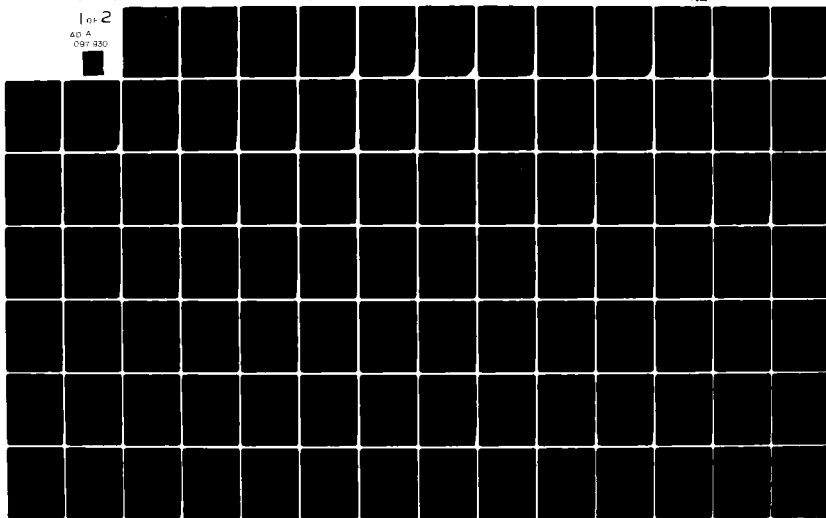


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**DAVID W. TAYLOR NAVAL SHIP
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Bethesda, Maryland 20084



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MEASUREMENTS OF THE EFFECT OF TRIM ON
THE NOMINAL WAKE OF THE NAVAL
AUXILIARY OILER AO-177

by

Michael B. Wilson
Gary A. Hampton

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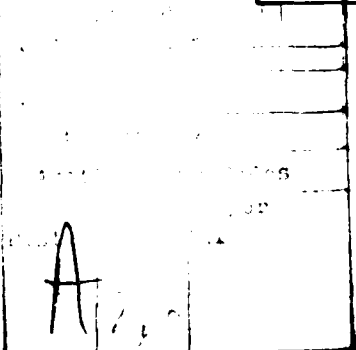
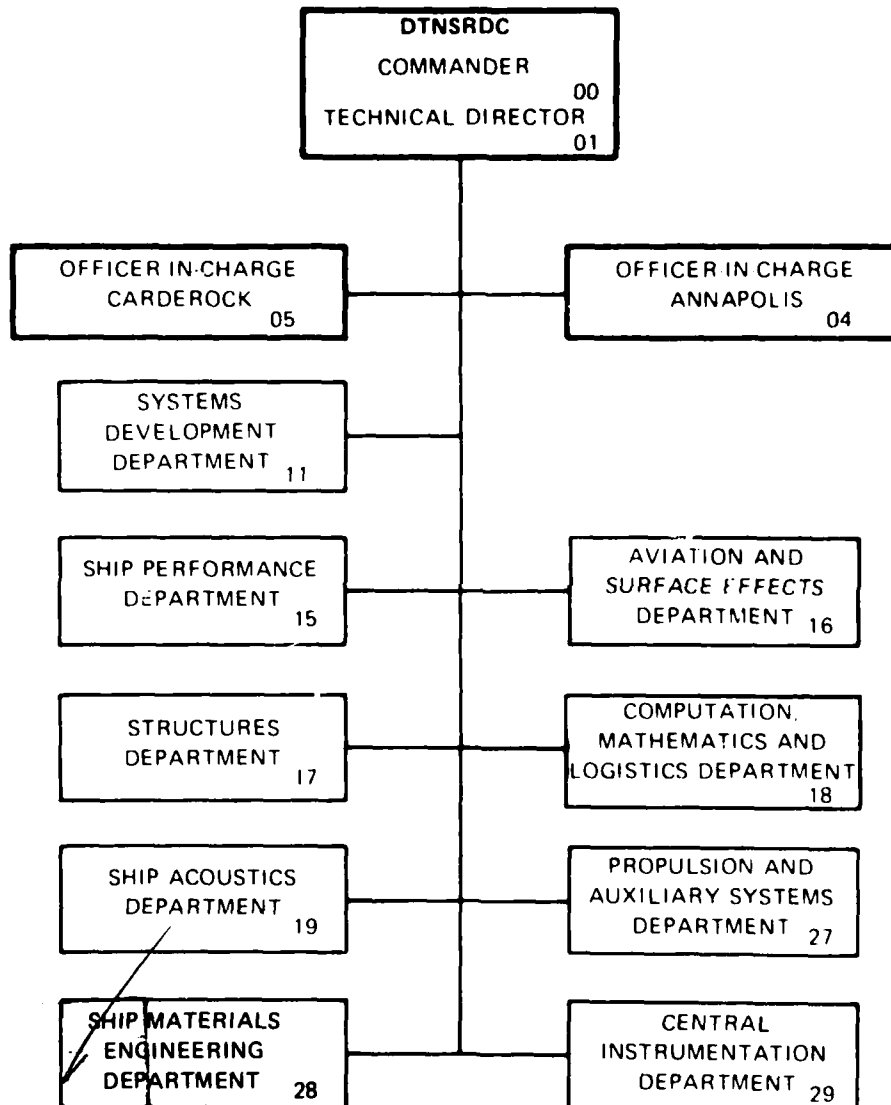
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MEASUREMENTS OF THE EFFECT OF TRIM ON THE NOMINAL WAKE OF
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NOTATION

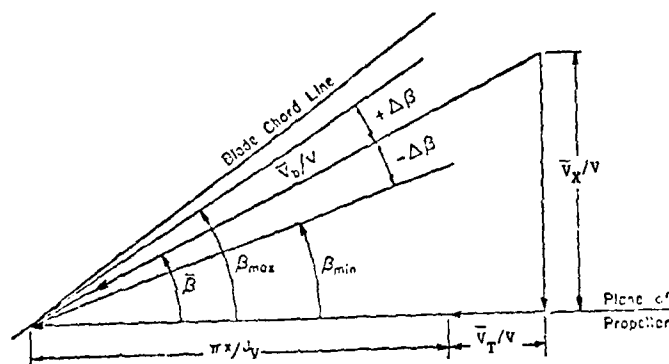
Conventional Symbol	Symbol Used on Computer Plots	Definition	Units*
A_N	COS COEFF	Cosine coefficient of the N^{th} harmonic	-
B_N	SIN COEFF	Sine coefficient of the N^{th} harmonic	-
C_B		Block coefficient	-
C_P		Prismatic coefficient	-
C_X		Maximum section area coefficient	-
D		Propeller diameter	L
C_W		Wake gradient parameter	-
J_V	JV	Apparent advance coefficient $J_V = V/nD$	-
N	N	Harmonic number	-
n		Propeller rate of revolution(rps)	Rev/T
r/R or x	RAD	Radial distance (r) from propeller axis expressed as ratio to propeller radius	-
r_{hub}		Hub radius	L
R		Propeller radius	L
∇		Ship displacement volume	L^3
V		Ship or model velocity (free stream)	L/T
$V_R(x, \theta)$	VR	Radial component of fluid velocity at a given point	L/T
$\bar{V}_R(x)$		Circumferential average radial velocity component	L/T

* M = mass; L = length; T = time.

<u>Conventional Symbol</u>	<u>Symbol Used on Computer Plots</u>	<u>Definition</u>	<u>Units</u>
$V_R(x, \theta)/V$	VR/V	Radial velocity ratio	-
$\bar{V}_R(x)/V$	VRBAR	Average radial velocity ratio	-
$V_T(x, \theta)$	VT	Tangential component of the fluid velocity at a given point	L/T
$\bar{V}_T(x)$		Circumferential average tangential velocity component	L/T
$V_T(x, \theta)/V$	VT/V	Tangential velocity ratio	-
$\bar{V}_T(x)/V$	VTBAR	Average tangential velocity ratio	-
$(\bar{V}_T(x)/V)_N$	AMPLITUDE	Amplitude (B_N for single- screw symmetric; C_N otherwise) of N^{th} harmonic of N^{th} tangential velocity component ratio	-
$V_X(x, \theta)$	VX	Longitudinal component of fluid velocity at a given point (parallel to propeller axis)	L/T
$\bar{V}_X(x)$		Circumferential average velocity component	L/D
$V_X(x, \theta)/V$	VX/V	Axial velocity ratio	-
$\bar{V}_X(x)/V$	VXBAR	Average axial velocity ratio	-
$(\bar{V}_X(x)/V)_N$	AMPLITUDE	Amplitude (A_N for single- screw symmetric; C_N otherwise) of N^{th} harmonic of longitudinal velocity component ratio	-
$V_{X_c}(x, \theta)$		$=V_X(x, \theta) - V_T(x, \theta) \tan \gamma(x, \theta)$ longitudinal velocity component corrected for tangential velocity	L/T
Z		Number of propeller blades	-

<u>Conventional Symbol</u>	<u>Symbol Used on Computer Plots</u>	<u>Definition</u>	<u>Units</u>
ϕ_N	PHASE ANGLE	Phase angle of the N^{th} harmonic	deg
$1-w_X(r/R)$	1-WX	Volumetric mean velocity ratio corrected for tangential velocity $1-w_X = \frac{2 \int_{r_{\text{hub}}/R}^{r/R} (\bar{V}_{X_c}(x)/V) x dx}{(r/R)^2 - (r_{\text{hub}}/R)^2}$ where $\bar{V}_{X_c}(x)/V =$ $\int_0^{2\pi} \left(\frac{V_{X_c}(x, \theta)}{2\pi V} \right) d\theta$	-
$1-w_{VX}(x)$	1-WVX	Volumetric mean velocity ratio without tangential velocity correction $1-w_{VX} = \frac{2 \int_{r_{\text{hub}}/R}^{r/R} (\bar{V}(x)/V) x dx}{(r/R)^2 - (r_{\text{hub}}/R)^2}$	-
$\beta(x, \theta)$		Advance angle for a given point in flow	deg
$\bar{\beta}(x)$	BBAR	Circumferential average advance angle	deg
$+\Delta\beta$	BPOS	Variation of maximum advance angle from the mean value (see sketch)	deg
$-\Delta\beta$	BNEG	Variation of the minimum advance angle from the mean value (see sketch)	deg

Conventional Symbol	Symbol Used on Computer Plots	Definition	Units
θ	ANGLE	Position angle of point in wake field, measured positive counter- clockwise from 12 o'clock, looking forward	deg



VELOCITY DIAGRAM OF BETA ANGLES

ABSTRACT

Wake survey measurements of the nominal wake behind the AO-177 hull have been obtained from model experiments and are presented for cases involving trim variations and a slight change in displacement. Extensive tables and plots of the basic wake data display the three velocity component distributions, summaries of useful averaged wake quantities, and distributions of wake harmonics. Radial distributions of a wake steepness parameter are compared for the various trim conditions, and it appears that any difficulties produced by the ship wake are not introduced by the expected changes in trim.

ADMINISTRATIVE INFORMATION

This work was funded under Naval Sea Systems Command (NAVSEA) Work Request Number OH738, Ship Performance Department Work Unit Number 1532-100.

INTRODUCTION

The AO-177 Class Naval Auxiliary Oiler is a single-screw, finely-shaped oil tanker equipped with a seven-bladed, 45-degree skewed propeller operating behind a conventional clearwater stern arrangement. Some of its principal particulars are given below.

Particulars of the AO-177

	<u>U.S. Customary</u>	<u>S.I.</u>
Waterline Length, L_{WL}	560.5 ft	170.8 m
Beam	88 ft	26.8 m
Mean Draft (Design)	32.5 ft	9.9 m
Mean Draft (Trial)	31.5 ft	9.6 m
Displacement (Design)	27,380 Tons	27,820 tonnes
Displacement (Trial)	26,390 Tons	26,810 tonnes
Propeller Diameter, D	21 ft	6.4 m
Vertical Tip Clearance, a_z	6.12 ft	1.865 m
Horizontal Tip Clearance, a_{x_t}	11.4 ft	3.48 m
Full Power Speed, V	21.5 knots	

Particulars of the AO-177 (Continued)

Form Coefficients Based on L_{WL} :

$$C_B = 0.605$$

$$C_P = 0.62$$

$$C_X = 0.975$$

$$\nabla/L_{WL}^3 = 5.24 \times 10^{-3}$$

On Builders Trials conducted in July 1980 with the first of the Class AO-177, there were experienced serious levels of airborne noise, traces of propeller blade cavitation erosion with bent trailing edge, and some unpleasant localized structural vibration levels. It is likely that all these problems can be traced in one way or another to the characteristics of fluctuating cavities that appear near the propeller blade tips as each blade passes through the large wake shadow behind the hull centered about the 12 o'clock position of the propeller disc. The details of this wake are important to understanding the sources of any propeller-excited difficulties.

As best as can be determined, the initial trial was run in a bow-down trim condition that differed somewhat from the design condition. It could not be estimated with assurance just what the effects of trim were on the wake distribution of this ship, so the experiments described in this report were performed to establish what changes were introduced by operation at the estimated trim of the trial, and also to establish any trends produced by a more extreme bow down condition.

The estimated trial displacement of 26,390 tons (26,810 tonnes) is 96.4 percent of the original full load design value. Relative changes of static trim, away from the design condition, can be defined in terms of an angle based on the length between perpendiculars and the difference in trim.

	Trim Condition	Change in Trim Angle
Design	1.5 ft (0.457 m) x Stern	--
Trial (Estimated)	1.0 ft (0.305 m) x Bow	0.26 deg
Extreme Trim Case	3.5 ft (1.067 m) x Bow	0.92 deg

PROCEDURE

Wake survey experiments were conducted in the deep water basin of Carriage 2 using David W. Taylor Naval Ship Research and Development Center (DTNSRDC) Model 5326 which represents the AO-177 hull with a linear scale ratio of $\lambda = 25.682$. The model was run with the bilge keels attached, but with the rudder removed to accommodate the wake survey probe.

The three velocity components of the wake velocity were obtained with DTNSRDC pitot tube rake Number 8 connected to a bank of differential pressure transducers. This rake consists of five, 5-hole spherically-headed pitot tubes mounted on a foil shaped housing. The tips of the pitot tubes were located at a nominal propeller plane taken as 4.62 ft (1.408 m) aft of Station 19.5 full-scale, corresponding to the location of the plane of the original wake survey reported by Remmers and Hendrican.^{1*} As indicated in Figure 1, the experimental wake plane is 1.12 ft (0.3414 m) aft full-scale of the propeller reference plane, and happens to pass through the leading edge of the propeller swept outline at a radius of about 0.75R. Some details of the propeller geometry for DTNSRDC Propeller Number 4677 are given by Hendrican and Remmers² and Valentine and Chase.³

The radial locations of the pitot tubes are of course fixed on the model apparatus, and are expressed nondimensionally as radius ratios r/R , given for full-scale propeller diameters of 21 ft (6.4 m) and 23 ft (7.01 m) in the following table.

	Radius Ratios, r/R	
	D=21 ft (6.4 m)	D=23 ft (7.01 m)
Tube 1	0.359	0.328
Tube 2	0.556	0.508
Tube 3	0.774	0.707
Tube 4	1.017	0.929
Tube 5	1.178	1.076

The radius ratios for the 23 ft (7.01 m) diameter are useful for certain comparisons that overlap with the original AO wake survey results of Reference 1.

* References are listed on Page 9.

However, the final design propeller installed on the ship has a diameter of 21 ft (6.4 m), and all the new wake data have been analyzed on that basis. The radial positions of the pitot tube locations and relative position of the 21 ft (6.4 m) propeller disc with respect to the afterbody hull sections are shown in Figure 2.

Certain other definitions and conventions are also presented in Figure 2. When viewed looking forward, the angle θ is measured positive counterclockwise, with zero at 12 o'clock. The tangential and radial velocity components, V_T and V_R respectively, are taken as shown in Figure 2 to agree with the convention described by Hadler and Cheng.⁴

The shape of the pitot tube rake is such that the trim of the model could be altered by forces generated on the rake in various angular positions. In order to maintain the natural trim the same throughout each survey, the model was first towed free to trim with the rake in the zero degree position for each experimental condition at a speed corresponding to the ship speed of 20 knots. The model was then locked in trim for that particular experiment.

Five wake survey experiments reported on here correspond to a ship speed of 20 knots and the following ship conditions of displacement and trim.

Date	Experiment No.	Displacement		Trim	
		(Tons)	(tonnes)	(ft)	(m)
May 1974	21	27,380	27,820	1.5	0.457 x Stern
Aug 1980	1	27,380	27,820	1.5	0.457 x Stern
Aug 1980	2	26,390	26,810	1.5	0.457 x Stern
Aug 1980	3	26,390	26,810	1.0	0.305 x Bow
Aug 1980	4	26,390	26,810	3.5	1.067 x Bow

The new data presented in this report are for the latter four cases (Experiments 1 through 4).

The model basin water temperature was constant throughout the test period at 74 deg Fahrenheit (23 deg Celsius).

RESULTS AND DISCUSSION

Results of the individual wake experiments are presented in both graphical and tabular form in Appendices A through D for the results of Experiments 1 through 4, respectively. In each appendix, the plotted data for the three velocity component ratios are given in the first five figures. Two additional figures in each appendix show the radial distributions of the mean velocity component ratios and the

advance angles. Five of the tables of each appendix present summary information on the several averaged velocity component ratios, advance angles, and the results of harmonic analysis for the longitudinal and tangential velocity components. The final table in each appendix presents the measured data for the three velocity component ratios at the experimental radius ratios. All the interpolated results in the appendices have been based on propeller diameter $D=21$ ft (6.4 m).

To confirm and also to establish a basis on which to correlate the wake survey data, Experiment 1 (August 1980) of the present series was performed with the same condition as Experiment 21 (May 1974) reported in Reference 1. A comparison between some results of these two experiments at a condition representing a full-scale displacement of 27,380 Tons (27,820 tonnes) and 1.5 ft (0.457 m) trim by the stern is given in Table 1 on the basis of propeller diameter $D=23$ ft (7.01 m). The repeatability of magnitudes of the various averaged wake quantities in the outer half of the propeller disc ranges from 1 to 3 percent for $\bar{V}_X/V$ and 0.2 to 2 percent for $1-w_X$. At the innermost measurement radius, the repeatability degrades to plus or minus 6 to 8 percent for those same quantities.

The effects of trim may be displayed in several ways. Table 2 summarizes the averaged velocity ratios and other derived wake characteristics for the results of Experiments 2, 3, and 4 pertaining to a full-scale displacement of 26,390 Tons (26,810 tonnes). Plotted data for the detailed trim comparison of the three velocity component ratios versus the position angle θ are given in Figures 3 through 7. Figure 8 is a composite graph of the radial distributions of the several averaged velocity component ratios. Figure 9 shows comparisons of the radial distributions of the advance angles.

In general, it appears that the influence of trim-by-the-bow is to deepen the wake shadow very slightly, noticeable only at the inner radii. That is, the V_X/V ratios near the 12 o'clock position in the wake field are decreased systematically as the trim is changed from 1.5 ft (0.457 m) by the stern to 3.5 ft (1.067 m) by the bow. At the middle and outer radii ($r/R = 0.774$ and outward) the velocity patterns for V_X/V at the different trims become indistinguishable. These trends are reflected in the slight decreases in the circumferential average velocity ratio $\bar{V}_X/V$ and the volumetric mean velocity ratio $1-w_X$ with increasing trim-by-the-bow. The effect on the magnitudes of both $\bar{V}_X/V$ and $1-w_X$ ranges from about 7 to 8 percent decrease at the innermost radius to about 2 percent decrease at the outermost radii.

In Figure 9, the effect of trim on mean angle of advance $\bar{\beta}$ is negligible even at the inner radius ratios. The variations of minimum and maximum advance angles from the mean, $-\Delta\beta$ and $+\Delta\beta$, indicate that increasing trim-by-the-bow tends to exaggerate slightly the deviations of advance angle on the negative side. Qualitatively, this indicates that increasing bow down trim produces slight increases in the mean foil section angles of attack, so that suction side cavitation would be slightly exaggerated as well. Quantitatively, the effect is very small, and is confined to the inner radii of the propeller disc.

It is interesting to try to discern any effect of trim on the wake harmonics. Figures 10 and 11 contain a series of composite plots for the harmonics $N=1$ through 8, showing the radial distributions of harmonic amplitudes for the longitudinal velocity component V_X/V . Figures 12 and 13 contain the same series of comparisons for the tangential velocity component V_T/V . This presentation is useful for displaying the harmonic amplitude as well as the location of changes of phase angle (where the amplitude curve crosses zero). From these graphs, the measurable influence of trim on the harmonic amplitudes is only slight, and confined to the lower harmonic orders.

For the case of the longitudinal velocity component harmonics (Figures 10 and 11), there is a slight increase in the magnitude of the harmonic amplitude with increasing bow-down trim, at the inner radii ($r/R < 0.6$) for the orders $N=1$ and 2. This is reversed for $N=3$, and appears mixed for the higher orders. This is consistent with the slight deepening of the V_X/V velocity defect at the inner radii that was noted previously.

For the case of the tangential velocity component harmonics (Figures 12 and 13), the effect of increasing bow-down trim is to reduce the harmonic amplitude at the inner radii for $N=1$. The higher harmonic orders show no particular effect of trim.

In general terms, the wake of the AO-177 has a definite spike-like character, with a deep velocity defect and rather steep velocity gradients centered about the 12 o'clock position. These are prominent features evident in Figure 14 which is an iso-wake contour plot corresponding to the trial condition of 26,390 Tons (26,810 tonnes) displacement and 1 ft (0.305 m) trim by the bow. One measure of the relative steepness of such a wake has been suggested by Odabasi and Fitzsimmons,⁵ who have defined a parameter describing the local wake gradient per unit axial velocity at a given radius.

$$G_W = \frac{1}{r/R} \left| \frac{dw/d\theta}{1-w} \right|$$

where the local circumferential wake slope is $dw/d\theta$, θ is in radians, and w is the local wake.

It has been proposed in Reference 5, as part of a complete wake criterion for avoiding problems with cavitation-induced pressure fluctuations, that the wake gradient parameter should satisfy

$$G_W < 1.0$$

inside the angular interval θ_B ($\frac{1}{2} \theta_B$ to either side of the 12 o'clock position), and for radii ranging from $0.7R$ to $1.15R$. The angular interval θ_B in degrees depends on the number of propeller blades

$$\theta_B = \frac{360}{Z} + 10$$

so for the seven-bladed AO propeller, $\theta_B = 61.4$ degrees. This criterion is supposed to be based in part on wake data from model experiments of ships with known propeller-excited vibration problems. The complete wake assessment scheme of Reference 5 has become known as the British Ship Research Association (BSRA) wake quality criterion, and although it has been widely quoted, there is as yet relatively little published evidence on how well it works. Only the wake gradient part of it is considered here, and is used only to indicate the relative effects of trim.

Figure 15 is a composite plot of the radial distribution of the wake gradient parameter G_W for the AO-177, showing the effects of trim changes compared with the original design case of displacement and trim. The G_W values are shown along the ray $\theta = 30^\circ$ which is near the edge of the recommended angular interval $\frac{1}{2}\theta_B$, and passes through the characteristic wake slope feature of the prominent hull wake shadow. On the basis of the gradient parameter, it appears that the wake of this ship is quite steep. The G_W exceeds 1.0 everywhere in the interval $0.7R < r \leq 1.15 R$. It is fair to state that this constitutes a single indicator of a possibly troublesome wake, but without firmer connection between wake steepness and fluctuating propeller-induced pressures and resulting hull vibration or airborne

noise problems, a general conclusion is premature. What is useful to the present discussion is to note that trim seems to exert a relatively minor effect on this steepness tendency in the crucial outer radius region. It appears that bow-down trim variation in the range considered should not introduce any substantially worse wake characteristics than exist already with the wake produced in the original trim condition. It should be noted that at the time of the original AO-177 wake experiments, wake quality assessment schemes were not available for making preliminary judgments on the possibility of problems with the interaction of steep wakes and propeller-induced fluctuating pressures.

CONCLUSIONS

1. Extensive wakedata are made available for future investigations of the AO-177 propeller-wake interaction problems.
2. There are noticeable, consistent, but small changes in the velocity patterns and harmonic amplitudes of the wake of the AO due to trim-by-the-bow. The effects are discernible mainly at the inner radii (typically $r/R < 0.6$) and are confined to the region centered about the 12 o'clock position in the wake. The changes due to the maximum trim excursion of 0.52 deg are only slightly larger than the typical repeatability bounds for a wake survey. The effect of a trim change of 0.26 deg appears to be within the error bounds inherent in a wake survey experiment.
3. Radial distributions of the wake gradient parameter $G_W > 1.0$ for this wake shows that difficulties from unsteady cavitation pressure pulses may be expected. The effect on G_W of the trim change of 0.26 deg is small, and would not be expected to produce new or different problems with the wake.

ACKNOWLEDGMENTS

The authors are grateful to Ms. Rae Hurwitz and Mr. Stewart Jessup for performing the analyses of the wake survey data. The assistance of Mr. Mark Vranicar in preparing the graphs is also appreciated.

