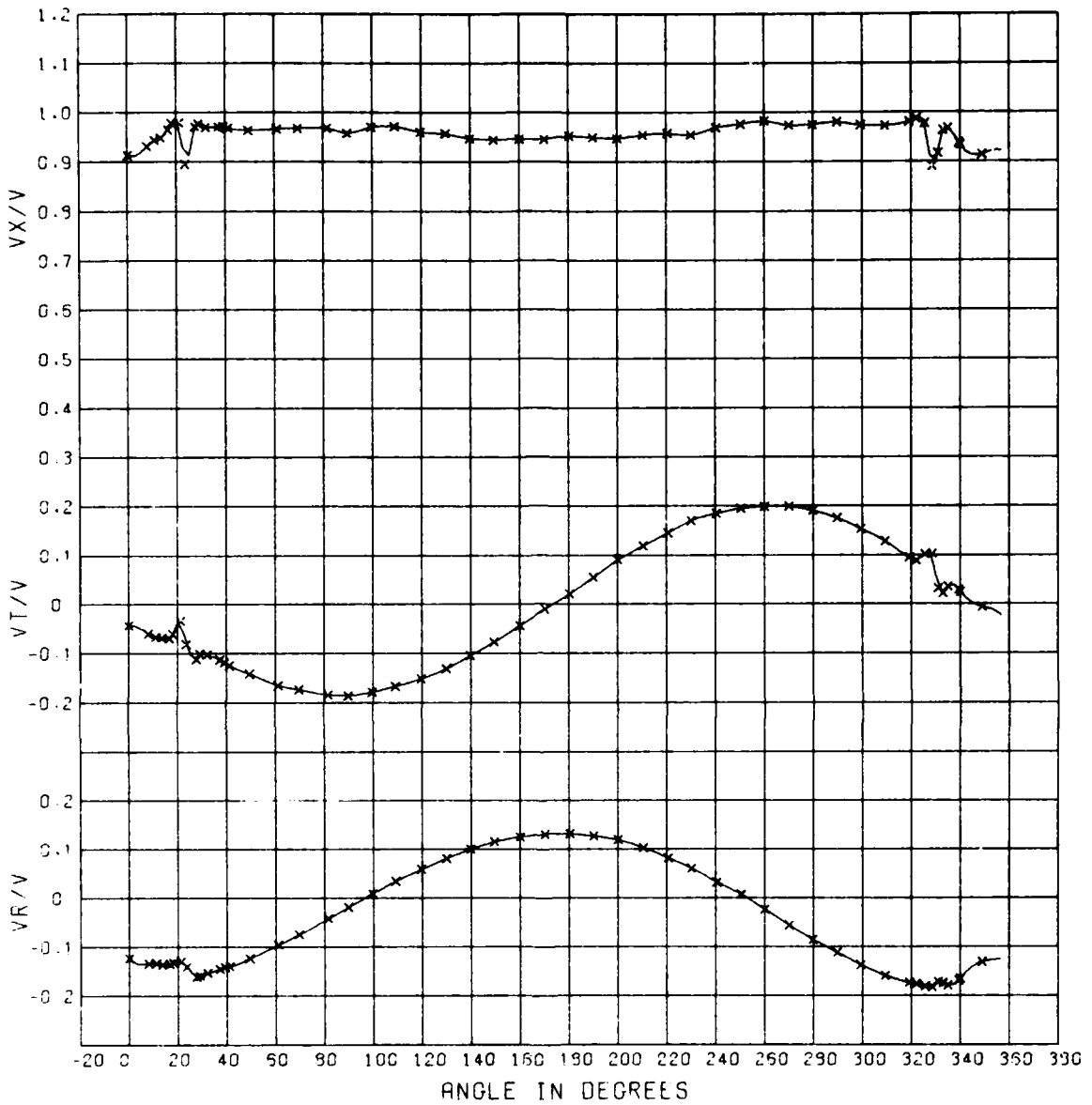

Figure C-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 11

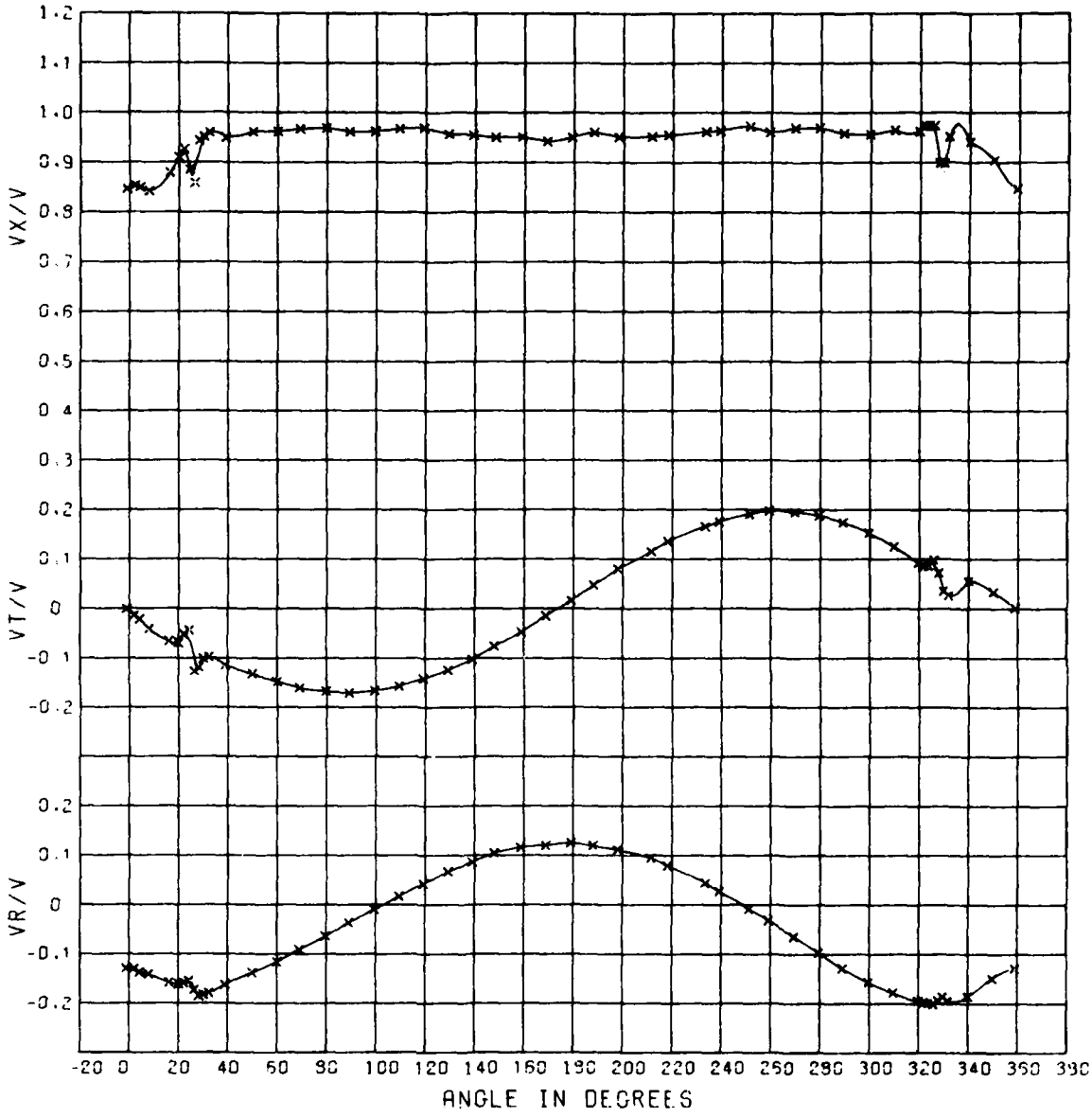

Figure C-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 11

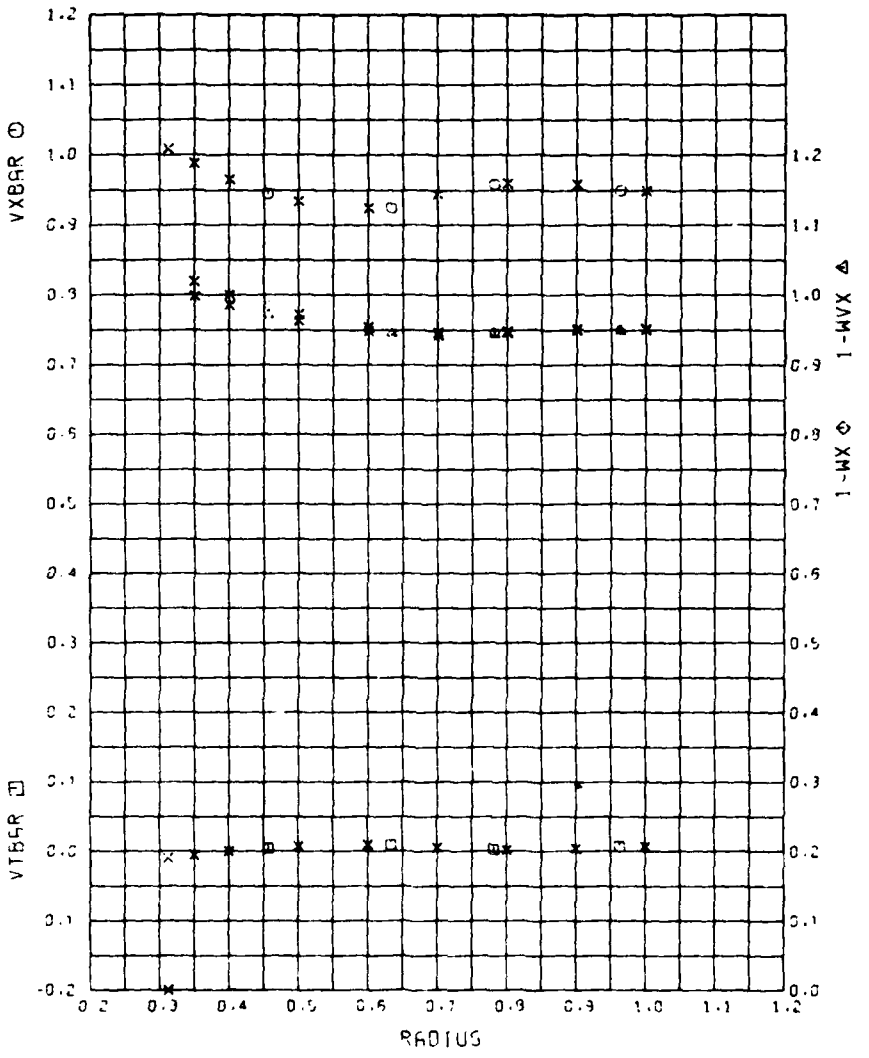

Figure C-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 11

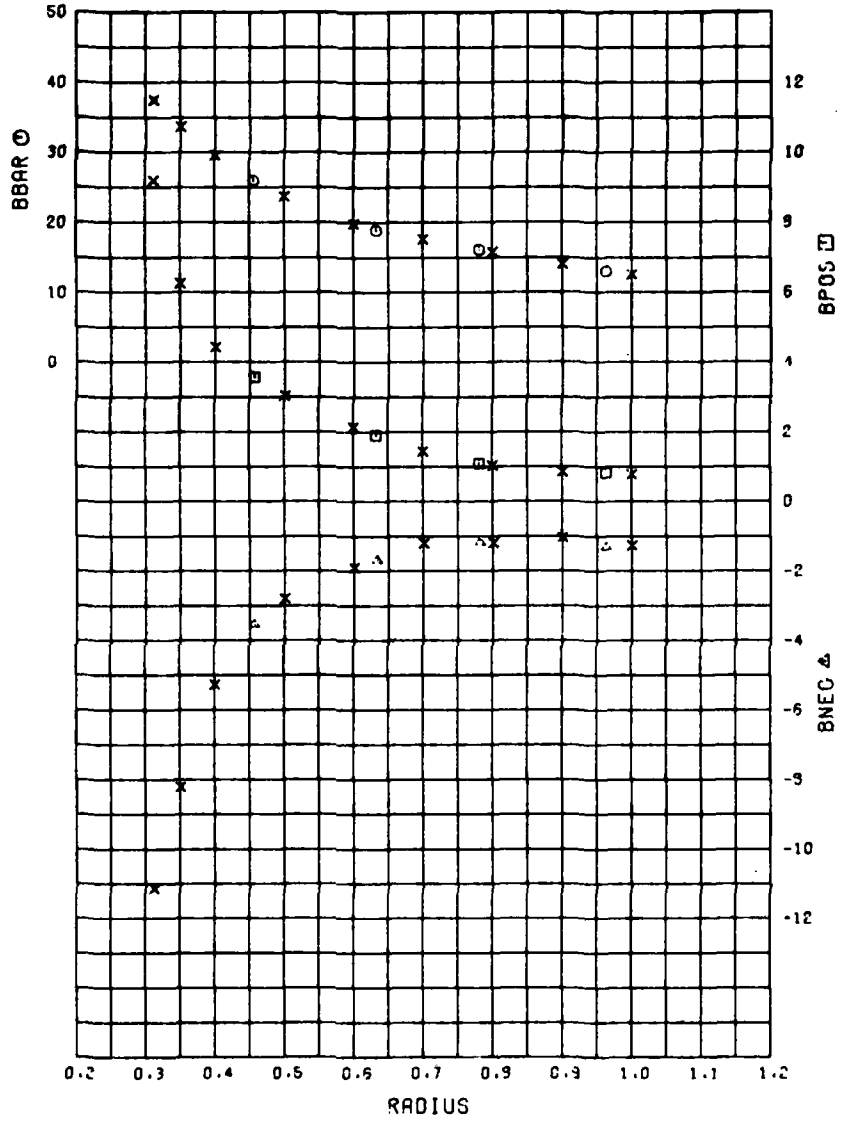

Figure C-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 11

TABLE C-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA,
MODEL 5365, EXPERIMENT 11

RADIUS = .456					RADIUS = .633				RADIUS = .781				RADIUS = .963		
ANGLE	VT/V	VT/V	VR/V	ANGLE	VT/V	VT/V	VR/V	ANGLE	VT/V	VT/V	VR/V	ANGLE	VT/V	VT/V	VR/V
-.9	.819	-.813	-.888	-9.0	.889	-.894	-.895	0.0	.913	-.863	-.123	-1.0	.867	-.881	-.129
7.1	.825	-.838	-.877	.5	.884	-.881	-.894	0.0	.931	-.868	-.136	0.2	.896	-.916	-.138
7.1	.850	-.872	-.886	2.4	.906	-.866	-.899	11.0	.963	-.867	-.133	0.3	.898	-.922	-.137
10.8	.879	-.883	-.887	4.5	.907	-.867	-.884	13.0	.948	-.866	-.139	0.1	.862	-.846	-.141
10.8	.883	-.881	-.884	6.5	.923	-.872	-.899	14.0	.950	-.869	-.137	10.4	.879	-.866	-.156
13.2	.895	-.871	-.884	10.6	.939	-.878	-.110	16.0	.966	-.878	-.134	20.2	.910	-.878	-.161
16.8	.907	-.873	-.898	14.6	.963	-.862	-.125	17.1	.963	-.869	-.136	22.2	.927	-.893	-.159
19.1	.919	-.877	-.896	16.8	.968	-.843	-.123	18.0	.970	-.868	-.133	24.4	.881	-.846	-.153
17.1	.904	-.897	-.103	18.5	.922	-.838	-.117	21.1	.979	-.833	-.129	24.4	.891	-.842	-.154
19.3	.981	-.137	-.116	20.6	.883	-.832	-.119	22.9	.997	-.837	-.128	26.4	.859	-.827	-.173
21.8	.967	-.148	-.118	22.8	.855	-.813	-.139	24.8	.993	-.827	-.134	28.2	.944	-.819	-.184
23.2	.927	-.133	-.126	24.6	.825	-.803	-.145	27.8	.988	-.822	-.142	28.3	.946	-.819	-.186
23.2	.981	-.122	-.115	26.5	.968	-.851	-.165	28.8	.975	-.803	-.161	30.8	.954	-.808	-.182
26.8	.973	-.116	-.112	28.5	.951	-.812	-.166	29.8	.977	-.801	-.168	30.4	.969	-.802	-.183
29.8	.969	-.117	-.118	30.7	.962	-.803	-.163	32.8	.978	-.803	-.153	32.4	.960	-.808	-.179
29.8	.971	-.118	-.118	32.6	.963	-.806	-.160	37.1	.970	-.813	-.145	35.8	.958	-.815	-.162
31.3	.971	-.122	-.108	32.8	.966	-.810	-.138	39.1	.971	-.819	-.141	98.8	.981	-.133	-.138
33.2	.968	-.128	-.107	34.5	.951	-.816	-.135	41.1	.966	-.829	-.140	40.8	.982	-.140	-.116
39.1	.961	-.147	-.102	48.5	.935	-.828	-.129	49.2	.966	-.842	-.123	49.8	.987	-.168	-.091
49.4	.964	-.170	-.088	58.5	.963	-.868	-.169	61.8	.967	-.865	-.096	59.8	.969	-.187	-.068
59.8	.969	-.198	-.071	68.2	.968	-.895	-.842	69.7	.966	-.886	-.062	79.8	.962	-.171	-.037
69.8	.972	-.282	-.058	78.4	.958	-.175	-.866	81.6	.969	-.184	-.042	99.4	.963	-.167	-.010
79.8	.979	-.289	-.029	79.8	.955	-.188	-.842	89.7	.958	-.186	-.019	109.3	.968	-.157	.017
89.8	.970	-.218	-.007	98.8	.952	-.181	-.819	99.5	.970	-.179	.009	119.2	.976	-.142	.042
99.4	.976	-.285	.011	99.6	.994	-.175	.881	109.8	.972	-.167	.035	129.2	.956	-.126	.067
109.9	.970	-.191	.035	109.6	.963	-.165	.826	119.6	.962	-.152	.059	139.8	.956	-.102	.097
119.8	.980	-.174	.054	119.8	.933	-.146	.847	129.8	.958	-.132	.081	144.6	.951	-.076	.104
129.8	.953	-.149	.073	129.3	.926	-.126	.867	139.7	.967	-.105	.108	150.8	.952	-.040	.116
139.8	.956	-.119	.086	139.2	.918	-.101	.883	149.8	.967	-.077	.115	162.9	.963	-.015	.128
149.8	.967	-.081	.099	149.1	.912	-.073	.897	149.9	.962	-.077	.115	179.8	.958	.016	.125
159.8	.966	-.044	.107	158.8	.906	-.038	.905	168.8	.966	-.044	.126	188.8	.961	.047	.120
169.8	.966	-.000	.109	168.8	.903	-.004	.910	178.1	.961	-.018	.132	198.8	.952	.088	.111
180.4	.969	.023	.110	181.1	.906	.030	.910	178.1	.969	-.011	.130	211.3	.952	.115	.094
190.4	.967	.027	.108	187.1	.906	.064	.903	188.2	.951	.021	.131	219.8	.955	.126	.079
198.5	.967	.067	.105	201.2	.895	.109	.894	188.3	.955	.022	.132	233.3	.962	.106	.044
208.6	.968	.102	.101	209.3	.915	.138	.898	198.8	.969	.059	.127	239.8	.966	.078	.027
218.8	.953	.139	.086	221.8	.924	.184	.879	208.8	.967	.098	.119	251.2	.972	.041	-.009
228.5	.956	.178	.074	227.4	.925	.186	.852	218.6	.956	.115	.102	259.8	.961	.197	-.033
238.9	.961	.193	.052	241.6	.929	.207	.832	220.5	.958	.145	.082	269.4	.969	.195	-.065
248.2	.966	.209	.036	249.7	.939	.212	-.019	230.8	.954	.178	.061	279.3	.978	.186	-.097
258.3	.966	.219	.018	261.5	.963	.210	-.058	240.3	.969	.184	.033	289.8	.959	.176	-.129
258.3	.966	.220	.010	269.8	.939	.215	-.077	250.3	.976	.196	.007	299.5	.956	.153	-.157
268.8	.971	.224	-.008	281.8	.933	.205	-.103	259.9	.982	.190	-.024	309.6	.965	.129	-.178
278.8	.966	.228	-.031	289.8	.936	.192	-.123	269.9	.973	.199	-.056	319.6	.963	.093	-.195
278.6	.961	.213	-.053	289.8	.937	.182	-.127	270.6	.974	.198	-.086	321.9	.974	.067	-.197
288.5	.951	.198	-.078	301.6	.932	.166	-.146	289.6	.980	.175	-.112	323.7	.975	.036	-.198
298.2	.951	.177	-.091	309.9	.919	.168	-.159	295.3	.973	.153	-.137	325.7	.976	.008	-.202
311.8	.957	.142	-.111	319.8	.944	.184	-.169	309.2	.972	.128	-.159	327.7	.981	.029	-.197
319.1	.954	.129	-.114	326.1	.955	.193	-.176	319.1	.981	.099	-.176	327.8	.987	.116	-.208
319.2	.954	.118	-.116	327.9	.933	.181	-.188	322.8	.987	.088	-.177	329.6	.988	.138	-.186
319.2	.959	.115	-.116	329.9	.911	.117	-.181	329.8	.983	.093	-.188	329.7	.997	.133	-.186
327.1	.964	.104	-.116	331.8	.866	.098	-.171	326.8	.972	.111	-.182	331.7	.992	.125	-.194
327.8	.967	.098	-.116	333.9	.852	.096	-.193	328.8	.983	.102	-.181	339.9	.981	.095	-.185
329.1	.967	.105	-.117	336.2	.866	.063	-.152	329.9	.988	.105	-.186	349.9	.989	.033	-.169
338.9	.969	.128	-.117	339.9	.883	.029	-.140	330.9	.986	.137	-.172	359.8	.967	.001	-.179
332.9	.981	.136	-.113	330.8	.887	.010	-.136	332.9	.963	.023	-.175	382.2	.896	-.016	-.130
335.8	.995	.116	-.096	348.8	.895	.011	-.133	336.9	.964	.036	-.179				
336.8	.972	.086	-.071	368.3	.891	.009	-.185	340.8	.944	.035	-.178				
338.8	.966	.067	-.051	366.8	.876	.010	-.168	348.9	.914	-.006	-.131				
334.9	.962	.067	-.092	367.8	.879	-.030	-.185	368.8	.913	-.063	-.123				
341.8	.967	.035	-.039	392.3	.876	-.076	-.169								
362.9	.961	.032	-.035	395.8	.909	-.044	-.095								
366.8	.956	.027	-.031	388.5	.906	-.051	-.094								
367.8	.952	.026	-.033												
369.8	.961	.026	-.036												
351.8	.929	.012	-.048												
356.8	.927	-.006	-.056												
358.8	.928	-.010	-.066												
359.1	.919	.011	-.088												
363.1	.925	-.038	-.077												

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 11

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND W/O PR11
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.945	.925	.958	.949	1.009	.998	.985	.934	.924	.945	.960	.958	.949
VTBAR =	.004	.009	.003	.007	-.010	-.005	-.000	.007	.009	.005	.002	.004	.007
VRBAR =	-.007	-.033	-.026	-.040	.040	.025	.008	-.017	-.031	-.028	-.027	-.033	-.040
1-WVX =	.971	.945	.943	.948	0.000	.998	.985	.963	.948	.943	.946	.949	.950
1-WX =	.984	.950	.946	.950	0.000	1.019	1.001	.972	.954	.947	.948	.951	.952
BBAR =	25.93	18.90	16.08	13.02	37.46	33.67	29.56	23.64	19.84	17.58	15.74	14.04	12.56
BPOS =	3.56	1.91	1.09	.83	9.18	6.25	4.43	3.03	2.14	1.44	1.03	.85	.78
THETA =	80.00	80.00	102.50	77.50	20.00	20.00	80.00	80.00	80.00	80.00	102.50	77.50	77.50
BNEG =	-3.53	-1.67	-1.18	-1.31	-11.09	-8.15	-5.19	-2.80	-1.89	-1.21	-1.20	-1.04	-1.27
THETA =	335.00	332.50	327.50	357.50	0.00	0.00	0.00	335.00	332.50	330.00	327.50	327.50	357.50

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 C-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 11

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND W/O PR11
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0233	.0347	.0195	.0167	.0152	.0116	.0063	.0018
PHASE ANGLE =	283.6	283.5	282.2	283.3	288.8	298.0	305.6	308.8
RADIUS = .633								
AMPLITUDE =	.0083	.0237	.0064	.0044	.0080	.0060	.0052	.0046
PHASE ANGLE =	37.0	278.5	297.3	312.8	324.3	355.9	27.4	50.9
RADIUS = .781								
AMPLITUDE =	.0036	.0178	.0075	.0061	.0069	.0031	.0024	.0013
PHASE ANGLE =	196.3	276.8	294.9	311.8	290.3	339.8	347.7	272.1
RADIUS = .963								
AMPLITUDE =	.0184	.0255	.0148	.0130	.0125	.0065	.0066	.0042
PHASE ANGLE =	263.7	263.7	248.8	245.5	237.9	237.2	235.2	235.1

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0020	.0035	.0032	.0041	.0027	.0007	.0023	.0041
PHASE ANGLE =	156.6	128.6	136.1	159.1	156.7	235.5	274.0	305.2
RADIUS = .633								
AMPLITUDE =	.0028	.0034	.0013	.0006	.0034	.0035	.0046	.0053
PHASE ANGLE =	58.3	88.3	99.7	207.8	290.5	322.8	298.2	318.0
RADIUS = .781								
AMPLITUDE =	.0007	.0018	.0013	.0026	.0024	.0018	.0009	.0012
PHASE ANGLE =	299.5	91.4	263.7	283.8	261.8	332.6	313.0	175.5
RADIUS = .963								
AMPLITUDE =	.0041	.0015	.0031	.0026	.0009	.0019	.0012	.0013
PHASE ANGLE =	190.2	241.9	257.2	329.6	351.8	335.0	337.4	27.3

TABLE C-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 11

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND W/O PR11
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0732	.0472	.0446	.0392	.0317	.0267	.0202	.0148
PHASE ANGLE =	265.3	287.5	279.6	279.3	266.9	273.2	269.8	252.2
RADIUS = .350								
AMPLITUDE =	.0573	.0436	.0368	.0332	.0263	.0217	.0155	.0104
PHASE ANGLE =	267.9	286.5	280.0	279.9	271.1	277.5	274.4	255.0
RADIUS = .400								
AMPLITUDE =	.0393	.0392	.0278	.0242	.0203	.0163	.0104	.0055
PHASE ANGLE =	273.1	285.1	280.8	281.0	278.1	285.2	284.2	263.4
RADIUS = .500								
AMPLITUDE =	.0141	.0316	.0143	.0120	.0123	.0090	.0048	.0023
PHASE ANGLE =	300.1	282.2	284.1	286.5	299.0	311.9	333.5	24.1
RADIUS = .600								
AMPLITUDE =	.0079	.0254	.0096	.0053	.0087	.0064	.0051	.0047
PHASE ANGLE =	19.9	279.3	293.1	303.7	320.7	347.6	21.8	49.7
RADIUS = .700								
AMPLITUDE =	.0033	.0198	.0071	.0095	.0073	.0049	.0041	.0018
PHASE ANGLE =	75.5	279.2	304.5	323.3	313.2	355.3	17.1	34.7
RADIUS = .800								
AMPLITUDE =	.0046	.0178	.0079	.0062	.0070	.0027	.0021	.0017
PHASE ANGLE =	209.9	275.7	290.7	305.9	283.7	330.5	333.1	261.1
RADIUS .900								
AMPLITUDE =	.0118	.0209	.0101	.0071	.0094	.0036	.0038	.0036
PHASE ANGLE =	249.0	268.0	283.3	304.8	291.4	294.4	290.8	241.9
RADIUS 1.000								
AMPLITUDE =	.0184	.0255	.0168	.0130	.0125	.0065	.0060	.0042
PHASE ANGLE =	263.7	263.7	248.8	245.5	237.9	237.2	235.2	235.1

TABLE C-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND W/O PR11
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0094	.0060	.0058	.0084	.0131	.0074	.0059	.0052
PHASE ANGLE =	209.5	179.6	166.5	165.2	138.8	154.5	140.7	173.7
RADIUS = .350								
AMPLITUDE =	.0068	.0049	.0049	.0072	.0098	.0051	.0035	.0028
PHASE ANGLE =	204.7	169.1	158.5	163.5	140.2	157.2	150.3	196.2
RADIUS = .400								
AMPLITUDE =	.0040	.0040	.0040	.0058	.0061	.0025	.0014	.0022
PHASE ANGLE =	192.7	151.1	149.0	161.3	143.8	165.6	198.3	271.9
RADIUS = .500								
AMPLITUDE =	.0018	.0035	.0027	.0030	.0011	.0015	.0035	.0052
PHASE ANGLE =	107.3	113.2	125.9	158.1	206.6	304.4	287.5	312.5
RADIUS = .600								
AMPLITUDE =	.0028	.0035	.0017	.0010	.0030	.0033	.0047	.0058
PHASE ANGLE =	63.7	91.9	105.3	172.6	288.9	321.0	296.7	317.8
RADIUS = .700								
AMPLITUDE =	.0014	.0028	.0001	.0016	.0030	.0025	.0025	.0018
PHASE ANGLE =	30.0	88.3	176.3	269.1	274.0	326.6	300.1	298.9
RADIUS = .800								
AMPLITUDE =	.0008	.0015	.0015	.0027	.0023	.0017	.0007	.0014
PHASE ANGLE =	272.5	93.3	263.8	286.6	260.5	334.0	321.1	165.7
RADIUS = .900								
AMPLITUDE =	.0024	.0004	.0026	.0028	.0011	.0016	.0007	.0012
PHASE ANGLE =	207.5	194.4	268.3	306.8	275.0	337.3	355.8	128.3
RADIUS = 1.000								
AMPLITUDE =	.0041	.0015	.0031	.0026	.0009	.0019	.0012	.0013
PHASE ANGLE =	190.2	241.9	257.2	329.8	351.8	335.0	337.4	27.3

TABLE C-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 11

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND W/O PR11
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2175	.0025	.0019	.0038	.0022	.0041	.0012	.0008
PHASE ANGLE =	187.3	305.7	205.8	204.7	186.1	205.1	207.7	214.4
RADIUS = .633								
AMPLITUDE =	.1986	.0140	.0080	.0061	.0062	.0044	.0049	.0045
PHASE ANGLE =	190.1	306.5	306.5	307.0	314.3	313.2	317.4	331.0
RADIUS = .781								
AMPLITUDE =	.1884	.0100	.0054	.0034	.0021	.0016	.0015	.0014
PHASE ANGLE =	187.5	322.6	332.0	314.2	315.0	298.9	326.2	323.2
RADIUS = .963								
AMPLITUDE =	.1799	.0077	.0033	.0029	.0036	.0031	.0029	.0025
PHASE ANGLE =	185.7	325.9	25.0	87.7	119.5	123.6	135.3	157.1

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0019	.0023	.0032	.0025	.0027	.0015	.0017	.0018
PHASE ANGLE =	46.2	47.7	63.1	63.2	84.5	100.0	147.5	199.2
RADIUS = .633								
AMPLITUDE =	.0030	.0034	.0013	.0005	.0016	.0024	.0031	.0028
PHASE ANGLE =	339.4	331.7	15.6	279.1	168.0	193.6	186.5	199.4
RADIUS = .781								
AMPLITUDE =	.0004	.0004	.0006	.0021	.0020	.0022	.0017	.0008
PHASE ANGLE =	124.2	181.7	150.3	190.1	191.4	192.0	201.7	196.5
RADIUS = .963								
AMPLITUDE =	.0025	.0018	.0024	.0023	.0016	.0016	.0009	.0008
PHASE ANGLE =	175.3	194.1	202.7	221.8	236.2	252.5	313.0	336.9

LE C-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 11

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND W/O PR11
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2403	.0205	.0120	.0134	.0100	.0101	.0125	.0116
PHASE ANGLE =	181.5	119.4	135.2	164.9	149.0	171.7	150.4	161.7
RADIUS = .350								
AMPLITUDE =	.2335	.0132	.0119	.0146	.0129	.0127	.0098	.0080
PHASE ANGLE =	183.2	119.4	138.1	169.0	151.0	175.1	152.8	168.3
RADIUS = .400								
AMPLITUDE =	.2254	.0050	.0061	.0092	.0071	.0080	.0045	.0041
PHASE ANGLE =	185.3	118.5	147.6	178.6	156.7	183.1	159.8	168.2
RADIUS = .500								
AMPLITUDE =	.2120	.0071	.0033	.0036	.0021	.0027	.0020	.0018
PHASE ANGLE =	188.5	303.6	279.8	247.4	281.0	246.7	294.4	316.0
RADIUS = .600								
AMPLITUDE =	.2015	.0133	.0074	.0057	.0058	.0041	.0047	.0043
PHASE ANGLE =	190.1	305.3	303.2	301.6	312.4	308.2	315.7	330.2
RADIUS = .700								
AMPLITUDE =	.1936	.0119	.0067	.0051	.0044	.0032	.0034	.0031
PHASE ANGLE =	188.9	314.2	317.1	308.3	313.4	307.8	319.8	329.2
RADIUS = .800								
AMPLITUDE =	.1873	.0097	.0054	.0030	.0016	.0012	.0011	.0010
PHASE ANGLE =	187.3	324.2	330.0	317.2	317.1	294.9	330.2	319.1
RADIUS = .900								
AMPLITUDE =	.1824	.0083	.0036	.0012	.0016	.0013	.0013	.0012
PHASE ANGLE =	186.1	328.3	1.0	36.3	115.2	132.0	128.9	168.6
RADIUS = 1.000								
AMPLITUDE =	.1799	.0077	.0033	.0029	.0036	.0031	.0029	.0025
PHASE ANGLE =	185.7	325.9	25.0	87.7	119.5	123.6	135.3	157.1

TABLE C-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND W/O PR11
PROPELLER DIAMETER = 6.00 FEET JA = .139

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0077	.0095	.0084	.0060	.0065	.0060	.0038	.0017
PHASE ANGLE =	121.8	114.8	88.7	83.4	65.0	56.7	46.6	21.4
RADIUS = .350								
AMPLITUDE =	.0054	.0068	.0057	.0045	.0054	.0045	.0026	.0005
PHASE ANGLE =	115.1	108.3	83.7	79.7	68.0	60.9	59.7	33.7
RADIUS = .400								
AMPLITUDE =	.0030	.0040	.0043	.0040	.0040	.0028	.0016	.0007
PHASE ANGLE =	96.6	91.8	75.3	73.4	73.7	71.2	90.6	147.8
RADIUS = .500								
AMPLITUDE =	.0022	.0025	.0026	.0026	.0020	.0013	.0023	.0024
PHASE ANGLE =	8.8	8.3	51.4	50.8	99.0	142.8	166.8	199.5
RADIUS = .600								
AMPLITUDE =	.0031	.0035	.0016	.0005	.0015	.0022	.0031	.0029
PHASE ANGLE =	342.3	335.9	23.2	328.7	153.6	189.5	183.5	199.5
RADIUS = .700								
AMPLITUDE =	.0013	.0014	.0006	.0010	.0019	.0025	.0025	.0018
PHASE ANGLE =	348.9	330.7	40.6	195.8	179.9	189.7	191.6	197.0
RADIUS = .800								
AMPLITUDE =	.0007	.0007	.0007	.0010	.0020	.0021	.0015	.0006
PHASE ANGLE =	142.3	174.6	162.7	190.9	194.2	193.8	205.4	198.1
RADIUS = .900								
AMPLITUDE =	.0020	.0017	.0017	.0014	.0018	.0016	.0007	.0004
PHASE ANGLE =	165.8	178.9	192.2	208.1	214.3	218.5	256.1	329.4
RADIUS = 1.000								
AMPLITUDE =	.0025	.0018	.0024	.0023	.0016	.0016	.0009	.0008
PHASE ANGLE =	175.3	194.1	202.7	221.8	230.2	252.5	313.0	356.9

APPENDIX D

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 12

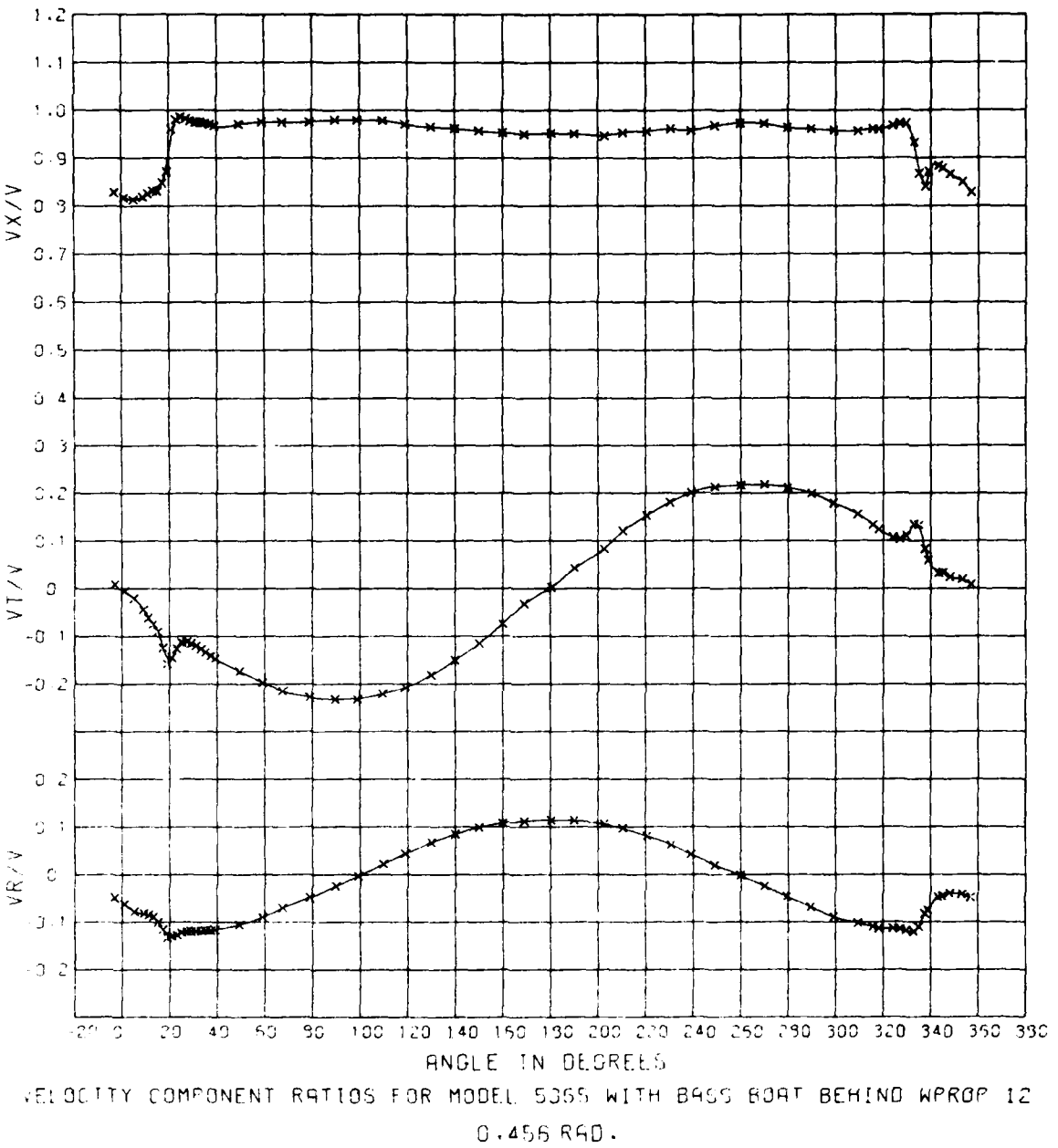

Figure D-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 12

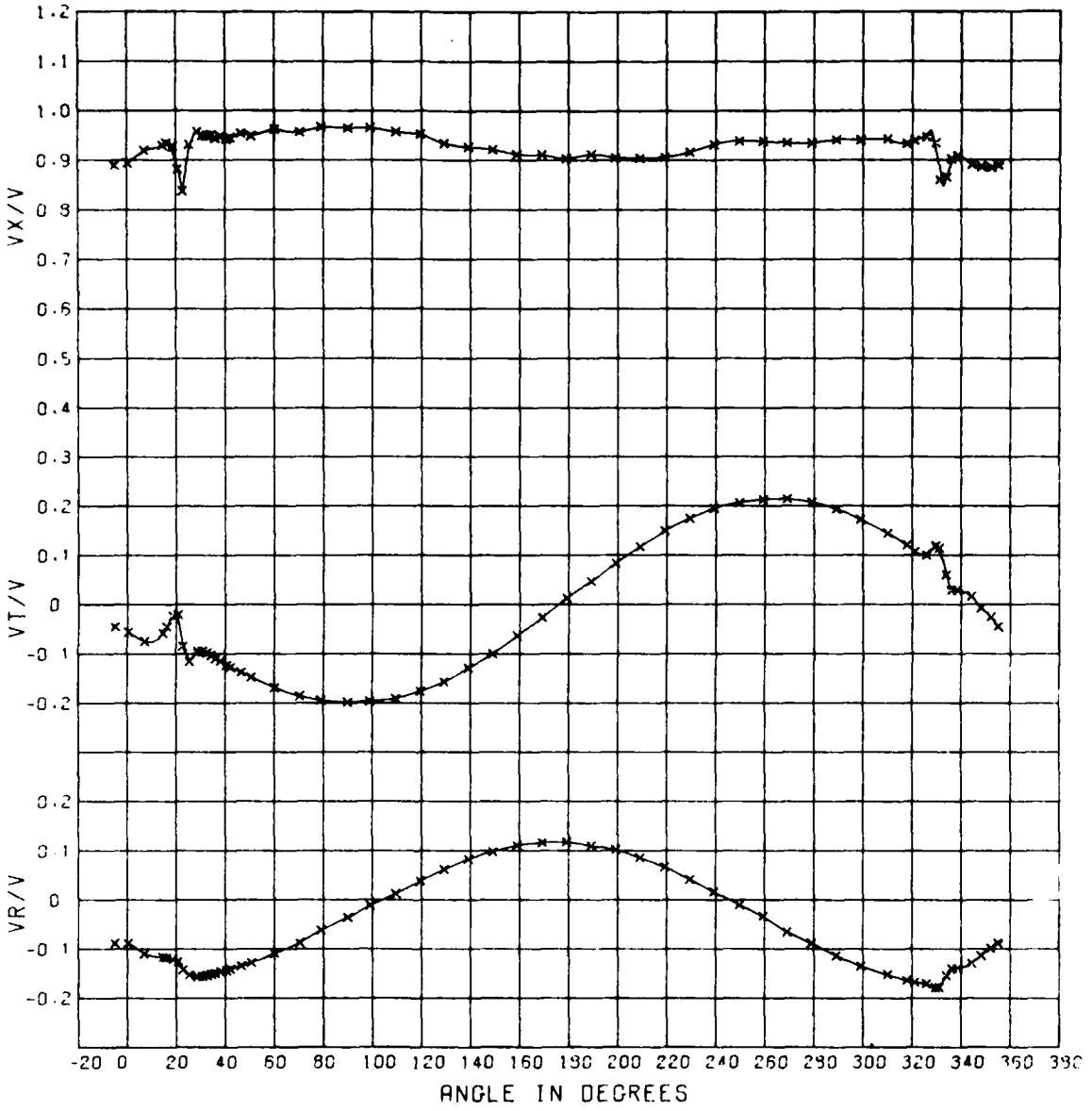

Figure D-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 12

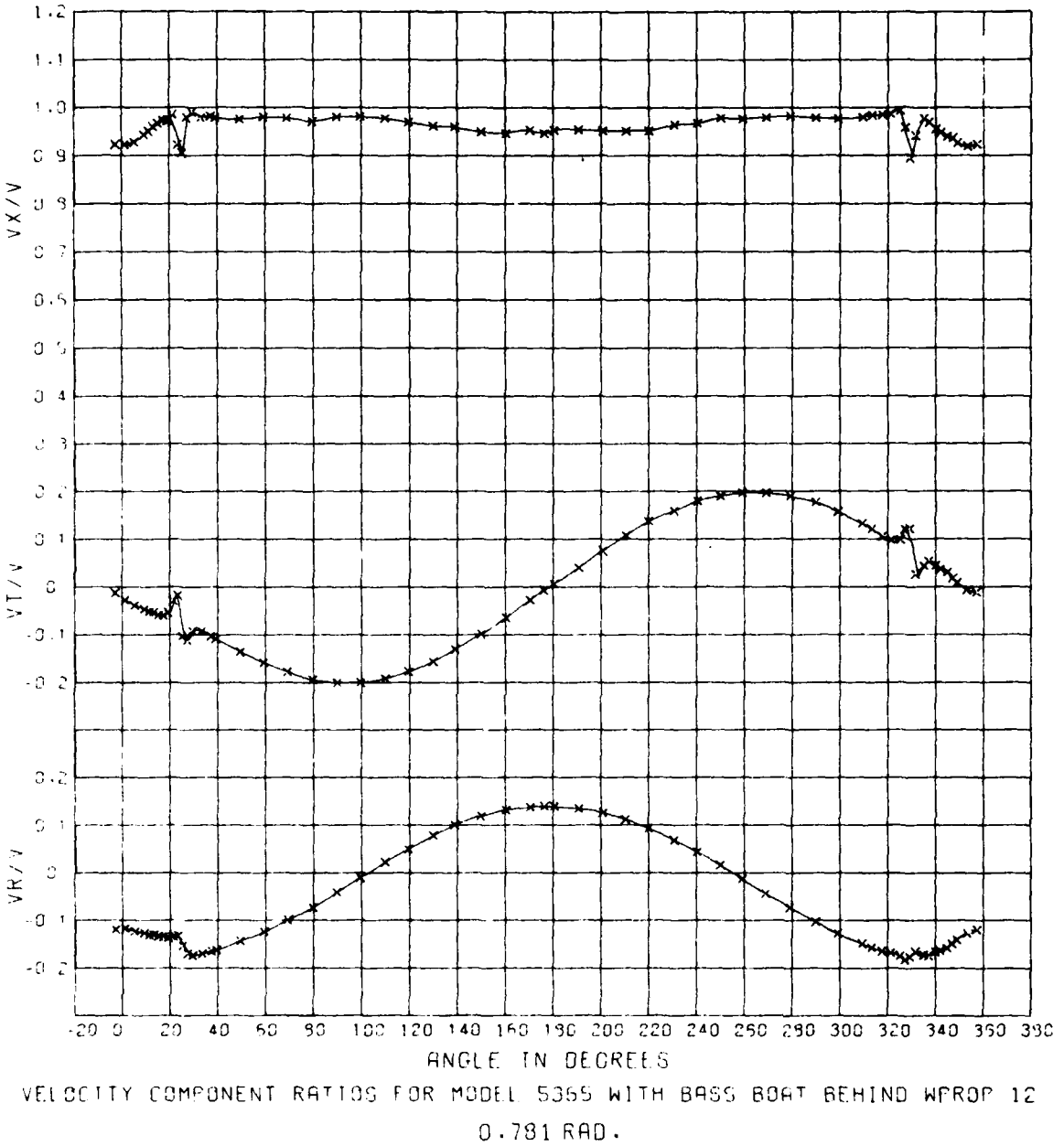

Figure D-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 12

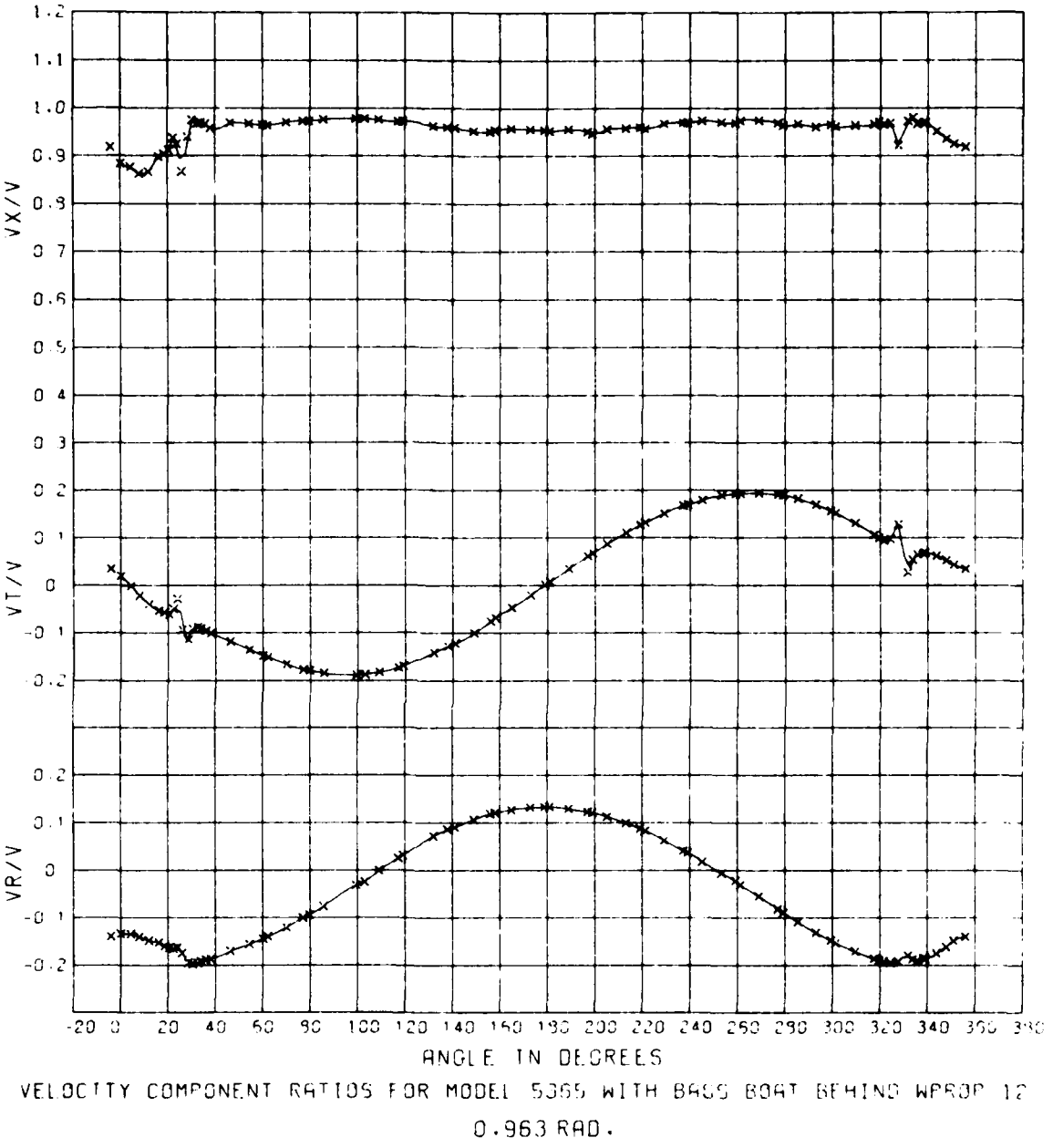

Figure D-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 12

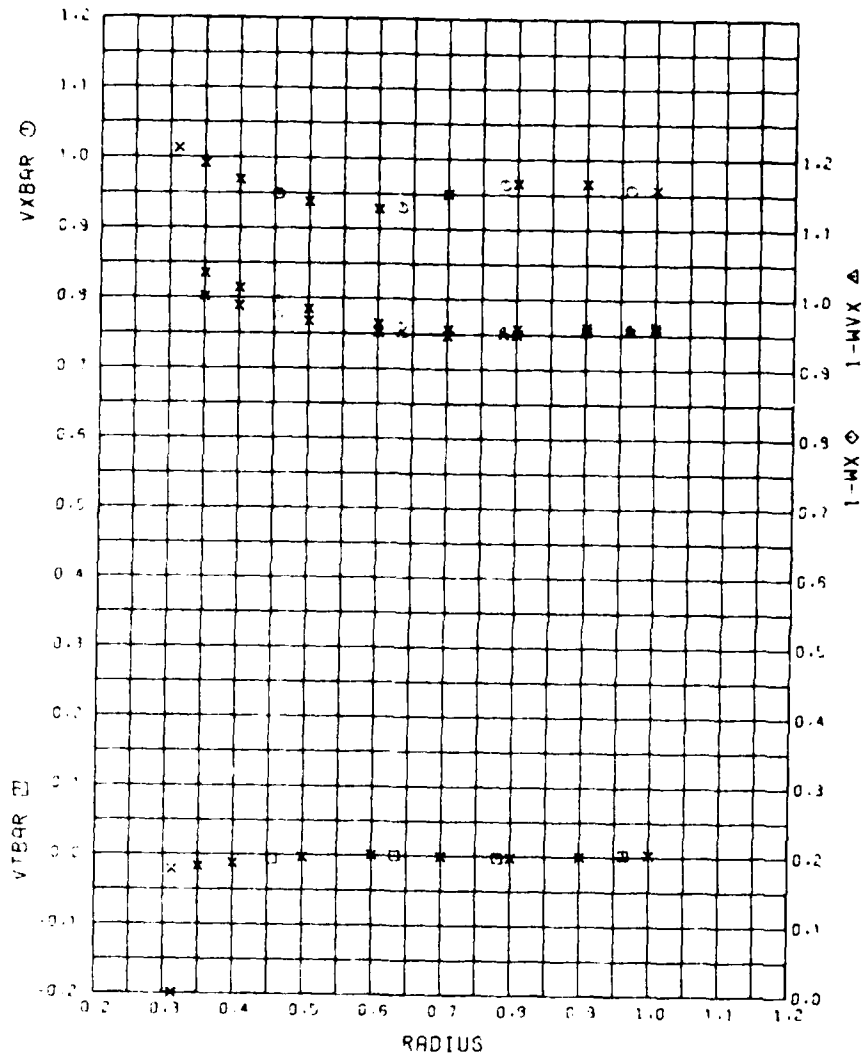

Figure D-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 12

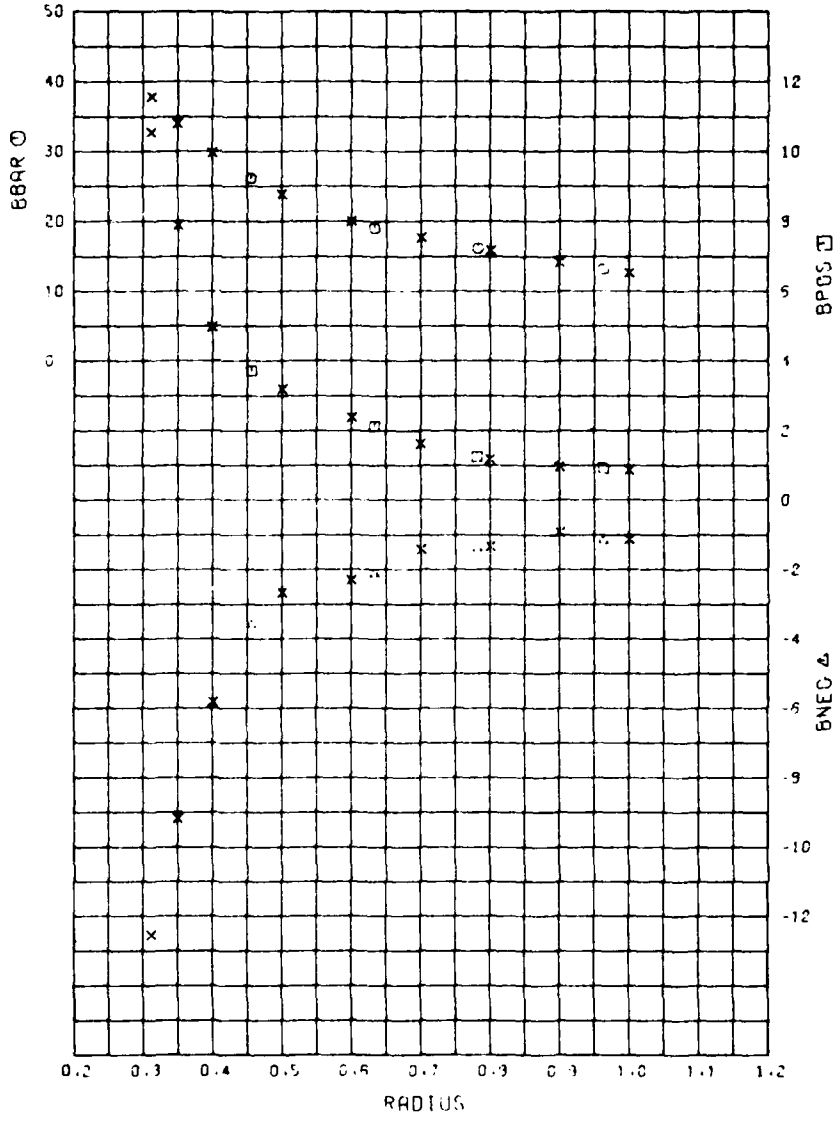

Figure D-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 12

TABLE D-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA,
MODEL 5365, EXPERIMENT 12

RADIUS = .656

ANGLE	VR/V	VT/V	VR/V
-3.0	.829	.889	-.845
1.1	.819	-.865	-.863
5.1	.814	-.821	-.870
9.2	.819	-.846	-.892
13.2	.826	-.862	-.885
17.2	.833	-.879	-.889
21.1	.831	-.898	-.888
25.2	.849	-.926	-.916
29.2	.877	-.957	-.933
33.2	.905	-.984	-.931
37.2	.928	-.1006	-.931
41.2	.948	-.1026	-.931
45.2	.963	-.1037	-.931
49.2	.973	-.1041	-.931
53.2	.977	-.1041	-.931
57.2	.976	-.1037	-.931
61.2	.971	-.1029	-.931
65.2	.962	-.1017	-.931
69.2	.950	-.1001	-.931
73.2	.936	-.983	-.931
77.2	.921	-.964	-.931
81.2	.907	-.945	-.931
85.2	.894	-.928	-.931
89.2	.884	-.914	-.931
93.2	.877	-.904	-.931
97.2	.874	-.899	-.931
101.2	.875	-.899	-.931
105.2	.880	-.904	-.931
109.2	.889	-.914	-.931
113.2	.902	-.928	-.931
117.2	.918	-.945	-.931
121.2	.935	-.964	-.931
125.2	.951	-.983	-.931
129.2	.964	-.1001	-.931
133.2	.973	-.1017	-.931
137.2	.977	-.1029	-.931
141.2	.976	-.1037	-.931
145.2	.971	-.1041	-.931
149.2	.962	-.1041	-.931
153.2	.950	-.1037	-.931
157.2	.936	-.1026	-.931
161.2	.921	-.1006	-.931
165.2	.907	-.984	-.931
169.2	.894	-.964	-.931
173.2	.884	-.945	-.931
177.2	.877	-.928	-.931
181.2	.874	-.914	-.931
185.2	.875	-.904	-.931
189.2	.880	-.899	-.931
193.2	.889	-.899	-.931
197.2	.902	-.904	-.931
201.2	.918	-.914	-.931
205.2	.935	-.928	-.931
209.2	.951	-.945	-.931
213.2	.964	-.964	-.931
217.2	.973	-.983	-.931
221.2	.977	-.1001	-.931
225.2	.976	-.1017	-.931
229.2	.971	-.1029	-.931
233.2	.962	-.1037	-.931
237.2	.950	-.1041	-.931
241.2	.936	-.1041	-.931
245.2	.921	-.1037	-.931
249.2	.907	-.1026	-.931
253.2	.894	-.1006	-.931
257.2	.884	-.984	-.931
261.2	.877	-.964	-.931
265.2	.874	-.945	-.931
269.2	.875	-.928	-.931
273.2	.880	-.914	-.931
277.2	.889	-.904	-.931
281.2	.902	-.899	-.931
285.2	.918	-.899	-.931
289.2	.935	-.904	-.931
293.2	.951	-.914	-.931
297.2	.964	-.928	-.931
301.2	.973	-.945	-.931
305.2	.977	-.964	-.931
309.2	.976	-.983	-.931
313.2	.971	-.1001	-.931
317.2	.962	-.1017	-.931
321.2	.950	-.1029	-.931
325.2	.936	-.1037	-.931
329.2	.921	-.1041	-.931
333.2	.907	-.1041	-.931
337.2	.894	-.1037	-.931
341.2	.884	-.1026	-.931
345.2	.877	-.1006	-.931
349.2	.874	-.984	-.931
353.2	.875	-.964	-.931
357.2	.880	-.945	-.931
361.1	.889	-.928	-.931