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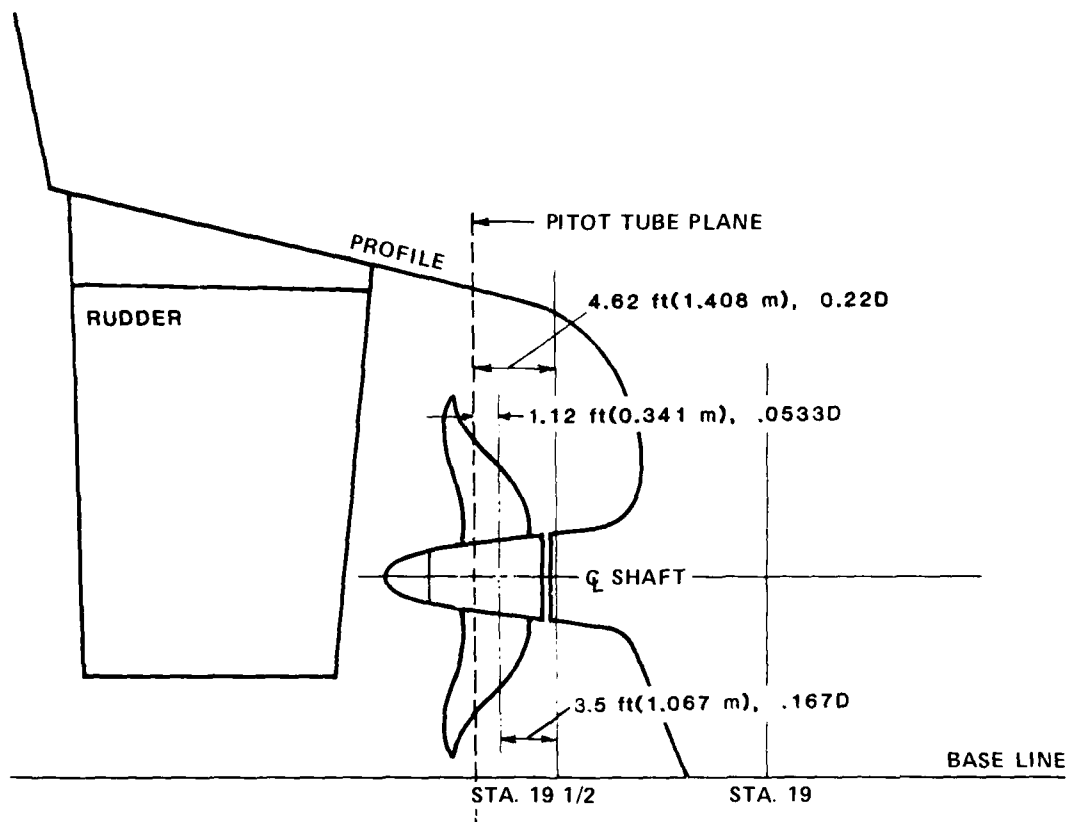


Figure 1 - AO 177 Wake Rake Pitot Tube Location in Relation to the 21-Foot (6.4 m) Design Propeller

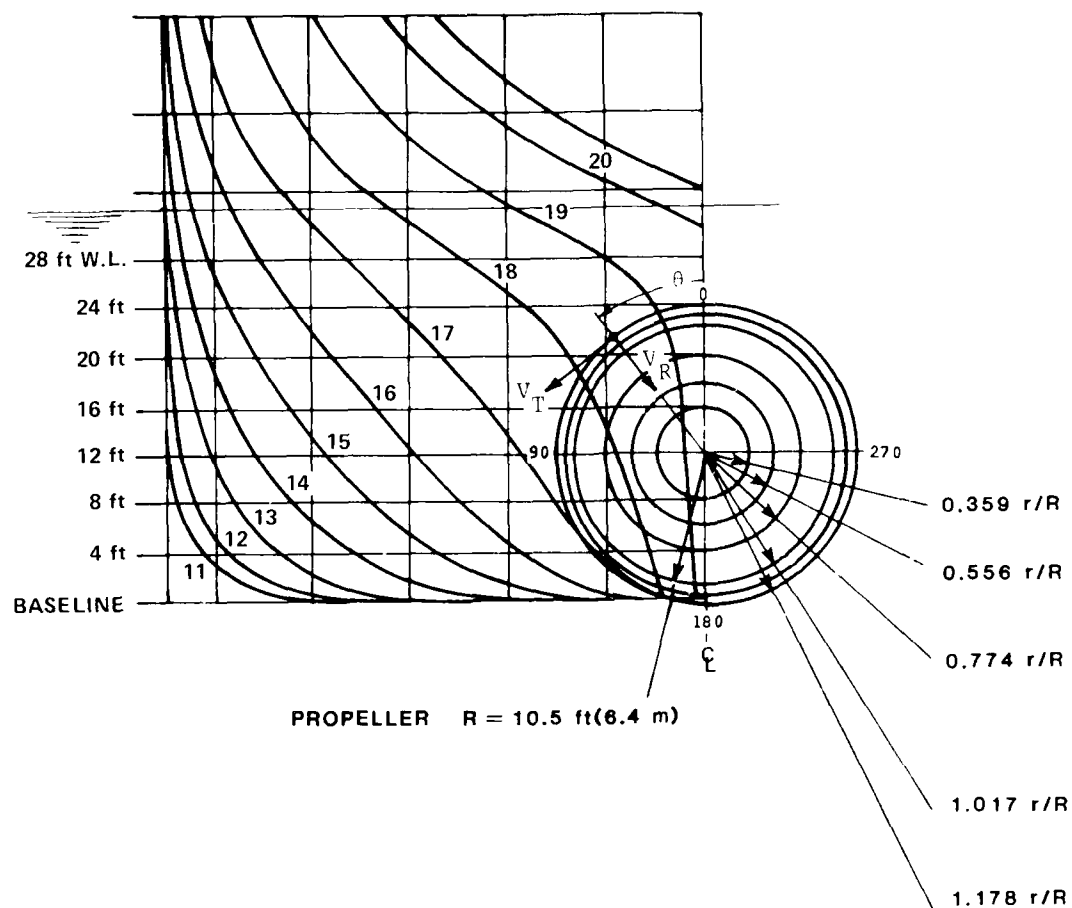


Figure 2 - AO 177 STERN BODY PLAN WITH TEST RADII

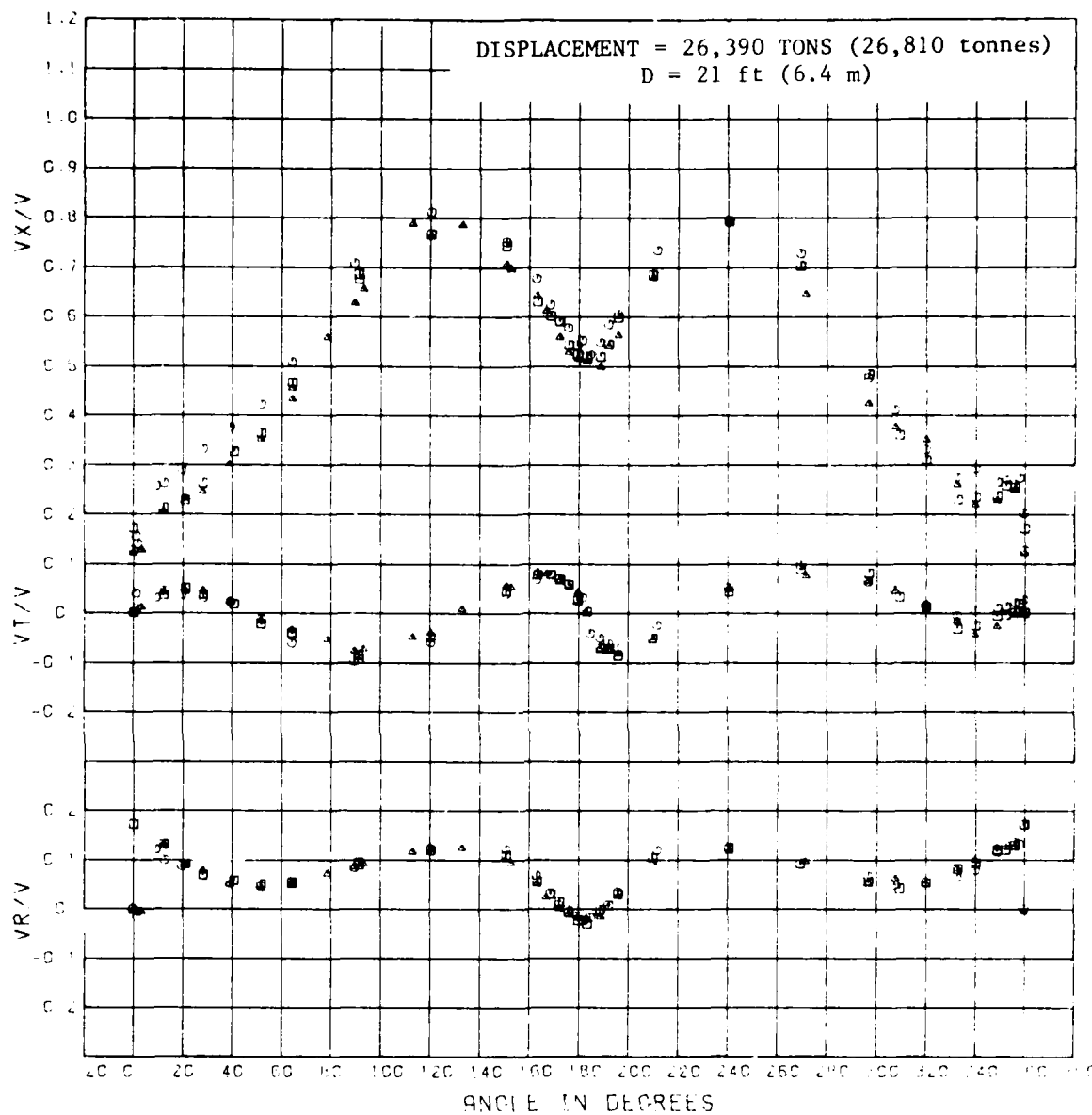


Figure 3 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.359
COMPOSITE OF EXPERIMENTS 2, 3, AND 4

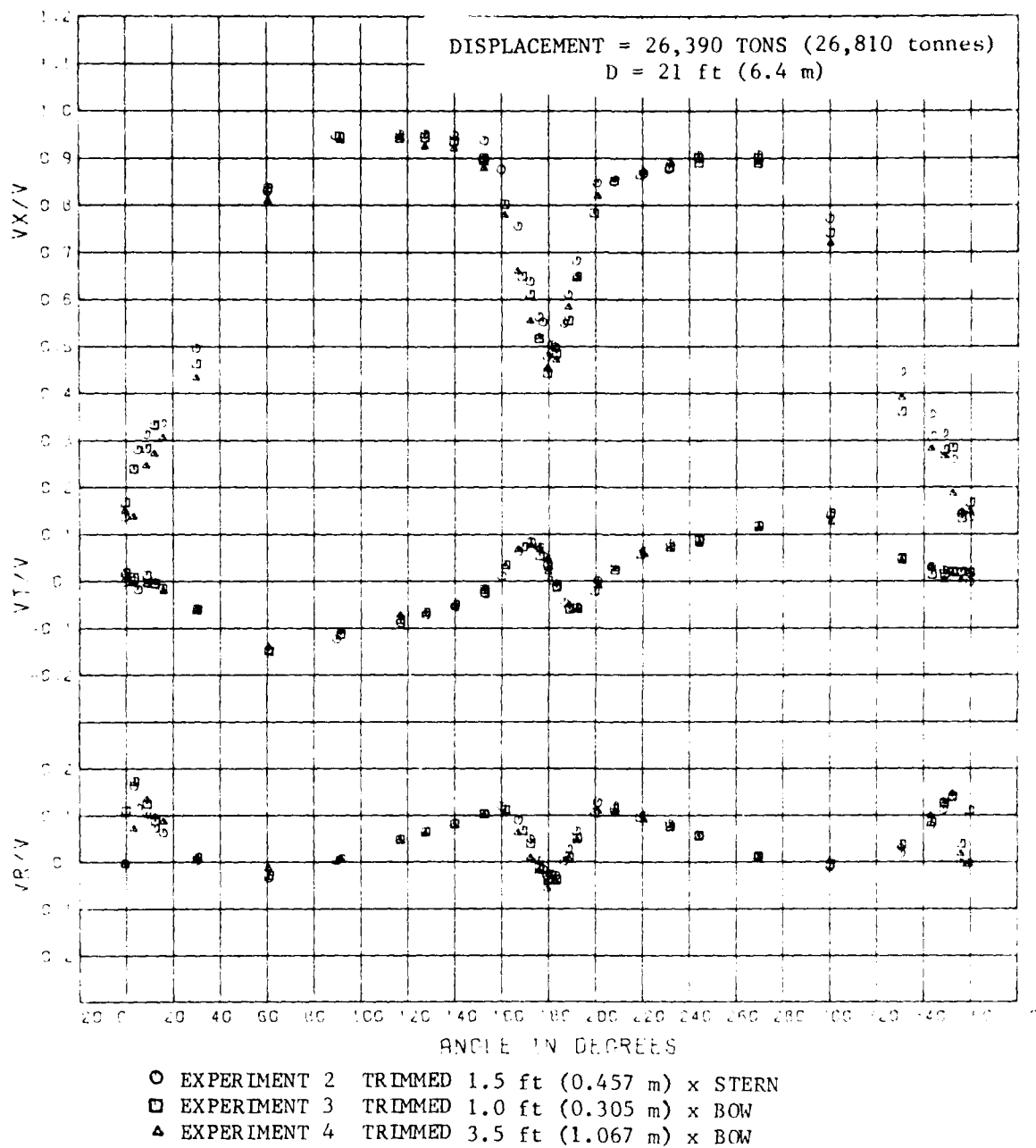


Figure 4 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.556
COMPOSITE OF EXPERIMENTS 2, 3, AND 4

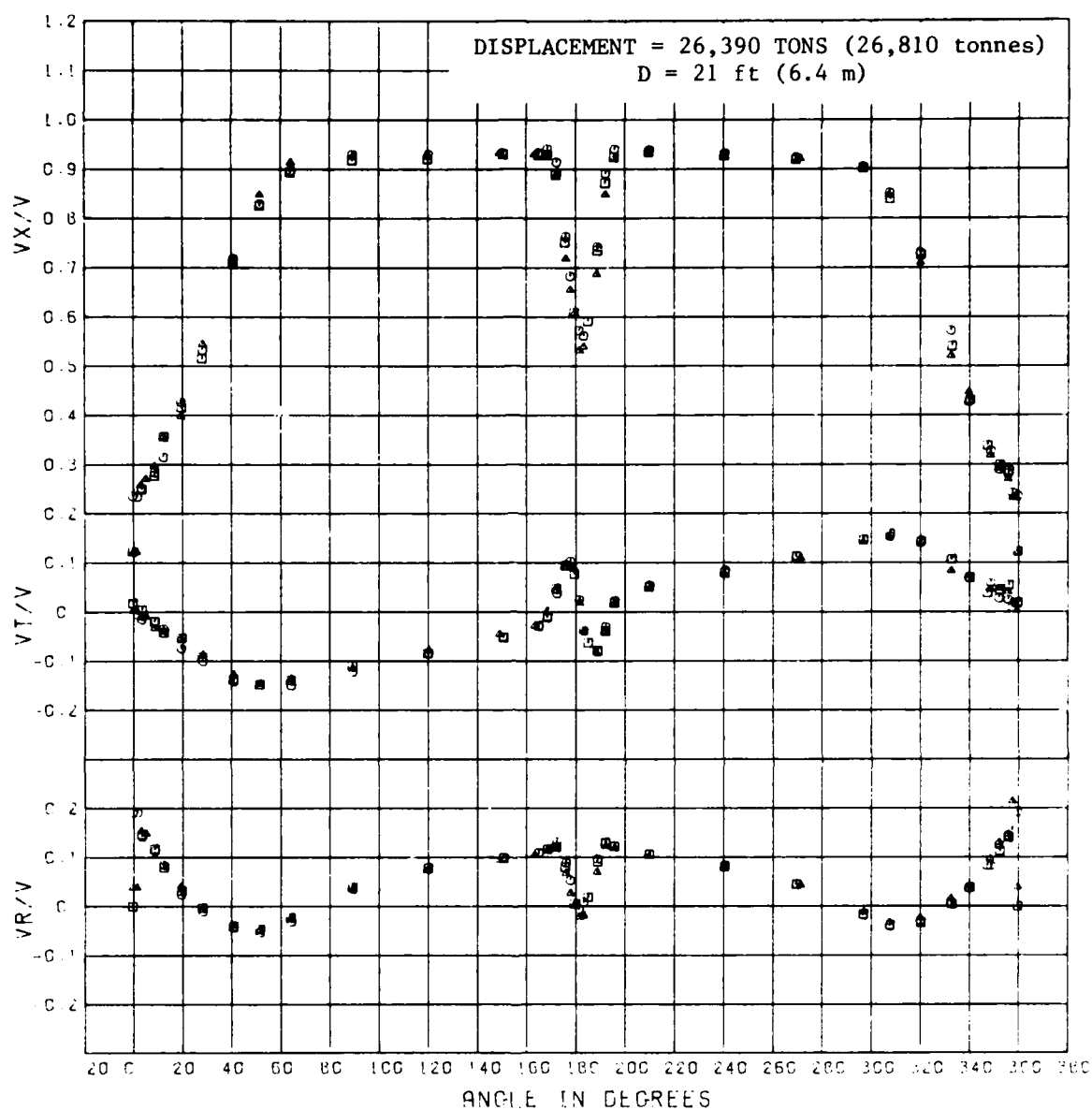


Figure 5 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.774
COMPOSITE OF EXPERIMENTS 2, 3, AND 4

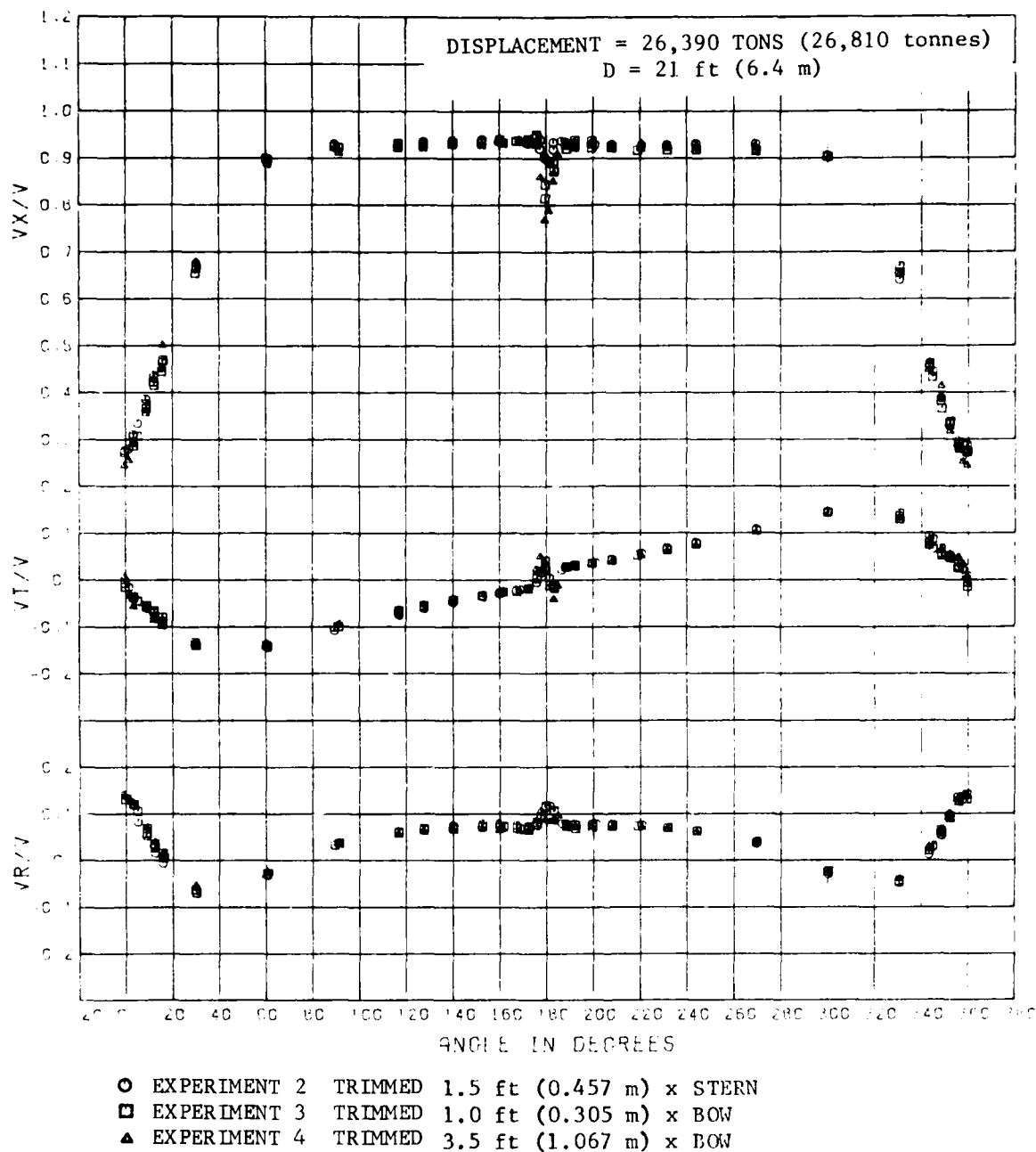


Figure 6 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.017
COMPOSITE OF EXPERIMENTS 2, 3, AND 4

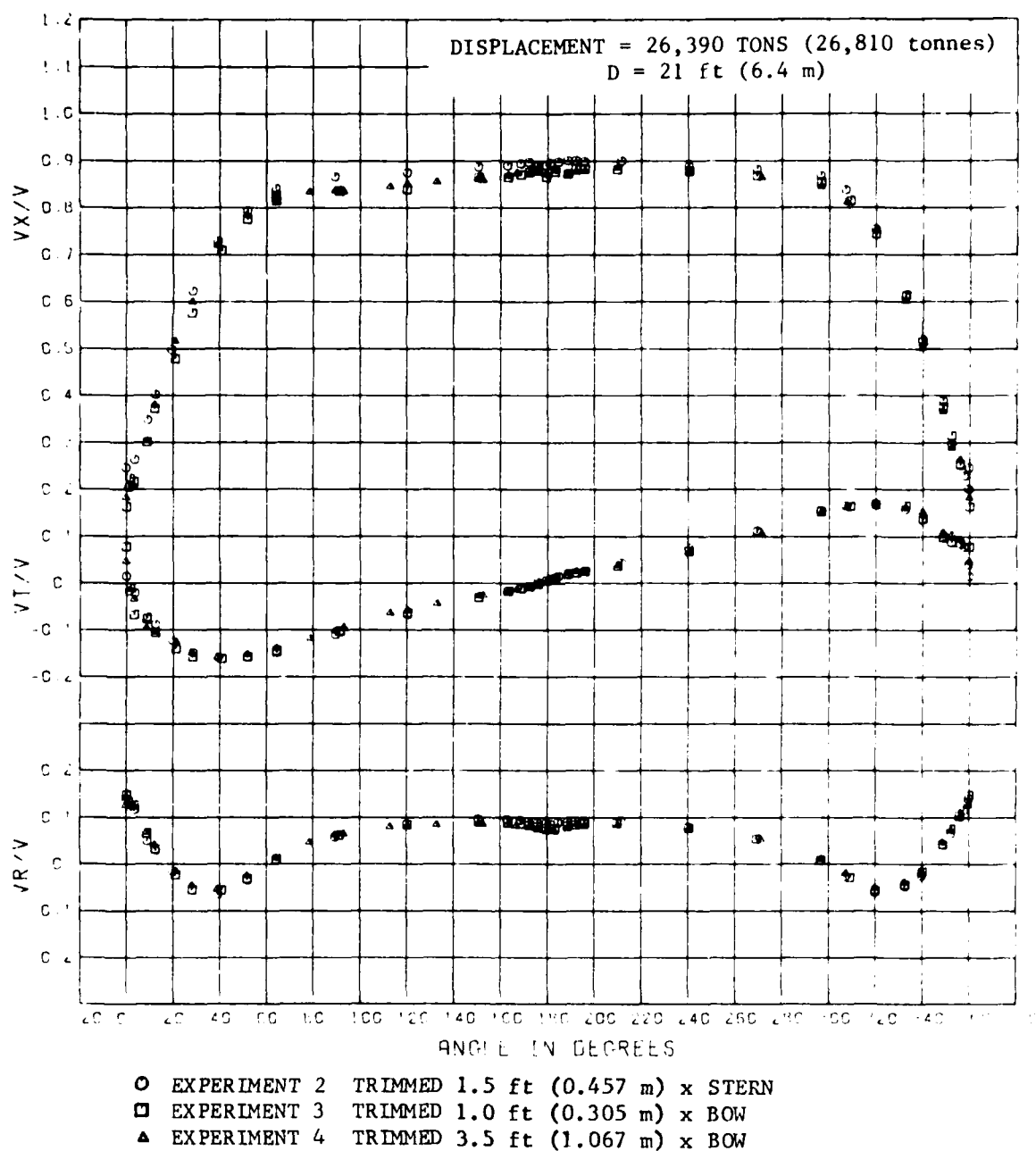


Figure 7 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.178
COMPOSITE OF EXPERIMENTS 2, 3, AND 4

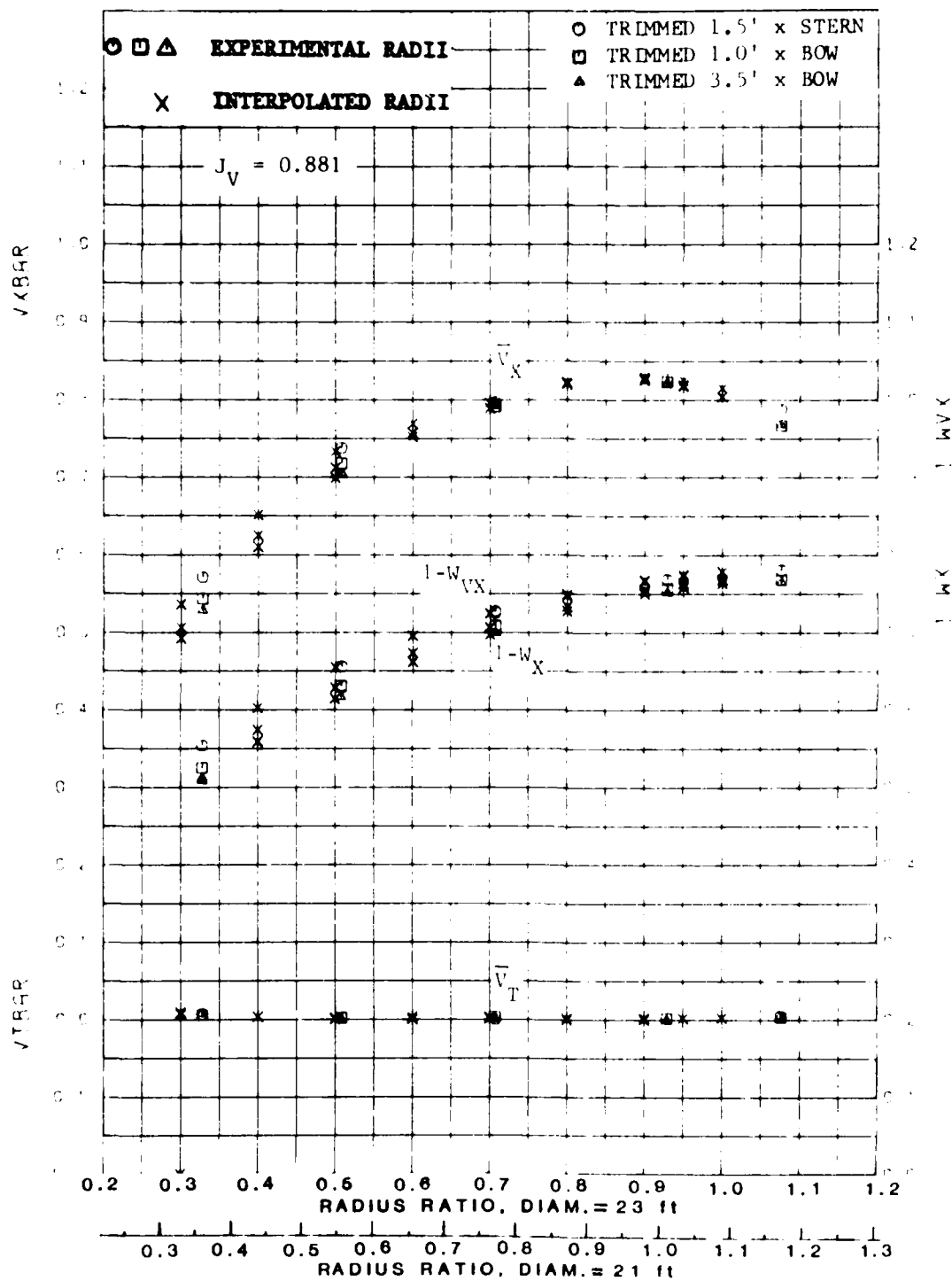


Figure 8 - RADIAL DISTRIBUTION OF THE MEAN VELOCITY COMPONENT RATIOS,
COMPOSITE OF EXPERIMENTS 2, 3, AND 4
DISPLACEMENT 26,390 TONS (26,810 tonnes)

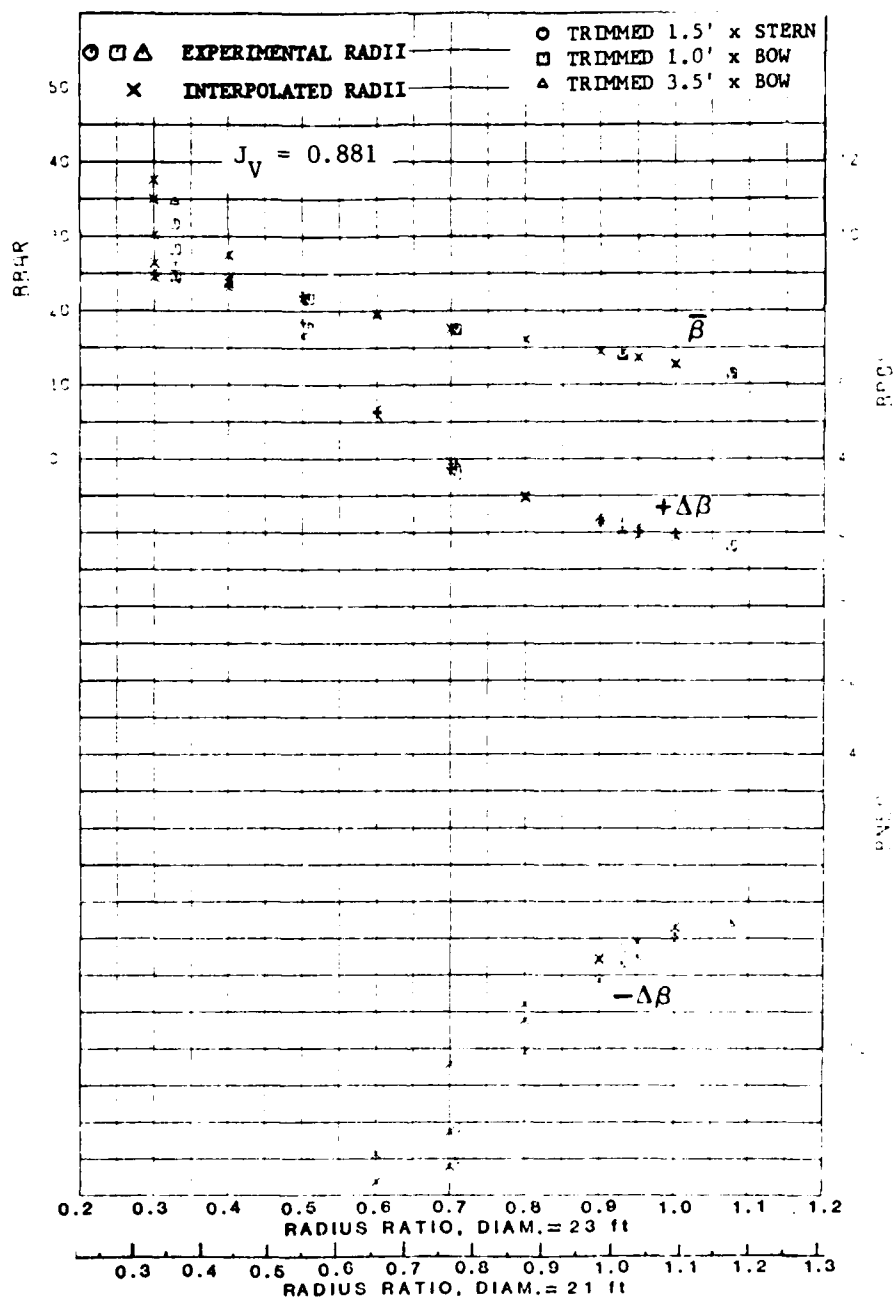


Figure 9 - RADIAL DISTRIBUTION OF THE MEAN ADVANCE ANGLE AND THE MAXIMUM VARIATIONS OF THE ADVANCE ANGLE FOR MODEL 5326
 COMPOSITE OF EXPERIMENTS 2, 3, AND 4
 DISPLACEMENT 26,390 TONS (26,810 tonnes)