RADIUS = .733

ANGLE	VR/V	VT/V	VR/V
-5.0	.891	-.845	-.888
.4	.896	-.856	-.889
7.0	.920	-.875	-.910
14.5	.930	-.850	-.917
16.0	.935	-.865	-.910
18.6	.927	-.823	-.921
20.6	.881	-.821	-.927
22.6	.884	-.820	-.125
24.6	.838	-.845	-.143
26.6	.910	-.123	-.153
28.6	.903	-.108	-.156
30.6	.959	-.095	-.157
32.5	.949	-.095	-.156
34.5	.950	-.098	-.154
36.5	.956	-.103	-.152
38.5	.944	-.110	-.150
40.5	.948	-.115	-.147
42.5	.944	-.120	-.142
44.5	.936	-.130	-.135
46.5	.944	-.140	-.129
48.5	.943	-.123	-.105
50.5	.952	-.109	-.089
52.5	.956	-.106	-.087
54.5	.947	-.106	-.063
56.5	.944	-.109	-.036
58.5	.944	-.190	-.012
60.5	.936	-.191	.012
62.5	.952	-.176	.038
64.5	.936	-.157	.063
66.5	.944	-.129	.088
68.5	.922	-.108	.110
70.5	.912	-.084	.110
72.5	.911	-.027	.117
74.5	.913	.013	.110
76.5	.945	.047	.110
78.5	.936	.086	.102
80.5	.934	.117	.086
82.5	.936	.175	.067
84.5	.916	.176	.041
86.5	.932	.195	.016
88.5	.939	.226	-.010
90.5	.938	.213	-.036
92.5	.935	.214	-.066
94.5	.934	.208	-.099
96.5	.941	.196	-.114
98.5	.942	.172	-.136
100.5	.935	.145	-.157
102.5	.939	.120	-.164
104.5	.946	.107	-.167
106.5	.937	.100	-.171
108.5	.941	.110	-.179
110.5	.932	.119	-.183
112.5	.941	.115	-.179
114.5	.945	.068	-.155
116.5	.902	.029	-.148
118.5	.909	.027	-.141
120.5	.910	.031	-.141
122.5	.881	.016	-.129
124.5	.886	-.007	-.114
126.5	.885	-.025	-.099
128.5	.894	-.045	-.088
130.5		-.056	-.089

RADIUS = .781

ANGLE	VR/V	VT/V	VR/V
-2.9	.923	-.013	-.128
1.1	.923	-.027	-.117
5.1	.928	-.039	-.124
9.3	.963	-.047	-.127
11.3	.950	-.052	-.131
13.2	.961	-.053	-.131
15.2	.967	-.059	-.134
17.3	.974	-.068	-.136
19.0	.981	-.072	-.135
19.2	.983	-.076	-.139
19.2	.973	-.055	-.137
21.3	.945	-.029	-.136
23.3	.923	-.017	-.132
25.3	.905	-.003	-.156
27.3	.978	-.111	-.170
29.3	.949	-.093	-.175
29.6	.991	-.091	-.174
33.3	.974	-.093	-.171
37.2	.982	-.103	-.165
39.3	.979	-.109	-.162
43.4	.975	-.136	-.144
47.3	.978	-.159	-.124
49.8	.978	-.178	-.099
51.8	.978	-.196	-.074
53.8	.982	-.208	-.041
55.8	.981	-.208	-.018
57.8	.974	-.192	-.023
59.8	.969	-.178	.058
61.8	.962	-.157	.079
63.8	.959	-.138	.101
65.8	.969	-.099	.119
67.8	.967	-.065	.132
69.8	.951	-.027	.138
71.8	.966	-.007	.148
73.8	.952	.005	.139
75.8	.954	.007	.148
77.8	.954	.048	.135
79.8	.951	.076	.127
81.8	.952	.109	.112
83.8	.966	.138	.093
85.8	.967	.159	.066
87.8	.962	.148	.044
89.8	.974	.196	.016
91.8	.977	.197	-.011
93.8	.980	.197	-.044
95.8	.982	.190	-.073
97.8	.979	.177	-.103
99.8	.977	.159	-.129
101.8	.982	.132	-.149
103.8	.981	.121	-.158
105.8	.986	.108	-.164
107.8	.986	.097	-.166
109.8	.994	.098	-.176
111.8	.957	.121	-.161
113.8	.973	.033	-.177
115.8	.973	.020	-.167
117.8	.977	.043	-.171
119.8	.969	.054	-.175
121.8	.955	.044	-.176
123.8	.944	.037	-.164
125.8	.939	.031	-.158
127.8	.937	.017	-.149
129.8	.934	.010	-.151
131.8	.926	-.006	-.142
133.8	.919	-.007	-.128
135.8	.921	-.033	-.128
137.8	.921	-.027	-.117

RADIUS = .828

ANGLE	VR/V	VT/V	VR/V
-6.0	.914	.834	-.140
-.1	.896	-.819	-.135
6.3	.877	-.801	-.135
8.8	.903	-.821	-.141
12.8	.907	-.848	-.149
16.2	.898	-.854	-.153
18.5	.904	-.857	-.161
20.6	.896	-.863	-.163
22.5	.918	-.861	-.164
24.4	.934	-.858	-.166
26.8	.925	-.828	-.163
28.5	.962	-.894	-.174
30.3	.975	-.891	-.170
32.5	.968	-.887	-.196
34.8	.969	-.890	-.192
36.8	.966	-.899	-.189
38.8	.957	-.191	-.188
40.5	.969	-.110	-.171
42.5	.967	-.135	-.156
44.5	.964	-.148	-.144
46.5	.964	-.151	-.141
48.5	.973	-.166	-.121
50.5	.973	-.177	-.108
52.5	.972	-.179	-.099
54.5	.976	-.165	-.077
56.5	.978	-.189	-.031
58.5	.979	-.147	-.025
60.5	.976	-.183	-.001
62.5	.972	-.174	.025
64.5	.971	-.178	.031
66.5	.962	-.142	.071
68.5	.98(	-.127	.086
70.5	.959	-.122	.091
72.5	.951	-.108	.107
74.5	.951	-.076	.119
76.5	.954	-.069	.121
78.5	.958	-.047	.127
80.5	.956	-.020	.133
82.5	.981	.001	.133
84.5	.988	.008	.136
86.5	.956	.035	.138
88.5	.962	.062	.123
90.5	.951	.068	.122
92.5	.967	.068	.122
94.5	.956	.087	.113
96.5	.959	.110	.100
98.5	.963	.127	.085
100.5	.967	.132	.086
102.5	.968	.151	.063
104.5	.972	.165	.061
106.5	.972	.169	.037
108.5	.974	.179	.018
110.5	.971	.189	-.006
112.5	.969	.197	-.022
114.5	.974	.193	-.035
116.5	.974	.194	-.055
118.5	.969	.191	-.082
120.5	.974	.190	-.089
122.5	.967	.192	-.103
124.5	.959	.178	-.132
126.5	.961	.170	-.132
128.5	.965	.157	-.148
130.5	.962	.152	-.156
132.5	.966	.131	-.171
134.5	.966	.106	-.187
136.5	.971	.088	-.186
138.5	.969	.090	-.191
140.5	.965	.094	-.194
142.5	.969	.093	-.194
144.5	.971	.101	-.197
146.5	.977	.109	-.192
148.5	.972	.077	-.188
150.5	.981	.094	-.187
152.5	.966	.066	-.192
154.5	.975	.069	-.186
156.5	.967	.067	-.186
158.5	.968	.068	-.186
160.5	.961	.061	-.175
162.5	.953	.036	-.162
164.5	.975	.063	-.160
166.5	.836	.040	-.160
168.1	.886	.019	-.135

TABLE D-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 12

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND WPROP 12
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.949	.930	.964	.957	1.013	.992	.969	.938	.928	.950	.966	.966	.957
VTBAR =	-.006	.001	-.002	.003	-.022	-.017	-.012	-.003	.001	-.001	-.002	-.000	.003
VRBAR =	-.009	-.033	-.027	-.043	.035	.021	.005	-.018	-.031	-.029	-.028	-.035	-.043
1-WVX =	.975	.949	.948	.954	0.000	1.002	.988	.967	.952	.947	.950	.954	.956
1-WX =	.997	.960	.955	.959	0.000	1.035	1.014	.984	.964	.956	.958	.960	.961
BBAR =	26.15	19.05	16.20	13.14	37.82	33.08	29.82	23.84	19.99	17.71	15.86	14.16	12.67
BPOS =	3.71	2.14	1.25	.92	10.55	7.89	4.97	3.19	2.38	1.63	1.18	.96	.87
THETA =	92.50	82.50	95.00	102.50	20.00	22.50	22.50	92.50	82.50	95.00	95.00	97.50	102.50
BNEG =	-3.59	-2.13	-1.40	-1.17	-12.54	-9.19	-5.82	-2.67	-2.31	-1.42	-1.34	-.92	-1.13
THETA =	337.50	332.50	330.00	7.50	5.00	5.00	5.00	335.00	332.50	330.00	330.00	327.50	7.50

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 D-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 12

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND WPROP 12
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0247	.0352	.0210	.0181	.0171	.0121	.0064	.0039
PHASE ANGLE =	285.3	274.5	276.0	273.2	271.1	269.3	263.1	214.0
RADIUS = .633								
AMPLITUDE =	.0132	.0254	.0061	.0039	.0061	.0034	.0023	.0021
PHASE ANGLE =	16.3	271.1	280.1	300.8	303.7	22.8	91.3	32.0
RADIUS = .781								
AMPLITUDE =	.0025	.0177	.0070	.0054	.0072	.0025	.0014	.0018
PHASE ANGLE =	87.3	272.0	284.1	302.6	279.1	312.4	308.4	346.4
RADIUS = .963								
AMPLITUDE =	.0123	.0217	.0101	.0097	.0106	.0077	.0056	.0046
PHASE ANGLE =	268.4	261.6	232.3	228.6	236.1	213.3	214.1	192.1

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0054	.0061	.0076	.0067	.0048	.0022	.0004	.0019
PHASE ANGLE =	191.3	151.6	150.6	148.9	147.1	147.5	209.0	333.7
RADIUS = .633								
AMPLITUDE =	.0032	.0023	.0010	.0009	.0021	.0039	.0036	.0045
PHASE ANGLE =	73.7	56.3	67.6	5.8	326.9	304.7	307.0	294.8
RADIUS = .781								
AMPLITUDE =	.0009	.0013	.0012	.0029	.0031	.0032	.0015	.0011
PHASE ANGLE =	261.2	216.8	282.3	300.4	315.0	306.3	301.4	357.0
RADIUS = .963								
AMPLITUDE =	.0028	.0024	.0005	.0001	.0004	.0011	.0013	.0006
PHASE ANGLE =	193.3	211.3	247.2	221.6	216.9	339.8	69.5	68.4

TABLE D-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 12

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND WPROP 12
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0712	.0440	.0458	.0430	.0390	.0373	.0236	.0146
PHASE ANGLE =	257.5	278.5	275.8	270.4	260.0	259.6	267.4	218.2
RADIUS = .350								
AMPLITUDE =	.0560	.0416	.0382	.0353	.0321	.0294	.0182	.0112
PHASE ANGLE =	261.7	277.4	275.8	270.8	262.0	260.9	266.8	217.5
RADIUS = .400								
AMPLITUDE =	.0391	.0385	.0293	.0264	.0242	.0203	.0120	.0074
PHASE ANGLE =	269.7	276.0	275.9	271.6	265.4	263.5	265.6	216.2
RADIUS = .500								
AMPLITUDE =	.0174	.0327	.0156	.0128	.0127	.0071	.0030	.0017
PHASE ANGLE =	306.0	273.4	276.3	275.6	277.6	279.3	257.8	209.6
RADIUS = .600								
AMPLITUDE =	.0133	.0271	.0076	.0051	.0070	.0029	.0018	.0016
PHASE ANGLE =	4.2	271.5	278.6	290.8	298.3	4.5	97.1	36.0
RADIUS = .700								
AMPLITUDE =	.0071	.0207	.0067	.0051	.0067	.0031	.0011	.0023
PHASE ANGLE =	37.8	272.5	288.6	311.6	294.5	354.8	32.3	7.6
RADIUS = .800								
AMPLITUDE =	.0018	.0174	.0070	.0054	.0073	.0025	.0015	.0015
PHASE ANGLE =	113.3	271.4	280.9	297.4	274.9	298.4	293.7	338.6
RADIUS = .900								
AMPLITUDE =	.0059	.0186	.0079	.0065	.0088	.0046	.0033	.0018
PHASE ANGLE =	249.6	266.7	252.6	253.0	250.5	232.1	234.3	211.0
RADIUS = 1.000								
AMPLITUDE =	.0123	.0217	.0101	.0097	.0106	.0077	.0056	.0046
PHASE ANGLE =	268.4	261.6	232.3	228.6	236.1	213.3	214.1	192.1

TABLE D-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND WPROP 12
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0199	.0184	.0190	.0171	.0152	.0123	.0080	.0083
PHASE ANGLE =	215.4	174.5	161.3	158.0	149.4	134.6	134.9	85.5
RADIUS = .350								
AMPLITUDE =	.0151	.0144	.0155	.0140	.0120	.0091	.0055	.0054
PHASE ANGLE =	212.5	171.1	159.4	156.3	149.0	135.6	136.1	79.1
RADIUS = .400								
AMPLITUDE =	.0099	.0099	.0114	.0102	.0084	.0055	.0027	.0025
PHASE ANGLE =	206.2	164.6	156.1	153.4	148.3	138.0	140.1	54.8
RADIUS = .500								
AMPLITUDE =	.0031	.0040	.0051	.0043	.0025	.0006	.0015	.0031
PHASE ANGLE =	163.6	133.4	143.9	143.2	145.5	229.2	298.5	307.3
RADIUS = .600								
AMPLITUDE =	.0031	.0025	.0015	.0007	.0013	.0033	.0034	.0046
PHASE ANGLE =	83.2	70.0	102.1	76.1	329.6	303.1	306.6	295.3
RADIUS = .700								
AMPLITUDE =	.0010	.0005	.0005	.0021	.0029	.0037	.0026	.0024
PHASE ANGLE =	56.3	78.6	320.8	310.8	319.4	304.7	302.7	308.7
RADIUS = .800								
AMPLITUDE =	.0012	.0015	.0013	.0029	.0030	.0030	.0013	.0010
PHASE ANGLE =	253.1	218.2	279.9	299.2	314.1	307.0	302.8	13.6
RADIUS = .900								
AMPLITUDE =	.0022	.0024	.0011	.0018	.0016	.0019	.0005	.0010
PHASE ANGLE =	219.1	216.7	270.0	294.1	304.9	316.3	34.5	61.3
RADIUS = 1.000								
AMPLITUDE =	.0028	.0024	.0005	.0001	.0004	.0011	.0013	.0006
PHASE ANGLE =	193.3	211.3	247.2	221.6	216.9	339.8	69.5	68.4

TABLE D-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 12

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND APROP 12
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2264	.0041	.0017	.0055	.0019	.0046	.0014	.0020
PHASE ANGLE =	182.3	7.8	197.5	182.4	181.9	167.6	152.7	99.5
RADIUS = .633								
AMPLITUDE =	.2044	.0141	.0085	.0061	.0060	.0049	.0045	.0032
PHASE ANGLE =	184.9	319.9	298.6	293.4	296.9	286.6	298.6	309.8
RADIUS = .781								
AMPLITUDE =	.1937	.0122	.0065	.0029	.0017	.0015	.0013	.0008
PHASE ANGLE =	182.4	349.8	329.2	288.7	296.7	267.8	302.0	287.4
RADIUS = .963								
AMPLITUDE =	.1865	.0096	.0028	.0033	.0041	.0033	.0021	.0018
PHASE ANGLE =	180.0	6.5	17.4	124.8	132.7	132.8	139.3	132.5

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0033	.0038	.0050	.0051	.0047	.0030	.0019	.0009
PHASE ANGLE =	49.3	54.7	47.1	50.3	63.5	50.9	81.0	233.6
RADIUS = .633								
AMPLITUDE =	.0027	.0015	.0012	.0015	.0023	.0030	.0032	.0029
PHASE ANGLE =	308.1	292.4	265.3	211.8	203.8	199.1	198.4	198.1
RADIUS = .781								
AMPLITUDE =	.0010	.0004	.0006	.0013	.0014	.0017	.0010	.0006
PHASE ANGLE =	306.9	191.2	204.1	192.5	198.1	214.2	194.7	202.9
RADIUS = .963								
AMPLITUDE =	.0010	.0010	.0012	.0010	.0013	.0007	.0009	.0002
PHASE ANGLE =	119.2	169.4	152.8	203.8	197.8	205.4	235.4	357.8

TABLE D-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 12

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND #PROP 12
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2533	.0234	.0174	.0226	.0167	.0203	.0134	.0123
PHASE ANGLE =	176.9	103.7	122.1	150.4	133.0	139.3	126.8	118.9
RADIUS = .350								
AMPLITUDE =	.2453	.0159	.0121	.0170	.0118	.0152	.0095	.0090
PHASE ANGLE =	178.6	99.6	125.1	153.6	135.4	142.1	128.0	117.4
RADIUS = .400								
AMPLITUDE =	.2358	.0077	.0061	.0107	.0063	.0095	.0052	.0053
PHASE ANGLE =	180.5	84.2	133.8	161.2	142.4	148.6	131.5	113.7
RADIUS = .500								
AMPLITUDE =	.2200	.0072	.0034	.0035	.0024	.0026	.0013	.0008
PHASE ANGLE =	183.5	329.7	273.6	224.3	268.4	211.7	276.6	14.5
RADIUS = .600								
AMPLITUDE =	.2078	.0132	.0079	.0056	.0058	.0045	.0042	.0030
PHASE ANGLE =	184.9	318.6	295.0	268.2	295.1	281.9	297.5	312.4
RADIUS = .700								
AMPLITUDE =	.1990	.0129	.0075	.0048	.0041	.0033	.0030	.0021
PHASE ANGLE =	183.8	334.9	313.2	292.3	298.2	283.5	300.9	304.4
RADIUS = .800								
AMPLITUDE =	.1926	.0121	.0062	.0024	.0012	.0011	.0010	.0006
PHASE ANGLE =	182.1	352.6	332.7	286.8	293.7	256.1	301.0	275.1
RADIUS = .900								
AMPLITUDE =	.1883	.0109	.0043	.0010	.0020	.0018	.0010	.0010
PHASE ANGLE =	180.7	3.2	353.4	143.0	134.0	143.1	139.5	143.2
RADIUS = 1.000								
AMPLITUDE =	.1865	.0096	.0028	.0033	.0041	.0033	.0021	.0018
PHASE ANGLE =	180.0	6.5	17.4	124.8	132.7	132.8	139.3	132.5

TABLE D-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 WITH BASS BOAT BEHIND WPROP 12
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0115	.0124	.0150	.0159	.0163	.0132	.0105	.0051
PHASE ANGLE =	80.3	71.7	55.3	48.9	53.4	35.3	43.8	2.5
RADIUS = .350								
AMPLITUDE =	.0088	.0097	.0119	.0126	.0127	.0100	.0077	.0033
PHASE ANGLE =	76.5	69.3	54.1	49.0	54.6	36.9	46.7	358.5
RADIUS = .400								
AMPLITUDE =	.0058	.0066	.0083	.0087	.0085	.0063	.0045	.0013
PHASE ANGLE =	68.4	64.6	51.7	49.3	57.2	40.5	54.1	341.5
RADIUS = .500								
AMPLITUDE =	.0023	.0022	.0029	.0028	.0024	.0012	.0014	.0018
PHASE ANGLE =	18.8	37.9	39.5	52.8	77.2	86.3	144.6	208.6
RADIUS = .600								
AMPLITUDE =	.0026	.0014	.0008	.0008	.0018	.0025	.0030	.0029
PHASE ANGLE =	315.7	308.4	291.6	203.2	194.2	194.4	195.1	199.0
RADIUS = .700								
AMPLITUDE =	.0020	.0007	.0008	.0014	.0018	.0023	.0020	.0017
PHASE ANGLE =	307.3	275.5	246.0	200.4	201.3	206.2	195.7	199.0
RADIUS = .800								
AMPLITUDE =	.0008	.0005	.0007	.0013	.0013	.0016	.0008	.0005
PHASE ANGLE =	307.1	178.4	194.0	191.6	197.5	215.8	196.1	205.5
RADIUS = .900								
AMPLITUDE =	.0003	.0009	.0009	.0011	.0012	.0010	.0006	.0002
PHASE ANGLE =	115.3	163.3	161.3	193.9	196.3	217.7	224.4	351.9
RADIUS = 1.000								
AMPLITUDE =	.0010	.0010	.0012	.0010	.0013	.0007	.0009	.0002
PHASE ANGLE =	119.2	169.4	152.8	203.8	197.8	205.4	235.4	357.8

APPENDIX E

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 13

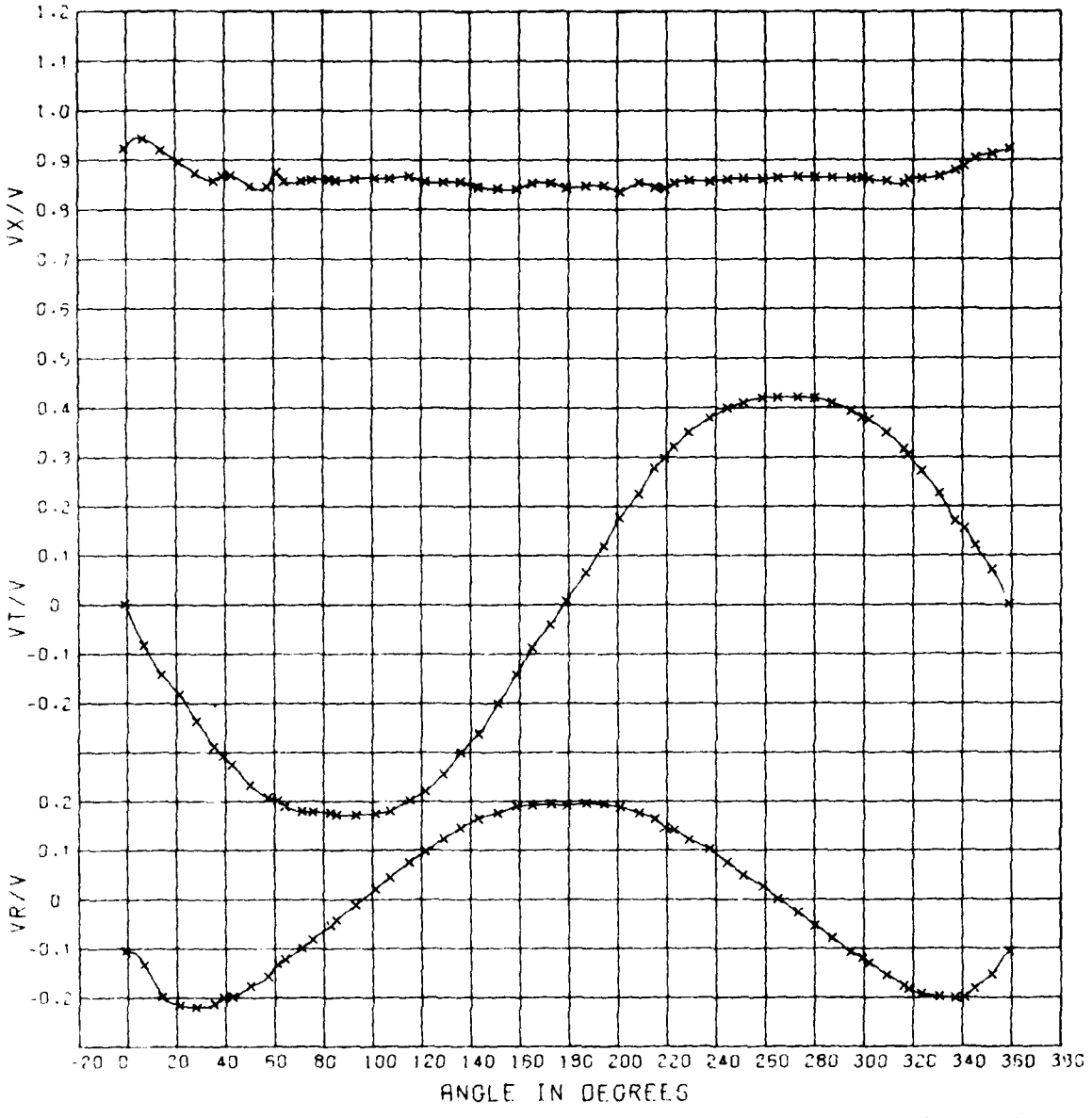

Figure E-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 13

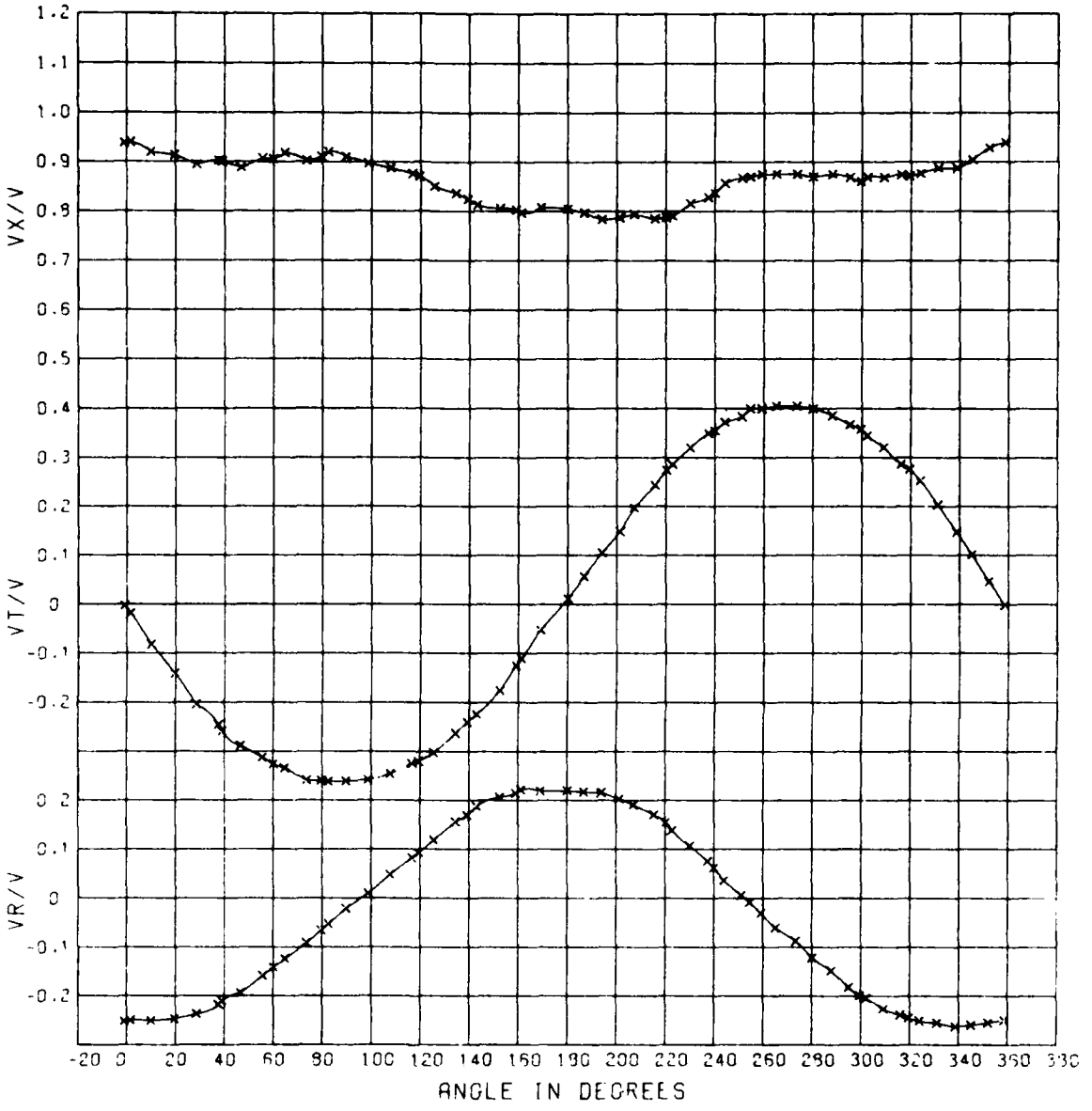

Figure E-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 13

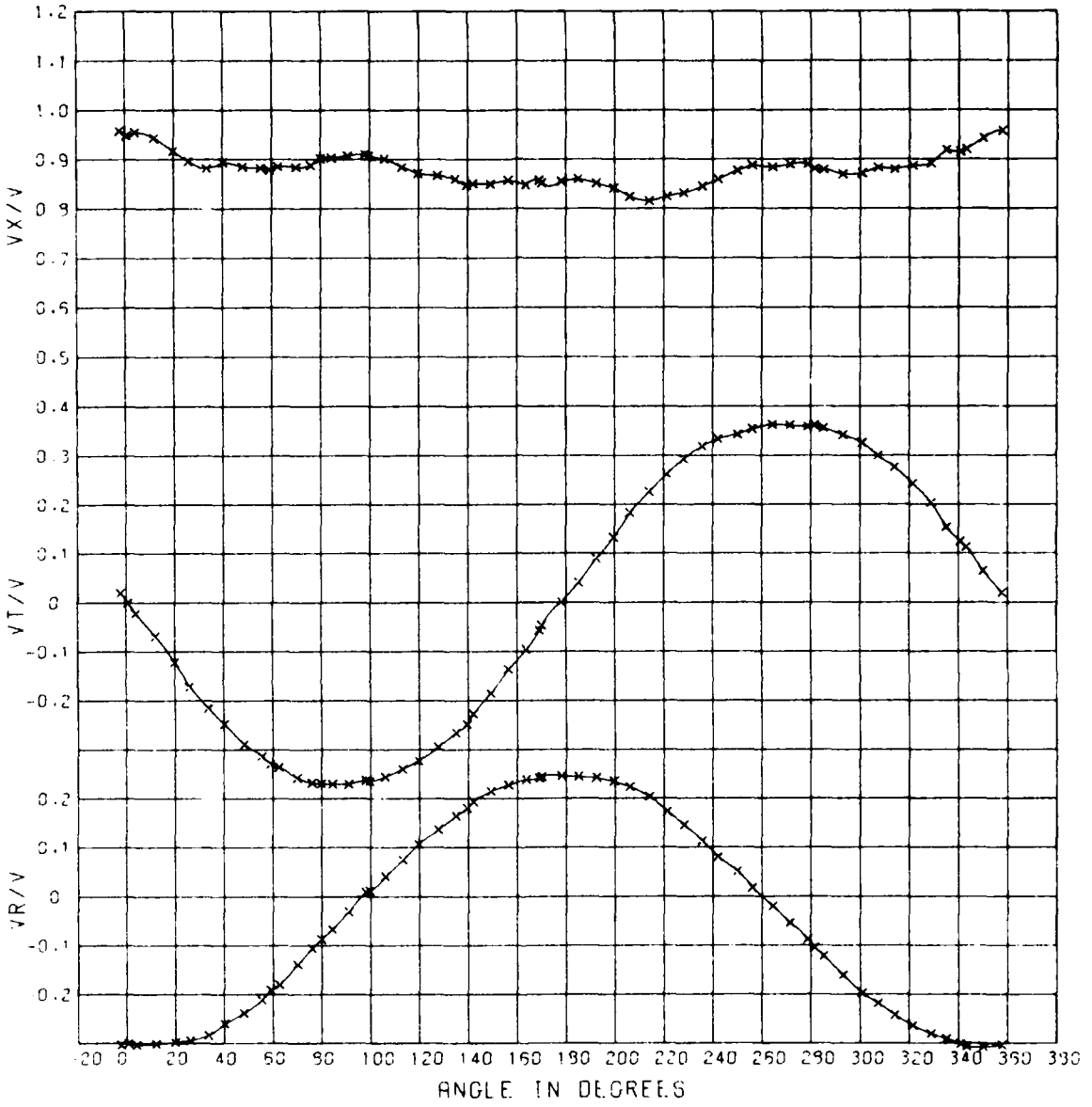

Figure E-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 13

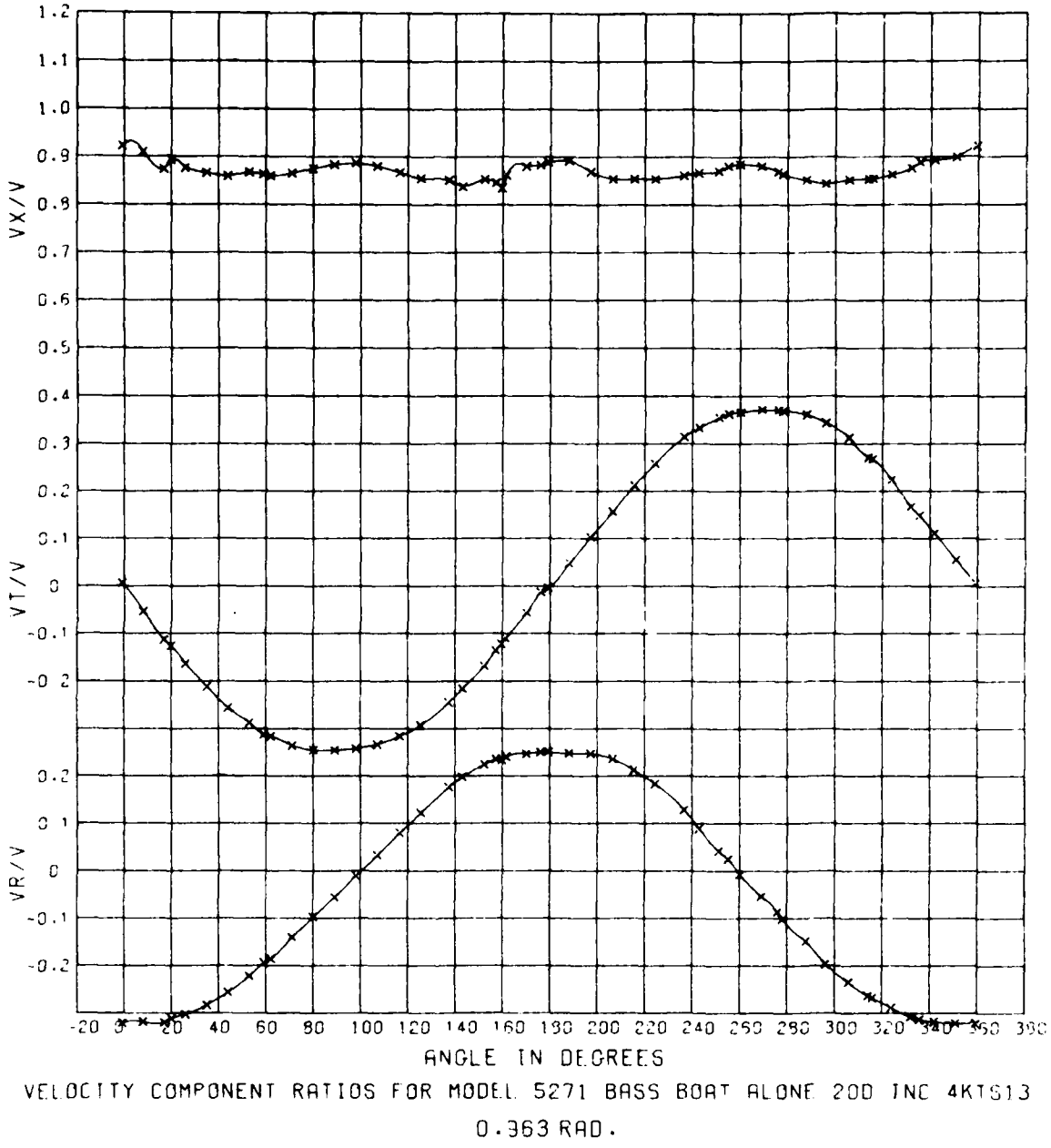

Figure E-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 13

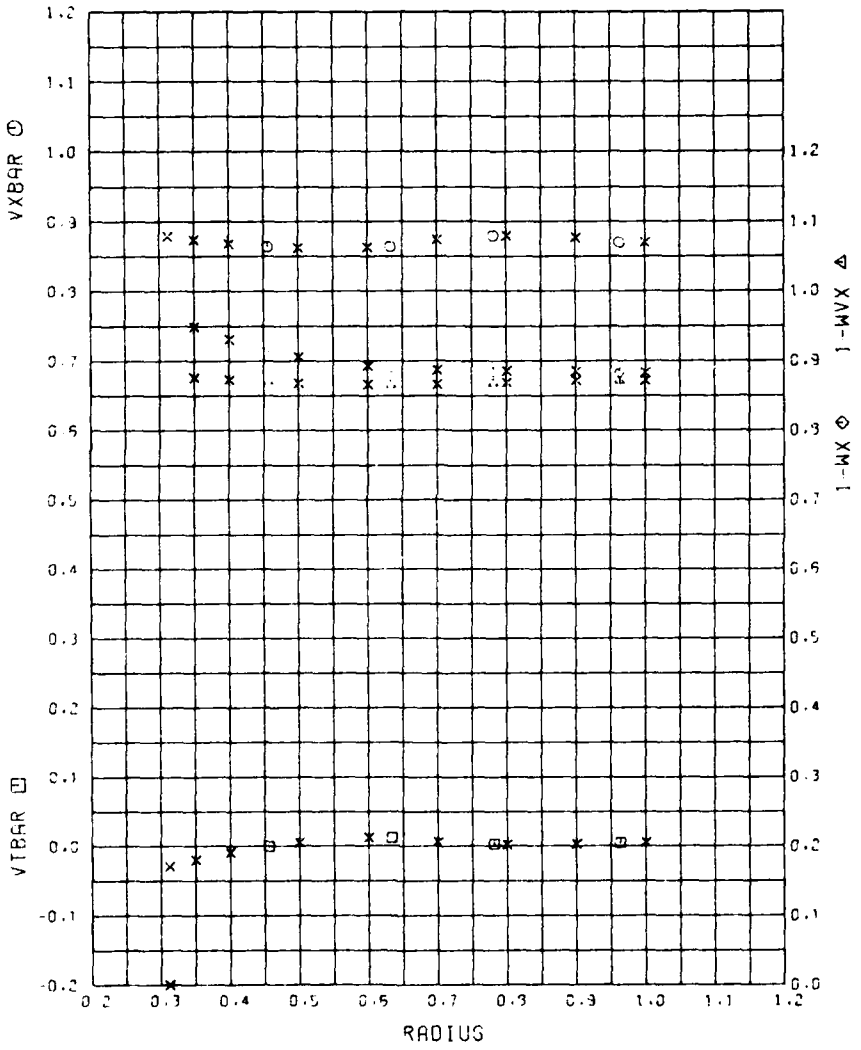

Figure E-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 13

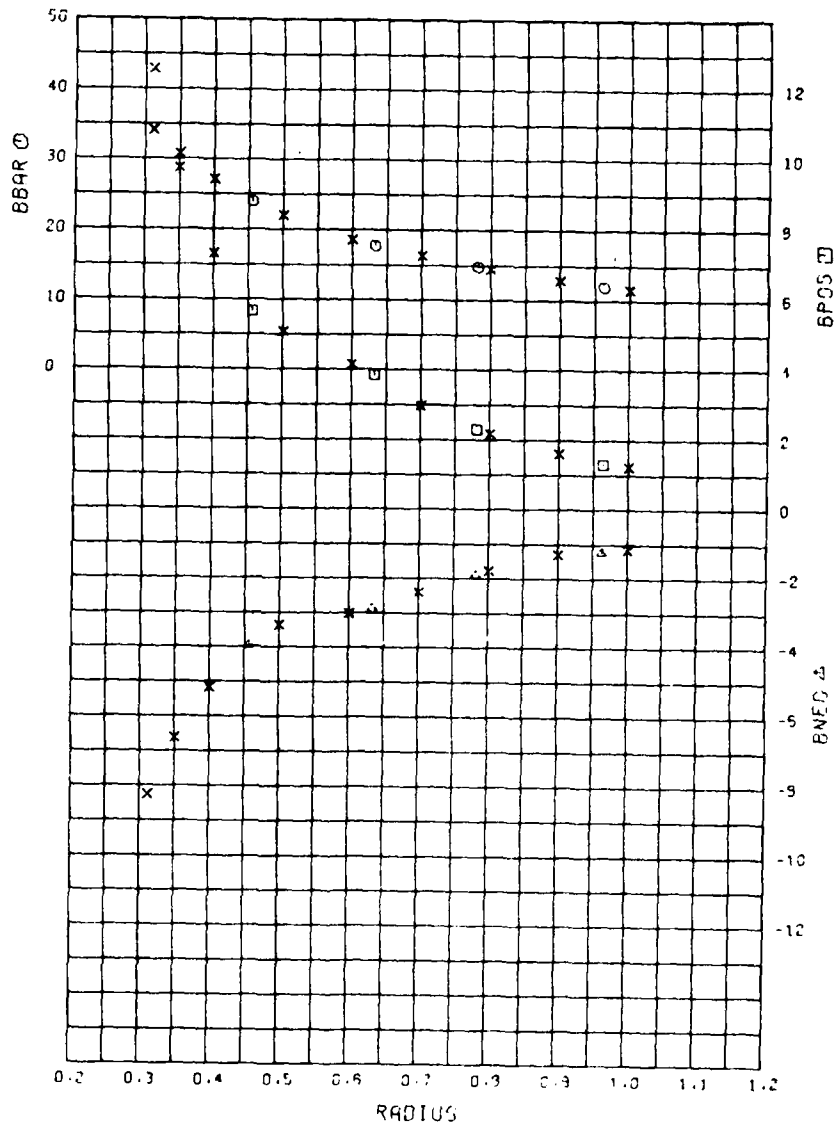

Figure E-6 - Radial Distribution of the Mean Advance Angles and Advance Angle Variations for Experiment 13

TABLE E -1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA
WITH BASS DYNAMOMETER BOAT, EXPERIMENT 13

RADIUS = .958				RADIUS = .833				RADIUS = .781				RADIUS = .963			
ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V
-1.8	.923	-.881	-.188	-1.8	.937	-.883	-.252	-2.6	.957	-.828	-.304	-.0	.922	-.886	-.321
1.6	.963	-.882	-.133	1.5	.939	-.818	-.256	.6	.958	-.801	-.308	0.0	.909	-.894	-.310
17.6	.923	-.562	-.198	18.8	.928	-.802	-.251	6.8	.954	-.822	-.303	17.8	.873	-.116	-.321
21.1	.896	-.183	-.216	19.6	.916	-.561	-.267	12.8	.963	-.868	-.302	28.8	.894	-.126	-.312
28.8	.871	-.236	-.220	24.5	.895	-.784	-.237	19.2	.926	-.116	-.298	26.8	.876	-.164	-.283
35.4	.867	-.288	-.213	37.5	.881	-.766	-.218	28.6	.907	-.127	-.299	35.8	.866	-.213	-.286
48.8	.868	-.789	-.200	39.8	.901	-.768	-.218	26.8	.896	-.177	-.296	44.8	.859	-.257	-.257
47.6	.866	-.326	-.198	46.6	.908	-.788	-.196	33.6	.901	-.216	-.284	53.8	.867	-.288	-.273
50.8	.866	-.367	-.176	55.6	.907	-.813	-.159	48.8	.896	-.258	-.268	59.8	.863	-.313	-.199
57.2	.865	-.392	-.157	59.9	.906	-.826	-.142	48.2	.899	-.266	-.268	67.8	.860	-.336	-.196
61.8	.875	-.398	-.131	66.6	.919	-.836	-.126	58.1	.885	-.289	-.239	71.8	.862	-.329	-.161
66.8	.885	-.418	-.122	73.5	.907	-.851	-.111	65.6	.882	-.316	-.211	71.8	.869	-.333	-.168
71.8	.887	-.428	-.099	79.6	.911	-.866	-.096	69.8	.878	-.338	-.192	88.8	.875	-.365	-.097
75.5	.898	-.427	-.081	87.6	.922	-.861	-.092	82.5	.885	-.336	-.168	89.8	.883	-.366	-.056
87.6	.901	-.423	-.053	89.6	.911	-.861	-.071	86.9	.886	-.368	-.138	98.8	.887	-.362	-.018
84.8	.898	-.427	-.061	98.6	.898	-.858	-.018	78.8	.887	-.366	-.186	107.8	.888	-.333	.033
97.8	.861	-.478	-.012	107.6	.887	-.866	.048	79.8	.907	-.369	-.857	116.5	.867	-.316	.088
101.8	.861	-.475	.021	116.5	.876	-.829	.083	84.2	.907	-.378	-.857	125.6	.856	-.298	.123
107.8	.867	-.478	.055	119.3	.871	-.821	.093	91.8	.907	-.371	-.831	137.3	.852	-.295	.177
115.8	.886	-.387	.076	125.6	.851	-.803	.119	96.8	.910	-.363	-.809	143.8	.816	-.218	.201
121.8	.857	-.382	.083	136.3	.837	-.263	.156	99.6	.907	-.366	-.811	143.8	.859	-.213	.197
127.2	.856	-.375	.107	139.1	.825	-.261	.178	106.8	.901	-.356	-.861	157.2	.863	-.169	.225
129.8	.856	-.365	.124	143.8	.813	-.229	.197	113.2	.886	-.368	-.875	157.2	.866	-.135	.236
136.8	.856	-.388	.146	157.1	.807	-.178	.207	119.8	.883	-.325	-.886	159.6	.825	-.125	.235
143.8	.866	-.287	.165	158.8	.803	-.175	.215	128.6	.859	-.323	-.889	159.6	.863	-.118	.234
151.8	.862	-.282	.176	161.8	.787	-.111	.222	127.6	.867	-.296	-.837	161.6	.862	-.118	.241
158.8	.862	-.183	.191	169.8	.807	-.852	.228	134.8	.866	-.266	-.165	178.8	.868	-.096	.267
159.2	.861	-.161	.188	174.6	.805	-.805	.222	229.6	.867	-.268	-.168	176.8	.882	-.813	.258
165.8	.851	-.887	.192	188.6	.806	-.817	.228	142.8	.858	-.227	-.196	179.3	.888	-.886	.251
172.6	.853	-.851	.196	188.6	.787	-.857	.218	149.2	.859	-.186	-.215	188.8	.891	-.868	.248
179.8	.861	-.885	.192	193.8	.783	-.185	.216	156.6	.857	-.136	-.224	197.8	.868	-.184	.248
186.9	.867	-.886	.196	201.1	.787	-.159	.203	163.6	.867	-.898	-.239	206.6	.853	-.157	.237
194.2	.867	-.121	.199	207.8	.796	-.197	.191	169.8	.851	-.858	-.263	215.6	.853	-.212	.213
200.6	.852	-.171	.187	215.6	.785	-.266	.171	169.8	.861	-.857	-.239	224.2	.853	-.258	.184
201.8	.836	-.181	.198	220.1	.787	-.276	.155	176.8	.861	-.867	-.266	236.6	.861	-.315	.129
208.5	.836	-.236	.176	227.6	.798	-.286	.138	178.8	.852	-.883	-.267	242.6	.866	-.371	.089
215.8	.861	-.779	.184	229.8	.816	-.328	.107	176.1	.857	-.882	-.265	251.8	.878	-.396	.062
219.8	.861	-.288	.166	237.3	.828	-.369	.076	185.8	.862	-.862	-.267	259.8	.881	-.383	.025
227.8	.851	-.321	.151	239.6	.837	-.396	.061	189.1	.855	-.868	-.263	268.8	.885	-.366	-.008
229.8	.858	-.351	.127	244.8	.857	-.372	.036	192.6	.850	-.859	-.262	269.8	.888	-.371	-.054
237.3	.858	-.379	.107	251.8	.866	-.381	.006	199.5	.861	-.132	-.235	276.8	.869	-.378	-.096
244.5	.861	-.408	.075	251.8	.864	-.385	-.009	206.8	.876	-.182	-.229	278.8	.884	-.378	-.102
251.8	.861	-.418	.059	256.6	.870	-.408	-.059	213.9	.815	-.226	-.203	287.8	.851	-.361	-.144
258.9	.861	-.428	.027	259.8	.875	-.408	-.038	221.1	.874	-.261	-.173	296.8	.863	-.363	-.198
265.8	.866	-.421	.001	266.8	.875	-.425	-.068	228.8	.831	-.293	-.166	305.8	.852	-.316	-.235
273.2	.866	-.421	-.026	273.6	.875	-.405	-.097	235.9	.866	-.318	-.113	314.8	.853	-.271	-.266
280.8	.866	-.428	-.053	280.8	.876	-.408	-.122	242.8	.859	-.333	-.088	315.8	.856	-.268	-.268
287.8	.866	-.418	-.078	287.8	.875	-.388	-.159	249.8	.876	-.363	-.051	323.8	.862	-.226	-.288
294.6	.867	-.398	-.107	294.8	.869	-.367	-.183	256.8	.887	-.396	-.018	332.8	.875	-.187	-.308
294.1	.867	-.381	-.128	294.8	.862	-.358	-.199	264.2	.886	-.362	-.878	339.6	.889	-.168	-.313
301.8	.861	-.376	-.129	302.2	.868	-.366	-.206	271.6	.885	-.361	-.856	341.8	.863	-.112	-.318
309.1	.858	-.358	-.165	309.8	.868	-.321	-.225	278.8	.890	-.358	-.837	350.8	.899	-.095	-.321
316.2	.861	-.317	-.176	316.8	.876	-.286	-.239	281.3	.882	-.361	-.184	359.2	.922	-.884	-.321
323.8	.862	-.286	-.163	319.6	.871	-.276	-.265	285.8	.876	-.356	-.122	360.8	.909	-.894	-.318
323.6	.862	-.272	-.192	323.8	.877	-.262	-.291	292.6	.866	-.362	-.181				
330.6	.867	-.227	-.198	331.8	.888	-.284	-.255	300.8	.867	-.331	-.196				
337.8	.878	-.171	-.208	338.8	.886	-.251	-.263	301.2	.886	-.321	-.198				
344.8	.888	-.156	-.199	339.2	.888	-.183	-.282	307.3	.867	-.288	-.218				
345.8	.886	-.121	-.181	345.8	.886	-.181	-.288	316.8	.878	-.276	-.243				
352.8	.913	-.872	-.163	352.8	.879	-.867	-.255	321.8	.886	-.266	-.266				
359.8	.877	-.881	-.188	359.8	.861	-.881	-.268	321.6	.885	-.268	-.266				
360.6	.861	-.882	-.133	359.8	.837	-.881	-.252	328.8	.891	-.284	-.281				
				361.5	.859	-.818	-.258	335.8	.914	-.156	-.291				
								342.8	.916	-.175	-.301				
								343.2	.928	-.113	-.308				
								349.8	.961	-.866	-.307				
								357.6	.957	-.878	-.306				
								360.6	.948	-.881	-.308				

TABLE E-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 13

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ALONE 20D INC 4KTS13
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.864	.864	.880	.870	.879	.874	.868	.862	.863	.874	.880	.877	.870
VTBAR =	-.000	.012	.003	.005	-.029	-.020	-.009	.005	.012	.006	.002	.003	.005
VRBAR =	-.011	-.035	-.039	-.044	.024	.013	.001	-.019	-.032	-.037	-.039	-.042	-.044
1-WJX =	.870	.865	.868	.871	0.000	.876	.873	.868	.866	.866	.869	.872	.872
1-WX =	.920	.890	.885	.883	0.000	.949	.931	.906	.893	.887	.886	.885	.883
BBAR =	24.02	17.73	14.82	11.98	34.09	30.74	27.17	22.02	18.60	16.33	14.50	12.90	11.55
BPOS =	5.67	3.84	2.30	1.31	12.57	9.75	7.31	5.08	4.15	2.97	2.18	1.62	1.23
THETA =	97.50	85.00	95.00	97.50	110.00	105.00	105.00	85.00	85.00	85.00	95.00	95.00	97.50
BNEG =	-3.96	-2.87	-1.89	-1.23	-8.26	-6.63	-5.17	-3.36	-3.02	-2.40	-1.77	-1.30	-1.16
THETA =	260.00	220.00	217.50	295.00	315.00	290.00	260.00	237.50	220.00	220.00	227.50	295.00	295.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WJX 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 E-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 13

VELOCITY COMPONENT RATIOS FOR MODEL 5571 BARE BOAT ALONE 200 RPS 4KTS13
PROPELLER DIAMETER 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0209	.0087	.0147	.0120	.0057	.0055	.0023	.0014
PHASE ANGLE =	92.7	88.8	82.7	[illegible]	69.4	84.8	29.1	62.0
RADIUS = .633								
AMPLITUDE =	.0575	.0179	.0103	.0136	.0011	.0057	.0018	.0016
PHASE ANGLE =	71.8	272.4	81.3	[illegible]	291.7	66.8	87.9	134.4
RADIUS = .781								
AMPLITUDE =	.0368	.0060	.0117	.0033	.0018	.0034	.0041	.0039
PHASE ANGLE =	75.6	172.8	84.4	48.5	254.8	64.8	112.2	48.1
RADIUS = .963								
AMPLITUDE =	.0086	.0084	.0062	.0048	.0052	.0033	.0018	.0043
PHASE ANGLE =	72.2	68.6	104.5	95.3	249.4	92.4	64.7	93.4

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0018	.0010	.0024	.0018	.0007	.0021	.0013	.0009
PHASE ANGLE =	21.6	38.8	13.2	300.6	325.1	280.5	226.0	355.0
RADIUS = .633								
AMPLITUDE =	.0020	.0024	.0006	.0025	.0011	.0005	.0020	.0019
PHASE ANGLE =	50.1	132.8	161.3	113.2	357.6	50.6	223.0	145.4
RADIUS = .781								
AMPLITUDE =	.0012	.0017	.0002	.0026	.0007	.0011	.0014	.0014
PHASE ANGLE =	72.5	320.7	261.3	328.2	123.4	147.6	214.5	162.5
RADIUS = .963								
AMPLITUDE =	.0010	.0004	.0018	.0012	.0027	.0026	.0023	.0011
PHASE ANGLE =	255.4	34.0	80.0	71.6	90.8	49.3	79.8	30.5

TABLE E-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 15

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ALONE 20D INC 4KTS13
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0656	.0698	.0239	.0173	.0161	.0049	.0041	.0078
PHASE ANGLE =	232.4	95.9	85.3	41.6	69.2	129.2	27.0	24.7
RADIUS = .350								
AMPLITUDE =	.0400	.0502	.0210	.0149	.0129	.0048	.0036	.0056
PHASE ANGLE =	226.2	95.3	84.7	49.4	69.2	113.9	25.8	27.4
RADIUS = .400								
AMPLITUDE =	.0139	.0282	.0177	.0128	.0092	.0051	.0030	.0032
PHASE ANGLE =	191.0	94.0	83.8	62.0	69.3	97.5	25.7	35.0
RADIUS = .500								
AMPLITUDE =	.0356	.0031	.0128	.0122	.0034	.0058	.0019	.0011
PHASE ANGLE =	79.2	292.6	82.0	87.7	69.4	77.9	36.6	111.6
RADIUS = .600								
AMPLITUDE =	.0556	.0170	.0103	.0143	.0003	.0059	.0016	.0016
PHASE ANGLE =	72.4	274.6	81.1	100.4	254.5	68.6	74.7	143.3
RADIUS = .700								
AMPLITUDE =	.0483	.0089	.0114	.0182	.0012	.0044	.0033	.0024
PHASE ANGLE =	73.7	244.3	81.9	97.7	255.8	64.1	107.9	57.8
RADIUS = .800								
AMPLITUDE =	.0340	.0063	.0116	.0206	.0020	.0032	.0041	.0041
PHASE ANGLE =	76.0	158.7	86.0	95.2	254.2	66.0	112.1	49.0
RADIUS = .900								
AMPLITUDE =	.0187	.0077	.0099	.0203	.0037	.0029	.0028	.0043
PHASE ANGLE =	76.5	106.8	96.0	94.7	250.9	80.4	104.3	66.9
RADIUS = 1.000								
AMPLITUDE =	.0086	.0084	.0062	.0188	.0052	.0033	.0013	.0043
PHASE ANGLE =	72.2	68.6	104.5	95.3	249.4	92.4	64.7	93.4

TABLE E-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ALONE 20D ING 4KTS13
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (Vx V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0019	.0085	.0078	.0120	.0016	.0058	.0004	.0057
PHASE ANGLE =	327.6	331.5	5.4	302.2	195.6	263.7	45.9	332.8
RADIUS = .350								
AMPLITUDE =	.0017	.0059	.0061	.0085	.0010	.0046	.0001	.0042
PHASE ANGLE =	344.1	334.6	6.6	301.9	208.3	266.6	229.8	334.5
RADIUS = .400								
AMPLITUDE =	.0017	.0030	.0042	.0047	.0005	.0033	.0007	.0024
PHASE ANGLE =	4.4	344.1	8.7	301.4	262.4	271.7	226.7	338.6
RADIUS = .500								
AMPLITUDE =	.0019	.0014	.0014	.0006	.0010	.0013	.0016	.0004
PHASE ANGLE =	31.3	108.4	20.9	120.3	339.2	292.0	225.5	92.7
RADIUS = .600								
AMPLITUDE =	.0020	.0026	.0005	.0026	.0012	.0004	.0020	.0017
PHASE ANGLE =	46.2	131.1	142.3	116.2	353.1	12.1	223.8	142.5
RADIUS = .700								
AMPLITUDE =	.0017	.0001	.0004	.0010	.0003	.0007	.0020	.0018
PHASE ANGLE =	61.7	14.6	213.3	359.7	20.6	149.8	223.5	156.9
RADIUS = .800								
AMPLITUDE =	.0011	.0019	.0001	.0028	.0008	.0011	.0012	.0013
PHASE ANGLE =	74.9	320.7	280.5	327.5	121.8	142.0	208.4	162.3
RADIUS = .900								
AMPLITUDE =	.0001	.0015	.0008	.0018	.0018	.0014	.0012	.0004
PHASE ANGLE =	181.0	327.3	72.6	340.1	102.8	78.2	100.8	105.1
RADIUS = 1.000								
AMPLITUDE =	.0010	.0004	.0018	.0012	.0027	.0026	.0029	.0011
PHASE ANGLE =	255.4	34.0	80.0	71.6	90.8	49.3	79.8	30.5

TABLE E-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 13

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ALONE 20D INC 4KTS13
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.4438	.0074	.0114	.0050	.0043	.0026	.0012	.0030
PHASE ANGLE =	181.9	150.6	185.6	183.2	20.9	207.7	184.0	175.0
RADIUS = .633								
AMPLITUDE =	.3919	.0104	.0073	.0024	.0019	.0006	.0026	.0002
PHASE ANGLE =	181.4	246.8	190.9	176.4	318.5	201.9	346.2	53.3
RADIUS = .781								
AMPLITUDE =	.3747	.0062	.0054	.0013	.0044	.0011	.0022	.0007
PHASE ANGLE =	180.8	99.9	178.4	323.2	11.4	158.1	12.1	44.3
RADIUS = .963								
AMPLITUDE =	.3649	.0081	.0021	.0013	.0041	.0018	.0005	.0006
PHASE ANGLE =	180.2	246.0	210.7	111.8	352.0	122.6	84.0	126.6

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0016	.0020	.0016	.0015	.0014	.0006	.0011	.0006
PHASE ANGLE =	147.9	189.9	176.9	209.2	142.3	166.1	174.4	145.1
RADIUS = .633								
AMPLITUDE =	.0015	.0007	.0009	.0005	.0010	.0011	.0010	.0010
PHASE ANGLE =	335.4	187.7	101.3	176.0	76.8	325.2	218.8	320.5
RADIUS = .781								
AMPLITUDE =	.0012	.0002	.0014	.0009	.0017	.0005	.0007	.0009
PHASE ANGLE =	352.5	281.2	265.1	151.4	275.0	225.2	250.3	226.6
RADIUS = .963								
AMPLITUDE =	.0005	.0009	.0004	.0004	.0004	.0005	.0006	.0005
PHASE ANGLE =	11.5	181.2	44.4	182.0	53.1	214.6	34.0	11.1

TABLE E-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 13

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ALONE 20D INC 4KTS13
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.5114	.0408	.0229	.0062	.0136	.0061	.0081	.0077
PHASE ANGLE =	182.2	100.5	178.4	197.4	36.6	201.6	166.8	173.7
RADIUS = .350								
AMPLITUDE =	.4913	.0292	.0201	.0059	.0105	.0050	.0059	.0063
PHASE ANGLE =	182.1	104.5	180.1	193.0	34.7	202.9	168.3	174.1
RADIUS = .400								
AMPLITUDE =	.4674	.0166	.0170	.0055	.0071	.0038	.0035	.0046
PHASE ANGLE =	182.0	114.8	182.6	187.9	30.5	205.0	171.7	174.5
RADIUS = .500								
AMPLITUDE =	.4277	.0067	.0118	.0045	.0028	.0019	.0004	.0020
PHASE ANGLE =	181.8	205.6	187.8	180.2	5.9	209.8	289.6	175.1
RADIUS = .600								
AMPLITUDE =	.3989	.0108	.0062	.0030	.0018	.0008	.0023	.0003
PHASE ANGLE =	181.5	244.5	191.1	176.2	319.9	209.3	342.9	159.3
RADIUS = .700								
AMPLITUDE =	.3831	.0022	.0065	.0006	.0031	.0008	.0025	.0005
PHASE ANGLE =	181.1	166.3	180.9	239.5	1.3	177.7	359.5	39.4
RADIUS = .800								
AMPLITUDE =	.3731	.0065	.0051	.0014	.0046	.0012	.0021	.0007
PHASE ANGLE =	180.8	98.8	172.6	328.1	11.7	154.1	14.8	46.9
RADIUS = .900								
AMPLITUDE =	.3669	.0023	.0032	.0008	.0047	.0015	.0011	.0006
PHASE ANGLE =	180.4	142.3	179.4	10.4	5.3	134.3	33.4	79.3
RADIUS = 1.000								
AMPLITUDE =	.3649	.0081	.0021	.0013	.0041	.0018	.0005	.0006
PHASE ANGLE =	180.2	246.0	210.7	111.8	352.0	122.6	84.0	126.6