Exp. No. 1 —○— 1.5 ft(0.457 m) × Stern
 2 - - -□- - - 1.5 ft(0.457 m) × Stern
 3 —△— 1.0 ft(0.305 m) × Bow
 4 —◇— 3.5 ft(1.067 m) × Bow

D = 21 ft(6.4 m)

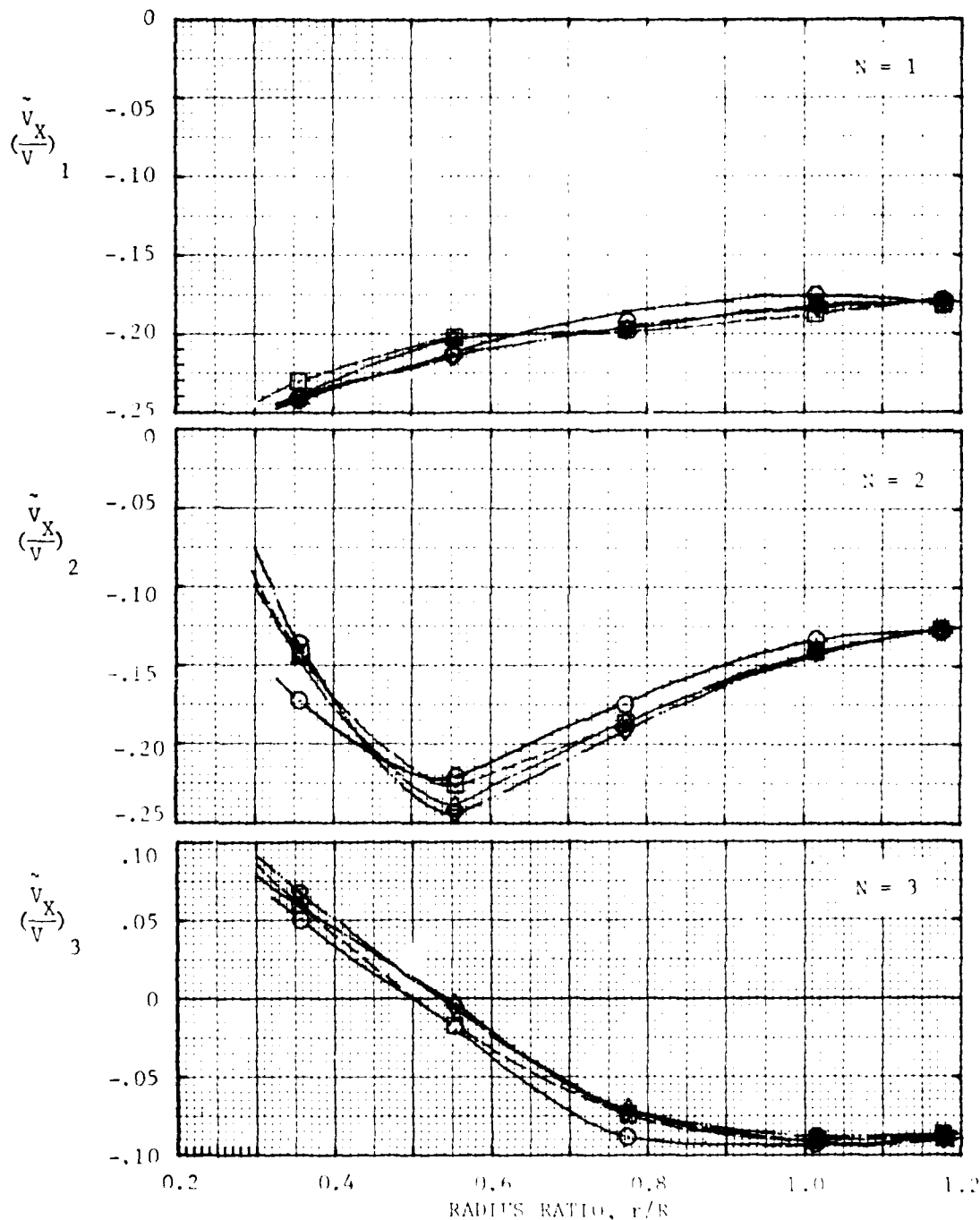


Figure 10 - RADIAL DISTRIBUTIONS OF THE HARMONIC AMPLITUDES $(\frac{\tilde{v}_x}{v})_N$ OF THE LONGITUDINAL VELOCITY COMPONENT, FOR $N = 1$ THROUGH 3

Exp. No. 1 —○— 1.5 ft (0.457 m) × Stern
 2 —□— 1.5 ft (0.457 m) × Stern
 3 —△— 1.0 ft (0.305 m) × Bow
 4 —◇— 3.5 ft (1.067 m) × Bow

D = 21 ft (6.4 m)

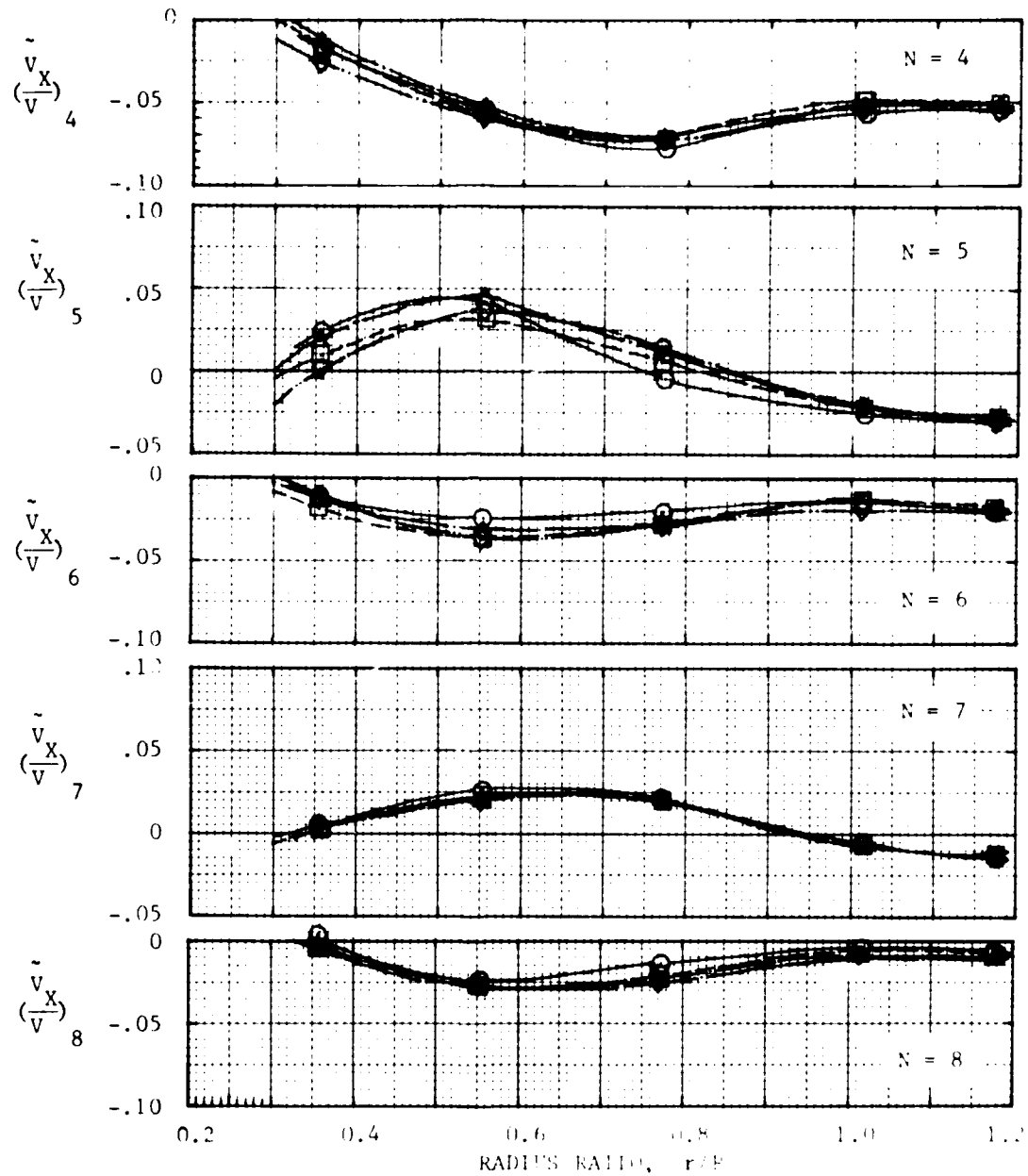


Figure 11 - RADIAL DISTRIBUTIONS OF THE HARMONIC AMPLITUDES $(\tilde{v}_x/v)_N$ OF THE LONGITUDINAL VELOCITY COMPONENT, FOR $N = 4$ THROUGH 8

Exp. No. 1 —○— 1.5 ft(0.457 m) × Stern
 2 —□— 1.5 ft(0.457 m) × Stern
 3 —△— 1.0 ft(0.305 m) × Bow
 4 —◇— 3.5 ft(1.067 m) × Bow

D = 21 ft(6.4 m)

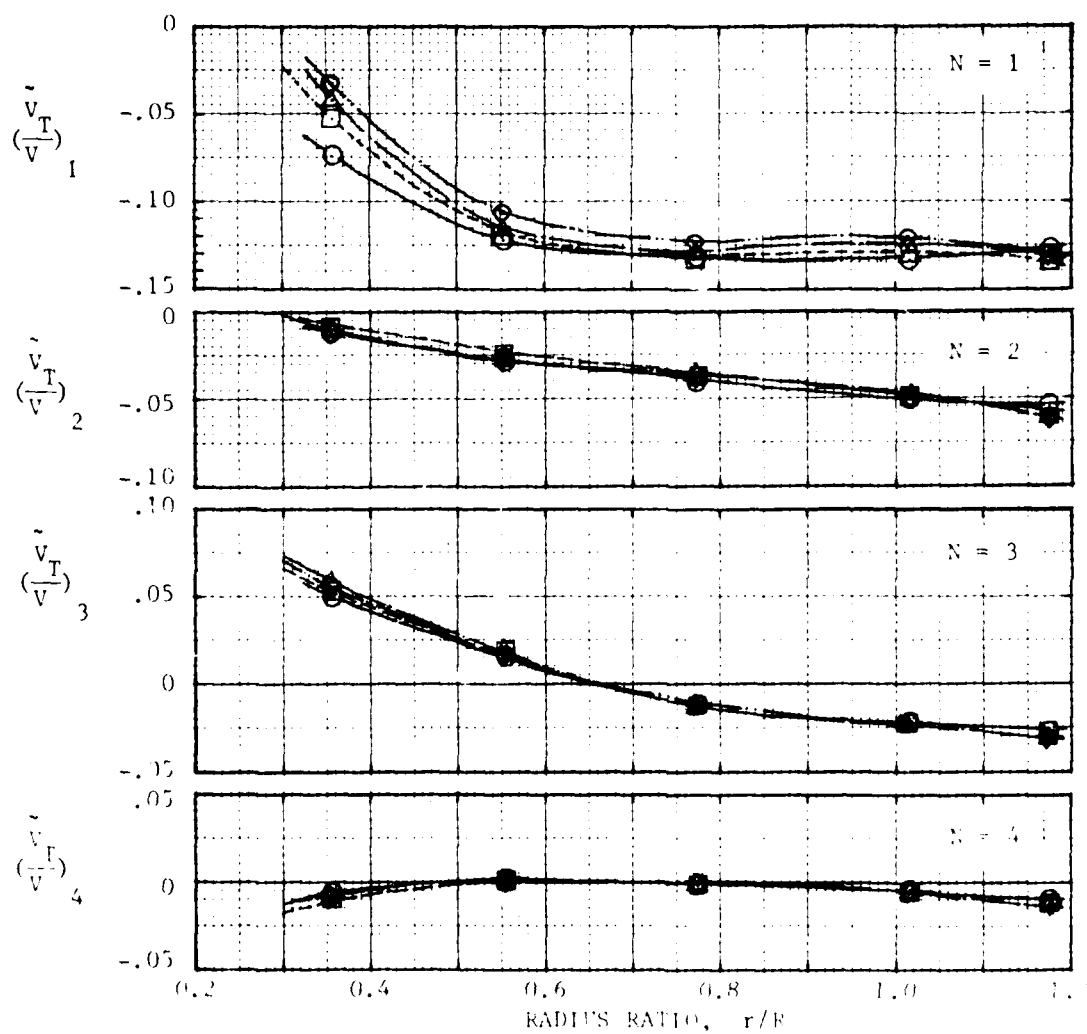


Figure 12 - RADIAL DISTRIBUTIONS OF THE HARMONIC AMPLITUDES $(\frac{v_T}{v})_N$ OF THE TANGENTIAL VELOCITY COMPONENT, FOR $N = 1$ THROUGH 4

Exp. No. 1 ———○——— 1.5 ft(0.457 m) × Stern
 2 ———□——— 1.5 ft(0.457 m) × Stern
 3 ———△——— 1.0 ft(0.305 m) × Bow
 4 ———◇——— 3.5 ft(1.067 m) × Bow

D = 21 ft(6.4 m)

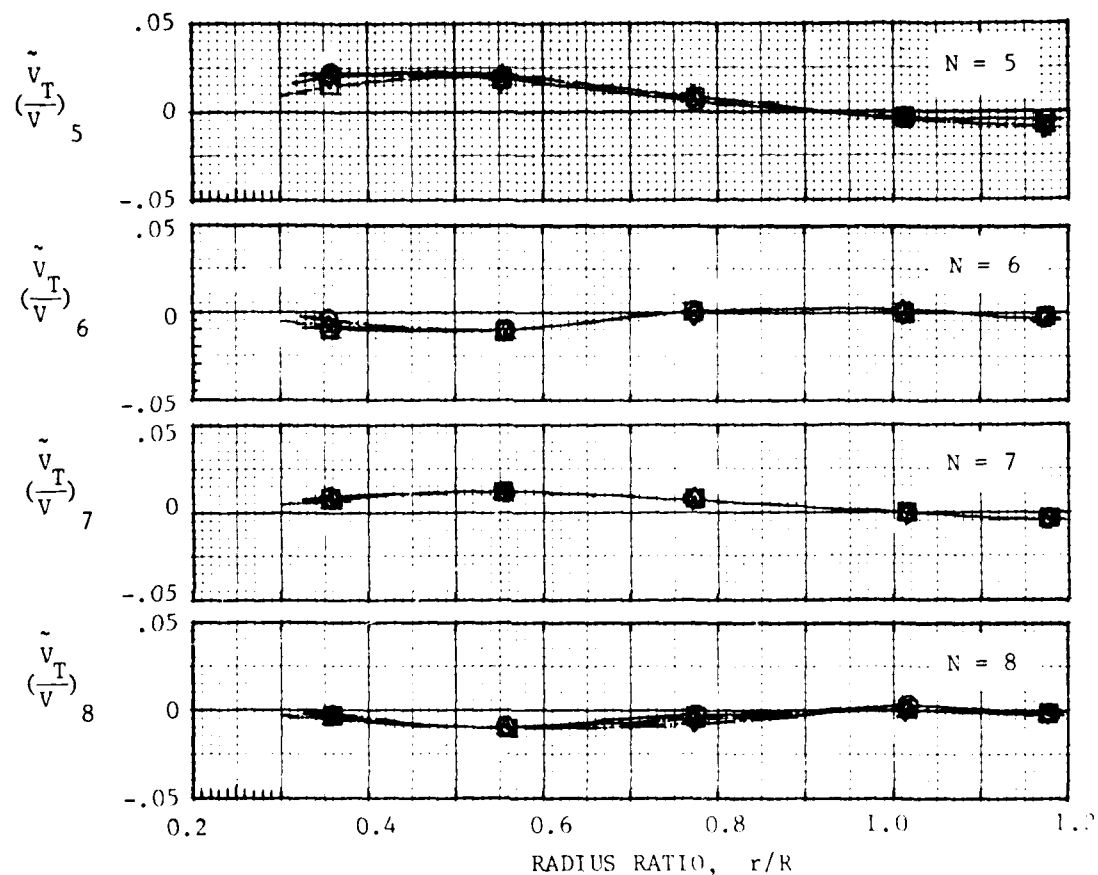


Figure 13 - RADIAL DISTRIBUTIONS OF THE HARMONIC AMPLITUDES $(\frac{\tilde{v}_T}{v})_N$ OF THE TANGENTIAL VELOCITY COMPONENT, FOR $N = 5$ THROUGH 8

26,390 Tons (26,810 tonnes) DISPLACEMENT
1.0 ft (0.305 m) TRIM BY THE BOW

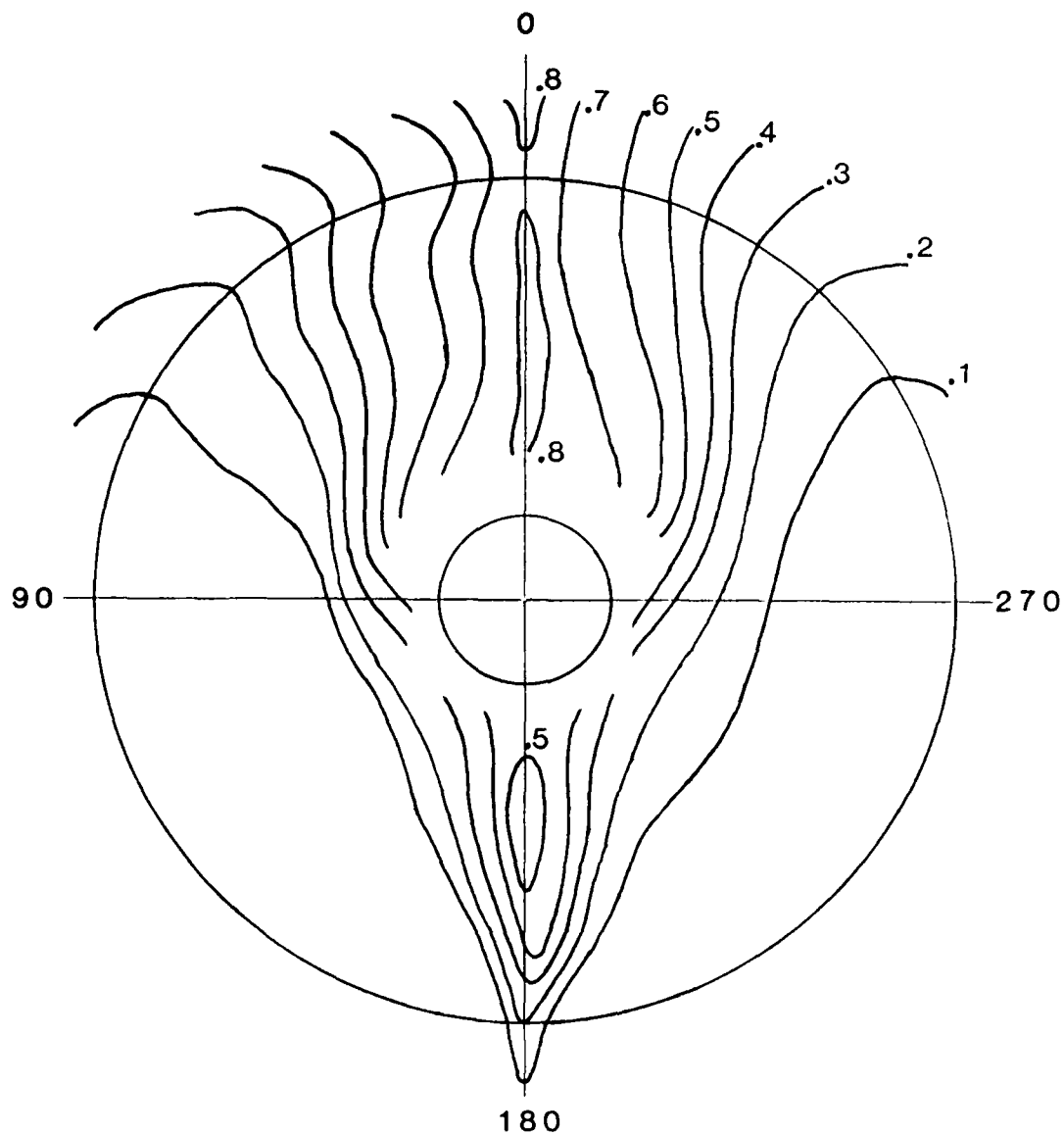


Figure 14 - CONTOUR PLOT OF THE LONGITUDINAL COMPONENT ISO-WAKE
 $w = (1 - V_x/V)$ FOR THE AO 177 (MODEL 5326)

- 1.5 ft (0.457 m) TRIM x STERN, DISPL = 27,380 Tons (27,820 tonnes)
- 1.5 ft (0.457 m) TRIM x STERN, DISPL = 26,390 Tons (26,810 tonnes)
- 1.0 ft (0.305 m) TRIM x BOW, DISPL = 26,390 Tons (26,810 tonnes)
- △— 3.5 ft (1.067 m) TRIM x BOW, DISPL = 26,390 Tons (26,810 tonnes)

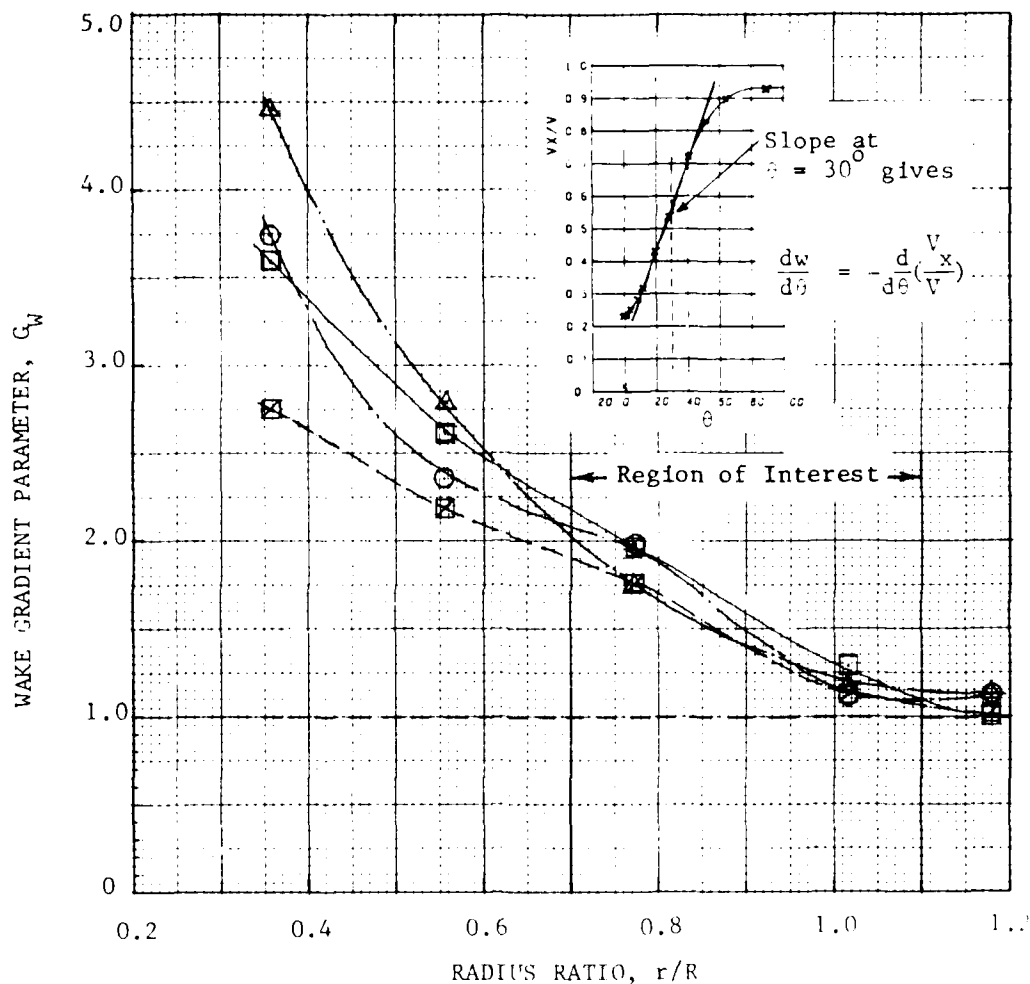


Figure 15 - RADIAL DISTRIBUTION OF THE WAKE GRADIENT PARAMETER FOR THREE TRIM CONDITIONS

(Taken along the ray $\theta = 30$ degrees)

Table 1 COMPARISON OF THE MEAN VELOCITY COMPONENT RATIOS AND OTHER DERIVED QUANTITIES FOR EXPERIMENT 21 (MAY 1974) AND EXPERIMENT 1 (AUG. 1980)

D = 23 ft (7.01 m), $J_V = 0.881$

EXPERIMENT	RADIUS	VXBAR	VTBAR	VRBAR	-WX	BBAR	BPOS	BNEG
1	.328	.615	.030	.054	.05	27.72	10.34	-16.14
1		.577	.007	.084	.558	26.12	10.61	-19.17
21	.508	.741	.000	.046	.680	22.25	6.38	-14.33
1		.752	-.001	.039	.648	22.60	7.33	-14.88
21	.707	.814	.000	.043	.741	17.38	3.46	-11.99
1		.797	.000	.049	.738	17.55	3.77	-14.68
21	.929	.817	.000	.030	.779	13.85	2.10	- 8.80
1		.839	-.002	.027	.777	14.21	2.38	- 9.30
21	1.076	.839	.000	.041	.792	12.33	1.71	- 8.36
1		.817	.001	.044	.791	12.01	1.69	- 8.55

EXPERIMENT 21 (MAY 1974)

An instrumentation problem with tube 5 ($r/R = 1.076$) gave erroneous data between 250° and 350° . Because of the symmetry of the hull (as verified by tubes 1 through 4) predicted values for V_Y/V , V_T/V , and V_R/V , were used between 250° and 350° for $r/R = 1.076$.

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
 VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
 VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
 W IS CIRCUMFERENTIAL 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).

Table 2 - COMPARISON OF THE MEAN VELOCITY COMPONENT RATIOS AND OTHER DERIVED QUANTITIES
FOR EXPERIMENTS 2, 3, AND 4, DISPLACEMENT 26,390 TONS (26,810 tonnes)

$D = 21 \text{ ft (6.4 m)}, J_V = 0.881$

EXPERIMENT	TRIM (feet)	RADIUS	VXBAR	VTBAR	VRBAR	1-WX	BBAR	BPOS	BNEG
2	1.5 x stern	0.359	.571	.007	.082	.554	25.90	10.33	-18.98
3	1.0 x bow		.543	.005	.085	.525	24.80	9.65	-16.41
4	3.5 x bow		.528	.007	.078	.508	24.15	10.93	-18.23
2	1.5 x stern	0.556	.738	.001	.038	.656	22.16	7.20	-18.52
3	1.0 x bow		.738	.002	.040	.631	21.59	7.53	-18.18
4	3.5 x bow		.735	.000	.038	.616	21.27	7.63	-17.13
2	1.5 x stern	0.774	.797	.000	.048	.728	17.55	3.73	-12.30
3	1.0 x bow		.791	.003	.046	.709	17.41	3.57	-14.15
4	3.5 x bow		.782	.001	.047	.700	17.42	3.84	-15.07
2	1.5 x stern	1.017	.828	.002	.029	.789	14.03	2.15	-9.31
3	1.0 x bow		.823	.002	.030	.757	13.95	2.25	-9.26
4	3.5 x bow		.821	.000	.030	.752	13.92	2.02	-9.74
2	1.5 x stern	1.178	.788	.005	.044	.781	11.59	1.59	-8.21
3	1.0 x bow		.767	.003	.043	.768	11.30	1.64	-8.89
4	3.5 x bow		.768	.005	.043	.765	11.31	1.67	-8.62

VBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.

VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.

VXBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.

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

BPOS IS MEAN ANGLE OF ADVANCE.

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

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

APPENDIX A
RESULTS OF EXPERIMENT 1

Corresponding to
Trim 1.5 ft (0.457 m) by the Stern
Displacement 27,380 Tons (27,830 tonnes)

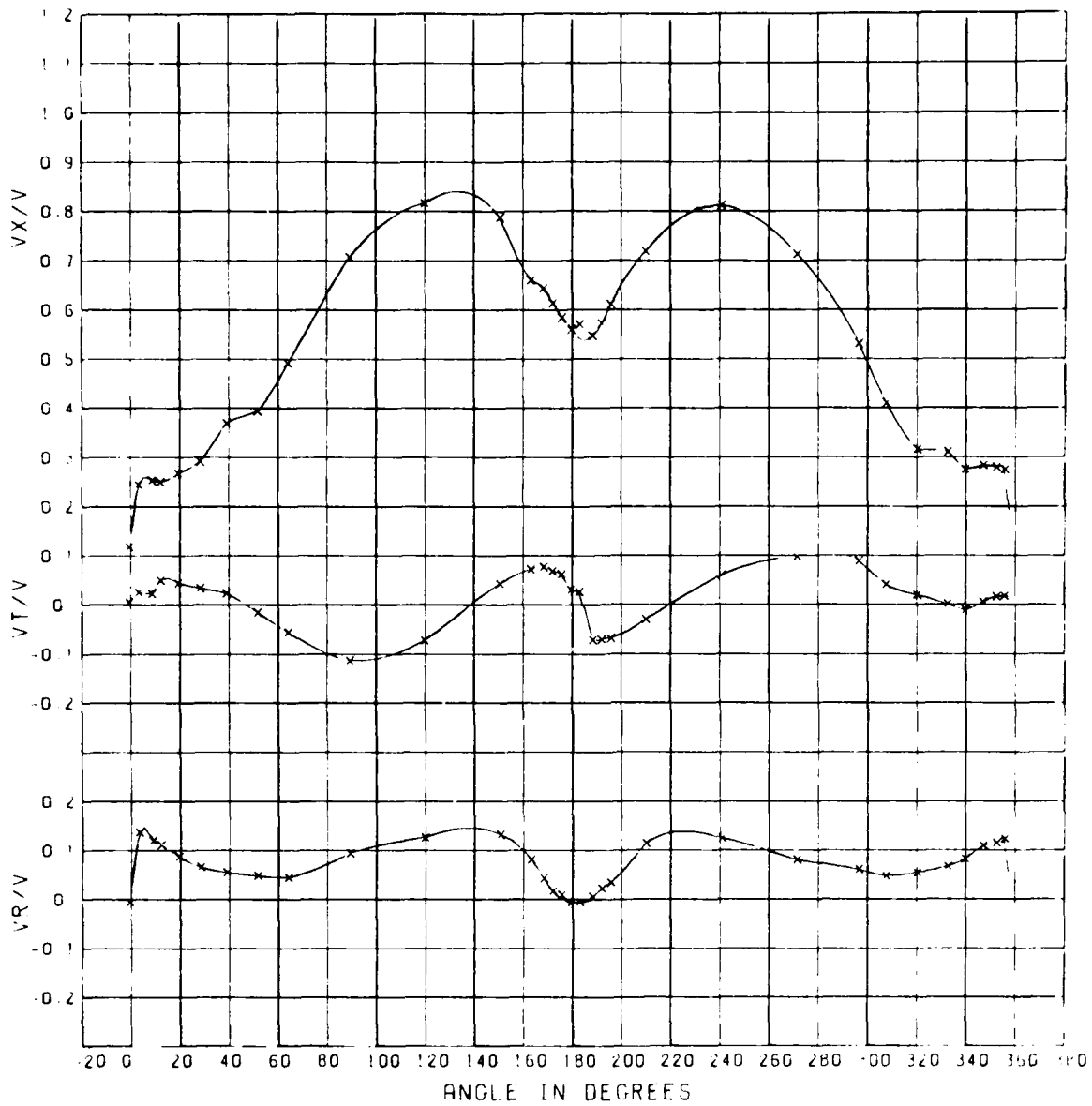


Figure A1 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.35
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS

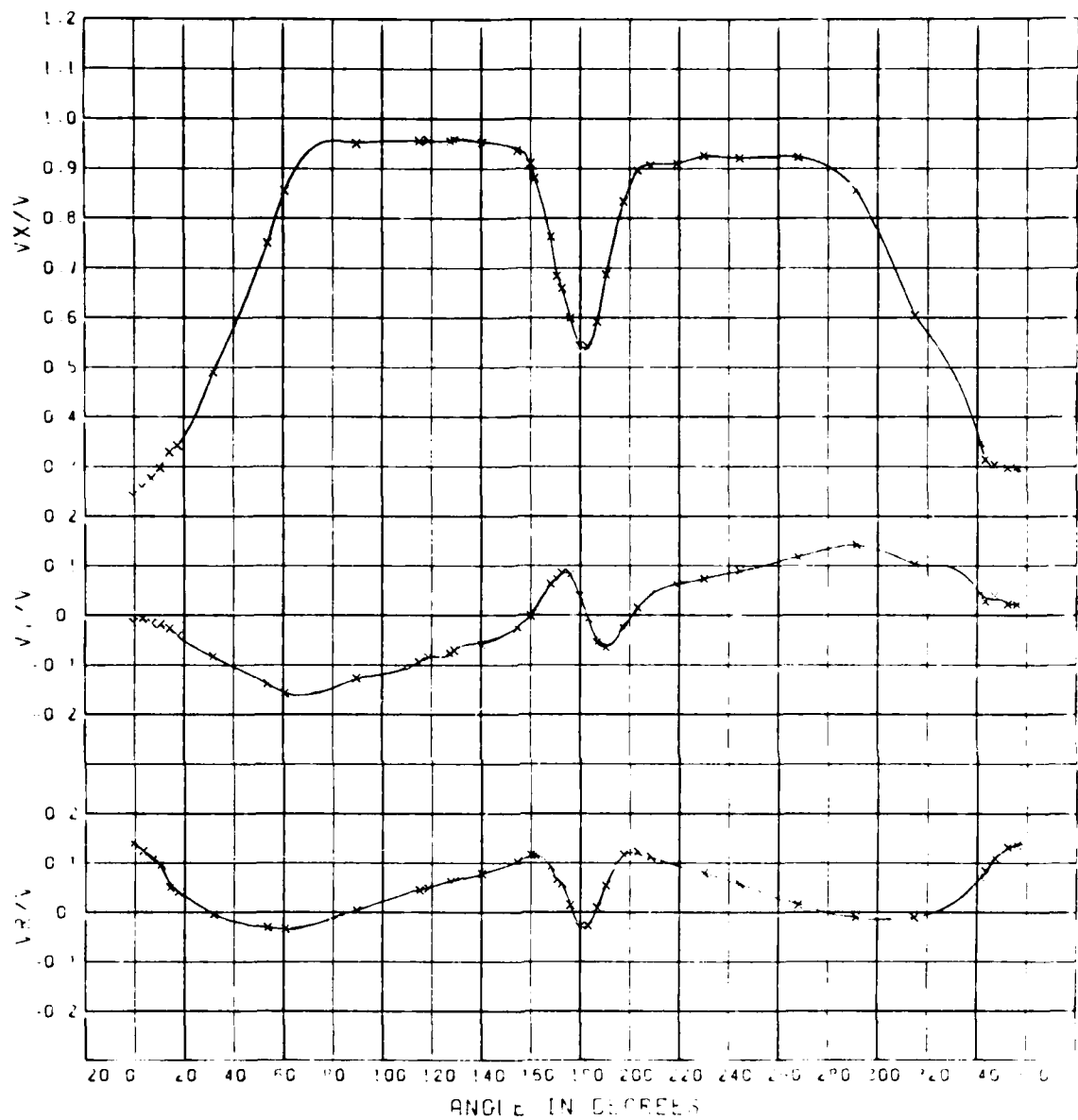


Figure A2 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.556
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS

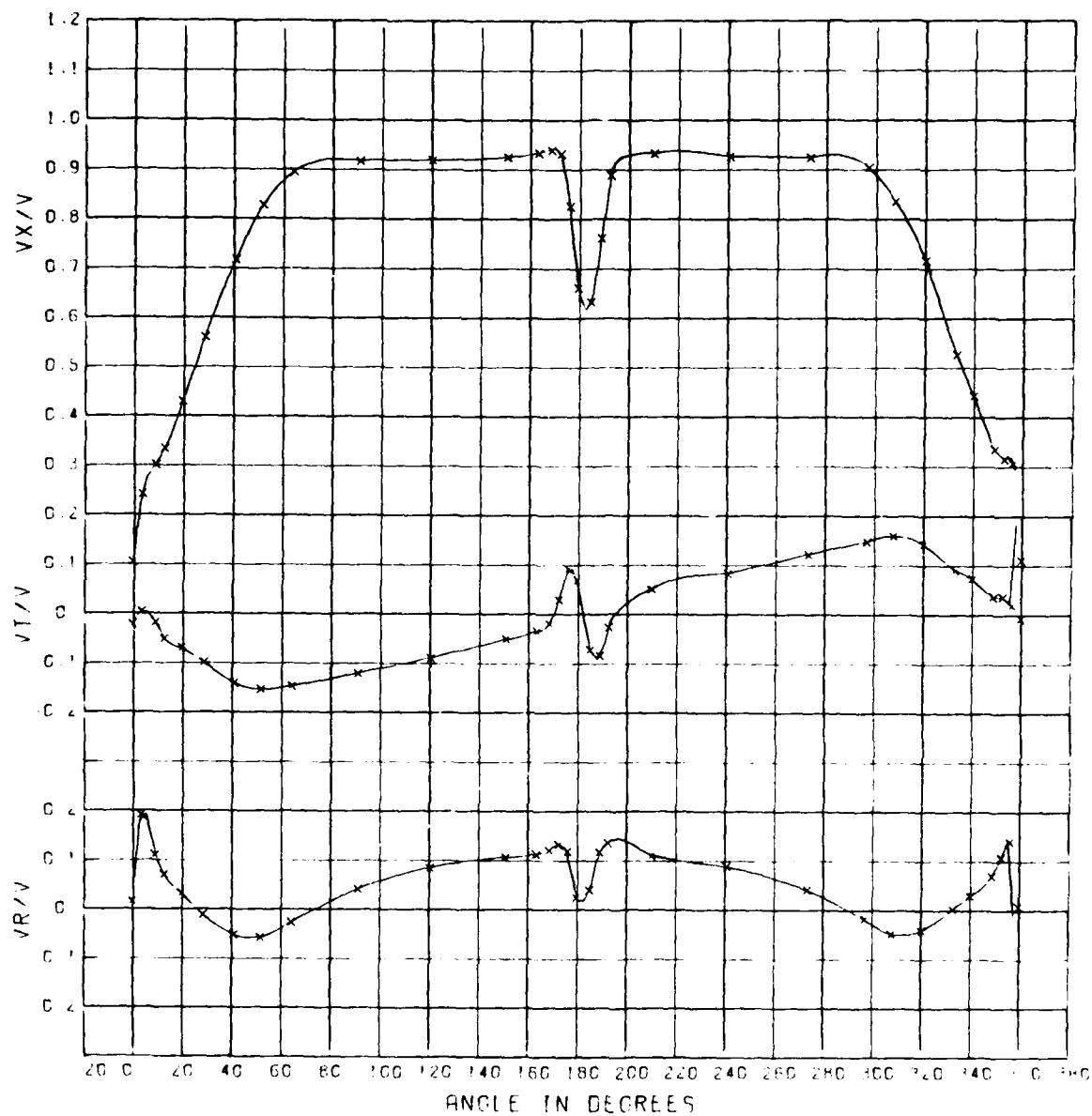


Figure A3 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.774
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS

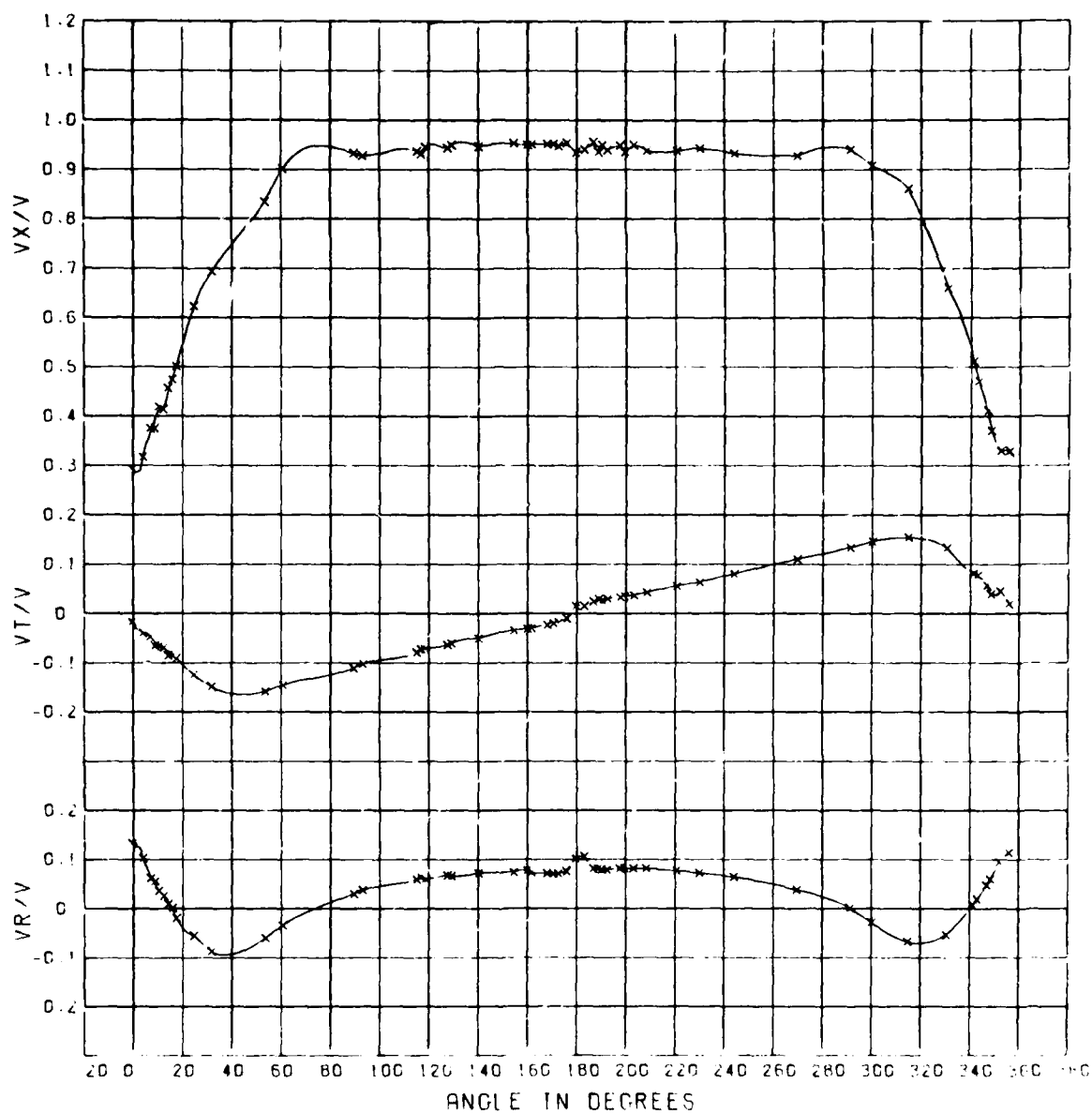


Figure A4 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.017
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS

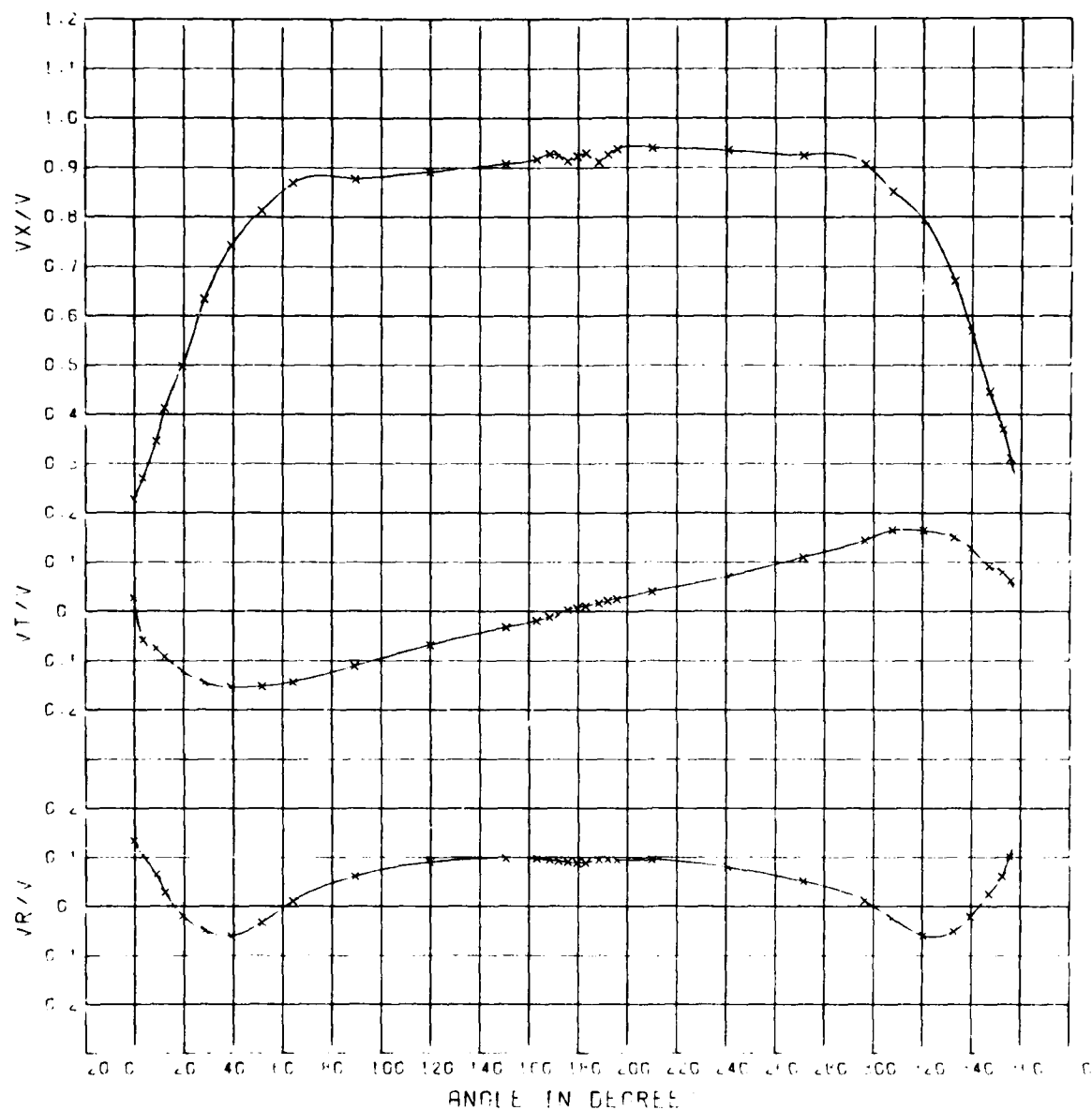


Figure A5 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.178
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,300 TONS

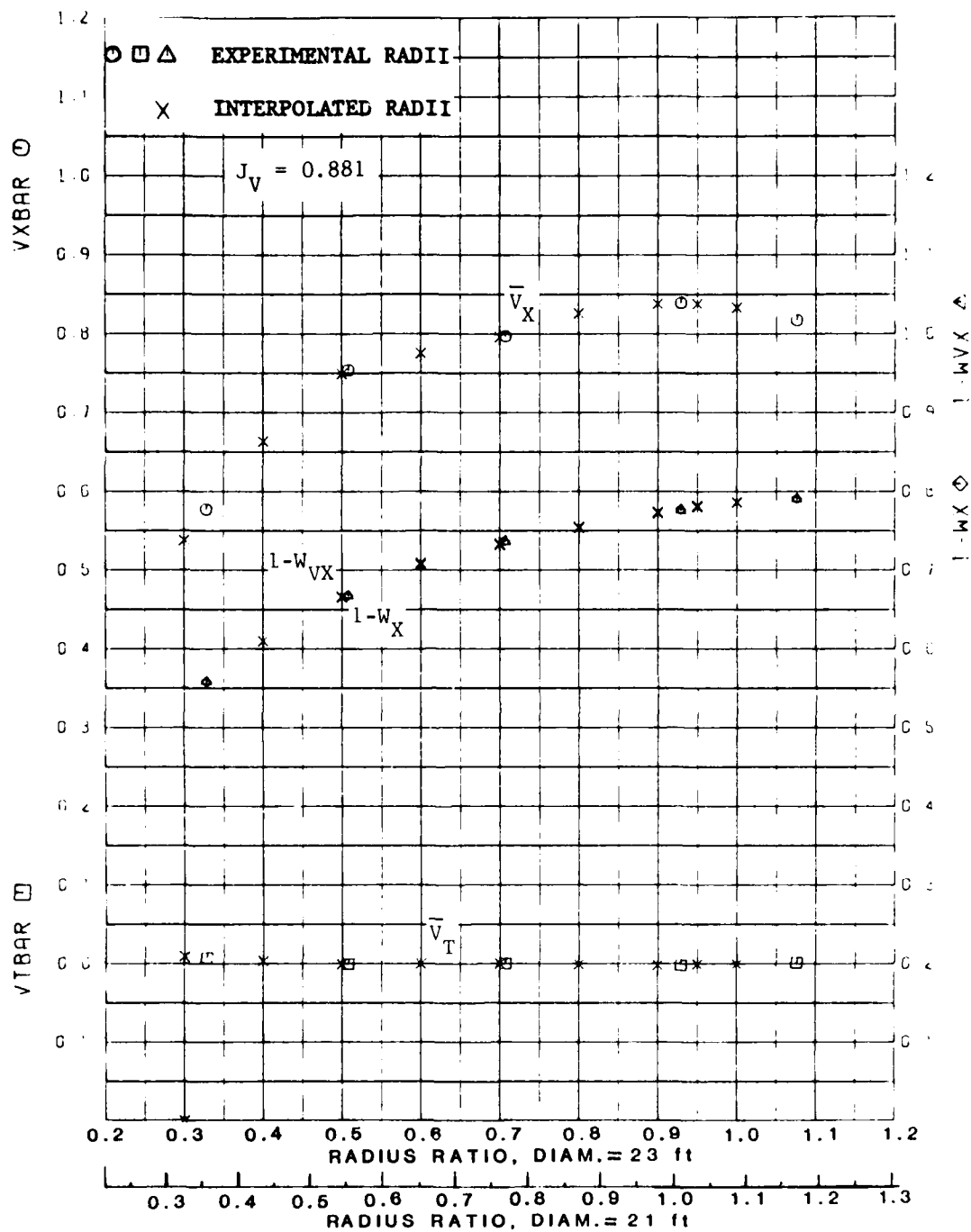


Figure A6 - RADIAL DISTRIBUTION OF THE MEAN VELOCITY COMPONENT RATIOS
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS

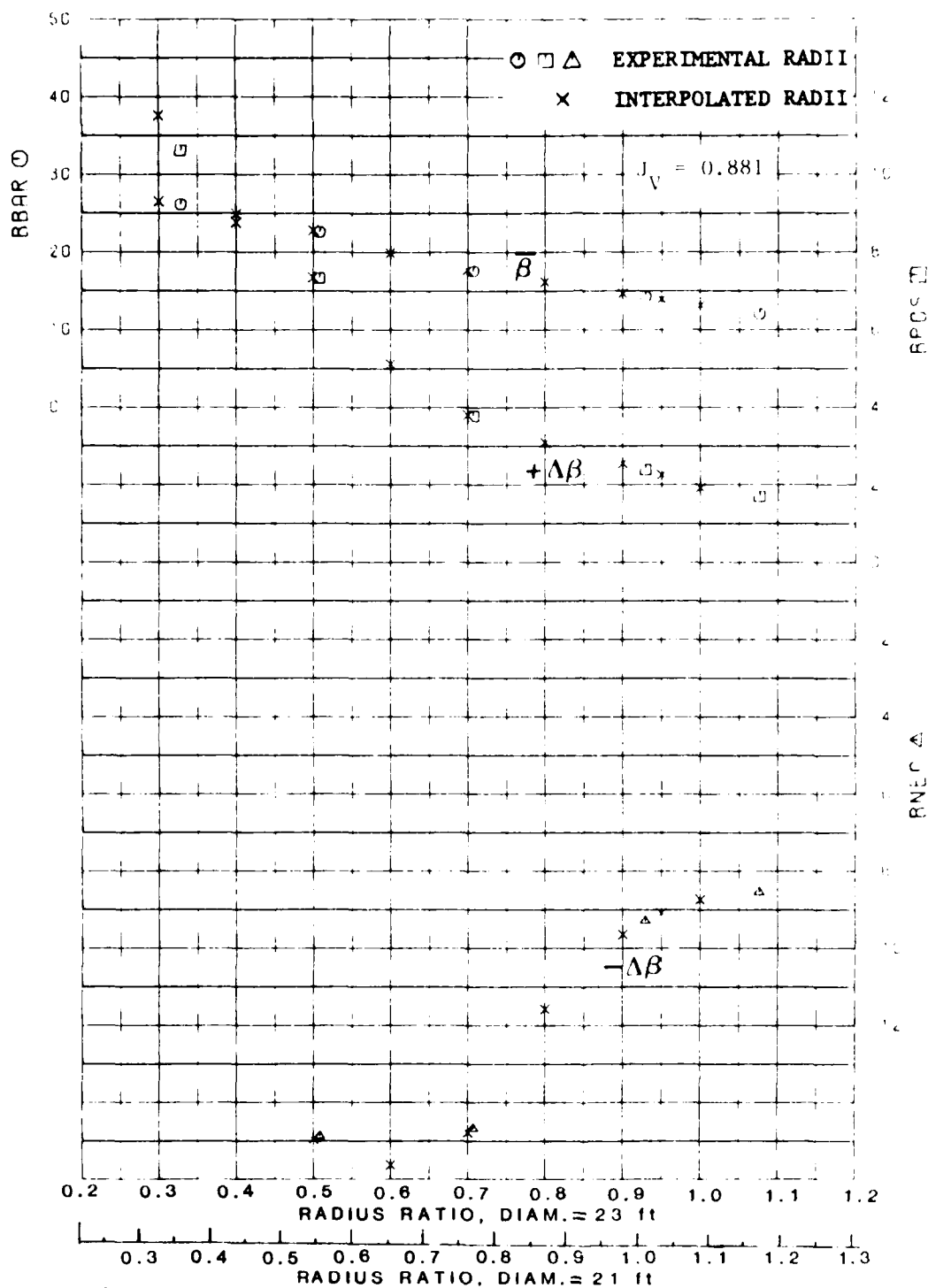


Figure A7 - RADIAL DISTRIBUTION OF THE MEAN ADVANCE ANGLE AND THE MAXIMUM VARIATIONS OF THE ADVANCE ANGLE FOR MODEL 5326
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS

Table A1 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE
ANGLES AND OTHER DERIVED QUANTITIES
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS
D = 21 ft (6.4m), $J_V = 1.01$

RADIUS =	.359	.566	.774	1.017	1.176	.000	.300	.400	.500	.600	.700	.800	.900	1.000
WBAR =	.577	.754	.797	.839	.817	.339	.499	.625	.717	.763	.783	.806	.833	.839
VBAR =	.807	-.001	.000	-.002	.001	.020	.011	.005	.001	-.000	.000	-.000	-.002	-.002
VRBAR =	.884	.039	.049	.027	.044	.153	.108	.071	.047	.043	.049	.044	.033	.027
1-WV =	.492	.613	.701	.753	.773	0.000	.435	.509	.580	.636	.676	.706	.731	.751
1-WY =	.493	.614	.704	.755	.775	0.000	.435	.509	.581	.639	.678	.708	.732	.753
RRAR =	.27.18	23.56	18.32	14.86	12.56	27.87	27.84	26.57	24.77	22.26	19.79	17.95	16.52	15.10
BPOS =	10.93	7.64	3.89	2.50	1.76	20.12	12.85	9.89	7.94	6.57	4.65	3.63	3.14	2.60
THETA =	115.00	77.50	200.00	75.00	202.50	172.50	117.50	117.50	103.50	77.50	60.00	77.50	75.00	75.00
RUFF =	-19.94	-15.48	-15.31	-9.71	-8.93	-36.70	-23.31	-18.33	-16.00	-16.07	-16.12	-16.34	-11.53	-9.84
THETA =	0.00	0.00	0.00	0.00	0.00	67.50	0.00	0.00	3.00	3.00	0.00	3.00	0.00	0.00

WBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WV IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WY IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
RRAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
THETA 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 A2 - HARMONIC ANALYSIS OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS

HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .359								
AMPLITUDE	-.2397	-.1439	.0669	-.0198	.0171	-.0150	-.0113	-.0044
RADIUS = .556								
AMPLITUDE	-.2147	-.0223	-.0187	-.0505	.0445	-.0313	.0194	-.0271
RADIUS = .774								
AMPLITUDE	-.0931	-.1766	-.0700	-.0630	.0255	-.0259	.0160	-.0235
RADIUS = 1.017								
AMPLITUDE	-.1304	-.1786	-.0315	-.0465	-.0216	-.0149	-.0155	-.0105
RADIUS = 1.179								
AMPLITUDE	-.1310	-.1273	-.0877	-.0523	-.0293	-.0205	-.0154	-.0124

Table A3 - HARMONIC ANALYSIS OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII
EXPERIMENT 1