TABLE E-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ALONE 20D INC 4KTS13
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0067	.0032	.0044	.0032	.0039	.0045	.0017	.0043
PHASE ANGLE =	147.8	195.4	213.4	209.7	211.9	158.6	135.7	154.4
RADIUS = .350								
AMPLITUDE =	.0051	.0029	.0034	.0026	.0028	.0032	.0014	.0031
PHASE ANGLE =	148.0	193.9	207.6	210.1	201.9	158.8	144.6	153.4
RADIUS = .400								
AMPLITUDE =	.0033	.0024	.0024	.0020	.0018	.0018	.0012	.0017
PHASE ANGLE =	148.1	192.0	196.5	210.2	179.8	159.9	158.0	151.3
RADIUS = .500								
AMPLITUDE =	.0005	.0016	.0013	.0011	.0014	.0002	.0010	.0001
PHASE ANGLE =	144.7	188.4	155.5	206.7	116.4	294.4	187.0	1.5
RADIUS = .600								
AMPLITUDE =	.0012	.0009	.0010	.0006	.0013	.0010	.0010	.0009
PHASE ANGLE =	334.7	186.7	110.9	187.5	85.1	326.6	211.8	325.9
RADIUS = .700								
AMPLITUDE =	.0014	.0003	.0001	.0008	.0007	.0005	.0009	.0007
PHASE ANGLE =	343.3	228.1	92.0	156.2	284.5	293.1	234.5	259.7
RADIUS = .800								
AMPLITUDE =	.0012	.0002	.0004	.0009	.0018	.0005	.0007	.0009
PHASE ANGLE =	354.8	284.0	284.9	151.8	274.7	217.4	254.5	223.6
RADIUS = .900								
AMPLITUDE =	.0008	.0003	.0001	.0009	.0011	.0006	.0003	.0004
PHASE ANGLE =	13.0	157.1	296.2	163.1	279.1	205.6	319.8	225.1
RADIUS = 1.000								
AMPLITUDE =	.0005	.0009	.0006	.0008	.0004	.0005	.0006	.0005
PHASE ANGLE =	41.5	149.2	99.9	192.0	53.1	214.6	34.0	11.1

APPENDIX F

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 14

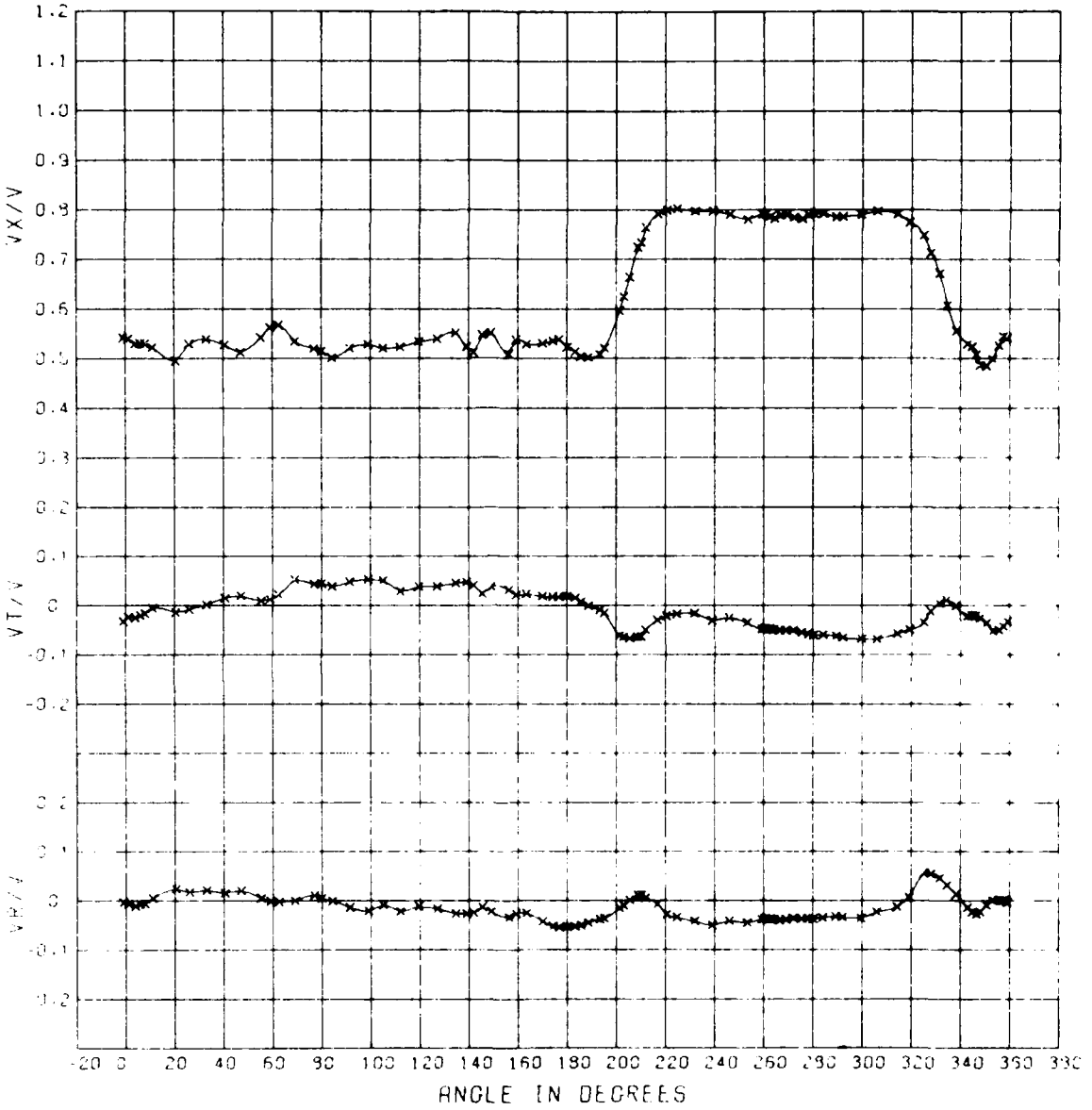

Figure F-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 14

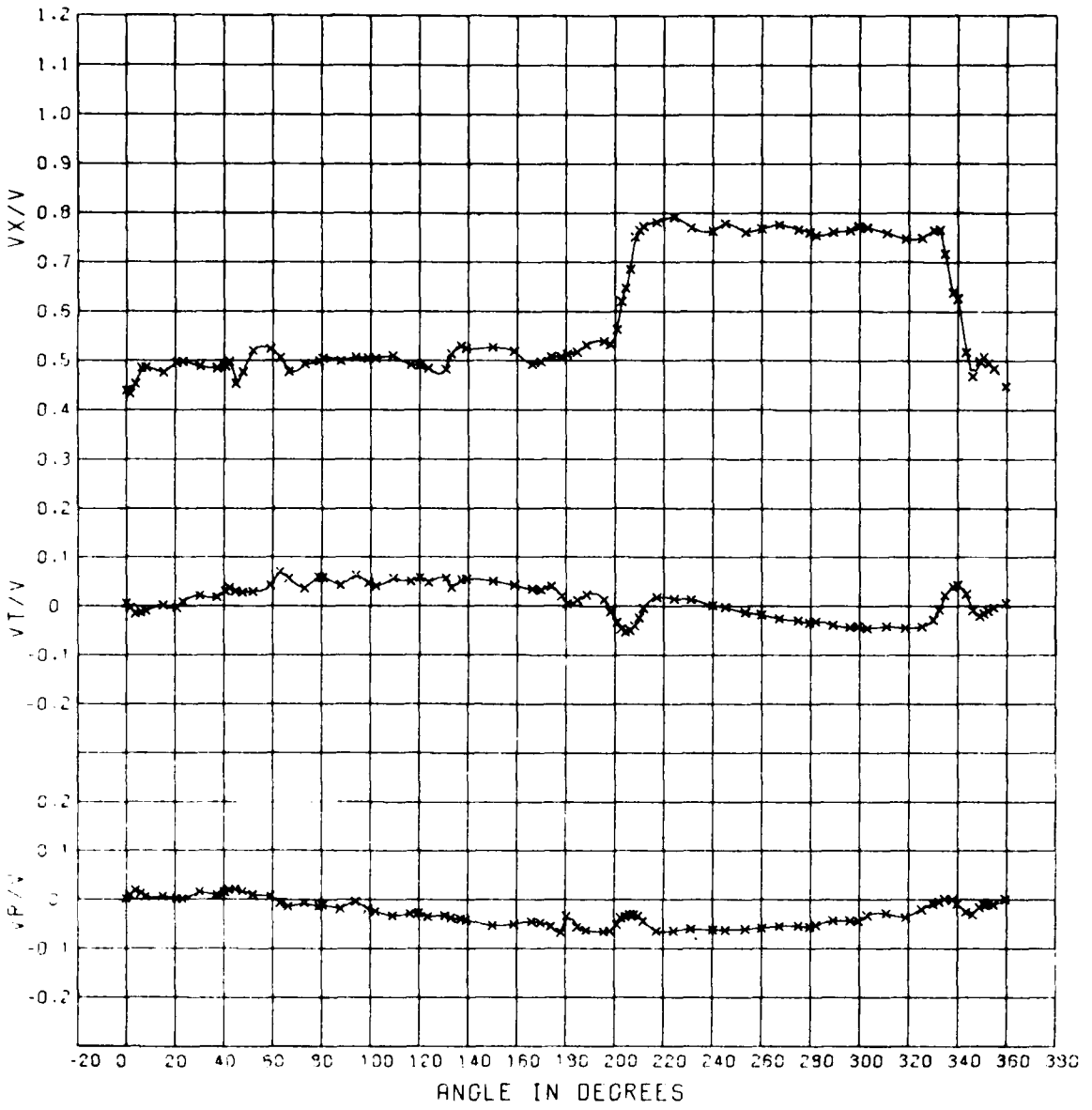

Figure F-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 14

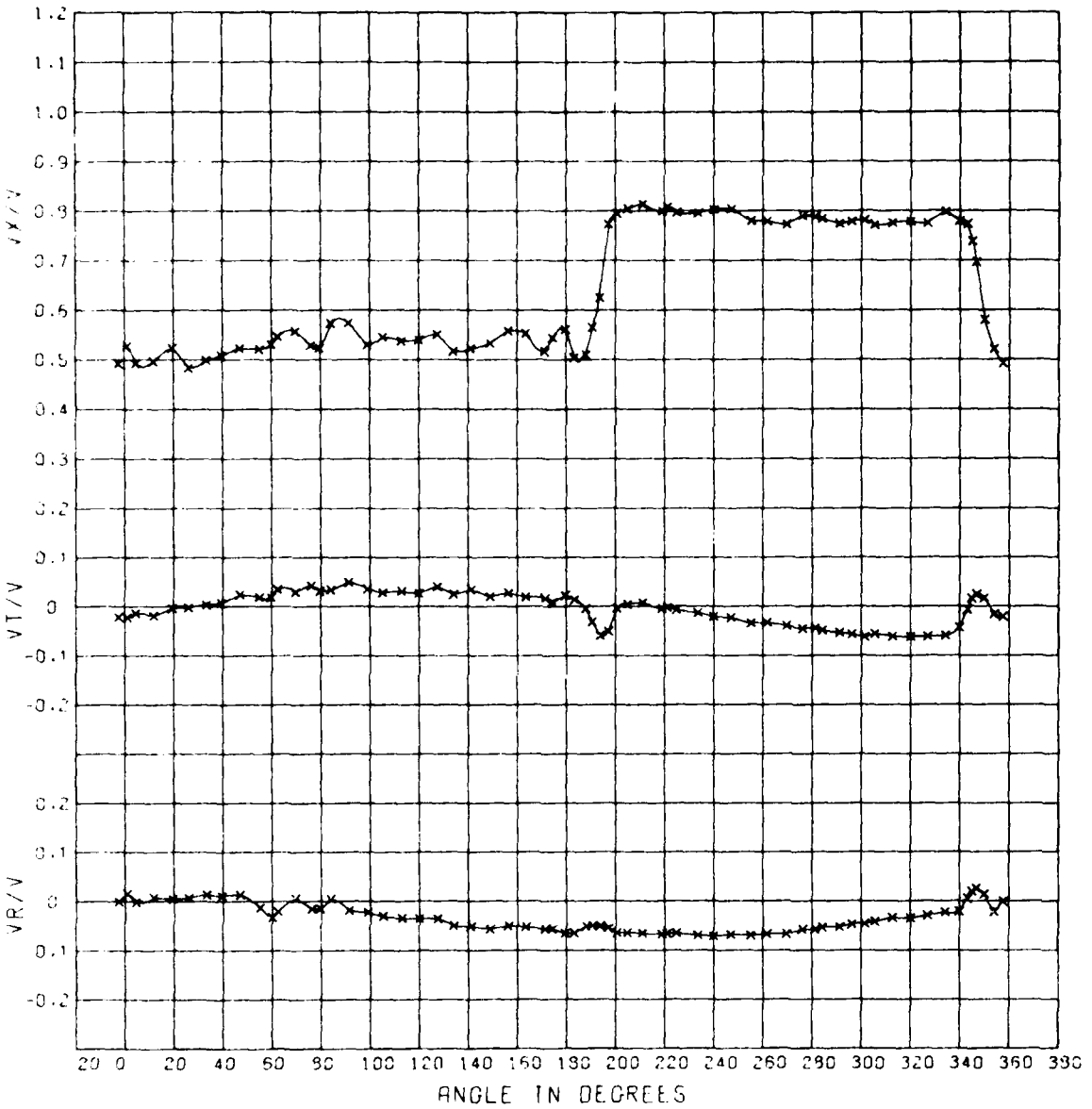

Figure F-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 14

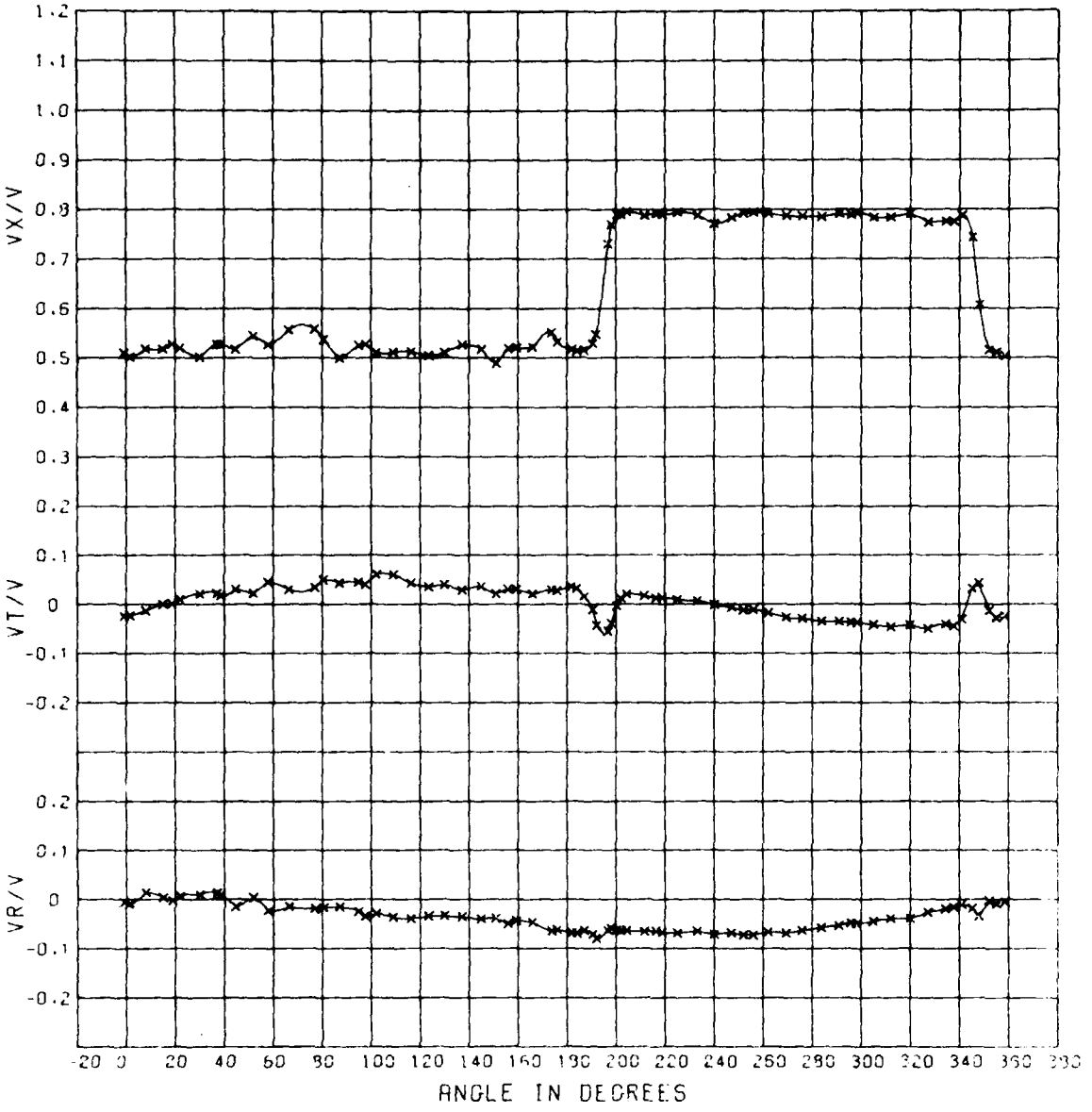

Figure F-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 14

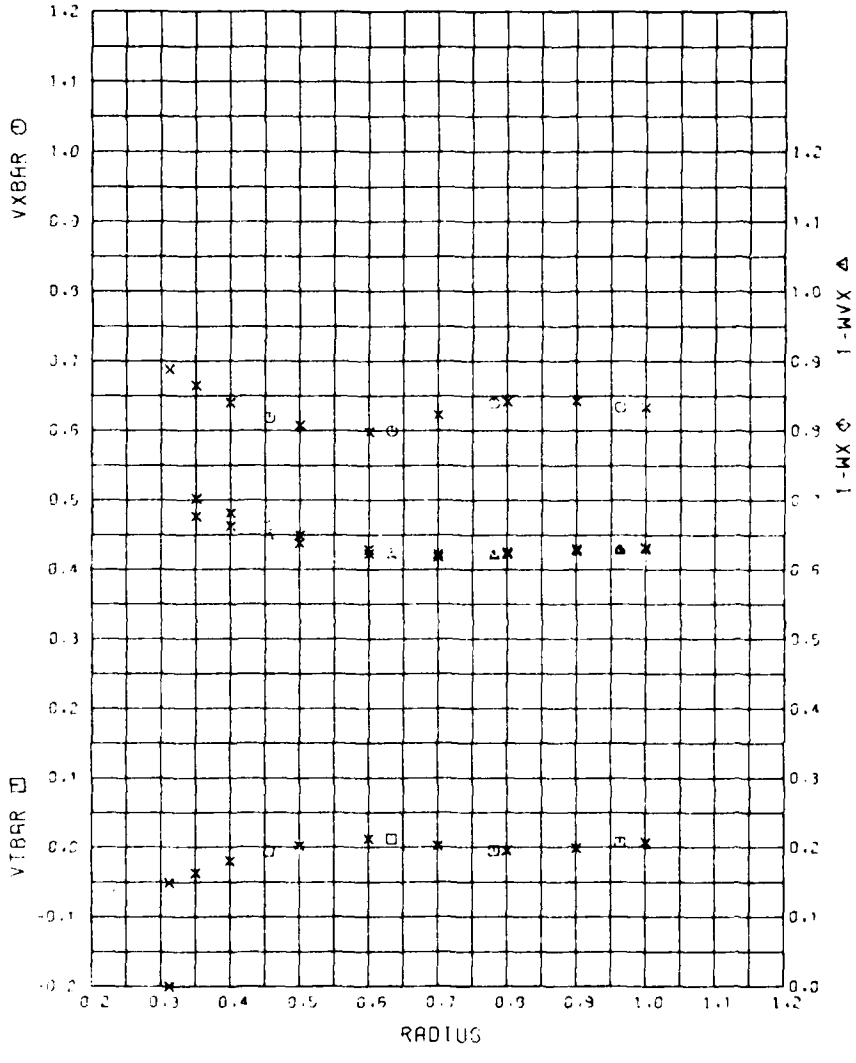

Figure F-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 14

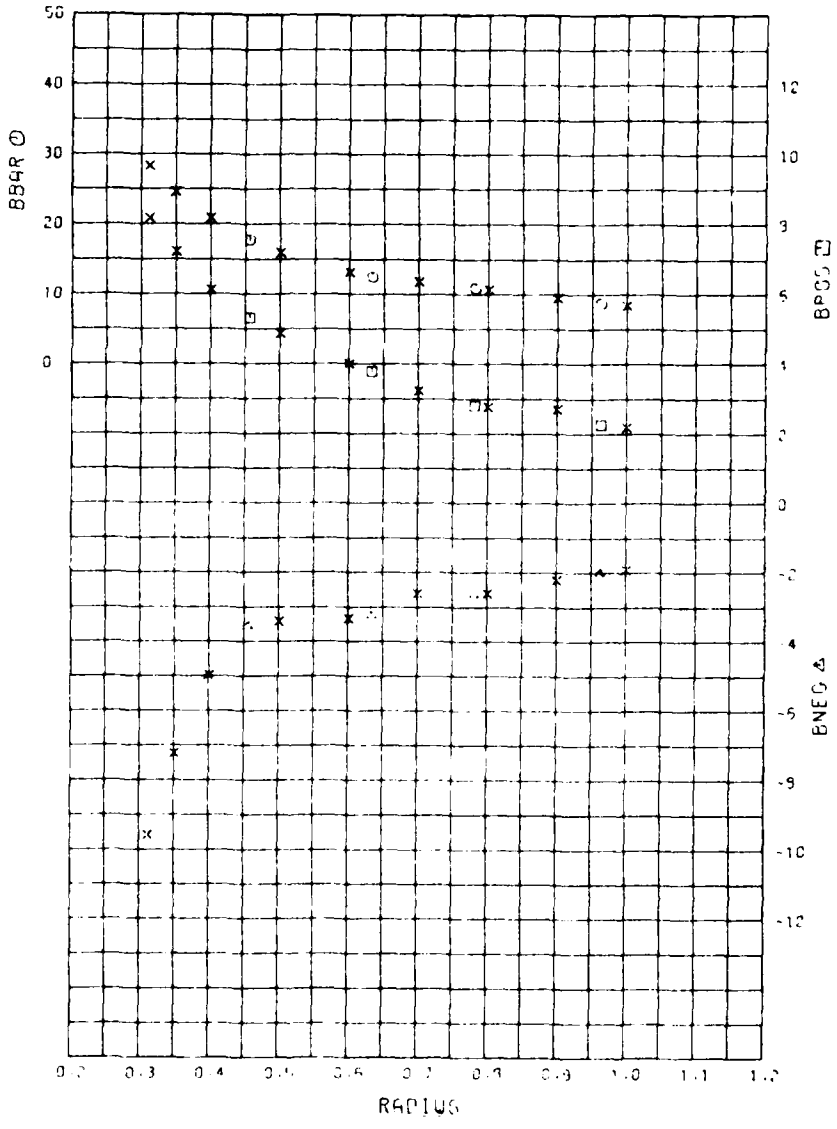

Figure F-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 14

TABLE F-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA
WITH BASS DYNAMOMETER BOAT, EXPERIMENT 14

TABLE F-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 14

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 0INC 4.5KTSW014
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.619	.600	.640	.634	.688	.665	.640	.608	.598	.623	.642	.643	.634
VTBAR =	-.006	.012	-.005	.007	-.051	-.037	-.020	.002	.012	.002	-.005	-.001	.007
VRBAR =	-.014	-.030	-.035	-.037	.007	.000	-.007	-.019	-.028	-.033	-.035	-.037	-.037
1-WVX =	.647	.620	.619	.627	0.000	.676	.662	.638	.623	.618	.622	.627	.630
1-WX =	.663	.625	.622	.629	0.000	.702	.681	.649	.629	.622	.625	.630	.632
BBAR =	17.76	12.51	10.92	8.78	28.34	24.62	20.45	15.45	13.13	11.81	10.70	9.53	8.46
BPOS =	5.32	3.77	2.81	2.27	8.17	7.21	6.12	4.87	4.00	3.23	2.77	2.71	2.19
THETA =	307.50	222.50	210.00	300.00	282.50	282.50	282.50	307.50	300.00	222.50	335.00	200.00	300.00
BNEG =	-3.55	-3.25	-2.64	-2.00	-9.59	-7.24	-4.47	-3.41	-3.33	-2.61	-2.61	-2.21	-1.92
THETA =	350.00	0.00	27.50	150.00	187.50	187.50	187.50	347.50	0.00	357.50	27.50	27.50	150.00

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 I-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 14

VELOCITY COMPONENT RATIOS FOR W.E. 527 BASS BOAT ONLY DTNS 4.5#TS#014
PROPELLER DIAMETER = 6.00 FEET JA = .734

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.1470	.0684	.0047	.0445	.0203	.0042	.0230	.0086
PHASE ANGLE =	182.7	273.5	189.0	272.3	18.0	269.3	10.2	104.0
RADIUS = .633								
AMPLITUDE =	.1568	.0596	.0247	.0430	.0109	.0226	.0161	.0052
PHASE ANGLE =	184.1	269.0	187.8	273.0	357.6	263.7	354.9	341.9
RADIUS = .781								
AMPLITUDE =	.1554	.0438	.0520	.0318	.0124	.0280	.0020	.0225
PHASE ANGLE =	184.2	268.5	178.2	265.4	160.8	257.8	359.5	261.9
RADIUS = .963								
AMPLITUDE =	.1627	.0428	.0438	.0342	.0139	.0249	.0068	.0206
PHASE ANGLE =	179.2	276.1	188.0	259.0	161.1	267.1	344.4	253.0

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0069	.0123	.0045	.0047	.0013	.0026	.0006	.0022
PHASE ANGLE =	.4	120.8	98.2	74.9	332.1	44.2	266.5	254.1
RADIUS = .633								
AMPLITUDE =	.0157	.0077	.0041	.0109	.0079	.0050	.0043	.0022
PHASE ANGLE =	312.2	58.2	301.3	82.2	127.6	41.3	180.9	224.3
RADIUS = .781								
AMPLITUDE =	.0116	.0148	.0042	.0016	.0119	.0030	.0066	.0095
PHASE ANGLE =	7.1	258.8	331.9	313.1	338.2	180.5	320.7	111.4
RADIUS = .963								
AMPLITUDE =	.0110	.0096	.0160	.0097	.0122	.0023	.0086	.0073
PHASE ANGLE =	336.1	247.1	355.5	256.1	339.5	151.4	350.8	48.3

TABLE F-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 14

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 0INC 4.5KTSW014
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.1301	.0683	.0114	.0375	.0243	.0205	.0244	.0219
PHASE ANGLE =	180.1	280.7	143.9	286.4	62.6	88.5	36.0	167.7
RADIUS = .350								
AMPLITUDE =	.1354	.0689	.0083	.0399	.0222	.0131	.0239	.0165
PHASE ANGLE =	180.9	278.4	150.0	281.6	48.7	87.8	27.7	156.2
RADIUS = .400								
AMPLITUDE =	.1414	.0691	.0061	.0425	.0210	.0043	.0236	.0115
PHASE ANGLE =	181.9	275.9	167.5	276.6	32.2	85.7	18.4	134.9
RADIUS = .500								
AMPLITUDE =	.1506	.0673	.0049	.0453	.0194	.0100	.0221	.0075
PHASE ANGLE =	183.2	272.0	195.1	269.6	10.0	267.3	5.1	79.4
RADIUS = .600								
AMPLITUDE =	.1559	.0621	.0183	.0442	.0140	.0202	.0182	.0053
PHASE ANGLE =	183.9	269.6	190.5	264.5	359.1	264.7	356.8	16.0
RADIUS = .700								
AMPLITUDE =	.1554	.0508	.0379	.0364	.0027	.0259	.0077	.0135
PHASE ANGLE =	184.6	268.2	179.6	259.0	129.8	259.2	356.5	272.7
RADIUS = .800								
AMPLITUDE =	.1556	.0427	.0534	.0312	.0139	.0282	.0014	.0237
PHASE ANGLE =	183.9	268.9	178.4	255.0	161.7	257.9	359.1	260.7
RADIUS = .900								
AMPLITUDE =	.1589	.0407	.0520	.0314	.0167	.0271	.0024	.0248
PHASE ANGLE =	181.5	272.6	181.9	255.9	162.6	261.6	341.4	256.1
RADIUS = 1.000								
AMPLITUDE =	.1627	.0428	.0438	.0342	.0139	.0249	.0068	.0206
PHASE ANGLE =	179.2	276.1	188.0	259.0	161.1	267.1	344.4	253.0

TABLE F-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY DTNC 4.5KTSW014
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0315	.0306	.0167	.0059	.0342	.0086	.0169	.0071
PHASE ANGLE =	66.2	183.3	86.3	311.2	319.8	206.3	341.3	96.5
RADIUS = .350								
AMPLITUDE =	.0215	.0231	.0160	.0036	.0233	.0049	.0114	.0039
PHASE ANGLE =	80.6	172.3	94.5	5.2	319.8	203.3	340.6	99.9
RADIUS = .400								
AMPLITUDE =	.0112	.0163	.0087	.0061	.0114	.0010	.0053	.0007
PHASE ANGLE =	62.1	151.2	91.8	60.7	320.2	173.6	337.7	141.8
RADIUS = .500								
AMPLITUDE =	.0098	.0122	.0119	.0115	.0042	.0044	.0027	.0032
PHASE ANGLE =	325.1	94.6	93.6	79.0	132.8	39.3	178.0	257.4
RADIUS = .600								
AMPLITUDE =	.0154	.0098	.0078	.0119	.0086	.0055	.0048	.0029
PHASE ANGLE =	310.7	68.2	290.0	82.2	131.1	39.4	176.6	243.8
RADIUS = .700								
AMPLITUDE =	.0118	.0059	.0048	.0050	.0041	.0013	.0027	.0057
PHASE ANGLE =	341.6	272.1	311.5	91.7	3.3	95.2	284.8	126.2
RADIUS = .800								
AMPLITUDE =	.0117	.0159	.0048	.0025	.0131	.0034	.0073	.0049
PHASE ANGLE =	9.6	257.8	334.7	290.8	337.2	183.1	323.9	108.6
RADIUS = .900								
AMPLITUDE =	.0109	.0154	.0135	.0074	.0149	.0035	.0090	.0087
PHASE ANGLE =	1.6	253.4	347.9	264.1	336.4	179.2	338.2	85.7
RADIUS = 1.000								
AMPLITUDE =	.0110	.0096	.0160	.0097	.0122	.0023	.0086	.0073
PHASE ANGLE =	336.1	247.1	359.5	256.1	339.5	151.4	350.8	48.3

TABLE F-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 14

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY OING 4.5KTSW014
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0494	.0044	.0044	.0126	.0061	.0026	.0096	.0045
PHASE ANGLE =	345.3	216.3	92.4	176.6	293.6	208.5	268.1	17.3
RADIUS = .633								
AMPLITUDE =	.0425	.0032	.0019	.0113	.0007	.0067	.0071	.0005
PHASE ANGLE =	340.2	314.2	68.8	185.9	165.5	171.9	255.3	235.3
RADIUS = .781								
AMPLITUDE =	.0428	.0074	.0058	.0056	.0054	.0060	.0005	.0068
PHASE ANGLE =	338.5	343.3	81.9	159.1	84.0	173.6	190.4	161.1
RADIUS = .963								
AMPLITUDE =	.0388	.0093	.0059	.0021	.0020	.0083	.0007	.0056
PHASE ANGLE =	335.6	328.1	82.0	160.1	350.7	175.7	288.2	175.2

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0043	.0057	.0024	.0065	.0005	.0011	.0019	.0010
PHASE ANGLE =	278.4	18.1	29.6	338.1	163.0	192.3	69.1	128.9
RADIUS = .633								
AMPLITUDE =	.0062	.0042	.0015	.0057	.0047	.0031	.0057	.0022
PHASE ANGLE =	240.4	342.5	193.8	350.2	50.8	314.9	76.8	172.5
RADIUS = .781								
AMPLITUDE =	.0028	.0049	.0047	.0010	.0062	.0003	.0035	.0034
PHASE ANGLE =	268.6	178.7	255.9	142.1	260.1	48.1	239.7	13.9
RADIUS = .963								
AMPLITUDE =	.0057	.0049	.0010	.0029	.0048	.0038	.0070	.0026
PHASE ANGLE =	262.4	161.8	291.7	150.9	256.2	12.5	262.5	338.6

TABLE F-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 14

VELOCITY COMPONENT RATIOS FOR M2 EL 5271 BASS BOAT ONLY CING 4.5ATSW014
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0612	.0087	.0017	.0113	.0133	.0074	.0083	.0090
PHASE ANGLE =	349.9	200.5	201.7	142.6	311.2	317.8	293.5	48.7
RADIUS = .350								
AMPLITUDE =	.0575	.0076	.0016	.0114	.0111	.0049	.0087	.0076
PHASE ANGLE =	348.8	202.8	140.1	154.8	307.3	309.0	284.1	41.2
RADIUS = .400								
AMPLITUDE =	.0533	.0060	.0028	.0119	.0086	.0025	.0093	.0060
PHASE ANGLE =	347.2	207.3	103.3	167.2	301.5	277.4	275.1	30.3
RADIUS = .500								
AMPLITUDE =	.0469	.0033	.0054	.0128	.0044	.0039	.0095	.0035
PHASE ANGLE =	343.9	229.6	86.6	181.4	285.9	186.3	264.0	6.7
RADIUS = .600								
AMPLITUDE =	.0431	.0026	.0047	.0120	.0011	.0063	.0080	.0009
PHASE ANGLE =	341.0	295.8	84.6	186.1	242.9	173.2	257.2	327.3
RADIUS = .700								
AMPLITUDE =	.0430	.0053	.0043	.0092	.0036	.0061	.0032	.0040
PHASE ANGLE =	339.5	336.4	82.4	174.3	91.7	172.5	249.4	162.5
RADIUS = .800								
AMPLITUDE =	.0426	.0078	.0057	.0052	.0055	.0061	.0005	.0071
PHASE ANGLE =	338.3	343.1	81.8	155.9	82.4	173.9	140.0	161.4
RADIUS = .900								
AMPLITUDE =	.0407	.0090	.0057	.0030	.0035	.0071	.0007	.0071
PHASE ANGLE =	336.8	336.6	81.6	151.9	64.3	175.2	82.5	166.3
RADIUS = 1.000								
AMPLITUDE =	.0388	.0093	.0059	.0021	.0020	.0083	.0007	.0056
PHASE ANGLE =	335.6	328.1	82.0	180.1	350.7	175.7	288.2	175.2

TABLE F-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY OINC 4.5KTSW014
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0095	.0081	.0082	.0034	.0178	.0099	.0130	.0074
PHASE ANGLE =	.3	96.5	357.7	281.6	236.1	147.9	255.2	17.0
RADIUS = .350								
AMPLITUDE =	.0068	.0062	.0063	.0040	.0119	.0070	.0081	.0048
PHASE ANGLE =	348.2	76.9	2.8	310.0	235.0	150.2	255.9	21.1
RADIUS = .400								
AMPLITUDE =	.0045	.0053	.0042	.0054	.0056	.0038	.0027	.0021
PHASE ANGLE =	319.5	45.4	12.2	328.6	231.7	156.8	258.9	36.6
RADIUS = .500								
AMPLITUDE =	.0051	.0060	.0014	.0070	.0028	.0013	.0043	.0019
PHASE ANGLE =	258.3	5.1	55.5	342.5	64.6	283.2	72.9	163.2
RADIUS = .600								
AMPLITUDE =	.0063	.0052	.0012	.0064	.0052	.0030	.0062	.0026
PHASE ANGLE =	241.7	347.8	154.5	344.3	54.6	312.5	75.6	173.6
RADIUS = .700								
AMPLITUDE =	.0039	.0012	.0029	.0022	.0021	.0012	.0012	.0012
PHASE ANGLE =	250.4	211.5	243.2	338.3	289.6	310.7	116.7	36.9
RADIUS = .800								
AMPLITUDE =	.0028	.0054	.0050	.0015	.0037	.0005	.0043	.0037
PHASE ANGLE =	271.7	177.1	257.3	150.1	258.7	57.4	243.1	11.9
RADIUS = .900								
AMPLITUDE =	.0039	.0062	.0050	.0030	.0070	.0020	.0067	.0037
PHASE ANGLE =	270.5	170.1	261.0	156.8	255.8	27.6	254.3	359.3
RADIUS = 1.000								
AMPLITUDE =	.0057	.0049	.0060	.0029	.0048	.0038	.0070	.0026
PHASE ANGLE =	262.4	161.8	261.7	154.9	256.2	12.5	262.5	338.6

APPENDIX G

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 15

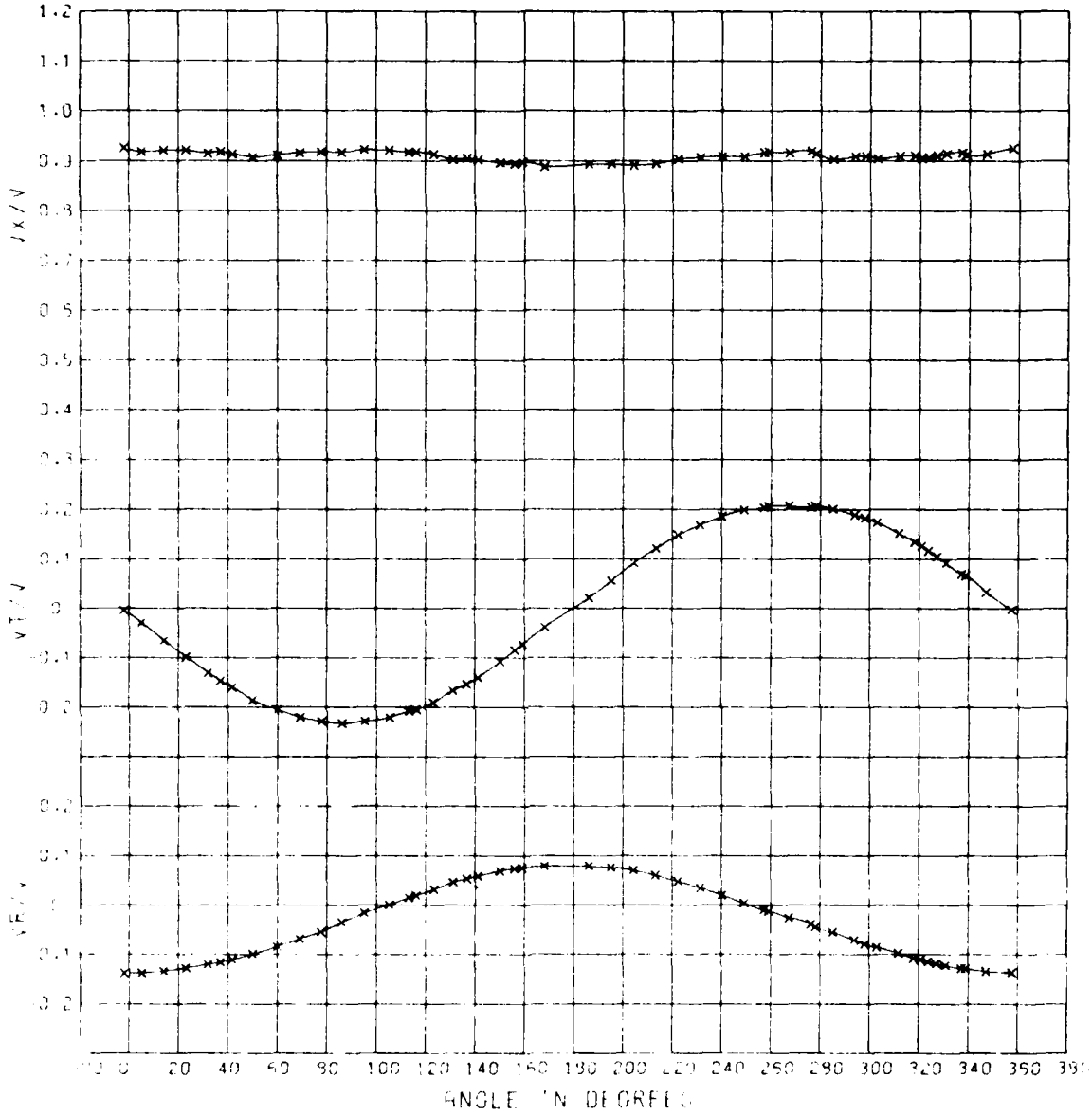

Figure G-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 15

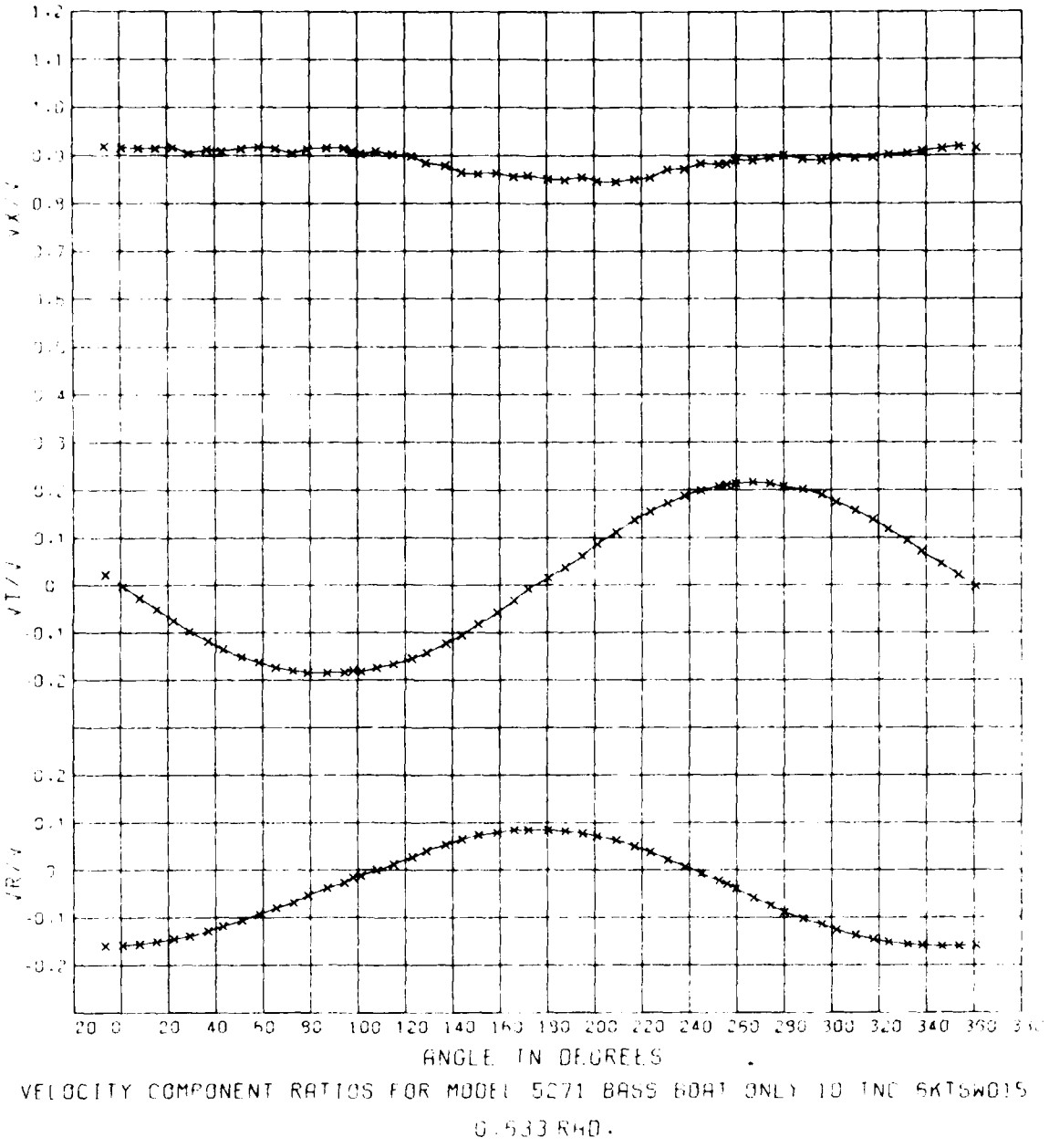

Figure G-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 15

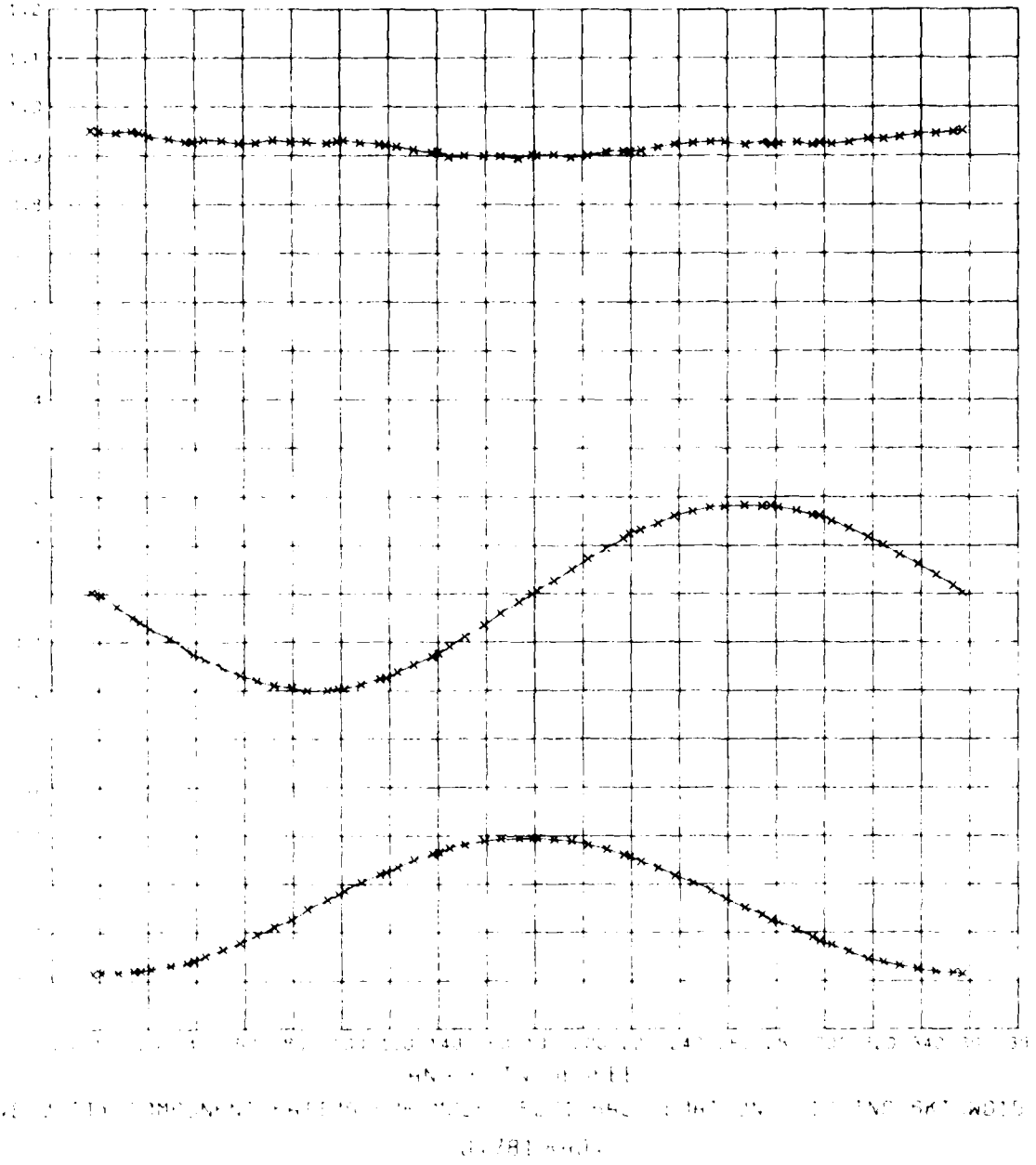

Figure G-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 15

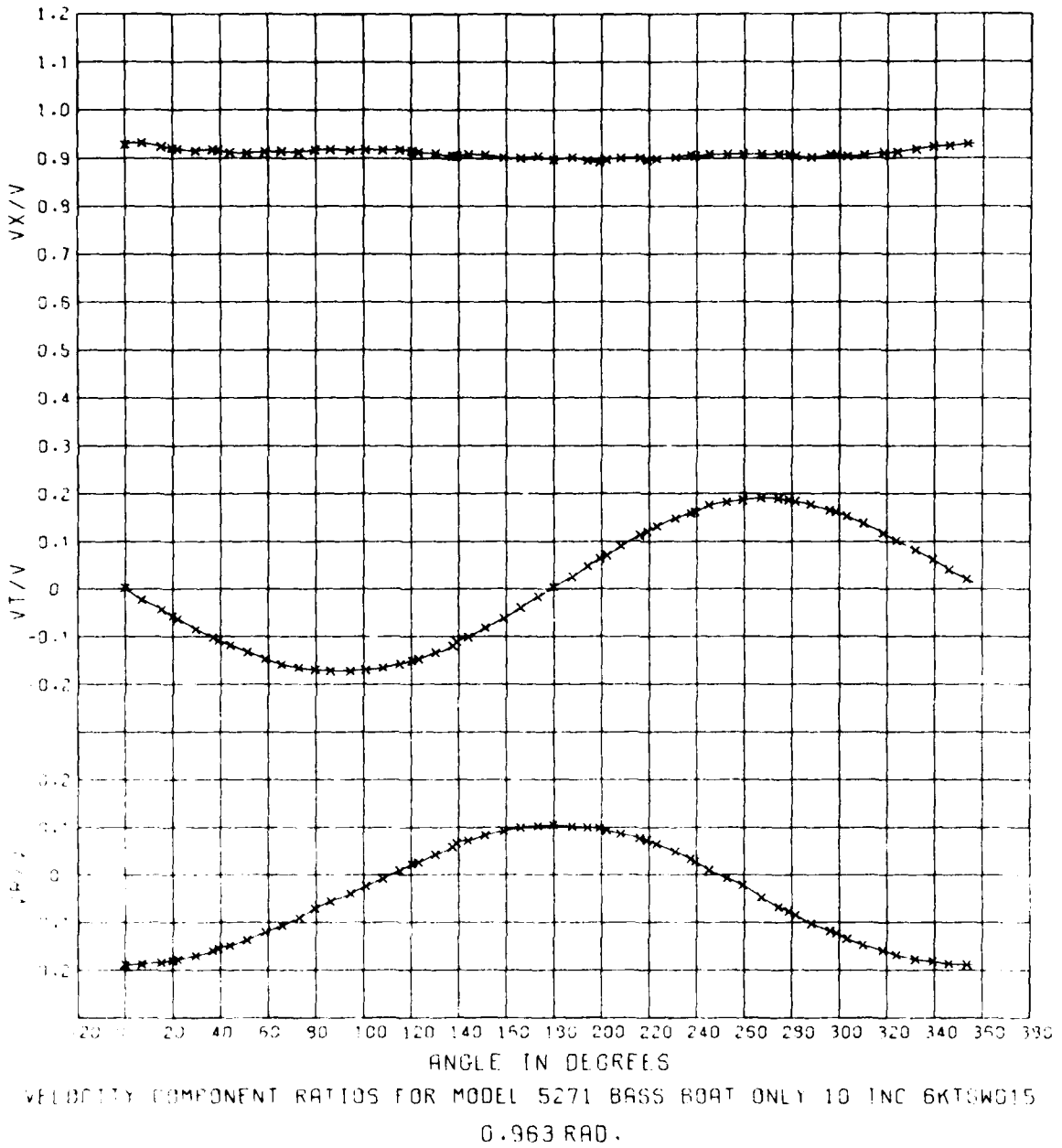

Figure G-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 15

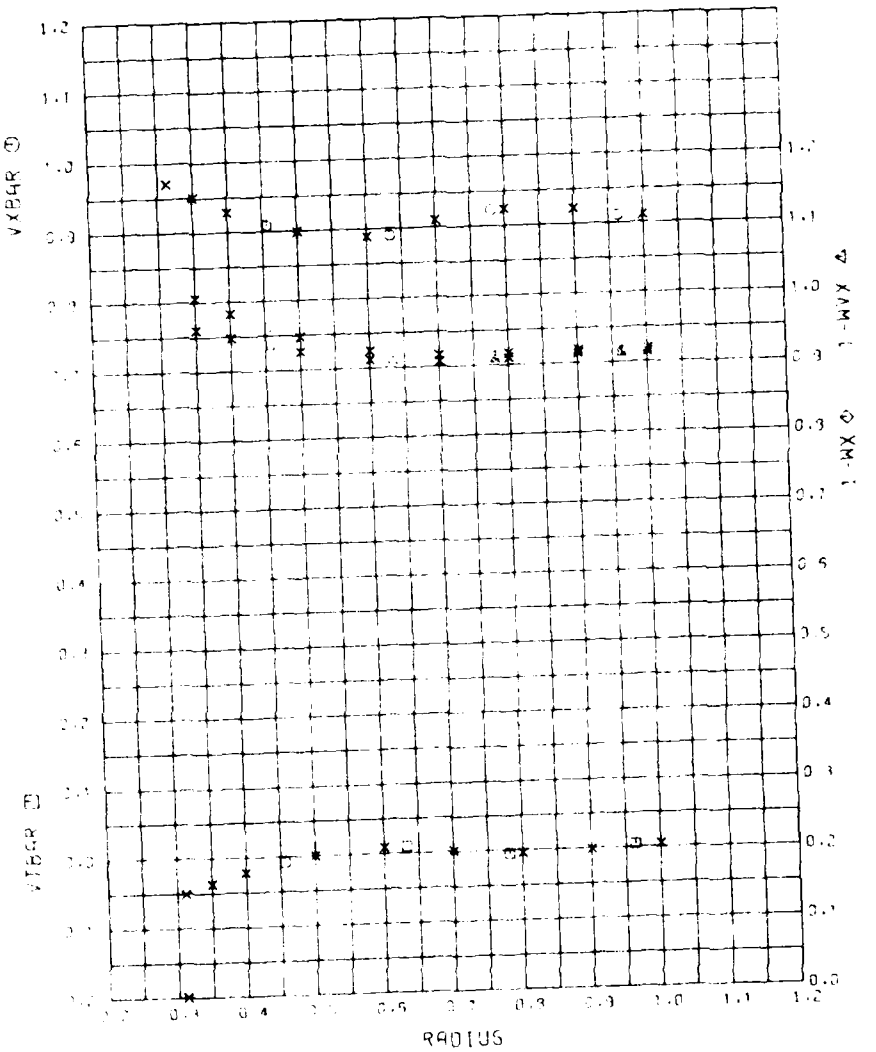

Figure G-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 15

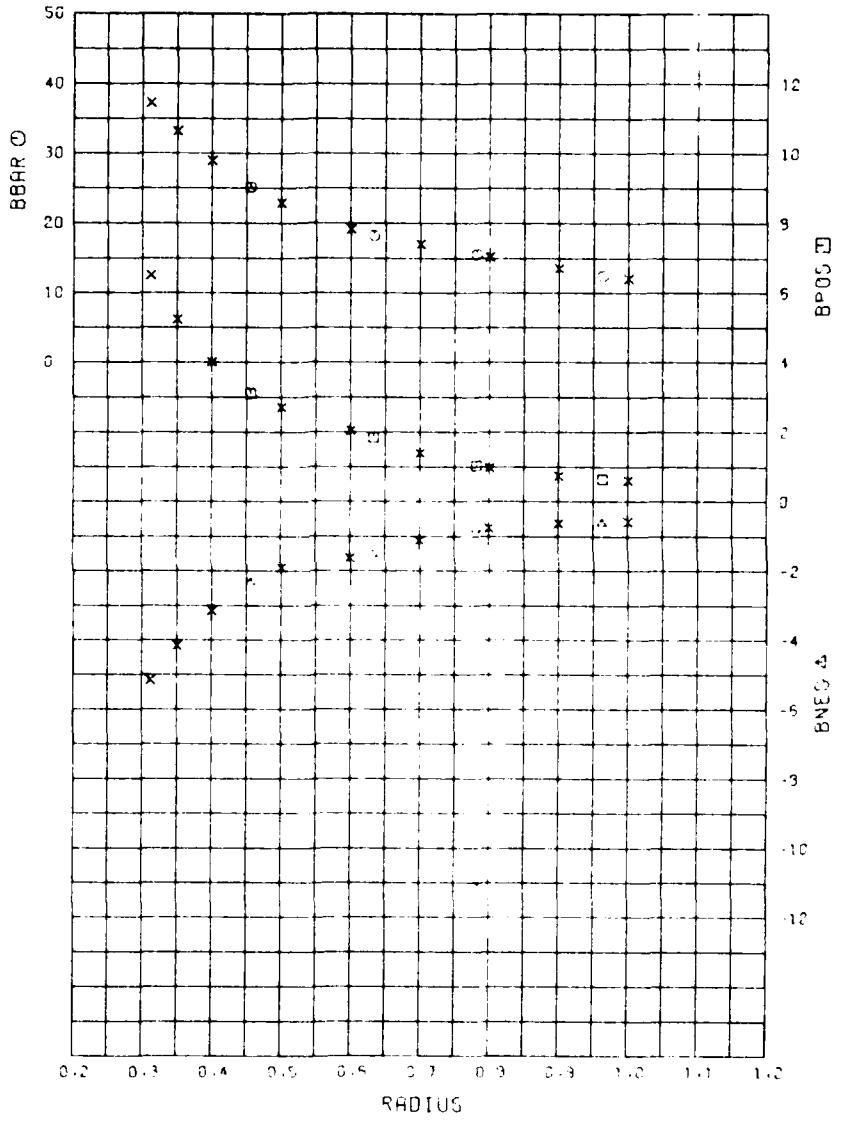

Figure G-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 15

TABLE G-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA
WITH BASS DYNAMOMETER BOAT, EXPERIMENT 15

RADIUS = .696

ANGLE	VX/V	VT/V	VR/V
-2.1	.975	-.064	-.137
5.0	.919	-.038	-.136
14.0	.921	-.066	-.136
23.0	.921	-.099	-.128
32.0	.915	-.131	-.121
37.0	.919	-.167	-.124
41.0	.919	-.168	-.111
50.0	.907	-.186	-.099
59.9	.911	-.209	-.084
69.0	.916	-.221	-.068
77.1	.917	-.229	-.054
78.0	.920	-.229	-.051
86.0	.917	-.233	-.034
95.0	.922	-.229	-.015
105.1	.921	-.221	.001
113.0	.918	-.209	.016
116.0	.918	-.205	.020
123.1	.916	-.198	.032
131.0	.913	-.186	.047
136.0	.906	-.154	.053
141.1	.907	-.168	.059
150.1	.907	-.187	.064
156.0	.895	-.086	.076
159.1	.897	-.072	.076
168.1	.889	-.038	.076
186.2	.896	.022	.079
195.2	.896	.056	.076
204.2	.891	.092	.078
213.2	.894	.121	.068
222.2	.906	.148	.065
231.2	.907	.168	.035
240.2	.909	.186	.028
249.0	.909	.198	.006
257.0	.917	.203	-.018
258.9	.918	.207	-.012
267.2	.910	.207	-.025
276.1	.920	.205	-.036
278.0	.915	.206	-.045
285.0	.903	.201	-.055
293.0	.909	.189	-.078
294.0	.910	.183	-.079
302.9	.906	.173	-.085
311.0	.911	.157	-.097
316.0	.911	.135	-.108
320.0	.905	.126	-.111
323.0	.907	.117	-.116
327.0	.918	.105	-.119
330.0	.916	.092	-.122
337.0	.915	.069	-.128
340.0	.917	.066	-.129
347.0	.916	.037	-.135
349.0	.925	-.002	-.136
357.9	.926	-.004	-.137
365.0	.919	-.030	-.138

RADIUS = .833

ANGLE	VX/V	VT/V	VR/V
-9.5	.919	-.022	-.168
.6	.916	-.082	-.158
8.8	.915	-.028	-.156
19.2	.916	-.051	-.151
28.4	.917	-.076	-.145
39.0	.906	-.098	-.139
46.8	.911	-.118	-.128
53.0	.906	-.139	-.119
61.2	.915	-.151	-.106
68.4	.917	-.162	-.093
75.6	.915	-.173	-.080
82.6	.905	-.188	-.068
85.0	.911	-.184	-.053
87.1	.916	-.185	-.038
96.1	.915	-.183	-.026
98.0	.910	-.188	-.016
101.4	.906	-.182	-.012
108.0	.909	-.175	.000
115.0	.903	-.167	.013
122.9	.898	-.155	.028
129.0	.895	-.141	.041
137.2	.879	-.122	.056
144.0	.885	-.105	.065
151.0	.882	-.082	.076
158.0	.876	-.057	.076
166.0	.855	-.032	.084
172.0	.858	-.007	.084
180.6	.852	.016	.085
187.5	.849	.038	.083
194.0	.855	.061	.077
201.0	.847	.087	.072
209.2	.856	.111	.063
217.0	.850	.137	.058
223.5	.855	.155	.038
230.9	.871	.172	.023
238.1	.872	.186	.008
245.0	.881	.198	-.007
252.6	.882	.208	-.022
256.0	.881	.216	-.029
259.0	.90.	.213	-.039
267.0	.890	.217	-.059
274.2	.895	.213	-.074
288.0	.90.	.208	-.089
288.0	.891	.201	-.103
295.0	.89.	.198	-.115
302.0	.896	.175	-.126
309.0	.895	.157	-.137
317.9	.907	.138	-.146
324.0	.902	.118	-.151
331.9	.905	.094	-.156
338.0	.904	.071	-.160
346.0	.916	.044	-.168
353.2	.916	.022	-.172
360.0	.916	-.002	-.158