TRIMMER 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS									
HARMONIC	1	2	3	4	5	6	7	8	
RADIUS = .200									
AMPLITUDE =	-.2722	.0024	.1416	.0280	-.0484	.0128	-.0335	.0321	
RADIUS = .300									
AMPLITUDE =	-.2400	-.0083	.0889	-.0011	-.0027	-.0062	-.0119	.0073	
RADIUS = .400									
AMPLITUDE =	-.2334	-.1696	.0421	-.0248	.0277	-.0209	.0042	-.0111	
RADIUS = .500									
AMPLITUDE =	-.2204	-.2116	.0014	-.0428	.0427	-.0287	.0148	-.0232	
RADIUS = .600									
AMPLITUDE =	-.2124	-.2122	-.0346	-.0552	.0355	-.0305	.0199	-.0270	
RADIUS = .700									
AMPLITUDE =	-.2071	-.1909	-.0637	-.0622	.0172	-.0292	.0195	-.0256	
RADIUS = .800									
AMPLITUDE =	-.2019	-.1713	-.0813	-.0613	.0016	-.0237	.0108	-.0212	
RADIUS = .900									
AMPLITUDE =	-.1957	-.1577	-.0862	-.0536	-.0112	-.0173	.0051	-.0144	
RADIUS = 1.000									
AMPLITUDE =	-.1903	-.1454	-.0913	-.0498	-.0224	-.0149	-.0146	-.0108	

Table A4 - HARMONIC ANALYSIS OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS									
HARMONIC	1	2	3	4	5	6	7	8	
RADIUS = .359									
AMPLITUDE =	-.0636	-.0556	.0560	-.0108	.0144	-.0090	.0059	-.0036	
RADIUS = .556									
AMPLITUDE =	-.1260	-.0324	.0034	-.0038	.0127	-.0129	.0103	-.0091	
RADIUS = .774									
AMPLITUDE =	-.1355	-.0366	-.0123	-.0006	.0030	-.0023	.0070	-.0078	
RADIUS = 1.017									
AMPLITUDE =	-.1304	-.0484	-.0235	-.0048	-.0024	.0036	.0033	.0018	
RADIUS = 1.178									
AMPLITUDE =	-.1330	-.0569	-.0279	-.0118	-.0074	-.0036	-.0033	-.0029	

Table A5 - HARMONIC ANALYSIS OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS

HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .200								
AMPLITUDE =	.0316	.0324	.1147	-.0191	.0140	.0012	-.0028	.0056
RADIUS = .300								
AMPLITUDE =	-.0008	.0168	.0763	-.0136	.0144	-.0067	.0032	-.0007
RADIUS = .400								
AMPLITUDE =	-.0008	-.0130	.0449	-.0099	.0142	-.0115	.0074	-.0053
RADIUS = .500								
AMPLITUDE =	-.1100	-.0070	.0202	-.0064	.0134	-.0133	.0098	-.0092
RADIUS = .600								
AMPLITUDE =	-.1200	-.0028	.0041	-.0026	.0121	-.0103	.0098	-.0094
RADIUS = .700								
AMPLITUDE =	-.1000	-.0045	-.0061	-.0009	.0101	-.0053	.0084	-.0090
RADIUS = .800								
AMPLITUDE =	-.1047	-.0070	-.0137	-.0007	.0067	-.0007	.0062	-.0058
RADIUS = .900								
AMPLITUDE =	-.1000	-.0026	-.0187	-.0018	.0022	.0033	.0034	-.0003
RADIUS = 1.000								
AMPLITUDE =	-.1000	-.0047	-.0228	-.0043	-.0010	.0038	.0007	.0018

Table A6 - INPUT DATA FOR WAKE SURVEY ANALYSES
EXPERIMENT 1

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 27,380 TONS

RADIUS RATIO = 0.359					RADIUS RATIO = 0.556					RADIUS RATIO = 0.774				
ANGLE	VX/V	VT/V	VZ/V	ANGLE	VX/V	VT/V	VZ/V	ANGLE	VX/V	VT/V	VZ/V	ANGLE	VX/V	VZ/V
-5	.114	.005	.005	-6	.241	.015	.140	-4	.103	.023	.015			
3.3	.244	.025	.137	3.2	.258	.007	.124	7.1	.242	.004	.191			
4.7	.241	.022	.120	6.9	.276	.015	.105	8.4	.300	.019	.110			
12.2	.247	.040	.111	10.4	.277	.013	.093	12.3	.334	.052	.070			
19.5	.267	.044	.087	14.1	.329	.027	.050	15.5	.429	.070	.031			
24.3	.291	.033	.065	17.4	.342	.042	.041	24.3	.560	.049	.012			
33.0	.369	.023	.055	31.7	.450	.063	.004	40.6	.705	.144	.051			
51.6	.394	.015	.044	53.5	.740	.117	.011	47.7	.728	.139	.053			
64.1	.432	.007	.044	60.6	.856	.157	.034	51.5	.822	.161	.054			
83.3	.707	.014	.091	89.4	.963	.123	.064	51.6	.812	.148	.054			
119.8	.816	.073	.125	94.6	.945	.113	.084	64.0	.900	.143	.024			
150.5	.778	.039	.130	115.0	.755	.045	.084	64.1	.849	.152	.024			
180.2	.744	.045	.135	114.5	.954	.085	.049	91.0	.917	.122	.040			
183.2	.661	.072	.081	127.6	.955	.078	.062	120.0	.912	.071	.085			
184.3	.664	.077	.063	129.1	.958	.071	.063	120.2	.924	.049	.084			
172.0	.614	.048	.014	140.1	.954	.057	.077	150.4	.923	.044	.107			
175.7	.524	.062	.007	140.2	.952	.061	.073	150.8	.927	.044	.104			
179.5	.546	.030	.007	154.4	.934	.045	.102	143.1	.930	.044	.111			
183.0	.570	.025	.004	154.5	.937	.045	.103	163.2	.935	.035	.113			
184.4	.577	.026	.004	159.9	.910	.026	.103	163.2	.932	.028	.113			
152.0	.572	.071	.022	161.4	.841	.011	.116	164.4	.932	.028	.113			
155.7	.611	.059	.035	167.2	.784	.041	.100	175.4	.825	.042	.115			
210.0	.714	.030	.114	168.6	.743	.065	.085	179.5	.681	.049	.024			
240.7	.811	.049	.123	170.5	.644	.073	.065	184.7	.632	.073	.040			
271.4	.713	.049	.081	172.5	.659	.063	.054	194.7	.761	.084	.117			
274.5	.643	.044	.060	175.9	.599	.082	.014	192.3	.847	.046	.135			
327.5	.610	.041	.047	179.7	.544	.039	.031	209.9	.933	.051	.110			
320.2	.316	.020	.054	181.2	.540	.004	.025	240.5	.927	.042	.084			
339.9	.274	.011	.042	184.2	.542	.004	.025	273.2	.924	.121	.041			
347.1	.243	.005	.042	186.8	.647	.006	.054	244.4	.404	.148	.014			
352.5	.274	.015	.114	190.3	.644	.025	.115	307.6	.436	.160	.049			
354.4	.275	.019	.123	197.6	.434	.015	.123	320.1	.717	.143	.042			
359.5	.114	.005	.005	203.1	.497	.041	.112	332.8	.526	.071	.002			
				204.4	.406	.041	.094	339.9	.443	.074	.024			
				219.2	.909	.060	.054	344.6	.335	.046	.070			
				230.0	.925	.073	.080	352.3	.316	.037	.107			
				244.4	.920	.049	.057	354.0	.307	.019	.134			
				247.9	.922	.115	.015	359.5	.118	.008	.001			
				241.3	.856	.142	.010	150.4	.103	.023	.015			
				314.7	.604	.103	.011							
				341.3	.347	.043	.071							
				343.2	.314	.029	.044							
				346.9	.363	.034	.110							
				352.2	.247	.022	.132							
				355.9	.248	.021	.136							
				359.4	.241	.015	.140							

CONTINUED

Table A6 - INPUT DATA FOR WAKE SURVEY ANALYSES
EXPERIMENT 1
TRIMMED 1.5 FEET BY THE STERN DISPLACEMENT 27,380 TONS

[illegible]

APPENDIX B
RESULTS OF EXPERIMENT 2

Corresponding to
Trim 1.5 ft (0.457 m) by the Stern
Displacement 26,380 Tons (26,810 tonnes)

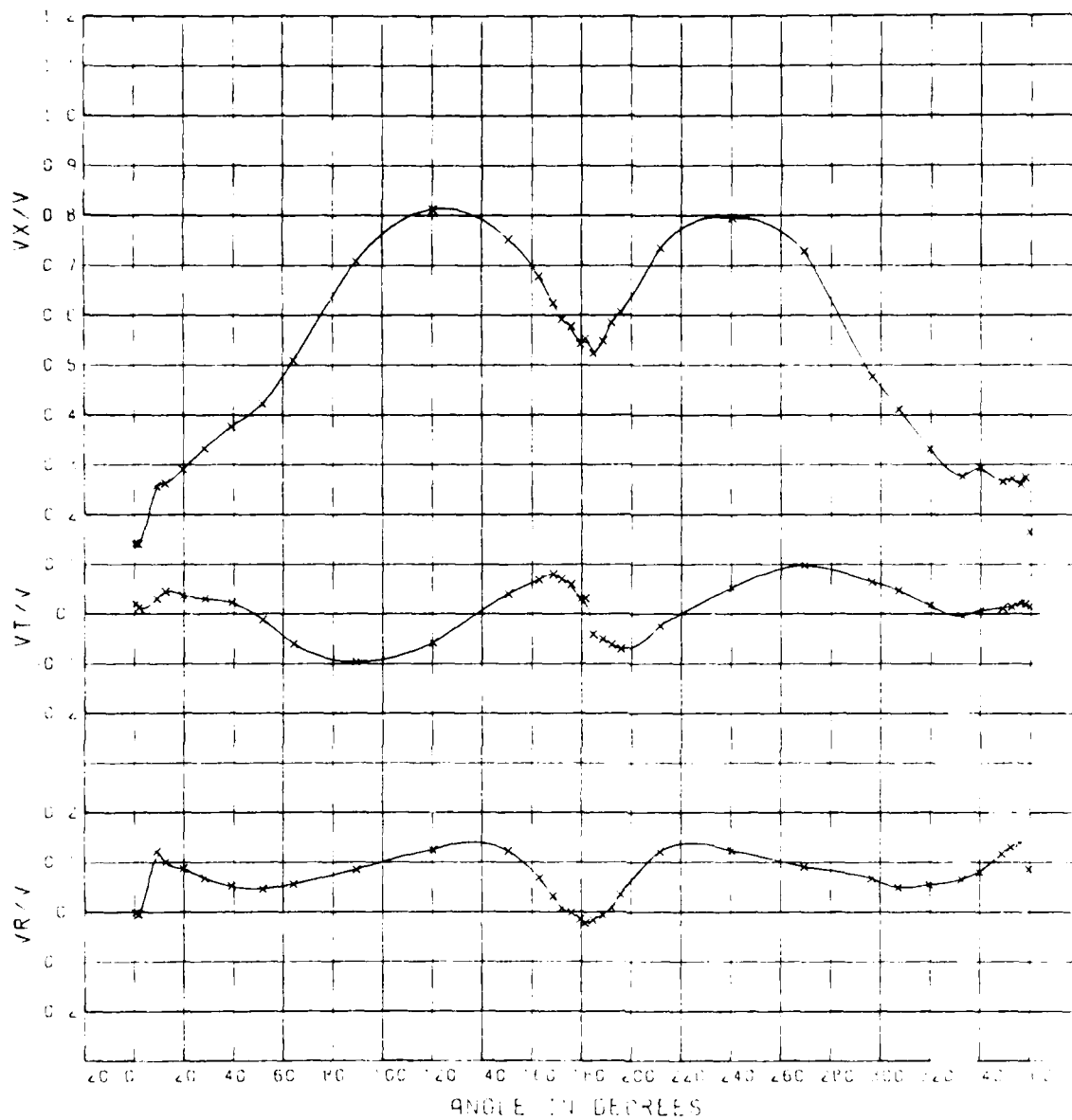


Figure B1 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND
RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.359
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,390 TONS

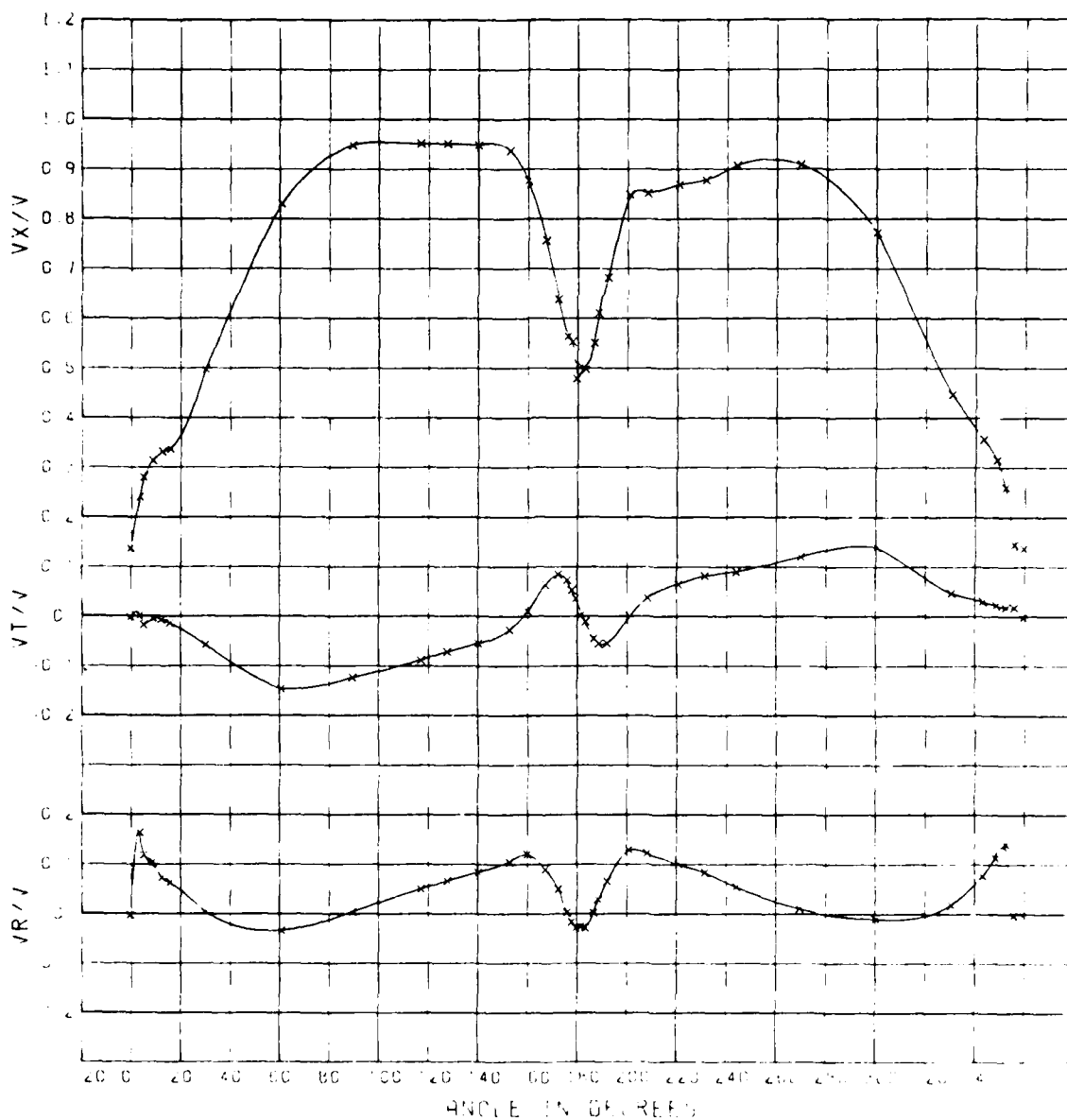


Figure B2 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.556
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,390 TONS

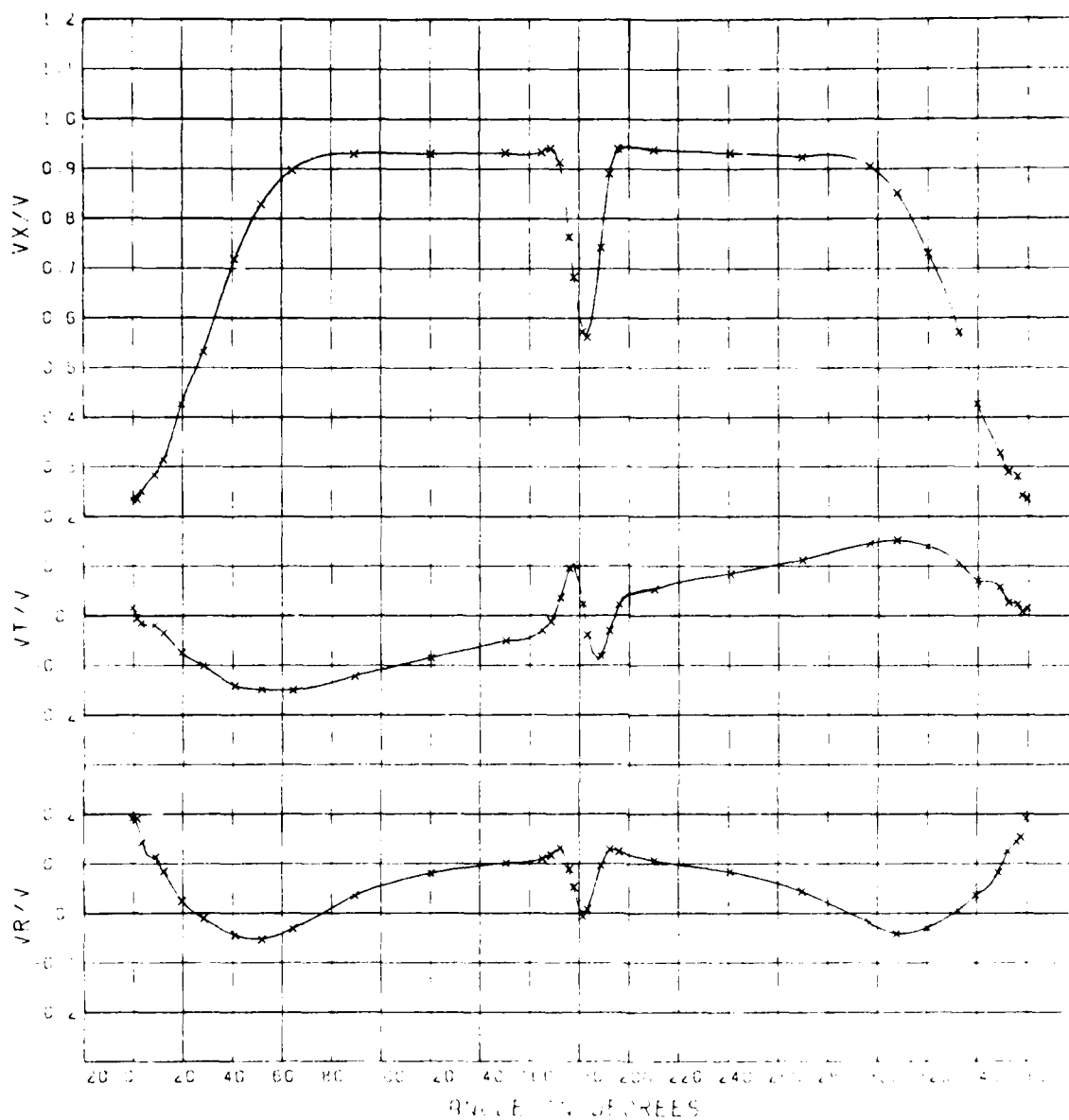


Figure B3 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.774
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,300 TONS

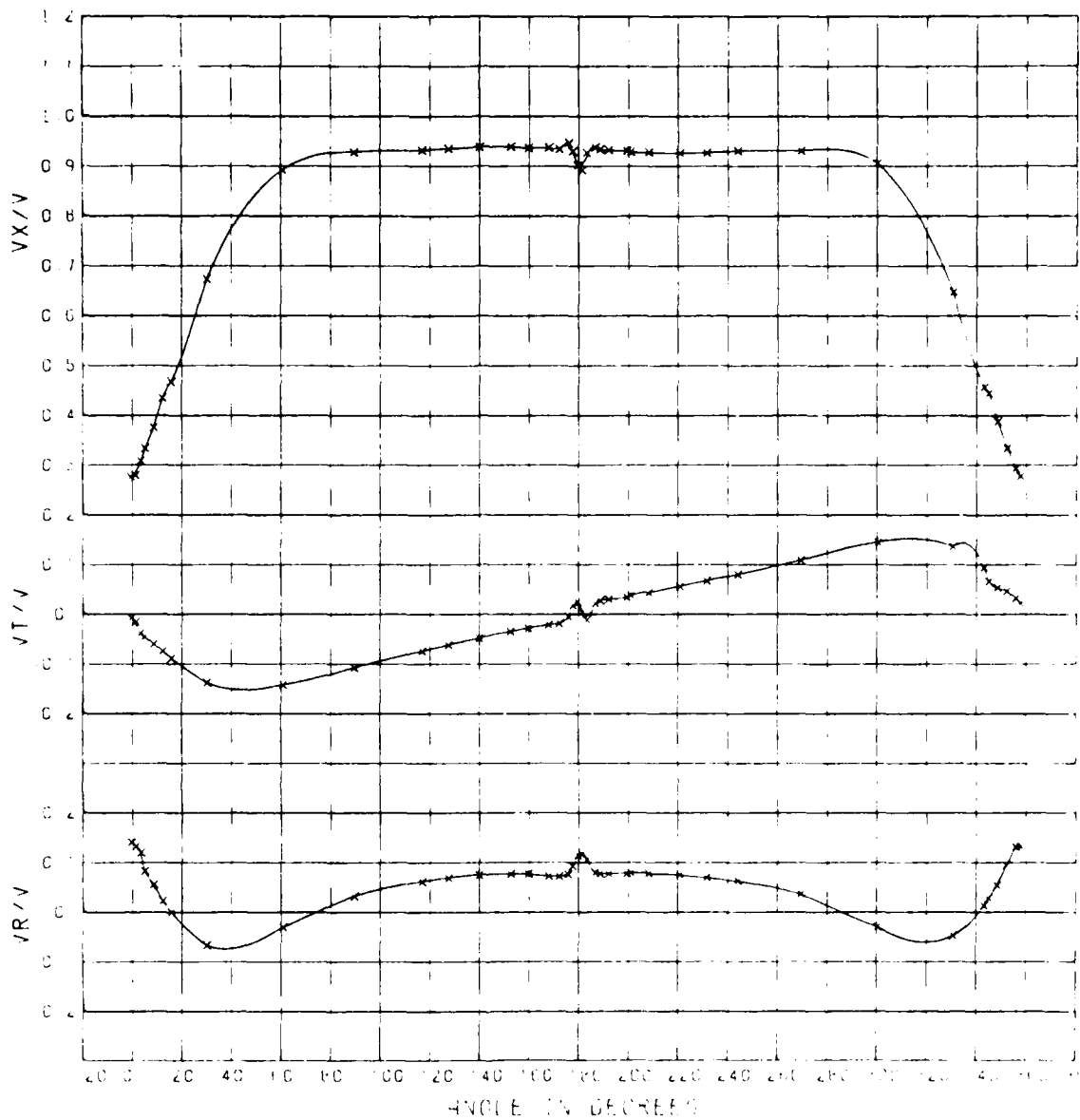


Figure B4 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.017
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,390 TONS

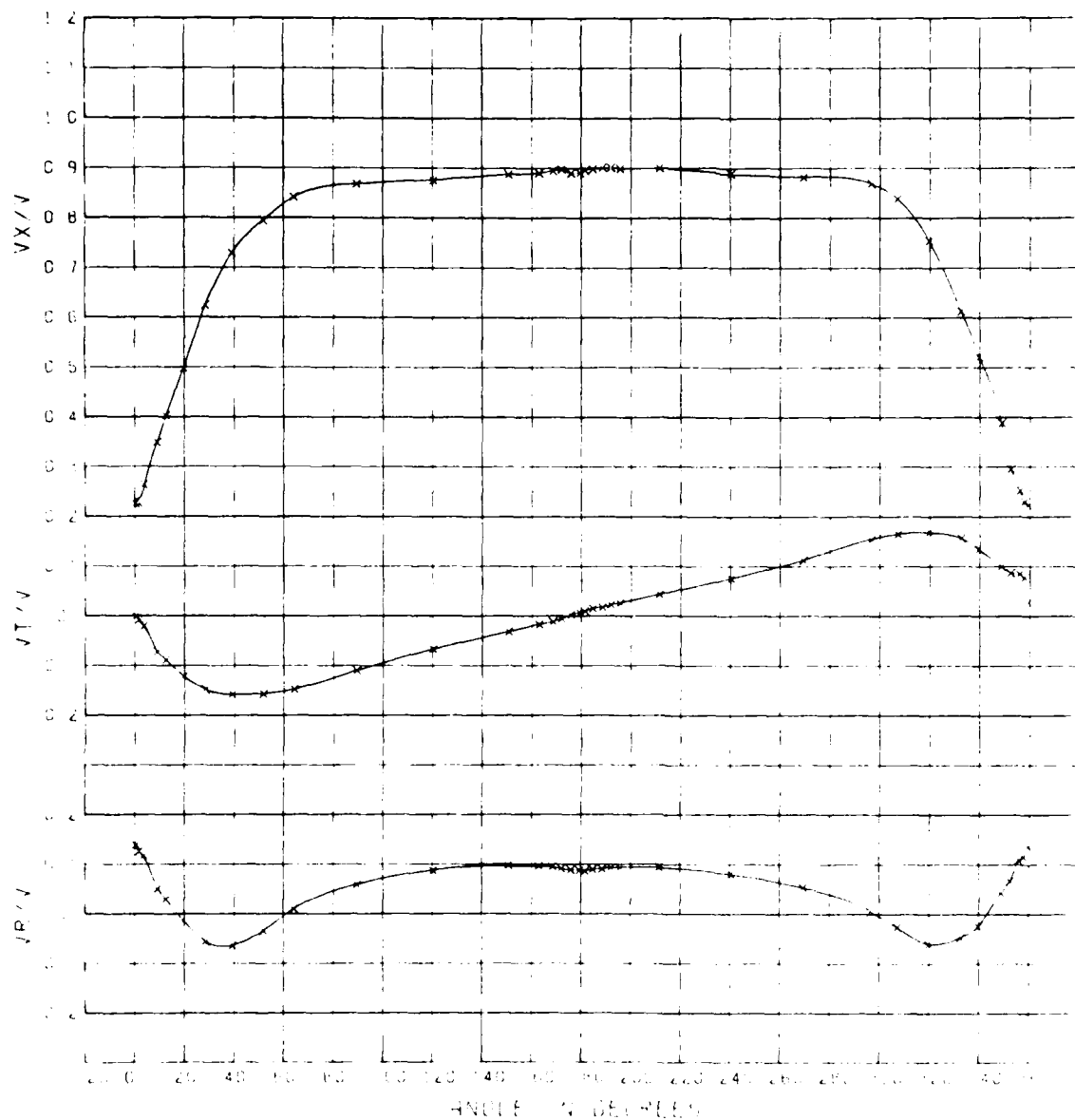


Figure B5 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.178
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,300 TONS

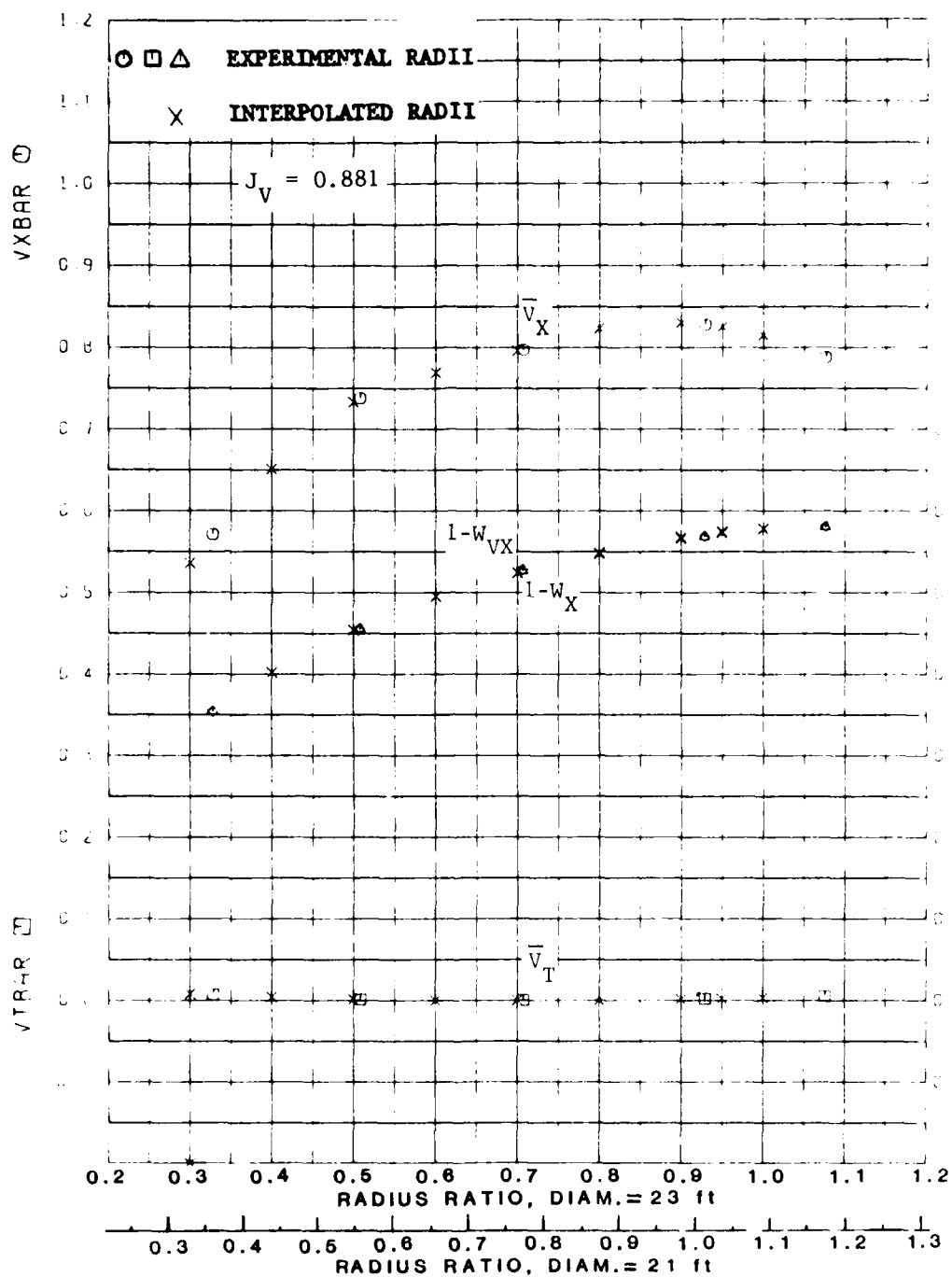


Figure B6 - RADIAL DISTRIBUTION OF THE MEAN VELOCITY COMPONENT RATIOS
 EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,390 TONS