RADIUS = .781

ANGLE	VX/V	VT/V	VR/V
-3.0	.951	-.001	-.184
.6	.949	-.022	-.181
7.5	.946	-.027	-.183
14.0	.949	-.056	-.179
17.0	.946	-.058	-.179
21.0	.939	-.072	-.176
29.2	.931	-.094	-.178
36.0	.927	-.116	-.163
39.0	.927	-.125	-.159
43.6	.932	-.136	-.144
48.9	.929	-.153	-.135
54.0	.925	-.164	-.122
65.0	.925	-.181	-.105
72.0	.932	-.189	-.088
76.9	.929	-.193	-.076
79.0	.927	-.196	-.070
86.0	.929	-.199	-.058
94.2	.926	-.200	-.032
98.6	.929	-.197	-.021
101.0	.931	-.196	-.013
108.0	.927	-.194	-.004
115.9	.926	-.176	.020
118.5	.921	-.176	.025
123.1	.919	-.162	.036
130.0	.917	-.146	.050
137.5	.907	-.129	.063
144.2	.909	-.123	.066
144.6	.897	-.108	.076
151.0	.901	-.088	.082
159.2	.902	-.065	.089
166.0	.899	-.048	.093
173.5	.896	-.016	.095
179.8	.902	-.000	.095
180.0	.901	.005	.095
181.0	.901	.008	.096
188.0	.902	.027	.093
195.2	.896	.050	.089
202.0	.901	.072	.082
209.6	.908	.094	.072
216.0	.912	.115	.061
219.5	.908	.125	.054
224.0	.912	.133	.043
231.2	.917	.146	.035
238.0	.921	.160	.019
245.6	.926	.171	.004
252.0	.928	.174	-.013
258.9	.929	.181	-.029
267.1	.922	.193	-.044
274.3	.929	.192	-.062
278.0	.926	.183	-.075
281.0	.925	.179	-.074
288.6	.927	.172	-.094
295.0	.923	.163	-.110
298.0	.926	.161	-.119
302.9	.926	.151	-.126
310.1	.929	.136	-.138
318.0	.936	.117	-.155
324.0	.934	.101	-.160
331.1	.939	.081	-.164
338.0	.941	.061	-.176
346.0	.947	.061	-.174
353.2	.945	.048	-.168
357.0	.948	.017	-.183
360.0	.951	-.003	-.194
	.949	-.002	-.191

RADIUS = .963

ANGLE	VX/V	VT/V	VR/V
0.0	.929	-.003	-.189
7.0	.931	-.021	-.187
7.0	.934	-.022	-.187
14.0	.926	-.043	-.183
19.0	.920	-.057	-.180
22.0	.919	-.063	-.178
29.6	.915	-.085	-.169
36.0	.918	-.103	-.168
39.0	.916	-.109	-.154
44.0	.917	-.118	-.149
51.2	.911	-.132	-.137
58.0	.916	-.146	-.121
59.2	.917	-.148	-.119
65.6	.916	-.158	-.107
72.0	.912	-.165	-.098
79.0	.921	-.169	-.073
80.0	.915	-.169	-.064
86.0	.919	-.172	-.055
94.1	.917	-.173	-.040
100.5	.914	-.178	-.023
101.0	.919	-.178	-.021
108.0	.918	-.165	-.004
115.0	.918	-.157	.003
120.2	.914	-.158	.023
122.9	.913	-.147	.027
130.1	.911	-.131	.043
137.3	.905	-.125	.059
139.0	.905	-.111	.067
144.0	.904	-.102	.071
151.0	.904	-.082	.083
158.0	.902	-.067	.092
164.0	.901	-.031	.100
173.2	.904	-.015	.103
179.8	.899	.004	.105
180.4	.897	.005	.104
187.5	.902	.026	.102
194.0	.898	.044	.100
199.0	.903	.064	.089
202.0	.897	.071	.094
208.0	.901	.090	.086
216.0	.90.	.113	.077
219.0	.896	.121	.072
223.0	.899	.131	.064
230.9	.901	.144	.049
237.1	.907	.159	.039
239.1	.904	.161	.028
245.0	.908	.176	.011
252.6	.908	.182	-.007
258.0	.908	.186	-.020
259.0	.91.	.186	-.023
267.0	.909	.191	-.047
274.2	.908	.190	-.067
278.6	.908	.187	-.076
281.9	.905	.184	-.085
288.0	.901	.177	-.103
295.9	.907	.165	-.114
298.9	.907	.161	-.124
303.1	.906	.153	-.134
310.0	.908	.137	-.144
318.6	.917	.117	-.153
324.0	.913	.102	-.164
331.9	.918	.082	-.177
339.2	.926	.062	-.187
346.0	.925	.040	-.186
353.5	.929	.021	-.189
360.0	.928	.001	-.193

TABLE G-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 15

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC 6KTSW015
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.909	.890	.923	.911	.971	.951	.928	.899	.889	.910	.924	.922	.911
VTBAR =	-.008	.010	-.004	.005	-.051	-.037	-.022	-.000	.009	.001	-.004	-.001	.005
VRBAR =	-.028	-.043	-.047	-.047	-.008	-.014	-.022	-.033	-.041	-.045	-.047	-.047	-.047
1-WVX =	.934	.909	.908	.912	0.000	.960	.947	.926	.912	.907	.910	.914	.914
1-WX =	.963	.921	.914	.917	0.000	1.006	.982	.947	.925	.916	.917	.919	.919
BBAR =	25.21	18.24	15.55	12.52	37.26	33.22	28.93	22.91	19.14	16.99	15.22	13.54	12.07
BPOS =	3.11	1.85	1.03	.65	6.51	5.23	4.01	2.71	2.04	1.39	.98	.74	.61
THETA =	95.00	90.00	100.00	80.00	100.00	100.00	100.00	92.50	90.00	85.00	102.50	102.50	85.00
BNEG =	-2.34	-1.53	-.80	-.62	-5.16	-4.16	-3.15	-1.91	-1.64	-1.12	-.76	-.63	-.58
THETA =	285.00	222.50	267.50	287.50	282.50	282.50	285.00	250.00	222.50	220.00	267.50	280.00	287.50

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 G-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 15

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC 6KTSW015
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0099	.0059	.0059	.0027	.0010	.0008	.0007	.0006
PHASE ANGLE =	73.0	274.9	87.3	78.8	291.9	305.3	351.0	82.8
RADIUS = .633								
AMPLITUDE =	.0304	.0102	.0048	.0040	.0017	.0022	.0004	.0009
PHASE ANGLE =	68.2	259.3	83.5	102.6	237.0	111.8	280.8	21.3
RADIUS = .781								
AMPLITUDE =	.0187	.0030	.0071	.0029	.0006	.0014	.0006	.0003
PHASE ANGLE =	91.4	283.9	105.6	98.7	279.3	88.9	12.8	330.7
RADIUS = .963								
AMPLITUDE =	.0103	.0012	.0056	.0034	.0001	.0004	.0007	.0002
PHASE ANGLE =	62.8	147.8	94.7	107.0	159.4	102.5	68.0	175.8

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0019	.0007	.0009	.0005	.0007	.0007	.0007	.0006
PHASE ANGLE =	180.6	356.1	73.2	46.5	146.4	205.6	151.4	81.7
RADIUS = .633								
AMPLITUDE =	.0008	.0020	.0009	.0003	.0010	.0004	.0011	.0009
PHASE ANGLE =	78.3	261.1	195.5	149.3	60.4	239.8	211.8	184.1
RADIUS = .781								
AMPLITUDE =	.0006	.0004	.0010	.0007	.0012	.0007	.0006	.0005
PHASE ANGLE =	27.5	75.0	270.7	294.0	211.0	72.1	172.7	34.0
RADIUS = .963								
AMPLITUDE =	.0003	.0007	.0009	.0012	.0005	.0005	.0004	.0006
PHASE ANGLE =	70.7	40.4	311.8	77.8	315.4	324.4	286.7	293.5

TABLE G-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 15

VELOCITY COMPONENT RATIOS FOR MODEL 5471 BASS BOAT ONLY 10 INC GKTSW015
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0372	.0105	.0101	.0033	.0036	.0064	.0024	.0018
PHASE ANGLE =	233.7	47.7	104.2	349.0	13.4	300.8	20.8	162.5
RADIUS = .350								
AMPLITUDE =	.0223	.0058	.0039	.0024	.0025	.0046	.0019	.0013
PHASE ANGLE =	231.6	38.1	105.2	10.1	6.0	300.8	17.0	153.2
RADIUS = .400								
AMPLITUDE =	.0059	.0031	.0021	.0021	.0014	.0026	.0012	.0008
PHASE ANGLE =	214.0	328.5	94.2	48.6	346.0	301.2	8.8	129.7
RADIUS = .500								
AMPLITUDE =	.0187	.0063	.0038	.0032	.0012	.0004	.0005	.0007
PHASE ANGLE =	67.1	279.4	79.7	90.5	219.4	104.4	326.7	53.5
RADIUS = .600								
AMPLITUDE =	.0296	.0106	.0054	.0040	.0017	.0019	.0004	.0009
PHASE ANGLE =	67.0	259.5	90.8	101.3	238.4	112.9	281.8	26.3
RADIUS = .700								
AMPLITUDE =	.0241	.0064	.0041	.0033	.0011	.0018	.0004	.0006
PHASE ANGLE =	80.0	267.6	94.1	100.0	251.8	100.5	341.7	3.7
RADIUS = .800								
AMPLITUDE =	.0177	.0024	.0022	.0018	.0005	.0013	.0007	.0003
PHASE ANGLE =	93.0	249.3	106.0	98.8	286.8	86.8	17.6	321.3
RADIUS = .900								
AMPLITUDE =	.0122	.0002	.0019	.0030	.0002	.0008	.0007	.0001
PHASE ANGLE =	87.8	15.2	108.2	102.9	320.5	82.6	43.6	258.3
RADIUS = 1.000								
AMPLITUDE =	.0103	.0012	.0053	.0028	.0001	.0004	.0007	.0002
PHASE ANGLE =	82.1	147.8	94.7	107.0	159.4	102.5	68.0	179.8

TABLE G-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC GKTSW015
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0052	.0060	.0038	.0019	.0043	.0013	.0025	.0035
PHASE ANGLE =	201.8	63.0	33.5	305.9	207.7	141.0	84.0	34.5
RADIUS = .350								
AMPLITUDE =	.0041	.0042	.0027	.0014	.0030	.0010	.0018	.0025
PHASE ANGLE =	198.5	59.9	38.4	2.2	203.7	155.8	90.8	38.0
RADIUS = .400								
AMPLITUDE =	.0029	.0021	.0018	.0008	.0016	.0008	.0011	.0014
PHASE ANGLE =	192.3	50.4	48.7	15.9	192.5	180.2	108.5	47.3
RADIUS = .500								
AMPLITUDE =	.0012	.0011	.0006	.0004	.0007	.0007	.0008	.0005
PHASE ANGLE =	163.9	266.2	112.7	82.1	89.0	219.7	184.9	142.3
RADIUS = .600								
AMPLITUDE =	.0008	.0020	.0009	.0004	.0011	.0006	.0011	.0009
PHASE ANGLE =	95.5	263.0	183.4	135.1	60.9	236.9	210.4	182.0
RADIUS = .700								
AMPLITUDE =	.0007	.0006	.0009	.0005	.0005	.0003	.0008	.0002
PHASE ANGLE =	50.8	260.1	239.3	276.6	179.4	89.1	192.1	117.0
RADIUS = .800								
AMPLITUDE =	.0006	.0006	.0011	.0007	.0013	.0007	.0005	.0006
PHASE ANGLE =	24.7	74.3	275.4	298.0	213.5	69.5	170.0	28.0
RADIUS = .900								
AMPLITUDE =	.0004	.0009	.0010	.0004	.0009	.0005	.0002	.0006
PHASE ANGLE =	30.2	63.8	296.2	26.0	231.5	38.1	204.6	348.0
RADIUS = 1.000								
AMPLITUDE =	.0003	.0007	.0008	.0012	.0005	.0005	.0004	.0006
PHASE ANGLE =	70.7	40.4	314.8	77.8	315.4	324.4	286.7	293.5

TABLE G-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 15

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC 6KTSW015
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2203	.0033	.0008	.0004	.0019	.0006	.0008	.0005
PHASE ANGLE =	182.2	103.0	32.3	291.2	19.6	169.3	41.8	201.6
RADIUS = .633								
AMPLITUDE =	.2005	.0040	.0006	.0012	.0012	.0004	.0008	.0003
PHASE ANGLE =	182.3	260.2	49.0	114.8	12.7	153.7	14.2	129.4
RADIUS = .781								
AMPLITUDE =	.1899	.0039	.0020	.0002	.0008	.0005	.0003	.0004
PHASE ANGLE =	181.3	71.1	12.0	257.9	31.9	114.6	356.4	162.0
RADIUS = .963								
AMPLITUDE =	.1799	.0041	.0017	.0008	.0003	.0004	.0002	.0002
PHASE ANGLE =	180.7	310.9	10.4	88.0	43.6	201.3	81.1	105.2

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0007	.0004	.0003	.0005	.0002	.0002	.0001	.0003
PHASE ANGLE =	25.5	166.3	49.5	302.6	312.9	28.0	298.5	153.0
RADIUS = .633								
AMPLITUDE =	.0006	.0004	.0003	.0007	.0003	.0003	.0003	.0005
PHASE ANGLE =	334.6	180.5	52.8	149.8	273.2	224.0	344.0	137.1
RADIUS = .781								
AMPLITUDE =	.0002	.0002	.0001	.0002	.0003	.0002	.0006	.0002
PHASE ANGLE =	51.4	99.8	250.3	337.5	110.4	79.8	354.8	287.0
RADIUS = .963								
AMPLITUDE =	.0001	.0001	.0006	.0002	.0004	.0006	.0003	.0002
PHASE ANGLE =	256.3	59.1	270.8	145.5	94.3	179.7	51.4	134.5

TABLE G-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 15

VELOCITY COMPONENT RATIOS FOR MODEL 5071 BASS BOAT ONLY 10 INC 6KTSW015
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2422	.0223	.0028	.0045	.0027	.0008	.0010	.0016
PHASE ANGLE =	181.3	96.6	10.3	292.1	31.2	164.7	91.9	220.7
RADIUS = .350								
AMPLITUDE =	.2359	.0162	.0021	.0032	.0025	.0007	.0009	.0013
PHASE ANGLE =	181.6	97.2	13.1	292.1	28.1	166.8	77.3	218.3
RADIUS = .400								
AMPLITUDE =	.2282	.0093	.0014	.0017	.0022	.0007	.0008	.0009
PHASE ANGLE =	181.9	98.6	19.1	292.1	23.9	168.7	58.7	213.1
RADIUS = .500								
AMPLITUDE =	.2146	.0004	.0005	.0003	.0017	.0006	.0009	.0004
PHASE ANGLE =	182.3	210.1	48.9	114.9	16.6	168.3	32.1	184.6
RADIUS = .600								
AMPLITUDE =	.2036	.0039	.0005	.0012	.0013	.0005	.0008	.0003
PHASE ANGLE =	182.4	277.2	61.1	114.2	12.6	159.4	17.6	135.3
RADIUS = .700								
AMPLITUDE =	.1954	.0013	.0014	.0004	.0010	.0005	.0005	.0004
PHASE ANGLE =	181.8	47.7	18.6	134.8	21.6	325.4	5.6	153.6
RADIUS = .800								
AMPLITUDE =	.1887	.0041	.0021	.0008	.0007	.0004	.0002	.0004
PHASE ANGLE =	181.2	70.2	12.0	266.4	34.1	114.9	355.8	162.1
RADIUS = .900								
AMPLITUDE =	.1830	.0024	.0021	.0001	.0005	.0003	.0001	.0003
PHASE ANGLE =	180.8	31.6	10.3	98.3	43.1	147.0	45.8	147.9
RADIUS = 1.000								
AMPLITUDE =	.1799	.0041	.0017	.0008	.0003	.0004	.0002	.0002
PHASE ANGLE =	180.7	310.9	10.4	88.0	43.6	201.3	81.1	105.2

TABLE G-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC GKTSw015
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0016	.0005	.0001	.0029	.0006	.0014	.0002	.0007
PHASE ANGLE =	80.3	88.4	284.9	319.5	61.5	41.9	227.9	294.5
RADIUS = .350								
AMPLITUDE =	.0012	.0004	.0001	.0021	.0004	.0010	.0001	.0004
PHASE ANGLE =	71.3	110.3	11.2	318.3	49.0	40.7	241.4	286.4
RADIUS = .400								
AMPLITUDE =	.0009	.0004	.0002	.0012	.0002	.0006	.0001	.0001
PHASE ANGLE =	53.4	142.8	42.5	315.1	9.8	37.8	266.7	235.2
RADIUS = .500								
AMPLITUDE =	.0007	.0005	.0003	.0002	.0003	.0001	.0002	.0004
PHASE ANGLE =	4.3	175.6	51.7	214.1	293.8	307.7	317.3	142.4
RADIUS = .600								
AMPLITUDE =	.0007	.0005	.0003	.0006	.0003	.0003	.0003	.0005
PHASE ANGLE =	338.0	181.9	53.1	151.9	277.3	227.9	339.8	137.0
RADIUS = .700								
AMPLITUDE =	.0003	.0003	.0001	.0002	.0001	.0000	.0005	.0001
PHASE ANGLE =	356.2	148.0	54.4	145.5	181.8	102.8	349.2	170.5
RADIUS = .800								
AMPLITUDE =	.0002	.0002	.0002	.0002	.0003	.0002	.0006	.0002
PHASE ANGLE =	64.3	92.2	251.4	336.5	108.3	85.2	356.6	289.9
RADIUS = .900								
AMPLITUDE =	.0001	.0002	.0004	.0001	.0004	.0003	.0004	.0001
PHASE ANGLE =	112.9	69.4	262.2	346.0	100.4	148.9	14.3	275.2
RADIUS = 1.000								
AMPLITUDE =	.0001	.0001	.0005	.0002	.0004	.0006	.0003	.0002
PHASE ANGLE =	256.3	59.1	270.2	145.5	94.3	179.7	51.4	134.5