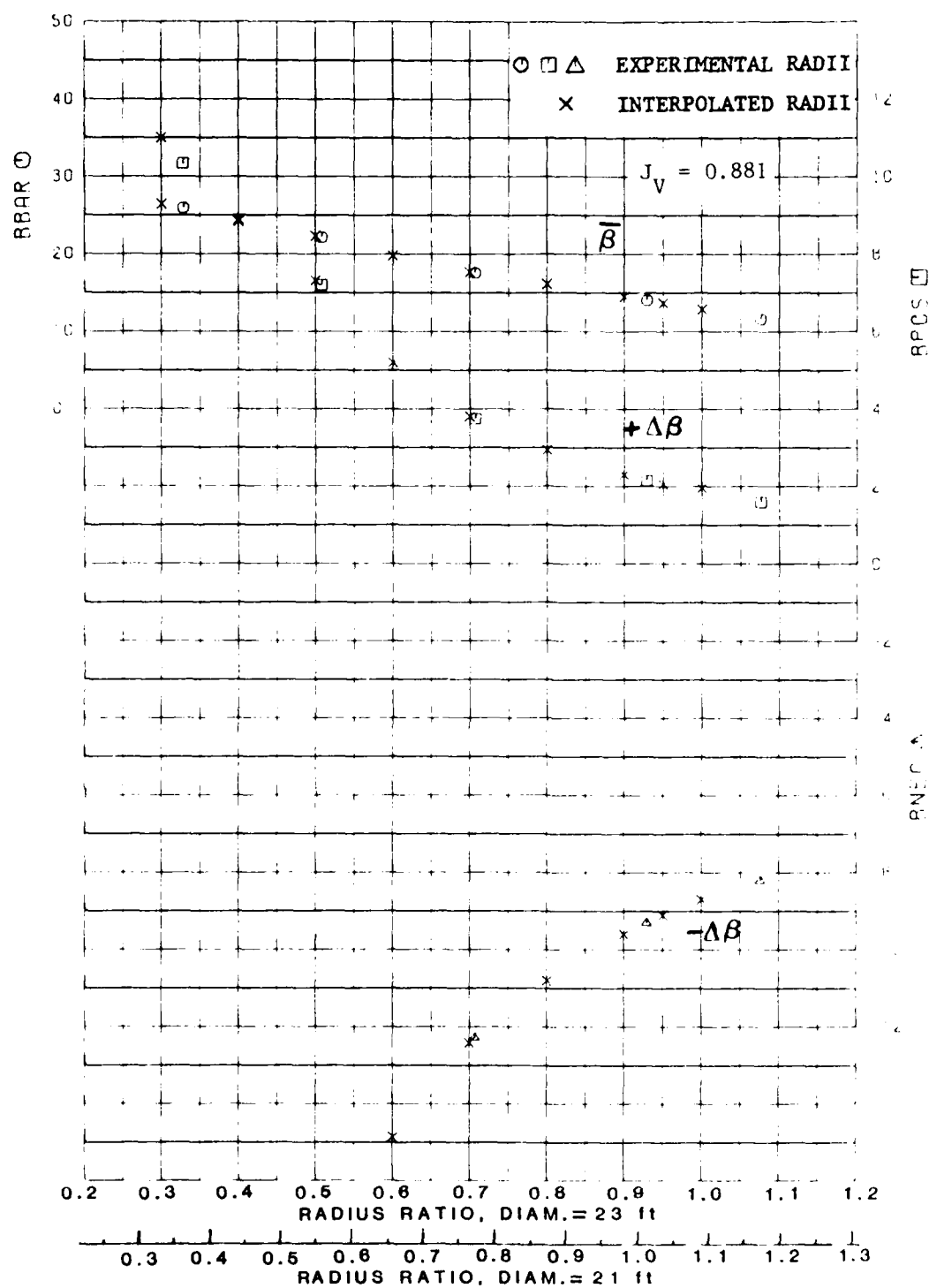


Figure B7 - RADIAL DISTRIBUTION OF THE MEAN ADVANCE ANGLE AND THE MAXIMUM VARIATIONS OF THE ADVANCE ANGLE FOR MODEL 5326 EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,390 TONS

Table B2 - HARMONIC ANALYSIS OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,300 TONS									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .359									
AMPLITUDE	=	-.2326	-.1425	.0587	-.0175	.0084	-.0198	.0023	-.0053
RADIUS = .556									
AMPLITUDE	=	-.2031	-.2272	-.0183	-.0536	.0301	-.0378	.0215	-.0290
RADIUS = .774									
AMPLITUDE	=	-.1991	-.1866	-.0741	-.0712	.0067	-.0294	.0193	-.0235
RADIUS = 1.017									
AMPLITUDE	=	-.1888	-.1429	-.0908	-.0491	-.0233	-.0133	-.0074	-.0063
RADIUS = 1.179									
AMPLITUDE	=	-.1807	-.1273	-.0882	-.0520	-.0294	-.0191	-.0133	-.0097

Table B3 - HARMONIC ANALYSIS OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,390 TONS

HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .200								
AMPLITUDE =	-.2728	.0099	.1392	.0361	-.0390	.0126	-.0279	.0336
RADIUS = .300								
AMPLITUDE =	-.2453	-.0947	.0866	.0002	-.0061	-.0096	-.0074	.0071
RADIUS = .400								
AMPLITUDE =	-.2240	-.1696	.0406	-.0284	.0163	-.0255	.0079	-.0125
RADIUS = .500								
AMPLITUDE =	-.2088	-.2148	.0010	-.0498	.0281	-.0352	.0181	-.0250
RADIUS = .600								
AMPLITUDE =	-.2027	-.2189	-.0327	-.0636	.0257	-.0366	.0227	-.0286
RADIUS = .700								
AMPLITUDE =	-.2010	-.2002	-.0595	-.0703	.0150	-.0329	.0224	-.0264
RADIUS = .800								
AMPLITUDE =	-.1981	-.1808	-.0770	-.0673	.0023	-.0262	.0154	-.0204
RADIUS = .900								
AMPLITUDE =	-.1941	-.1609	-.0858	-.0557	-.0120	-.0173	.0028	-.0112
RADIUS = 1.000								
AMPLITUDE =	-.1896	-.1451	-.0904	-.0496	-.0220	-.0134	-.0062	-.0066

Table B4 - HARMONIC ANALYSIS OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,390 TONS								
HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .359								
AMPLITUDE =	-.0532	-.0069	.0527	-.0119	.0131	-.0104	.0059	-.0060
RADIUS = .550								
AMPLITUDE =	-.1190	-.0243	.0166	.0015	.0180	-.0123	.0093	-.0116
RADIUS = .774								
AMPLITUDE =	-.1341	-.0370	-.0137	-.0003	.0057	-.0024	.0067	-.0060
RADIUS = 1.017								
AMPLITUDE =	-.1294	-.0445	-.0247	-.0070	-.0052	-.0005	-.0016	.0009
RADIUS = 1.178								
AMPLITUDE =	-.1354	-.0588	-.0282	-.0117	-.0074	-.0047	-.0038	-.0022

Table B5 - HARMONIC ANALYSIS OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,390 TONS

HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .200 AMPLITUDE =	.0361	.0113	.0070	-.0330	-.0019	-.0014	-.0009	.0059
RADIUS = .300 AMPLITUDE =	-.0238	-.0005	.0651	-.0186	.0087	-.0078	.0038	-.0024
RADIUS = .400 AMPLITUDE =	-.0709	-.0109	.0445	-.0079	.0154	-.0116	.0071	-.0080
RADIUS = .500 AMPLITUDE =	-.1053	-.0199	.0260	-.0009	.0142	-.0124	.0089	-.0111
RADIUS = .600 AMPLITUDE =	-.1235	-.0270	.0089	.0014	.0153	-.0097	.0092	-.0105
RADIUS = .700 AMPLITUDE =	-.1310	-.0329	-.0056	.0008	.0096	-.0049	.0081	-.0080
RADIUS = .800 AMPLITUDE =	-.1328	-.0380	-.0152	-.0010	.0041	-.0017	.0055	-.0046
RADIUS = .900 AMPLITUDE =	-.1296	-.0423	-.0203	-.0037	-.0011	-.0002	.0017	-.0007
RADIUS = 1.000 AMPLITUDE =	-.1292	-.0475	-.0242	-.0065	-.0047	-.0003	-.0012	.0009

Table B6 - INPUT DATA FOR WAKE SURVEY ANALYSES
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN, DISPLACEMENT 26,390 TONS

RADIUS RATIO = 0.359					RADIUS RATIO = 0.556					RADIUS RATIO = 0.774				
ANGLE	VX/V	VT/V	VZ/V	ANGLE	VX/V	VT/V	VZ/V	ANGLE	VX/V	VT/V	VZ/V	ANGLE	VX/V	VZ/V
1.0	1.27	0.01	0.00	-1.5	1.37	-0.02	-0.04	-1.4	1.35	0.05	0.19	1.91	1.27	0.01
1.0	1.50	0.00	-0.00	3.3	2.40	0.01	0.16	1.5	2.14	-0.06	0.15	1.91	1.50	0.00
1.7	1.40	0.12	-0.00	5.0	2.80	-0.19	0.14	3.2	2.51	-0.06	0.16	1.42	1.40	0.12
9.0	2.57	0.31	0.12	8.6	3.13	-0.05	0.10	8.7	2.83	-0.09	0.19	1.13	2.57	0.31
12.5	2.62	0.45	0.10	12.2	3.11	-0.07	0.71	12.2	2.75	-0.05	0.44	0.44	12.5	0.45
19.5	2.90	0.37	0.07	15.6	3.36	-0.14	0.63	19.4	2.77	-0.07	0.24	0.24	19.5	0.37
28.3	3.32	0.31	0.04	30.0	4.07	-0.54	0.64	28.2	5.32	-0.10	0.11	-0.11	28.3	0.31
39.1	3.76	0.23	0.02	47.4	4.40	-0.54	-0.14	40.4	7.18	-0.12	0.04	-0.04	39.1	0.23
51.7	4.22	-0.12	0.04	49.4	4.40	-0.54	-0.14	51.6	7.18	-0.12	0.04	-0.04	51.7	-0.12
64.1	4.10	-0.60	0.05	114.9	9.41	-0.04	0.05	64.2	6.47	-0.14	0.05	0.05	64.1	-0.60
69.3	7.78	-0.47	0.04	127.6	9.41	-0.04	0.05	69.3	6.47	-0.14	0.05	0.05	69.3	-0.47
120.2	4.12	-0.04	0.04	140.1	9.41	-0.04	0.05	120.2	6.47	-0.14	0.05	0.05	120.2	-0.04
150.5	7.52	0.06	0.12	152.8	9.37	-0.05	0.10	150.5	6.47	-0.14	0.05	0.05	150.5	0.06
162.9	6.77	0.09	0.04	160.0	8.76	0.10	0.10	162.9	6.47	-0.14	0.05	0.05	162.9	0.09
168.5	6.25	0.00	0.03	167.2	7.56	0.06	0.09	168.5	6.47	-0.14	0.05	0.05	168.5	0.00
172.0	5.42	0.01	0.07	172.3	6.34	0.04	0.04	172.0	6.47	-0.14	0.05	0.05	172.0	0.01
175.8	5.24	0.04	0.00	175.9	5.42	0.07	0.02	175.8	6.47	-0.14	0.05	0.05	175.8	0.04
179.4	5.62	0.04	-0.01	177.7	5.42	0.07	0.02	179.4	6.47	-0.14	0.05	0.05	179.4	0.04
181.4	5.53	0.02	-0.02	175.4	4.79	0.05	-0.01	181.4	6.47	-0.14	0.05	0.05	181.4	0.02
184.5	5.28	-0.04	-0.07	173.4	4.79	0.05	-0.01	184.5	6.47	-0.14	0.05	0.05	184.5	-0.04
186.5	5.44	-0.04	-0.07	141.3	5.04	-0.01	-0.02	186.5	6.47	-0.14	0.05	0.05	186.5	-0.04
192.0	6.00	-0.02	0.04	143.1	4.44	-0.02	-0.02	192.0	6.47	-0.14	0.05	0.05	192.0	-0.02
211.5	7.15	-0.07	0.04	186.6	5.50	-0.04	0.04	211.5	6.47	-0.14	0.05	0.05	211.5	-0.07
240.2	7.45	-0.05	0.12	192.0	6.42	-0.05	0.04	240.2	6.47	-0.14	0.05	0.05	240.2	-0.05
249.3	7.34	0.04	0.04	200.9	8.04	-0.00	0.12	249.3	6.47	-0.14	0.05	0.05	249.3	0.04
264.5	7.17	0.04	0.04	208.1	8.04	0.17	0.12	264.5	6.47	-0.14	0.05	0.05	264.5	0.04
274.5	6.17	0.05	0.04	220.6	8.04	0.17	0.12	274.5	6.47	-0.14	0.05	0.05	274.5	0.05
307.1	4.12	0.09	0.04	231.4	8.04	0.17	0.12	307.1	6.47	-0.14	0.05	0.05	307.1	0.09
312.5	3.11	0.17	0.04	243.4	8.04	0.17	0.12	312.5	6.47	-0.14	0.05	0.05	312.5	0.17
334.8	2.76	-0.05	0.04	262.5	8.04	0.17	0.12	334.8	6.47	-0.14	0.05	0.05	334.8	-0.05
344.7	2.65	0.05	0.04	300.1	8.04	0.17	0.12	344.7	6.47	-0.14	0.05	0.05	344.7	0.05
352.4	2.72	0.14	0.13	343.1	8.04	0.17	0.12	352.4	6.47	-0.14	0.05	0.05	352.4	0.14
357.4	2.40	0.14	0.13	344.5	8.04	0.17	0.12	357.4	6.47	-0.14	0.05	0.05	357.4	0.14
359.4	2.14	0.14	0.13	352.3	8.04	0.17	0.12	359.4	6.47	-0.14	0.05	0.05	359.4	0.14
377	1.77	0.11	0.00	356.5	8.04	0.17	0.12	377	6.47	-0.14	0.05	0.05	377	0.11

RADIUS RATIO = 1.017

ANGLE	VX/V	VI/V	V2/V
1.3	.276	-.009	.141
1.3	.279	-.015	.132
1.3	.306	-.041	.116
4.0	.334	-.044	-.043
4.7	.345	-.059	-.059
12.1	.438	-.070	-.028
15.8	.470	-.074	-.005
32.0	.671	-.114	-.070
60.6	.990	-.140	-.032
89.4	.930	-.139	-.032
114.9	.932	-.075	.062
127.5	.934	-.072	.067
140.1	.938	-.044	.075
152.4	.938	-.034	.075
160.0	.936	-.029	.074
167.2	.930	-.023	.073
168.6	.939	-.020	.070
172.0	.932	-.019	.070
172.3	.934	-.019	.073
175.7	.945	-.006	.075
175.9	.948	-.005	.074
177.4	.921	.071	.091
177.7	.934	.075	.093
178.4	.904	.074	.114
178.6	.900	.074	.114
181.3	.943	.004	.114
181.5	.940	.005	.114
183.1	.944	-.003	.107
183.2	.914	-.014	.104
184.6	.936	.022	.074
184.5	.936	.027	.074
184.7	.932	.027	.074
192.0	.932	.023	.075
192.2	.933	.032	.077
198.4	.911	.034	.074
200.9	.929	.034	.074
208.1	.926	.045	.074
208.2	.929	.042	.074
220.6	.924	.045	.075
220.8	.927	.046	.074
231.4	.925	.049	.067
231.6	.928	.046	.064
243.9	.921	.040	.063
244.2	.924	.040	.062
262.3	.911	.107	.035
268.5	.930	.104	.037
300.1	.906	.144	-.030
300.2	.905	.145	-.030
330.5	.955	.145	-.044
330.5	.940	.147	-.047
343.1	.957	.094	.013
345.0	.944	.046	.027
348.5	.947	.046	.054
352.2	.933	.052	.052
352.3	.933	.043	.040
354.4	.929	.049	.049
357.7	.924	.062	.124
359.5	.926	-.009	.141

CONTINUED

Table B6 - INPUT DATA FOR WAKE SURVEY ANALYSES
EXPERIMENT 2

TRIMMED 1.5 FEET BY THE STERN DISPLACEMENT 26,390 TONS

RADIUS RATIO = 1.178

ANGLE	VX/V	VI/V	V2/V
1.2	.246	.015	.140
1.7	.205	-.017	.135
3.6	.225	-.009	.125
9.0	.349	-.022	.117
12.5	.402	-.073	.044
19.6	.498	-.073	.024
24.3	.623	-.123	-.014
33.1	.724	-.149	-.057
51.7	.794	-.157	-.065
64.1	.441	-.144	-.035
64.3	.467	-.111	-.010
120.2	.875	-.068	.059
150.6	.947	-.032	.085
162.9	.940	-.013	.097
164.5	.944	-.013	.094
172.0	.948	-.005	.091
175.4	.940	.003	.081
179.4	.941	.006	.087
181.4	.946	.010	.084
184.6	.949	.015	.083
184.5	.901	.017	.090
182.0	.901	.023	.092
194.7	.944	.026	.094
211.5	.940	.044	.094
240.2	.944	.075	.080
269.3	.942	.112	.053
296.4	.944	.145	.004
337.1	.944	.163	-.027
339.7	.794	.164	-.061
332.5	.612	.157	-.044
339.4	.520	.136	-.025
344.7	.384	.100	-.042
352.4	.295	.047	.065
355.9	.241	.045	.104
357.4	.229	.077	.117
359.4	.201	.040	.132
359.8	.246	.015	.140

APPENDIX C
RESULTS OF EXPERIMENT 3

Corresponding to
Trim 1.0 ft (0.305 m) by the Bow
Displacement 26,300 Tons (26,810 tonnes)

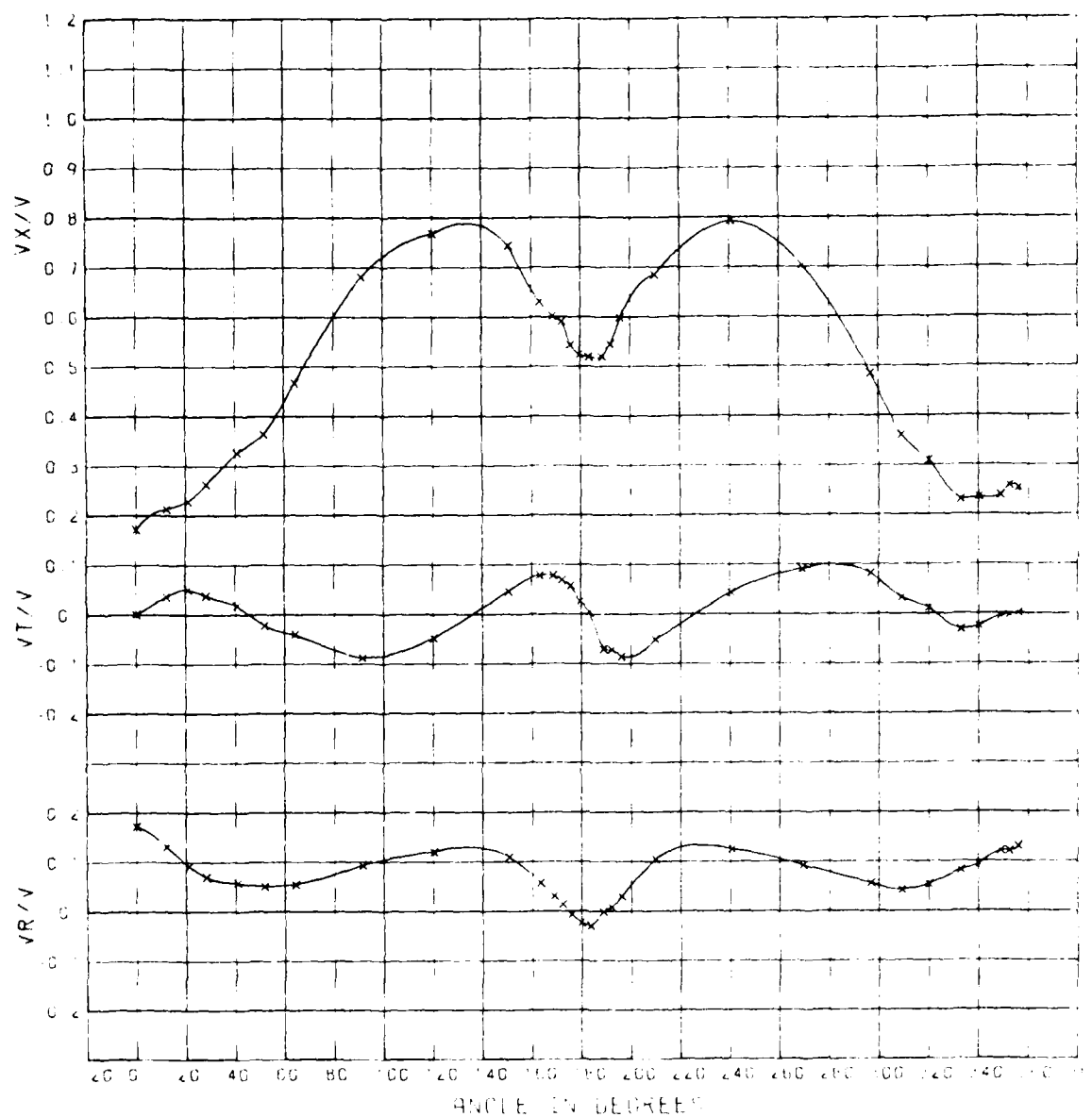


Figure C1 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.359
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW, DISPLACEMENT 26,300 TONS

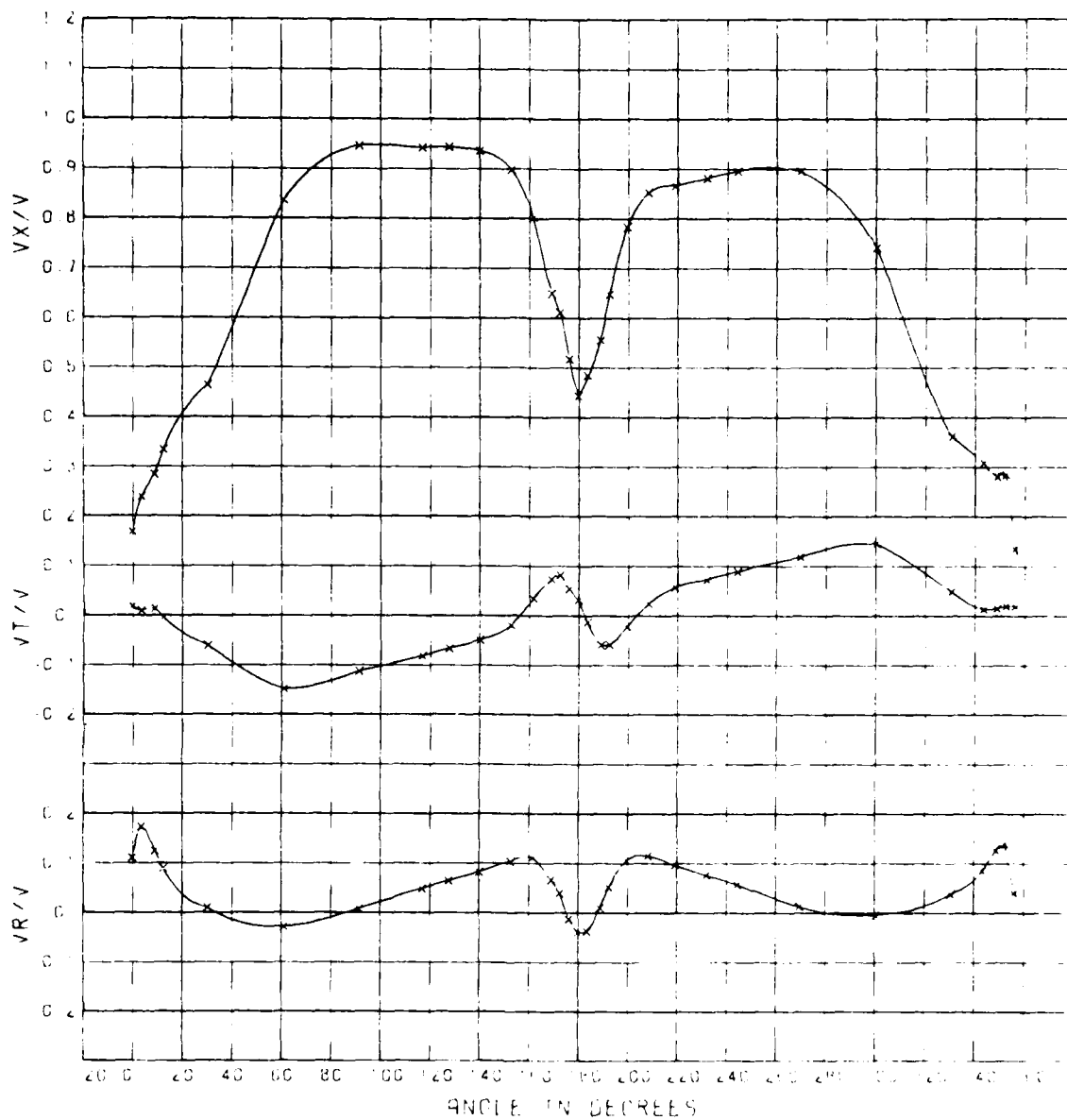


Figure C2 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.556
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW, DISPLACEMENT 26,390 TONS

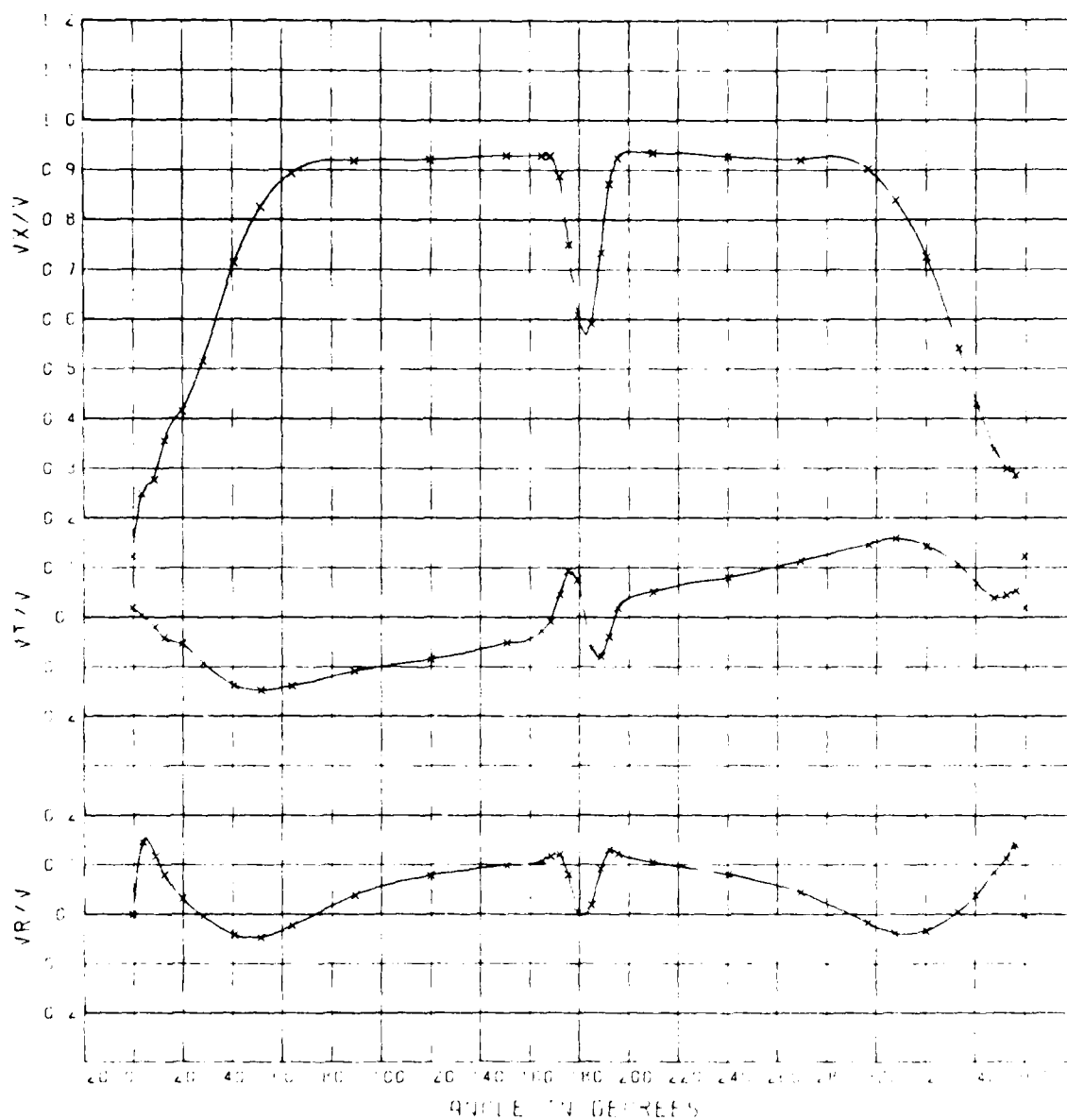


Figure C3 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.774
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW, DISPLACEMENT 26,000 TONS