APPENDIX H

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS

FOR EXPERIMENT 16

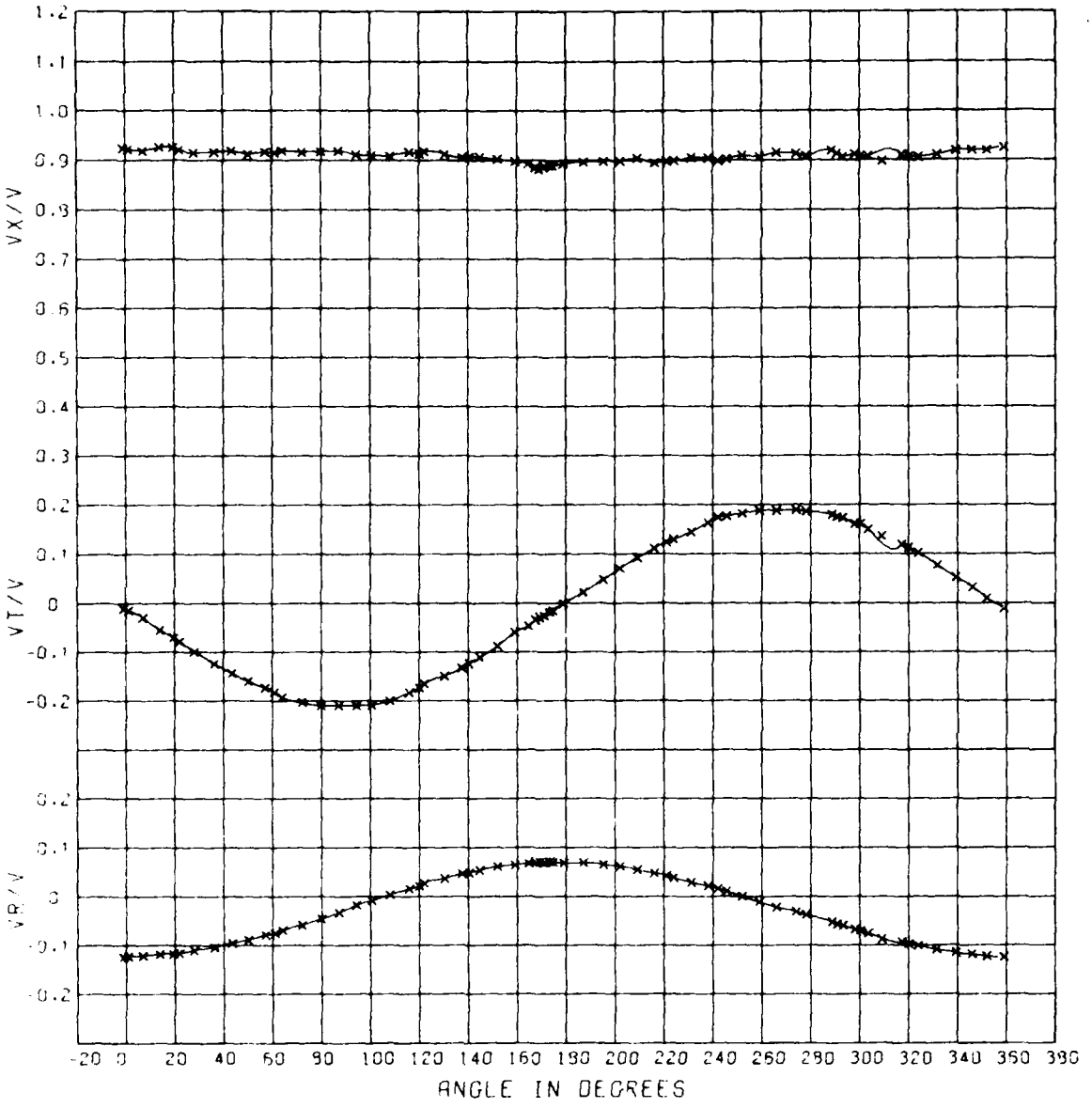

Figure H-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 16

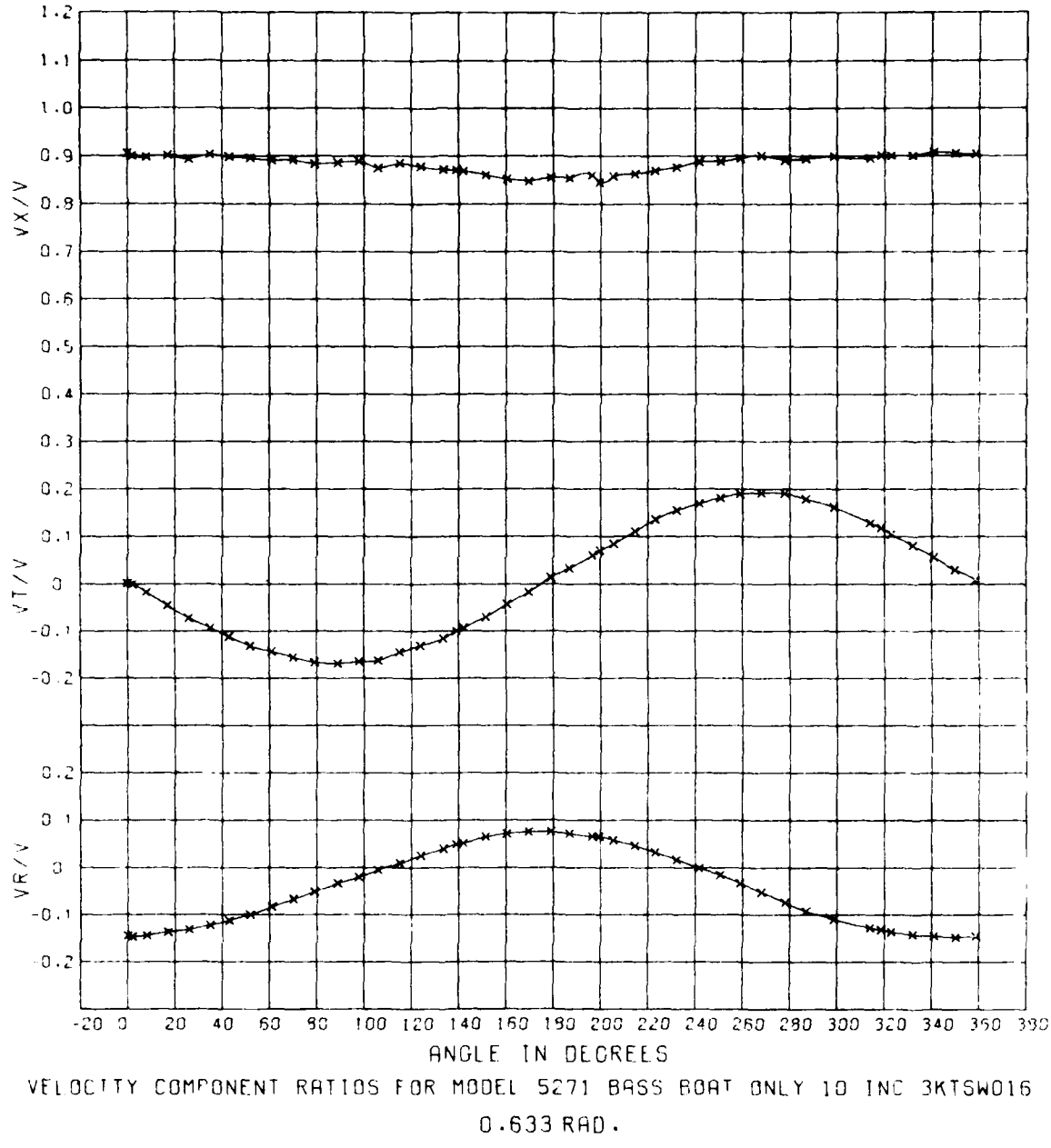

Figure H-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 16

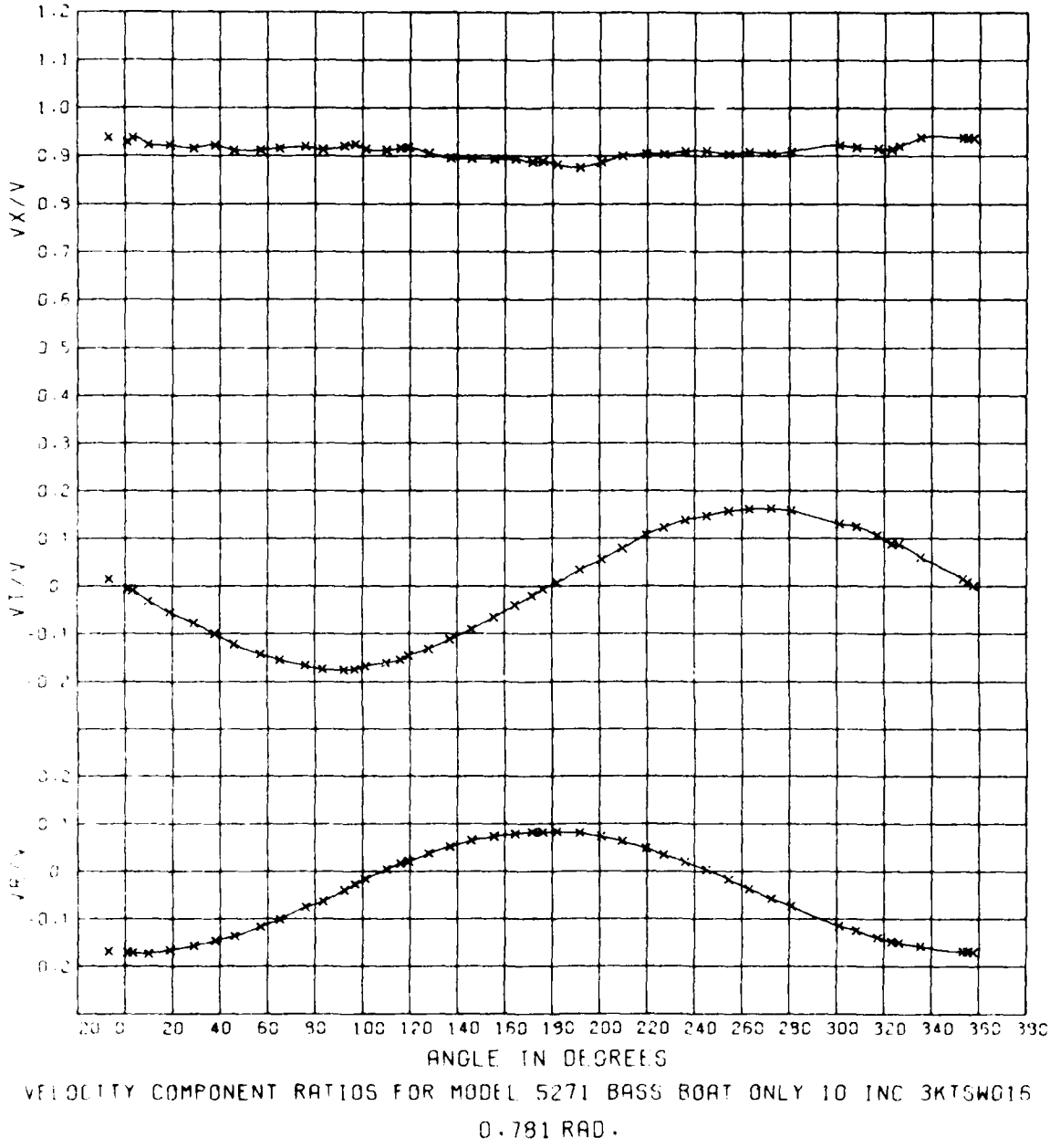

Figure H-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 16

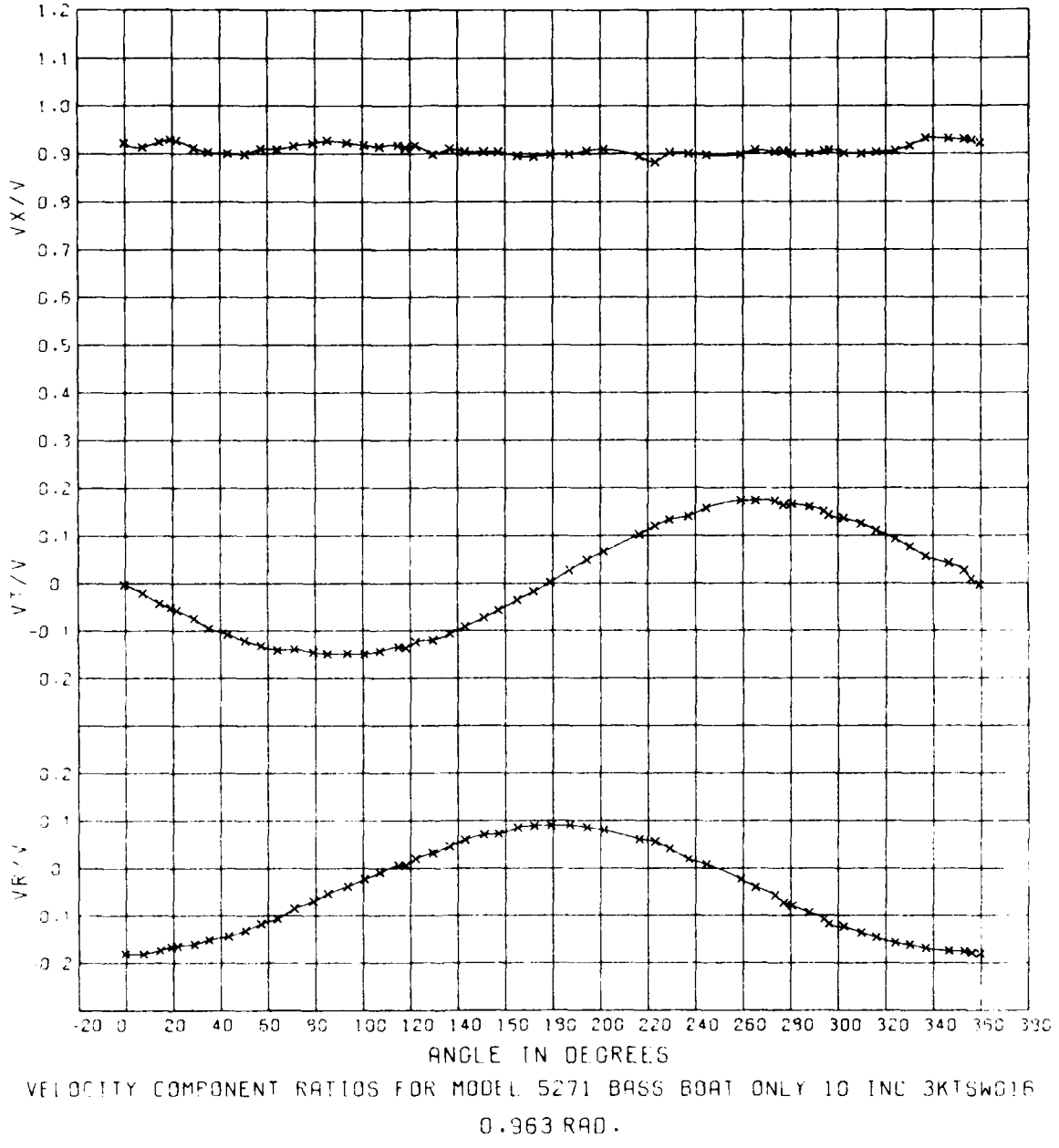

Figure H-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 16

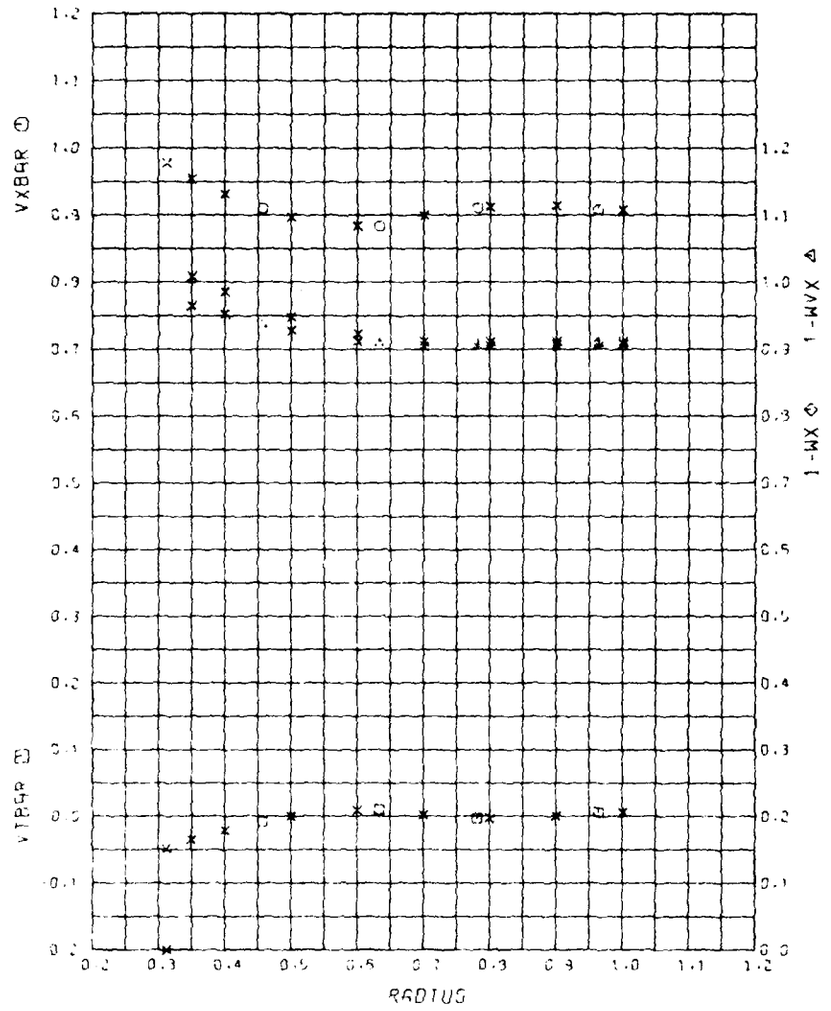

Figure H-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 16

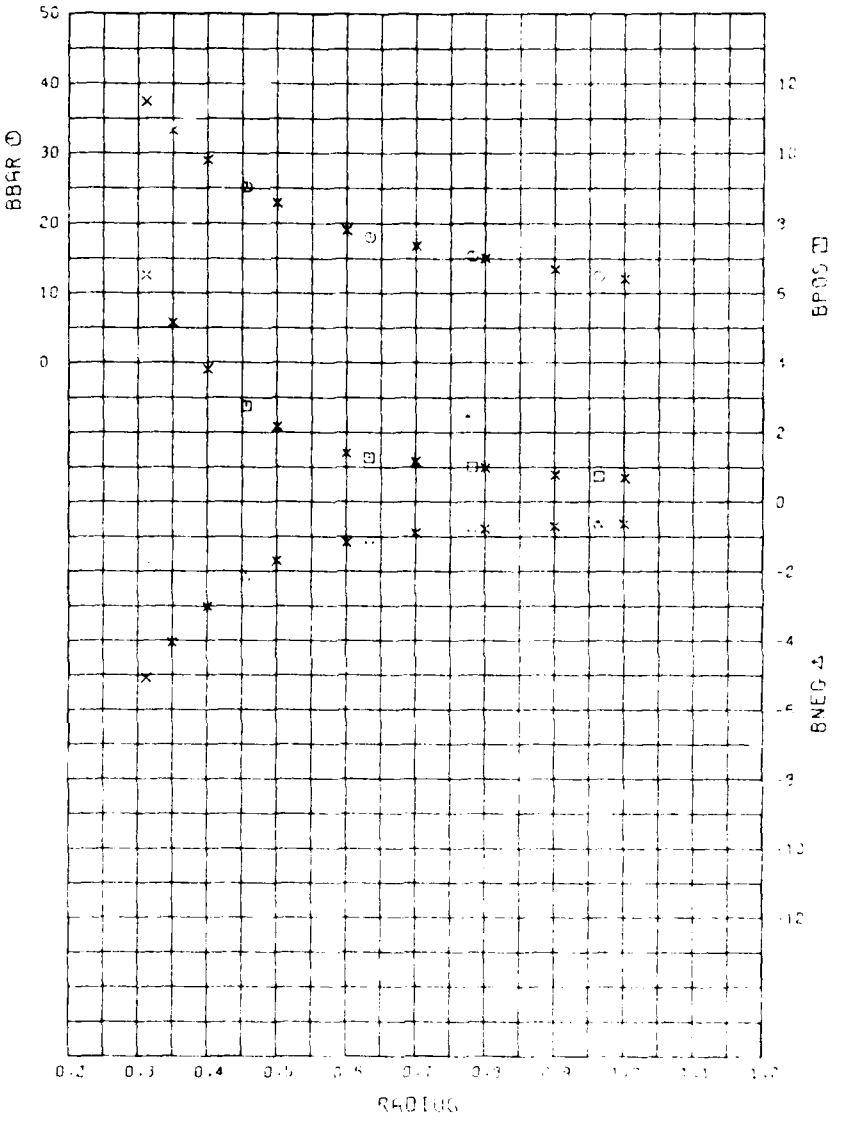

Figure H-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 16

TABLE H-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA
WITH BASS DYNAMOMETER BOAT, EXPERIMENT 16

RADIUS = .456				RADIUS = .633				RADIUS = .781				RADIUS = .963			
ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V	ANGLE	VX/V	VT/V	VR/V
-1.0	.926	-.011	-.126	0.0	.985	-.001	-.144	-6.9	.939	.015	-.169	-1.0	.926	-.002	-.177
1.0	.923	-.015	-.123	1.0	.899	-.008	-.146	1.0	.920	-.006	-.172	0.0	.921	-.006	-.183
7.0	.918	-.030	-.121	3.0	.899	-.010	-.143	3.3	.937	-.010	-.171	7.3	.913	-.021	-.181
14.0	.927	-.055	-.118	17.0	.901	-.046	-.136	10.0	.923	-.032	-.173	14.4	.924	-.042	-.173
19.5	.926	-.079	-.117	25.0	.893	-.072	-.131	19.0	.922	-.056	-.166	19.0	.929	-.053	-.166
21.9	.928	-.078	-.116	35.9	.902	-.092	-.122	29.0	.916	-.079	-.158	21.6	.927	-.057	-.164
28.0	.915	-.099	-.110	43.0	.898	-.112	-.112	38.0	.927	-.108	-.147	28.0	.911	-.074	-.148
36.3	.916	-.126	-.106	52.0	.895	-.131	-.099	46.0	.911	-.122	-.136	35.0	.903	-.099	-.131
43.4	.919	-.144	-.095	61.0	.891	-.142	-.083	57.0	.917	-.143	-.117	43.1	.900	-.108	-.143
50.0	.911	-.168	-.088	70.0	.891	-.155	-.067	65.1	.915	-.154	-.101	50.3	.899	-.121	-.132
57.0	.917	-.173	-.078	79.0	.886	-.165	-.051	76.0	.919	-.167	-.076	57.0	.915	-.132	-.117
64.9	.916	-.182	-.075	88.0	.886	-.168	-.034	83.7	.913	-.174	-.066	64.0	.908	-.140	-.106
64.8	.919	-.193	-.069	97.0	.889	-.164	-.021	92.3	.920	-.176	-.048	71.0	.916	-.138	-.084
72.0	.916	-.203	-.058	106.0	.875	-.162	-.009	96.9	.924	-.175	-.027	78.0	.922	-.145	-.069
79.6	.915	-.218	-.046	115.0	.885	-.146	-.010	101.3	.914	-.169	-.016	85.0	.926	-.144	-.053
86.0	.910	-.218	-.045	124.0	.879	-.138	.025	110.0	.912	-.161	.004	93.3	.923	-.144	-.039
87.0	.919	-.218	-.033	133.0	.871	-.116	.048	116.0	.916	-.155	.016	100.9	.918	-.149	-.023
94.2	.912	-.215	-.018	139.0	.871	-.108	.049	119.4	.917	-.147	.021	107.0	.915	-.143	-.009
100.9	.909	-.209	-.008	142.0	.869	-.093	.051	128.0	.905	-.132	.036	114.9	.918	-.136	.006
108.0	.908	-.208	.004	151.9	.866	-.069	.065	137.0	.895	-.113	.052	118.0	.912	-.136	.006
115.9	.916	-.182	.016	160.5	.853	-.043	.071	146.0	.895	-.091	.065	122.1	.917	-.123	.020
120.8	.911	-.173	.022	169.6	.868	-.017	.076	155.4	.893	-.066	.073	129.4	.897	-.121	.032
122.0	.916	-.165	.027	179.0	.895	.014	.074	164.4	.894	-.048	.079	136.5	.916	-.107	.047
130.3	.912	-.149	.037	187.0	.904	.033	.072	171.6	.888	-.029	.082	143.8	.906	-.091	.058
137.4	.906	-.133	.046	196.5	.901	.044	.066	178.0	.889	-.006	.082	150.9	.904	-.072	.078
144.3	.906	-.124	.049	199.5	.865	.078	.066	182.0	.881	.007	.083	157.8	.904	-.057	.072
144.6	.907	-.111	.055	204.4	.858	.085	.058	191.6	.876	.036	.080	165.8	.896	-.035	.065
151.8	.902	-.098	.061	215.9	.863	.111	.046	200.6	.887	.056	.073	172.8	.894	-.017	.048
159.8	.897	-.079	.065	223.0	.870	.136	.032	209.5	.880	.079	.064	179.8	.898	.002	.028
164.6	.903	-.057	.067	232.0	.875	.159	.017	219.6	.904	.087	.049	186.9	.899	.025	.008
167.6	.905	-.035	.070	241.6	.888	.169	-.001	227.0	.904	.123	.035	194.1	.905	.044	-.006
169.2	.881	-.038	.070	250.6	.888	.181	-.015	236.8	.905	.138	.019	201.3	.909	.057	-.008
171.8	.886	-.025	.069	259.0	.895	.198	-.033	246.8	.911	.167	.003	215.6	.898	.103	-.006
172.6	.895	-.019	.069	268.0	.901	.198	-.052	254.4	.901	.157	-.017	217.1	.898	.102	-.056
173.6	.888	-.019	.072	277.0	.891	.195	-.073	262.8	.900	.161	-.037	222.9	.892	.121	-.056
176.6	.889	-.016	.070	286.0	.896	.179	-.092	272.4	.905	.163	-.058	229.8	.902	.133	-.041
179.8	.892	-.001	.068	295.6	.899	.162	-.109	280.5	.905	.155	-.073	237.8	.900	.148	-.019
187.8	.897	.022	.059	313.0	.899	.129	-.127	281.0	.903	.161	-.075	244.5	.897	.156	-.009
195.2	.897	.048	.046	316.5	.901	.119	-.131	301.0	.922	.131	-.115	252.9	.898	.173	-.023
202.8	.899	.071	.032	322.9	.900	.105	-.139	308.2	.918	.129	-.126	260.8	.898	.173	-.048
209.8	.906	.092	.005	331.6	.900	.082	-.141	317.1	.915	.108	-.139	273.3	.904	.173	-.057
216.8	.895	.112	-.010	340.8	.904	.057	-.144	323.8	.914	.080	-.149	276.9	.906	.164	-.073
221.8	.897	.126	-.023	347.9	.906	.038	-.147	326.1	.919	.057	-.158	288.5	.908	.146	-.078
223.2	.899	.138	-.039	350.8	.907	.020	-.146	335.1	.939	.050	-.158	287.8	.908	.141	-.093
231.2	.906	.145	-.078	359.0	.901	.007	-.155	345.3	.951	.032	-.162	296.8	.905	.151	-.107
238.8	.906	.164	-.072	360.8	.904	.001	-.144	353.1	.939	.015	-.169	296.8	.908	.143	-.118
247.8	.899	.175	-.016					363.3	.937	-.010	-.171	307.3	.901	.137	-.123
249.6	.903	.176	-.011									309.6	.908	.135	-.136
252.8	.909	.182	-.000									316.8	.903	.111	-.165
259.2	.907	.188	-.011									323.9	.906	.093	-.197
266.8	.915	.190	-.022									330.8	.916	.077	-.161
274.8	.913	.184	-.031									336.6	.932	.057	-.168
278.8	.904	.186	-.037									346.3	.931	.042	-.174
288.6	.920	.174	-.042									352.9	.938	.027	-.174
288.3	.915	.176	-.059									356.8	.929	.009	-.179
291.8	.918	.175	-.058									359.8	.924	-.002	-.177
293.8	.904	.173	-.076									360.8	.921	-.006	-.183
298.8	.911	.168	-.060												
300.8	.909	.168	-.078												
309.1	.905	.161	-.069												
317.2	.913	.119	-.093												
322.9	.904	.149	-.074												
323.4	.906	.151	-.076												
329.8	.898	.136	-.107												
330.1	.906	.114	-.096												
328.1	.907	.112	-.099												
324.8	.906	.102	-.101												
331.6	.910	.077	-.108												
339.8	.917	.051	-.113												
339.9	.919	.052	-.119												
340.8	.920	.033	-.110												
352.6	.919	.018	-.122												
359.8	.924	-.011	-.126												
361.8	.921	-.015	-.121												

TABLE H-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 16

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC 3KTSW016
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.910	.884	.911	.908	.977	.955	.931	.897	.884	.899	.912	.913	.908
VTBAR =	-.008	.010	-.003	.006	-.048	-.035	-.021	.000	.009	.002	-.003	-.000	.006
VRBAR =	-.026	-.041	-.046	-.047	-.008	-.013	-.020	-.031	-.039	-.044	-.046	-.047	-.047
1-WVX =	.937	.909	.903	.906	0.000	.965	.952	.928	.912	.905	.905	.907	.908
1-WX =	.964	.918	.909	.910	0.000	1.009	.985	.946	.923	.912	.911	.912	.912
BBAR =	25.22	18.12	15.34	12.49	37.38	33.31	28.48	22.88	19.05	16.80	15.02	13.42	12.04
BPOS =	2.76	1.27	1.02	.74	6.52	5.16	3.81	2.17	1.40	1.16	.98	.78	.70
THETA =	85.00	95.00	95.00	85.00	80.00	80.00	82.50	90.00	92.50	95.00	95.00	95.00	85.00
BNEG =	-2.18	-1.13	-.79	-.66	-5.07	-4.06	-3.02	-1.70	-1.18	-.90	- 77	-.69	-.63
THETA =	242.50	200.00	285.00	222.50	280.00	242.50	242.50	242.50	200.00	200.00	255.00	285.00	222.50

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-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 16

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC 3KTSW016
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0106	.0032	.0032	.0016	.0029	.0017	.0004	.0002
PHASE ANGLE =	74.2	264.9	71.7	21.0	122.4	9.5	200.2	170.6
RADIUS = .633								
AMPLITUDE =	.0220	.0068	.0045	.0010	.0025	.0005	.0015	.0008
PHASE ANGLE =	98.3	267.2	74.0	190.6	209.8	69.4	192.2	92.4
RADIUS = .781								
AMPLITUDE =	.0176	.0032	.0077	.0014	.0023	.0037	.0006	.0033
PHASE ANGLE =	88.2	229.0	118.8	168.2	65.6	165.2	210.1	211.8
RADIUS = .963								
AMPLITUDE =	.0102	.0029	.0065	.0056	.0021	.0025	.0024	.0032
PHASE ANGLE =	53.9	157.1	134.8	90.4	126.6	291.4	217.6	271.8

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0012	.0014	.0014	.0005	.0018	.0010	.0012	.0012
PHASE ANGLE =	145.2	294.6	236.8	323.8	306.9	60.0	164.3	139.2
RADIUS = .633								
AMPLITUDE =	.0011	.0010	.0015	.0009	.0014	.0018	.0010	.0004
PHASE ANGLE =	224.9	356.5	156.8	68.4	255.2	272.2	98.8	337.1
RADIUS = .781								
AMPLITUDE =	.0008	.0004	.0010	.0019	.0015	.0003	.0010	.0002
PHASE ANGLE =	337.3	282.3	1.3	48.6	299.9	241.2	86.9	28.1
RADIUS = .963								
AMPLITUDE =	.0016	.0033	.0012	.0026	.0008	.0001	.0011	.0008
PHASE ANGLE =	206.5	269.1	208.4	152.3	251.6	12.8	179.7	77.3

TABLE H-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 16

VELOCITY COMPONENT RATIOS F = MODEL 5271 BARE BOAT ONLY 10 KNOTS&C16
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0205	.0071	.0053	.0037	.0118	.0007	.0024	.0049
PHASE ANGLE =	322.0	105.3	141.2	23.5	78.1	42.3	4.2	227.8
RADIUS = .350								
AMPLITUDE =	.0132	.0038	.0014	.0014	.0067	.0011	.0015	.0032
PHASE ANGLE =	335.4	110.1	146.0	22.9	82.8	20.2	3.0	226.9
RADIUS = .400								
AMPLITUDE =	.0077	.0007	.0011	.0030	.0053	.0015	.0005	.0015
PHASE ANGLE =	20.7	183.1	98.5	22.0	93.9	11.9	356.4	223.3
RADIUS = .500								
AMPLITUDE =	.0148	.0050	.0014	.0007	.0023	.0016	.0009	.0005
PHASE ANGLE =	68.8	204.9	62.2	20.8	160.9	10.1	192.9	94.4
RADIUS = .600								
AMPLITUDE =	.0212	.0048	.0043	.0007	.0027	.0008	.0015	.0010
PHASE ANGLE =	97.9	268.7	88.7	192.3	206.2	29.6	191.6	77.0
RADIUS = .700								
AMPLITUDE =	.0203	.0048	.0041	.0014	.0007	.0026	.0009	.0019
PHASE ANGLE =	94.4	254.7	104.0	197.0	108.0	156.3	144.4	145.3
RADIUS = .800								
AMPLITUDE =	.0168	.0029	.0023	.0014	.0025	.0037	.0007	.0035
PHASE ANGLE =	86.3	221.0	121.0	196.5	65.7	167.3	214.0	215.0
RADIUS = .900								
AMPLITUDE =	.0126	.0027	.0028	.0032	.0024	.0019	.0014	.0034
PHASE ANGLE =	71.5	176.8	129.5	192.5	83.7	201.0	219.6	234.7
RADIUS = 1.000								
AMPLITUDE =	.0102	.0029	.0015	.0014	.0021	.0025	.0024	.0032
PHASE ANGLE =	53.9	157.1	134.8	40.4	126.6	231.4	217.6	271.8

TABLE H-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC 3KTSW016
PROPELLER DIAMETER 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0033	.0038	.0033	.0021	.0048	.0066	.0026	.0041
PHASE ANGLE =	86.9	256.3	272.3	312.8	340.9	82.0	197.0	141.2
RADIUS = .350								
AMPLITUDE =	.0025	.0030	.0027	.0016	.0038	.0048	.0021	.0032
PHASE ANGLE =	95.2	262.3	265.6	312.2	335.8	80.4	191.8	141.1
RADIUS = .400								
AMPLITUDE =	.0017	.0021	.0020	.0010	.0027	.0027	.0016	.0022
PHASE ANGLE =	112.8	274.0	254.0	313.2	325.6	76.5	181.7	140.6
RADIUS = .500								
AMPLITUDE =	.0011	.0012	.0011	.0005	.0015	.0005	.0010	.0006
PHASE ANGLE =	173.7	315.4	220.5	5.4	287.5	322.8	145.8	135.5
RADIUS = .600								
AMPLITUDE =	.0011	.0011	.0006	.0007	.0014	.0017	.0010	.0003
PHASE ANGLE =	214.9	351.3	181.8	69.5	257.0	274.6	106.6	341.1
RADIUS = .700								
AMPLITUDE =	.0006	.0005	.0005	.0015	.0014	.0010	.0011	.0003
PHASE ANGLE =	302.9	2.3	20.3	45.1	284.5	265.3	86.5	344.3
RADIUS = .800								
AMPLITUDE =	.0008	.0006	.0011	.0018	.0015	.0002	.0009	.0002
PHASE ANGLE =	337.2	271.9	358.0	52.2	301.0	227.4	89.6	41.3
RADIUS = .900								
AMPLITUDE =	.0005	.0020	.0012	.0015	.0011	.0001	.0007	.0005
PHASE ANGLE =	252.0	266.3	331.1	109.6	290.6	114.7	137.4	73.3
RADIUS = 1.000								
AMPLITUDE =	.0016	.0033	.0012	.0026	.0008	.0001	.0011	.0008
PHASE ANGLE =	206.5	269.1	298.4	152.3	251.6	12.8	179.7	77.3

TABLE H-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 16

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC 3KTSw016
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.1958	.0033	.0058	.0001	.0003	.0006	.0010	.0014
PHASE ANGLE =	182.2	77.3	9.2	194.6	135.0	200.4	285.2	287.0
RADIUS = .633								
AMPLITUDE =	.1761	.0026	.0034	.0005	.0005	.0010	.0012	.0005
PHASE ANGLE =	181.9	301.3	7.9	103.0	98.9	109.4	344.0	86.3
RADIUS = .781								
AMPLITUDE =	.1654	.0033	.0027	.0011	.0005	.0002	.0012	.0006
PHASE ANGLE =	181.0	81.6	10.3	238.4	306.7	166.4	330.8	107.4
RADIUS = .963								
AMPLITUDE =	.1607	.0045	.0010	.0023	.0002	.0005	.0002	.0011
PHASE ANGLE =	181.6	291.7	107.0	100.8	176.4	342.8	98.1	192.2

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0027	.0008	.0009	.0012	.0009	.0008	.0010	.0009
PHASE ANGLE =	15.5	352.0	148.5	107.7	208.4	272.7	309.1	319.3
RADIUS = .633								
AMPLITUDE =	.0003	.0004	.0001	.0004	.0009	.0005	.0001	.0004
PHASE ANGLE =	161.6	35.1	5m.4	55.8	346.0	215.4	232.0	32.7
RADIUS = .781								
AMPLITUDE =	.0010	.0004	.0003	.0006	.0005	.0003	.0002	.0005
PHASE ANGLE =	169.9	158.7	17.7	337.7	23.5	83.1	11.3	238.0
RADIUS = .963								
AMPLITUDE =	.0012	.0003	.0013	.0019	.0002	.0007	.0003	.0002
PHASE ANGLE =	162.5	68.1	192.4	248.2	231.5	197.7	53.9	356.6

TABLE H-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 16

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC 3KTSW016
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2173	.0170	.0040	.0022	.0012	.0031	.0026	.0043
PHASE ANGLE =	182.0	90.2	10.8	256.2	268.1	252.5	240.5	280.7
RADIUS = .350								
AMPLITUDE =	.2111	.0126	.0040	.0015	.0007	.0022	.0020	.0034
PHASE ANGLE =	182.1	89.2	10.4	255.3	261.4	248.2	246.6	281.6
RADIUS = .400								
AMPLITUDE =	.2036	.0076	.0069	.0007	.0003	.0013	.0014	.0024
PHASE ANGLE =	182.2	86.6	9.8	251.7	230.4	236.9	259.9	283.4
RADIUS = .500								
AMPLITUDE =	.1902	.0012	.0051	.0003	.0005	.0006	.0009	.0008
PHASE ANGLE =	182.2	38.0	8.7	98.7	116.3	150.4	309.3	293.5
RADIUS = .600								
AMPLITUDE =	.1792	.0025	.0038	.0006	.0006	.0010	.0011	.0003
PHASE ANGLE =	182.0	300.4	7.9	96.4	103.1	112.2	340.8	73.4
RADIUS = .700								
AMPLITUDE =	.1705	.0019	.0033	.0007	.0002	.0006	.0013	.0006
PHASE ANGLE =	181.4	41.6	7.6	237.6	344.5	126.6	335.5	91.3
RADIUS = .800								
AMPLITUDE =	.1645	.0032	.0025	.0010	.0005	.0002	.0011	.0006
PHASE ANGLE =	181.0	60.9	11.7	235.0	304.1	183.6	330.3	113.8
RADIUS = .900								
AMPLITUDE =	.1613	.0016	.0012	.0008	.0003	.0003	.0005	.0007
PHASE ANGLE =	181.1	357.1	37.2	136.5	284.3	313.1	335.2	165.4
RADIUS = 1.000								
AMPLITUDE =	.1607	.0045	.0010	.0023	.0002	.0005	.0002	.0011
PHASE ANGLE =	181.6	291.7	107.0	100.8	176.4	342.8	98.1	192.2

TABLE H-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5271 BASS BOAT ONLY 10 INC 3KTSW016
PROPELLER DIAMETER = 6.00 FEET JA = .739

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

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0068	.0010	.0022	.0022	.0041	.0016	.0026	.0025
PHASE ANGLE =	15.1	321.1	146.6	117.0	185.7	314.9	318.9	283.0
RADIUS = .350								
AMPLITUDE =	.0055	.0010	.0018	.0019	.0031	.0013	.0021	.0020
PHASE ANGLE =	15.1	329.5	147.2	115.2	188.1	306.1	317.2	288.6
RADIUS = .400								
AMPLITUDE =	.0041	.0009	.0014	.0016	.0019	.0010	.0015	.0014
PHASE ANGLE =	15.1	340.4	147.9	112.3	193.5	291.7	314.2	299.4
RADIUS = .500								
AMPLITUDE =	.0017	.0007	.0006	.0010	.0005	.0007	.0006	.0007
PHASE ANGLE =	16.4	.8	148.5	102.2	247.9	257.2	302.5	341.3
RADIUS = .600								
AMPLITUDE =	.0002	.0004	.0001	.0005	.0008	.0005	.0002	.0005
PHASE ANGLE =	64.8	23.5	130.2	74.8	339.2	225.7	261.7	24.9
RADIUS = .700								
AMPLITUDE =	.0007	.0002	.0003	.0005	.0007	.0001	.0001	.0002
PHASE ANGLE =	169.4	130.8	18.9	10.1	3.9	123.7	325.5	260.7
RADIUS = .800								
AMPLITUDE =	.0010	.0005	.0002	.0006	.0005	.0004	.0002	.0005
PHASE ANGLE =	169.6	159.3	18.5	329.2	27.4	84.7	16.2	237.7
RADIUS = .900								
AMPLITUDE =	.0012	.0003	.0005	.0008	.0001	.0003	.0003	.0003
PHASE ANGLE =	166.3	141.3	191.4	271.4	42.2	150.0	38.5	250.4
RADIUS = 1.000								
AMPLITUDE =	.0012	.0003	.0013	.0013	.0002	.0007	.0003	.0002
PHASE ANGLE =	162.5	66.1	192.6	243.2	231.5	197.7	53.9	356.8

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