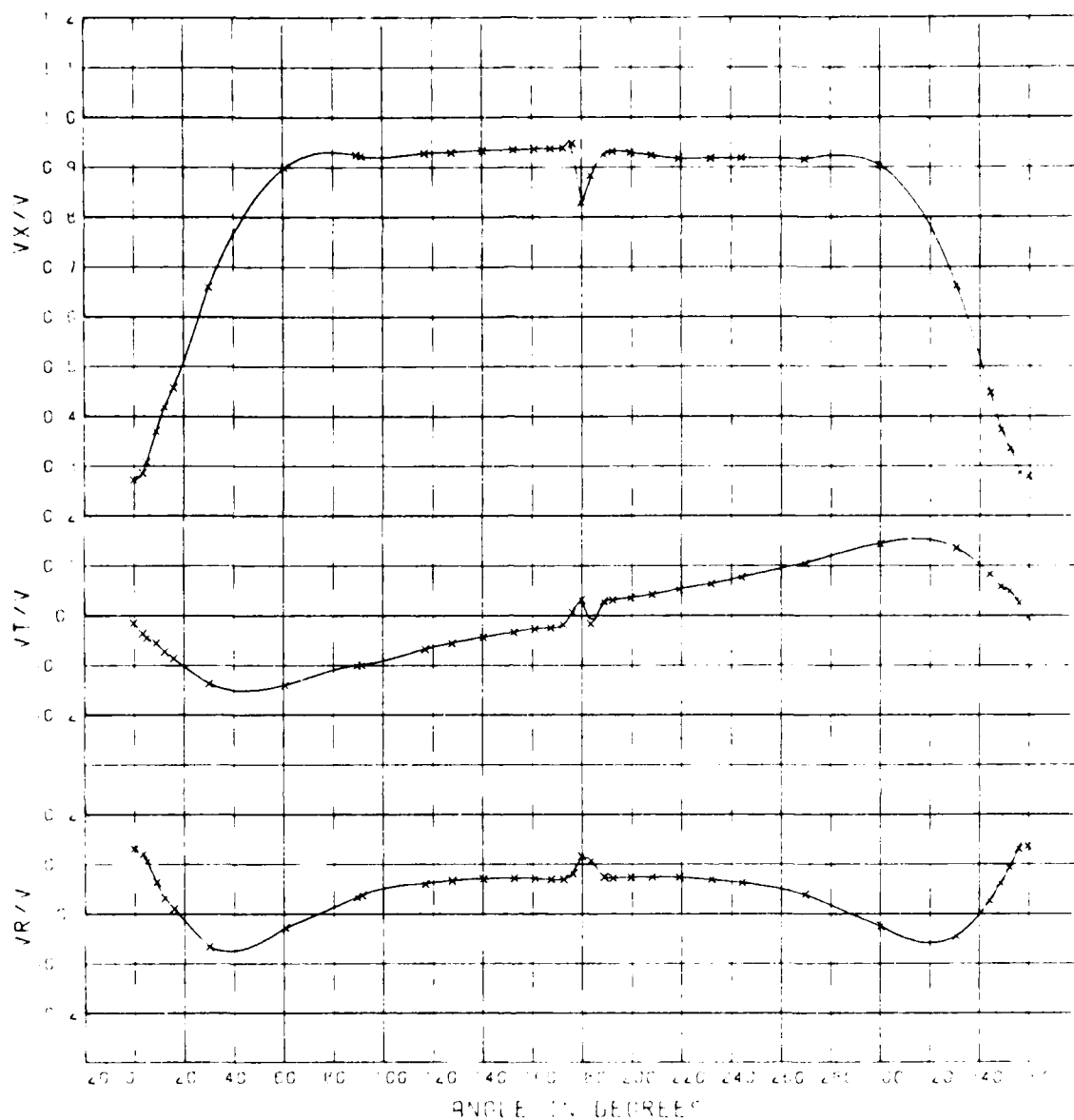


Figure C4 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.017
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW, DISPLACEMENT 26,390 TONS

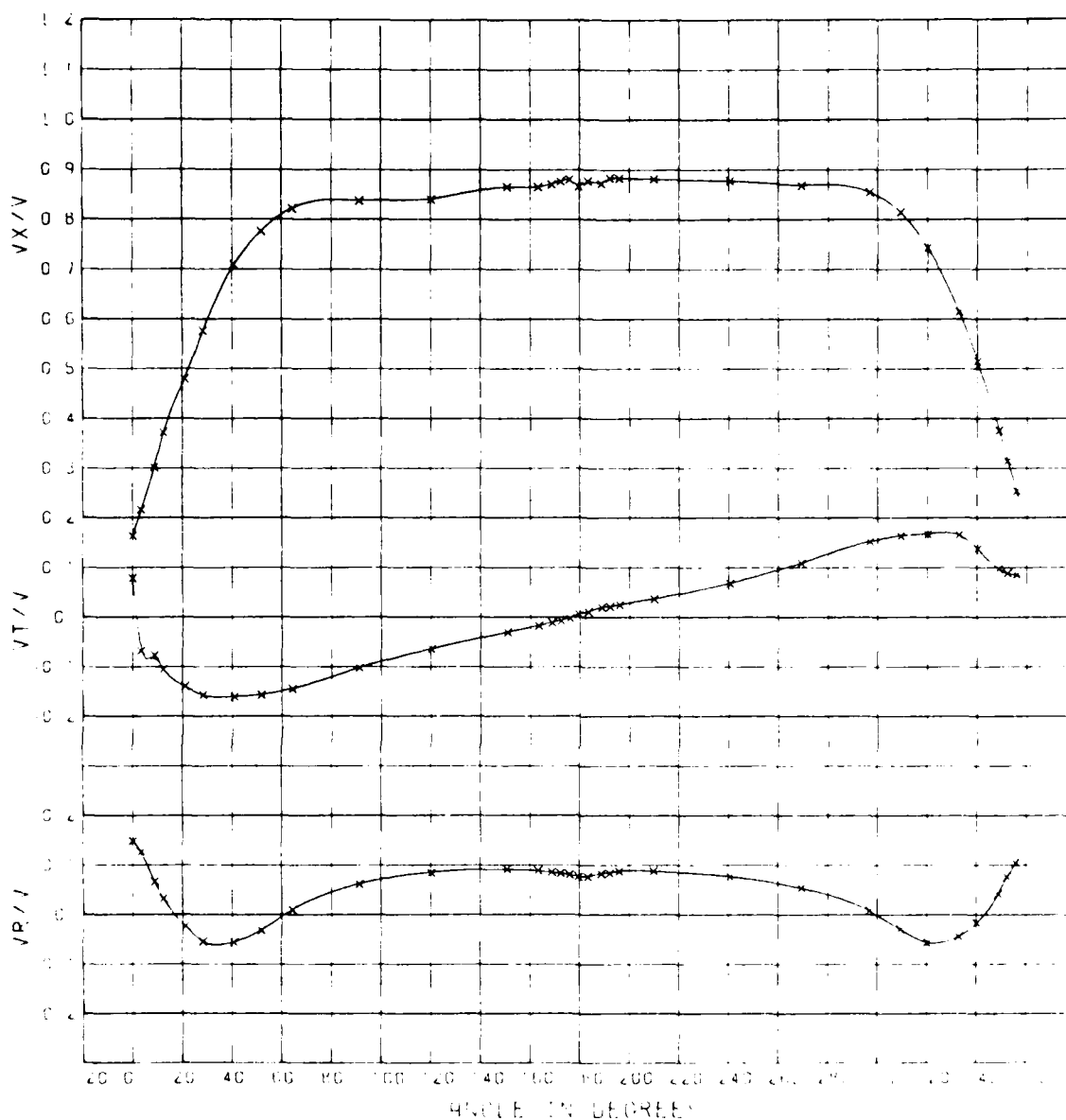


Figure C5 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.178
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW, DISPLACEMENT 26,390 LBS

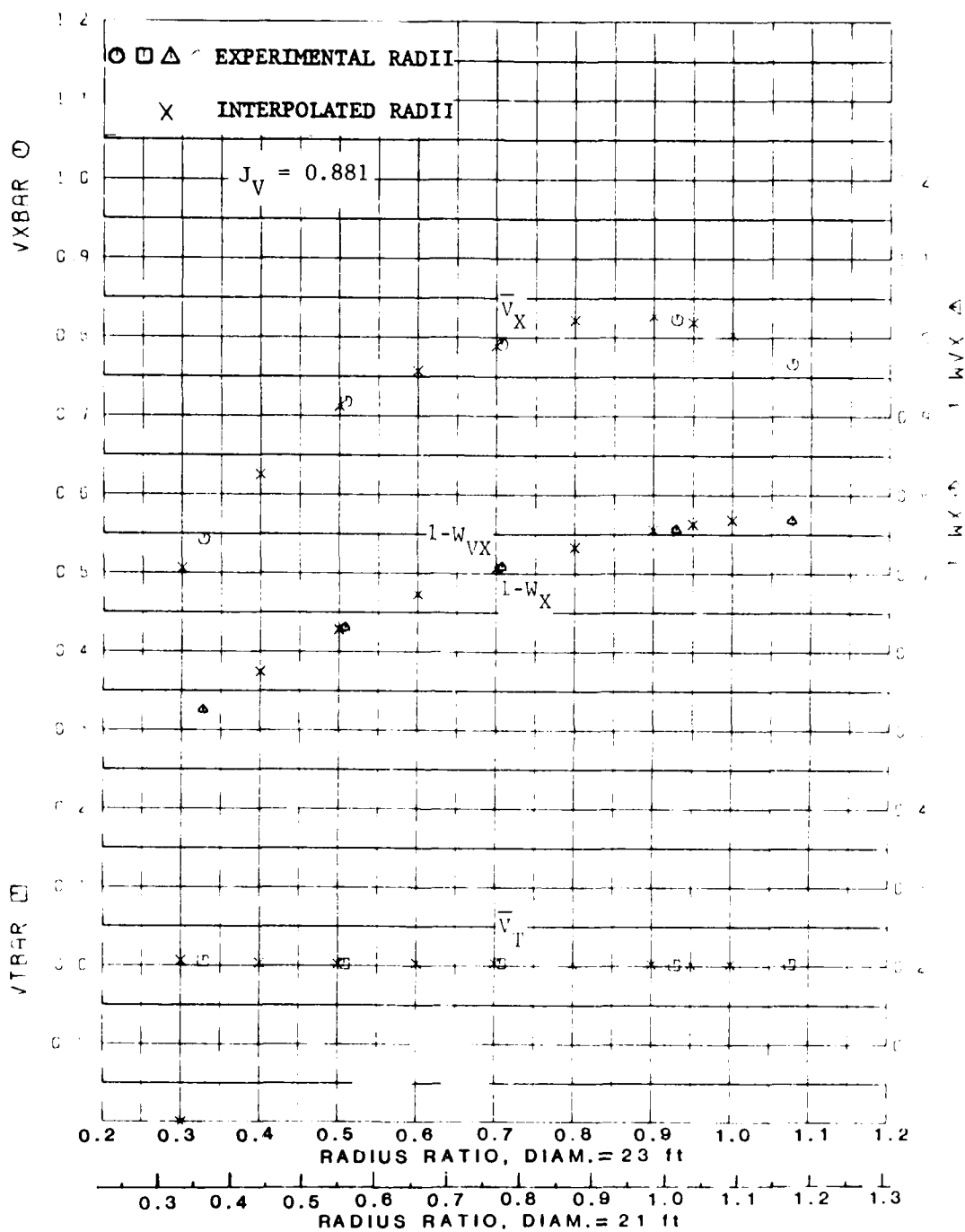


Figure C6 - RADIAL DISTRIBUTION OF THE MEAN VELOCITY COMPONENT RATIOS
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW, DISPLACEMENT 26,390 TONS

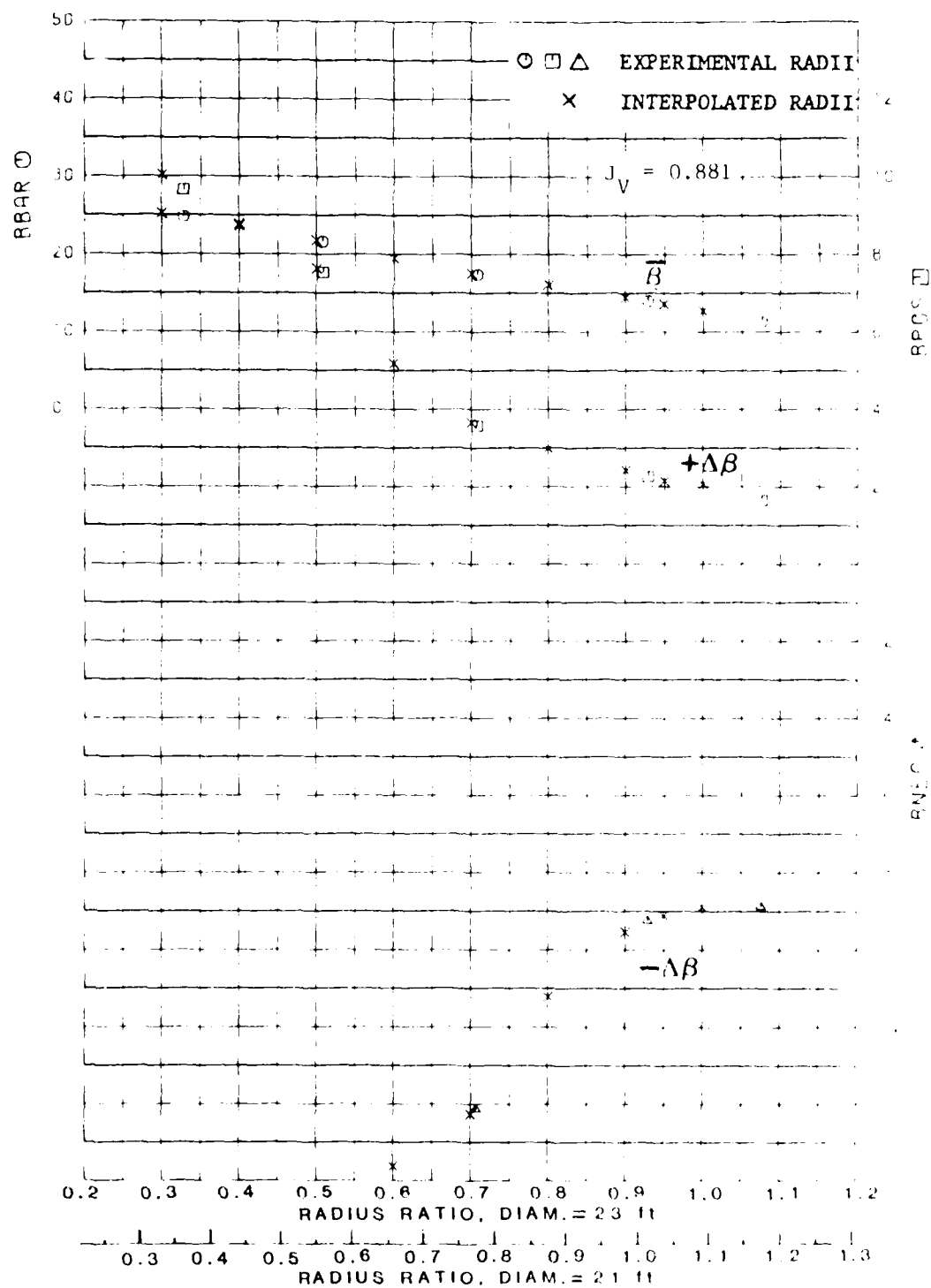


Figure C7 - RADIAL DISTRIBUTION OF THE MEAN ADVANCE ANGLE AND THE MAXIMUM VARIATIONS OF THE ADVANCE ANGLE FOR MODEL 5000 EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW, DISPLACEMENT 26,390 TONS

EXPERIMENT 3

$$H = 21 \text{ ft (6.4 m)}, J_V = 1.01$$
67

IS THE DIFFERENTIAL MEAN LONGITUDINAL VELOCITY.
IS THE DIFFERENTIAL MEAN TANGENTIAL VELOCITY.
IS THE DIFFERENTIAL MEAN RADIAL VELOCITY.
IS THE DIFFERENTIAL MEAN ANGULAR VELOCITY.
IS THE DIFFERENTIAL MEAN AXIAL VELOCITY WITH TANGENTIAL CORRECTION.
IS THE DIFFERENTIAL MEAN AXIAL VELOCITY WITH TANGENTIAL CORRECTION.
IS MEAN ANGLE OF ADVANCE.
IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES DELTA
IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES DELTA
IS ANGLE IN DEGREES AT WHICH CORRESPONDING REPS OR BERG OCCURS.
THESE

Table C2 - HARMONIC ANALYSIS OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW DISPLACEMENT 26,390 TONS

HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .359								
AMPLITUDE =	.2408	.1450	.0513	.0136	.0188	.0132	.0081	.0048
PHASE ANGLE =	269.0	267.4	75.5	240.2	85.7	251.9	142.9	211.6
RADIUS = .556								
AMPLITUDE =	.2077	.2387	.0187	.0537	.0450	.0322	.0196	.0289
PHASE ANGLE =	281.8	272.7	348.8	271.3	88.2	272.6	88.6	267.9
RADIUS = .774								
AMPLITUDE =	.1975	.1865	.0730	.0721	.0107	.0295	.0212	.0249
PHASE ANGLE =	269.6	268.7	268.4	266.4	69.9	260.4	69.4	259.7
RADIUS = 1.017								
AMPLITUDE =	.1834	.1425	.0932	.0543	.0221	.0164	.0071	.0103
PHASE ANGLE =	270.7	268.0	270.4	269.6	276.8	279.6	288.2	272.0
RADIUS = 1.178								
AMPLITUDE =	.1809	.1275	.0907	.0530	.0286	.0191	.0136	.0106
PHASE ANGLE =	263.2	268.0	266.2	265.6	267.1	268.8	262.9	269.0

Table C3 - HARMONIC ANALYSIS OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW DISPLACEMENT 26,360 TONS								
HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .200								
AMPLITUDE =	.3111	.0510	.1104	.0454	.0427	.0250	.0211	.0412
PHASE ANGLE =	250.5	146.6	91.1	119.3	273.8	130.9	233.8	105.0
RADIUS = .300								
AMPLITUDE =	.2603	.0925	.0789	.0128	.0018	.0082	.0089	.0126
PHASE ANGLE =	262.3	259.0	82.4	154.8	3.8	197.6	194.3	118.9
RADIUS = .400								
AMPLITUDE =	.2308	.1754	.0495	.0229	.0287	.1185	.0104	.0108
PHASE ANGLE =	273.1	269.9	69.1	259.7	87.5	263.6	118.6	254.1
RADIUS = .500								
AMPLITUDE =	.2142	.2256	.0242	.0442	.0432	.0288	.0189	.0244
PHASE ANGLE =	280.1	272.3	36.0	270.2	88.4	271.9	94.8	266.9
RADIUS = .600								
AMPLITUDE =	.2047	.2271	.0249	.0600	.0376	.0322	.0217	.0288
PHASE ANGLE =	278.1	271.7	300.1	269.4	86.8	268.5	82.6	265.4
RADIUS = .700								
AMPLITUDE =	.2002	.2028	.0549	.0695	.0215	.0313	.0232	.0272
PHASE ANGLE =	271.6	269.8	272.5	267.1	81.3	262.4	74.2	261.3
RADIUS = .800								
AMPLITUDE =	.1954	.1806	.0765	.0693	.0066	.0269	.0175	.0224
PHASE ANGLE =	269.5	268.6	269.2	267.1	54.4	262.8	66.7	260.8
RADIUS = .900								
AMPLITUDE =	.1889	.1605	.0871	.0605	.0105	.0198	.0060	.0150
PHASE ANGLE =	271.6	268.3	270.8	269.1	291.7	272.7	36.8	265.8
RADIUS = 1.000								
AMPLITUDE =	.1840	.1448	.0928	.0550	.0207	.0166	.0061	.0107
PHASE ANGLE =	271.0	269.1	270.6	269.7	278.0	279.3	295.3	271.3

Table C4 - HARMONIC ANALYSIS OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW DISPLACEMENT 26,390 TONS

HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .359								
AMPLITUDE =	.0442	.0103	.0591	.0091	.0184	.0089	.0078	.0057
PHASE ANGLE =	170.8	178.4	353.3	164.7	2.9	158.2	328.4	176.4
RADIUS = .556								
AMPLITUDE =	.1162	.0297	.0181	.0046	.0215	.0115	.0106	.0108
PHASE ANGLE =	181.7	174.9	3.4	71.1	2.5	158.9	1.9	161.0
RADIUS = .774								
AMPLITUDE =	.1305	.0366	.0145	.0025	.0386	.0716	.0079	.0072
PHASE ANGLE =	178.2	174.8	183.3	75.5	1.2	112.9	359.3	156.4
RADIUS = 1.017								
AMPLITUDE =	.1248	.0488	.0248	.0061	.0040	.0014	.0016	.0002
PHASE ANGLE =	181.3	181.3	182.4	187.4	177.1	348.6	222.9	219.0
RADIUS = 1.178								
AMPLITUDE =	.1324	.0627	.0312	.0142	.0104	.0064	.0054	.0033
PHASE ANGLE =	179.7	178.4	179.9	174.0	175.5	169.2	166.9	150.4

Table C5 - HARMONIC ANALYSIS OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW DISPLACEMENT 26,390 TONS							
HARMONIC	1	2	3	4	5	6	8
RADIUS = .200							
AMPLITUDE =	.0630	.0146	.1013	.0248	.0058	.0019	.0110 .0058
PHASE ANGLE =	26.2	349.0	348.5	184.1	4.1	10.7	265.4 304.6
RADIUS = .300							
AMPLITUDE =	.0173	.0022	.0738	.0140	.0148	.0058	.0076 .0032
PHASE ANGLE =	128.6	199.5	351.3	175.4	3.0	155.3	304.3 203.5
RADIUS = .400							
AMPLITUDE =	.0635	.0153	.0496	.0066	.0202	.0103	.0084 .0074
PHASE ANGLE =	176.8	176.6	354.8	151.8	2.8	158.9	340.7 169.8
RADIUS = .500							
AMPLITUDE =	.1014	.0254	.0286	.0342	.0220	.0119	.0101 .0101
PHASE ANGLE =	181.2	175.2	359.5	95.0	2.6	159.3	357.5 162.9
RADIUS = .600							
AMPLITUDE =	.1203	.0308	.0298	.0044	.0187	.0088	.0105 .0103
PHASE ANGLE =	180.5	174.2	3.3	67.1	2.3	156.4	1.6 159.8
RADIUS = .700							
AMPLITUDE =	.1272	.0338	.0059	.0035	.0128	.0039	.0094 .0087
PHASE ANGLE =	178.7	173.9	183.6	65.3	1.6	144.5	.7 157.6
RADIUS = .800							
AMPLITUDE =	.1284	.0373	.0156	.0017	.0076	.0011	.0068 .0058
PHASE ANGLE =	178.9	176.4	183.5	82.1	1.1	70.3	356.1 157.2
RADIUS = .900							
AMPLITUDE =	.1248	.0416	.0199	.0020	.0016	.0025	.0030 .0018
PHASE ANGLE =	180.6	180.4	183.5	186.4	2.1	359.2	334.5 164.7
RADIUS = 1.000							
AMPLITUDE =	.1245	.0476	.0241	.0054	.0033	.0018	.0014 .0003
PHASE ANGLE =	181.3	181.3	182.6	188.6	177.1	350.0	240.9 215.1

Table C6 - INPUT DATA FOR WAKE SURVEY ANALYSES
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW, DISPLACEMENT 26,390 TONS

RADIUS RATIO = 0.359					RADIUS RATIO = 0.556					RADIUS RATIO = 0.774				
ANGLE	VX/V	VT/V	VO/V		ANGLE	VX/V	VT/V	VO/V		ANGLE	VX/V	VT/V	VO/V	
-1.1	.172	.001	.172	-3	.164	.013	.110	-.4	.122	.019	-.001			
12.2	.213	.015	.131	3.3	.213	.013	.171	3.3	.276	.004	.145			
21.0	.224	.021	.092	6.7	.243	.013	.125	6.7	.346	-.021	.117			
24.2	.224	.021	.092	12.2	.314	-.005	.063	12.3	.416	-.054	.074			
40.8	.326	.013	.054	30.1	.464	-.001	.010	15.5	.515	-.054	.031			
51.7	.364	-.023	.051	60.7	.836	-.142	-.027	28.0	.713	-.02	-.004			
64.1	.464	-.020	.052	91.3	.946	-.114	.007	40.6	.826	-.113	-.042			
84.2	.647	-.041	.055	114.7	.943	-.043	.044	51.4	.893	-.143	-.047			
91.4	.676	-.075	.04	127.5	.944	-.067	.044	63.9	.918	-.140	-.023			
120.2	.767	-.043	.090	140.0	.836	-.030	.081	84.1	.920	-.110	-.023			
143.1	.744	-.045	.113	152.5	.895	-.019	.103	110.4	.929	-.052	.077			
163.1	.631	.073	.057	152.8	.895	-.024	.103	110.4	.929	-.052	.077			
184.7	.602	.073	.030	161.6	.803	.034	.112	164.6	.929	-.052	.077			
172.3	.540	.069	.014	169.9	.649	.073	.067	164.3	.929	-.052	.077			
175.4	.543	.057	-.007	176.1	.611	.052	.034	172.0	.884	.047	.121			
173.5	.524	.025	-.024	179.7	.517	.054	-.013	175.6	.741	.044	.080			
173.1	.519	.003	-.033	183.4	.443	.032	-.040	173.3	.605	.075	.004			
184.7	.521	-.011	-.062	184.8	.555	-.040	.010	184.9	.541	-.044	.014			
192.1	.544	-.073	.067	192.2	.548	-.059	.051	192.9	.471	-.049	.130			
192.4	.548	-.075	.036	199.5	.783	-.022	.103	195.5	.424	.014	.122			
204.4	.645	-.051	.103	204.1	.842	-.024	.115	205.7	.344	.079	.105			
204.5	.743	.043	.125	219.0	.766	.07	.095	240.2	.927	.079	.080			
204.4	.703	.040	.092	231.4	.741	.073	.075	269.4	.919	.113	.044			
204.4	.645	.042	.065	244.1	.700	.049	.045	294.7	.902	.145	-.017			
303.2	.413	.032	.042	244.2	.840	.049	.044	307.6	.839	.159	-.034			
332.7	.240	.012	.054	269.5	.900	.119	.012	320.2	.726	.143	-.034			
347.1	.245	-.023	.093	303.2	.840	.113	.013	332.9	.540	.105	.004			
344.4	.244	-.025	.120	340.5	.742	.145	-.005	340.2	.430	.069	.034			
344.3	.244	-.024	.120	340.5	.742	.145	-.005	347.3	.334	.047	.044			
344.6	.244	-.024	.120	340.5	.742	.145	-.005	352.4	.244	.044	.111			
344.6	.244	-.024	.120	340.5	.742	.145	-.005	352.3	.244	.044	.111			
344.6	.244	-.024	.120	340.5	.742	.145	-.005	356.1	.134	.034	-.001			
344.6	.244	-.024	.120	340.5	.742	.145	-.005	359.7	.144	.019	.110			

RADIUS RATIO = 1.017

ANGLE	VX/V	VI/V	VZ/V
3.3	.272	-.016	.131
9.7	.285	-.036	.120
15.5	.307	-.046	.103
21.0	.322	-.055	.087
26.7	.335	-.065	.064
32.1	.342	-.075	.033
37.6	.345	-.080	.027
43.0	.345	-.080	.015
48.4	.342	-.093	.005
53.8	.335	-.134	-.064
59.2	.322	-.140	-.069
64.6	.299	-.140	-.029
70.0	.285	-.142	-.028
75.4	.272	-.101	.033
80.8	.259	-.100	.037
86.2	.245	-.067	.054
91.6	.231	-.070	.061
97.0	.217	-.057	.064
102.4	.203	-.055	.064
107.8	.189	-.045	.071
113.2	.175	-.043	.064
118.6	.161	-.034	.072
124.0	.147	-.028	.070
129.4	.133	-.025	.072
134.8	.119	-.025	.064
140.2	.105	-.019	.065
145.6	.091	-.019	.072
151.0	.077	-.003	.072
156.4	.063	.007	.082
161.8	.049	.041	.117
167.2	.035	.062	.115
172.6	.021	.073	.104
178.0	.007	.088	.073
183.4	-.007	.042	.075
188.8	-.021	.045	.075
194.2	-.035	.045	.075
199.6	-.049	.042	.075
205.0	-.063	.042	.075
210.4	-.077	.042	.075
215.8	-.091	.042	.075
221.2	-.105	.042	.075
226.6	-.119	.042	.075
232.0	-.133	.042	.075
237.4	-.147	.042	.075
242.8	-.161	.042	.075
248.2	-.175	.042	.075
253.6	-.189	.042	.075
259.0	-.203	.042	.075
264.4	-.217	.042	.075
269.8	-.231	.042	.075
275.2	-.245	.042	.075
280.6	-.259	.042	.075
286.0	-.272	.042	.075
291.4	-.285	.042	.075
296.8	-.299	.042	.075
302.2	-.312	.042	.075
307.6	-.325	.042	.075
313.0	-.338	.042	.075
318.4	-.351	.042	.075
323.8	-.364	.042	.075
329.2	-.377	.042	.075
334.6	-.390	.042	.075
340.0	-.403	.042	.075
345.4	-.416	.042	.075
350.8	-.429	.042	.075
356.2	-.442	.042	.075
361.6	-.455	.042	.075
367.0	-.468	.042	.075
372.4	-.481	.042	.075
377.8	-.494	.042	.075
383.2	-.507	.042	.075
388.6	-.520	.042	.075
394.0	-.533	.042	.075
399.4	-.546	.042	.075
404.8	-.559	.042	.075
410.2	-.572	.042	.075
415.6	-.585	.042	.075
421.0	-.598	.042	.075
426.4	-.611	.042	.075
431.8	-.624	.042	.075
437.2	-.637	.042	.075
442.6	-.650	.042	.075
448.0	-.663	.042	.075
453.4	-.676	.042	.075
458.8	-.689	.042	.075
464.2	-.702	.042	.075
469.6	-.715	.042	.075
475.0	-.728	.042	.075
480.4	-.741	.042	.075
485.8	-.754	.042	.075
491.2	-.767	.042	.075
496.6	-.780	.042	.075
502.0	-.793	.042	.075
507.4	-.806	.042	.075
512.8	-.819	.042	.075
518.2	-.832	.042	.075
523.6	-.845	.042	.075
529.0	-.858	.042	.075
534.4	-.871	.042	.075
539.8	-.884	.042	.075
545.2	-.897	.042	.075
550.6	-.910	.042	.075
556.0	-.923	.042	.075
561.4	-.936	.042	.075
566.8	-.949	.042	.075
572.2	-.962	.042	.075

CONTINUED

Table C6 - INPUT DATA FOR WAKE SURVEY ANALYSES
EXPERIMENT 3

TRIMMED 1.0 FOOT BY THE BOW, DISPLACEMENT 26,390 TONS

RADIUS RATIO = 1.178

ANGLE	VX/V	VI/V	VZ/V
3.3	.163	.078	.144
9.7	.216	-.068	.124
15.5	.301	-.077	.065
21.0	.372	-.105	.031
26.7	.479	-.140	-.024
32.1	.576	-.159	-.054
37.6	.704	-.161	-.055
43.0	.827	-.158	-.032
48.4	.941	-.144	.004
53.8	.911	-.137	.010
59.2	.837	-.103	.041
64.6	.740	-.104	.061
70.0	.640	-.065	.084
75.4	.540	-.031	.091
80.8	.440	-.016	.084
86.2	.340	-.012	.086
91.6	.240	-.008	.086
97.0	.140	-.003	.080
102.4	.040	.005	.077
107.8	-.060	.011	.075
113.2	-.160	.040	.043
118.6	-.260	.041	.044
124.0	-.360	.041	.044
129.4	-.460	.041	.044
134.8	-.560	.041	.044
140.2	-.660	.041	.044
145.6	-.760	.041	.044
151.0	-.860	.041	.044
156.4	-.960	.041	.044
161.8	-.060	.041	.044
167.2	-.160	.041	.044
172.6	-.260	.041	.044
178.0	-.360	.041	.044
183.4	-.460	.041	.044
188.8	-.560	.041	.044
194.2	-.660	.041	.044
199.6	-.760	.041	.044
205.0	-.860	.041	.044
210.4	-.960	.041	.044
215.8	-.060	.041	.044
221.2	-.160	.041	.044
226.6	-.260	.041	.044
232.0	-.360	.041	.044
237.4	-.460	.041	.044
242.8	-.560	.041	.044
248.2	-.660	.041	.044
253.6	-.760	.041	.044
259.0	-.860	.041	.044
264.4	-.960	.041	.044
269.8	-.060	.041	.044
275.2	-.160	.041	.044
280.6	-.260	.041	.044
286.0	-.360	.041	.044
291.4	-.460	.041	.044
296.8	-.560	.041	.044
302.2	-.660	.041	.044
307.6	-.760	.041	.044
313.0	-.860	.041	.044
318.4	-.960	.041	.044
323.8	-.060	.041	.044
329.2	-.160	.041	.044
334.6	-.260	.041	.044
340.0	-.360	.041	.044
345.4	-.460	.041	.044
350.8	-.560	.041	.044
356.2	-.660	.041	.044
361.6	-.760	.041	.044
367.0	-.860	.041	.044
372.4	-.960	.041	.044

APPENDIX D
RESULTS OF EXPERIMENT 4

Corresponding to
Trim 3.5 ft (1.067 m) by the Bow
Displacement 26,390 Tons (26,810 tonnes)

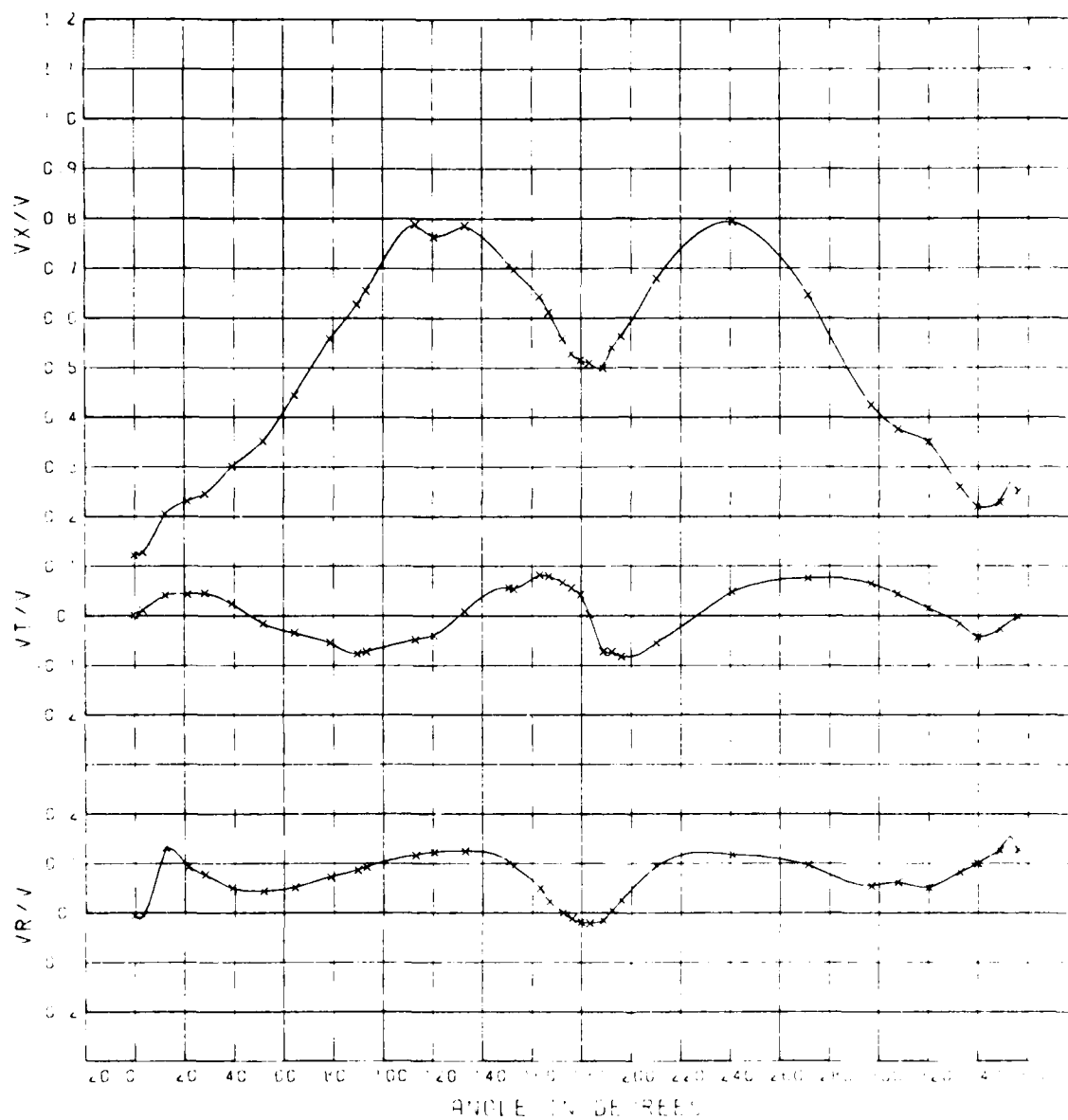


Figure D1 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND
RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.359
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS

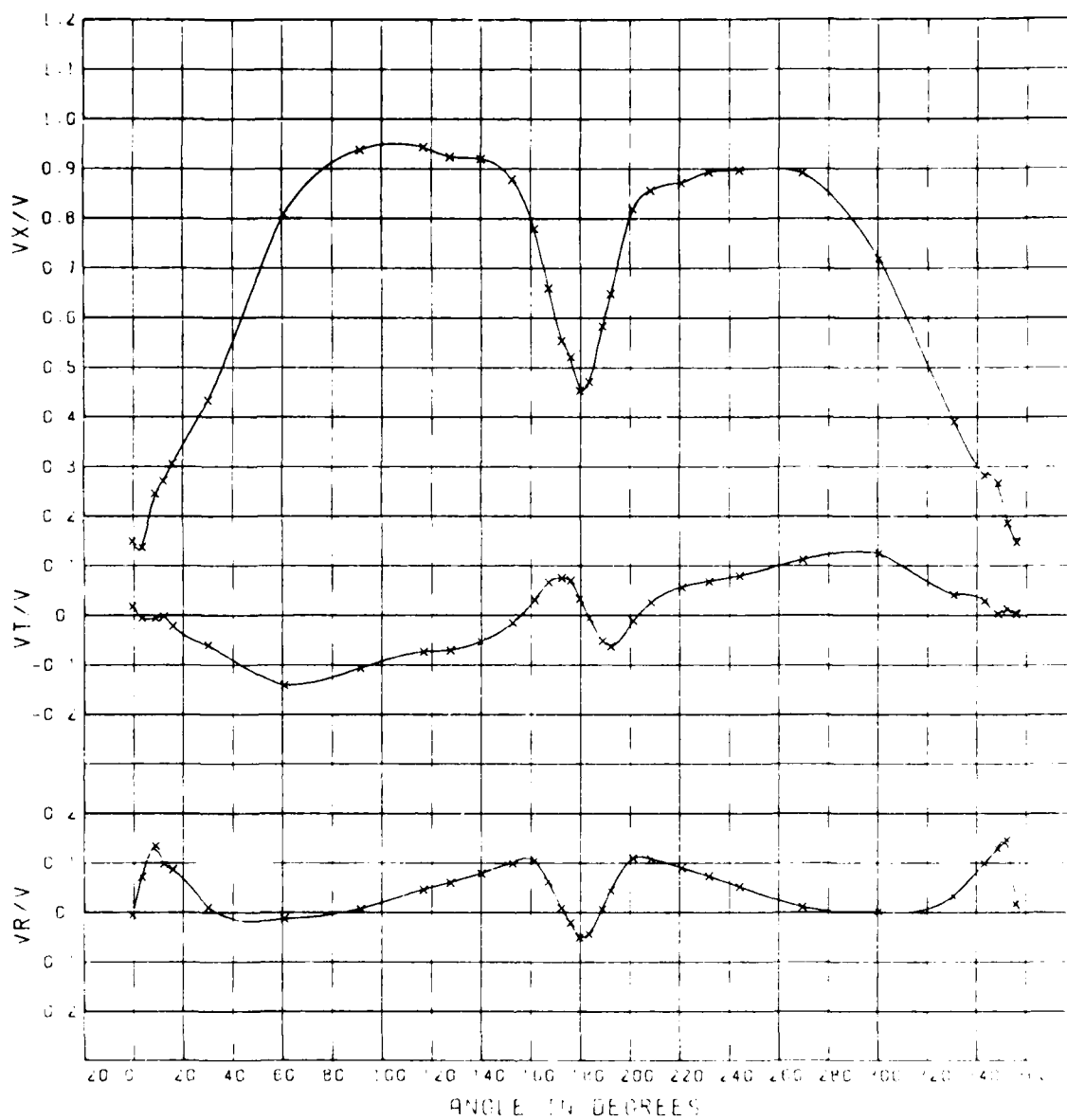


Figure D2 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.556
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS

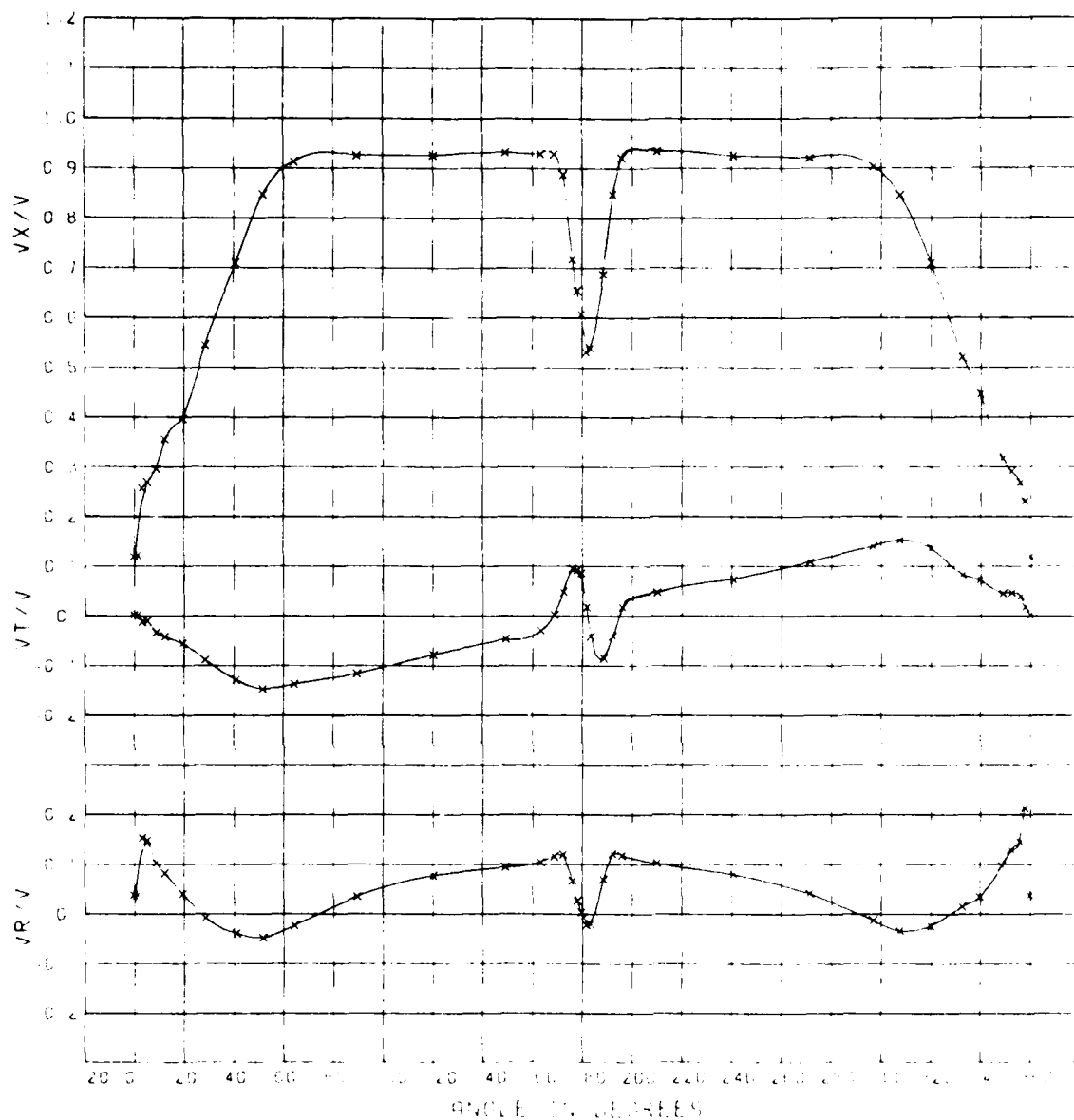


Figure D3 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 0.774
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS

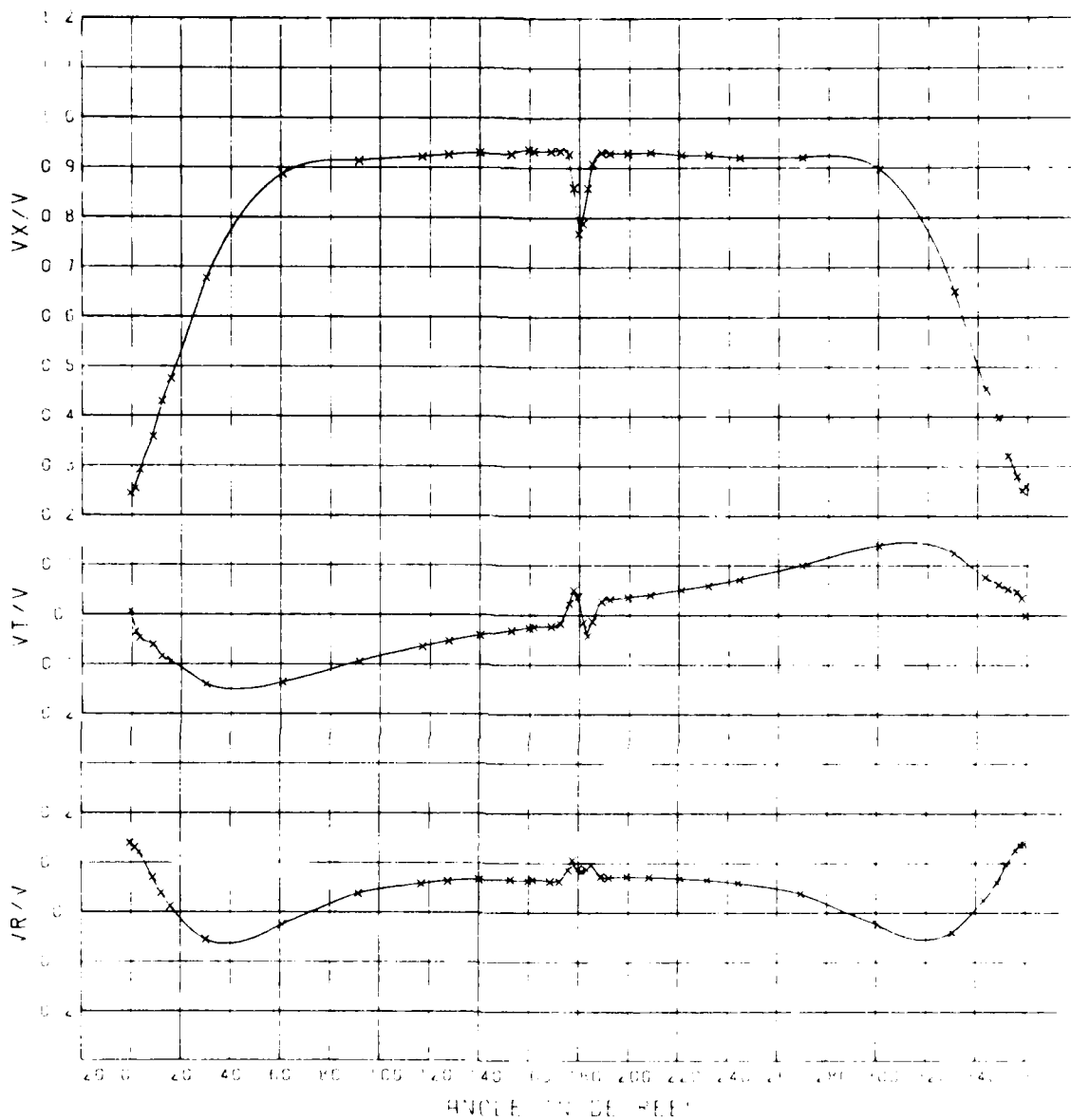


Figure D4 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.017
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,300 TONS

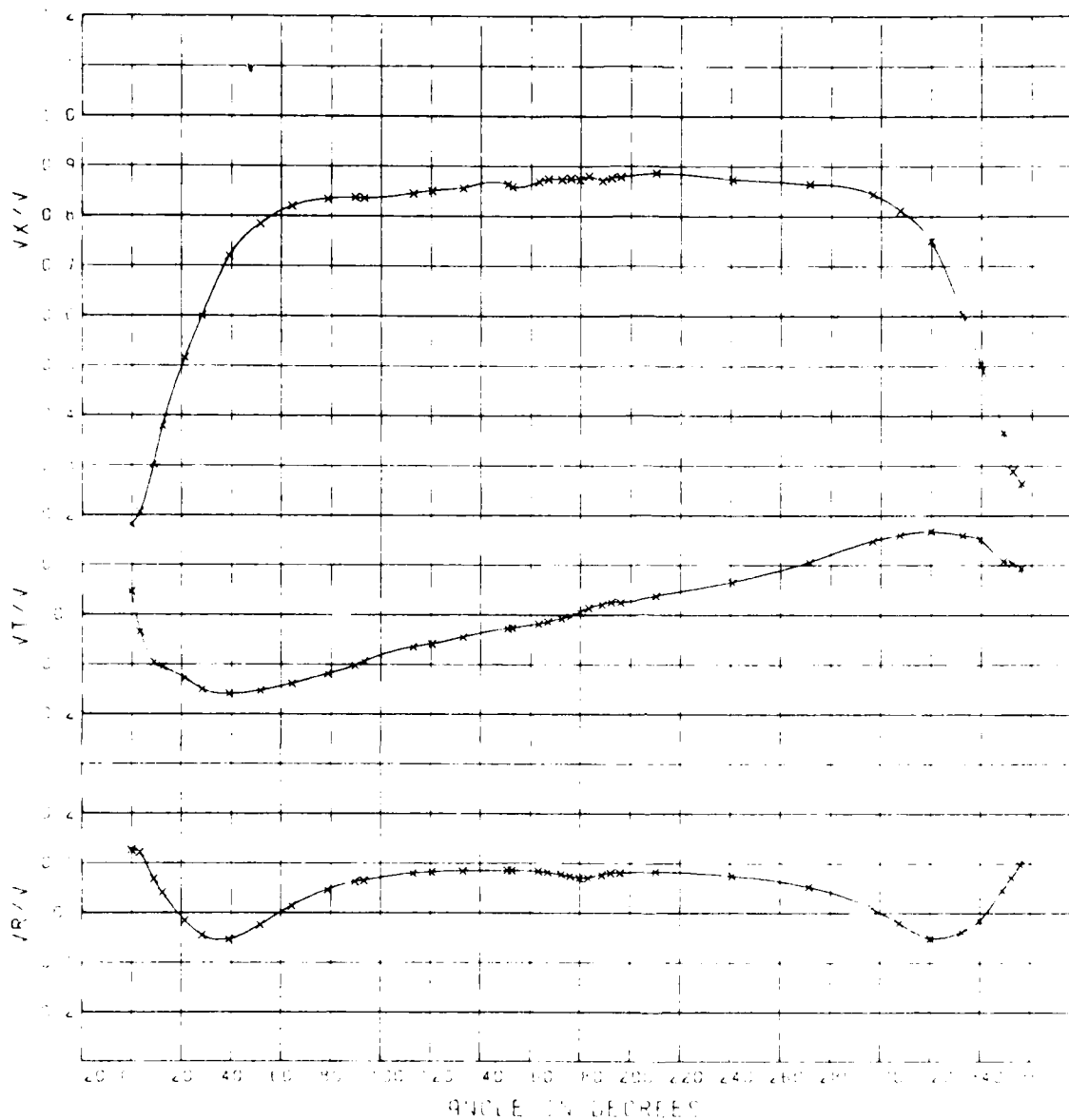


Figure D5 - CIRCUMFERENTIAL DISTRIBUTION OF THE LONGITUDINAL, TANGENTIAL AND RADIAL VELOCITY COMPONENT RATIOS - RADIUS RATIO = 1.178
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS

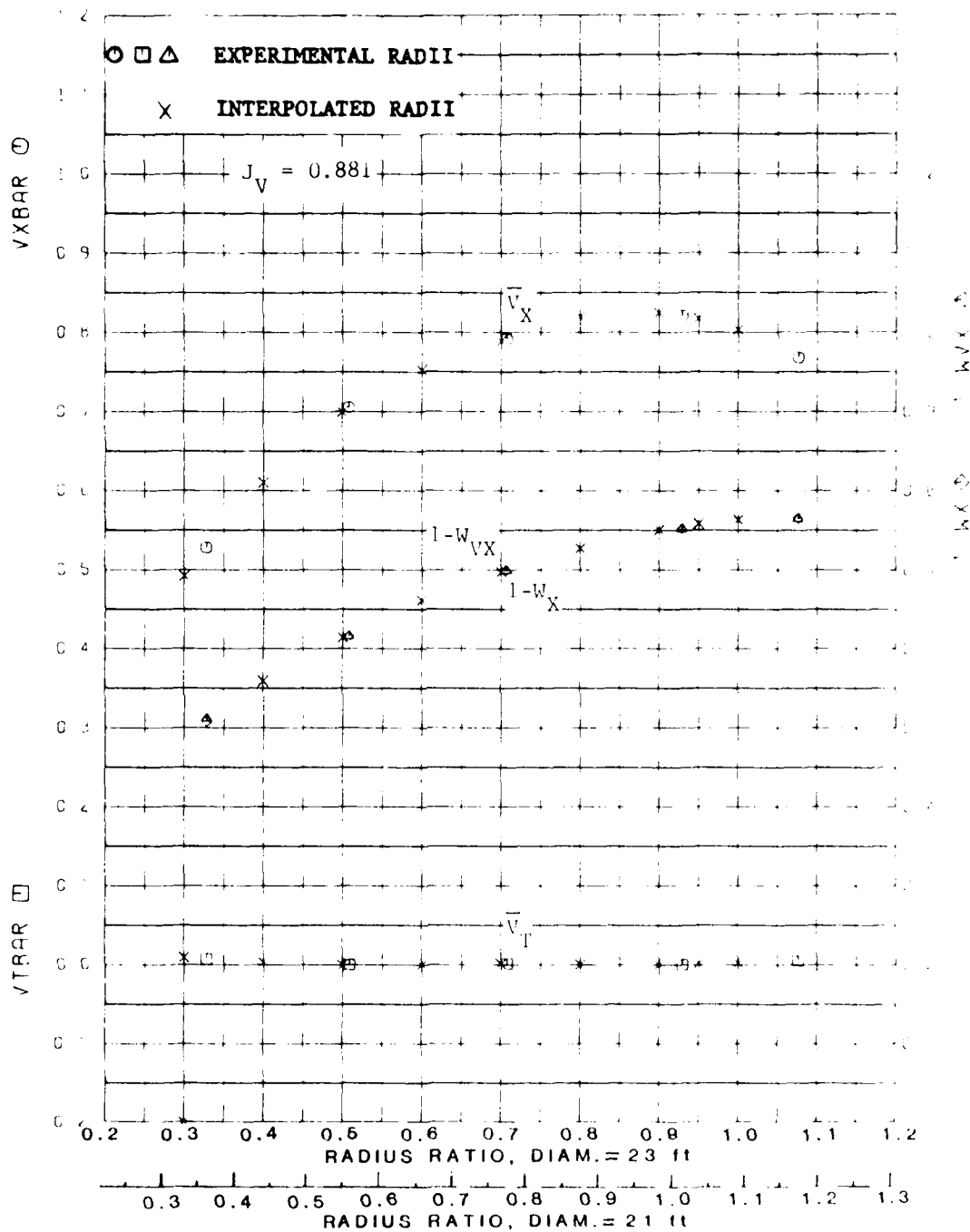


Figure D6 - RADIAL DISTRIBUTION OF THE MEAN VELOCITY COMPONENT RATIOS
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS

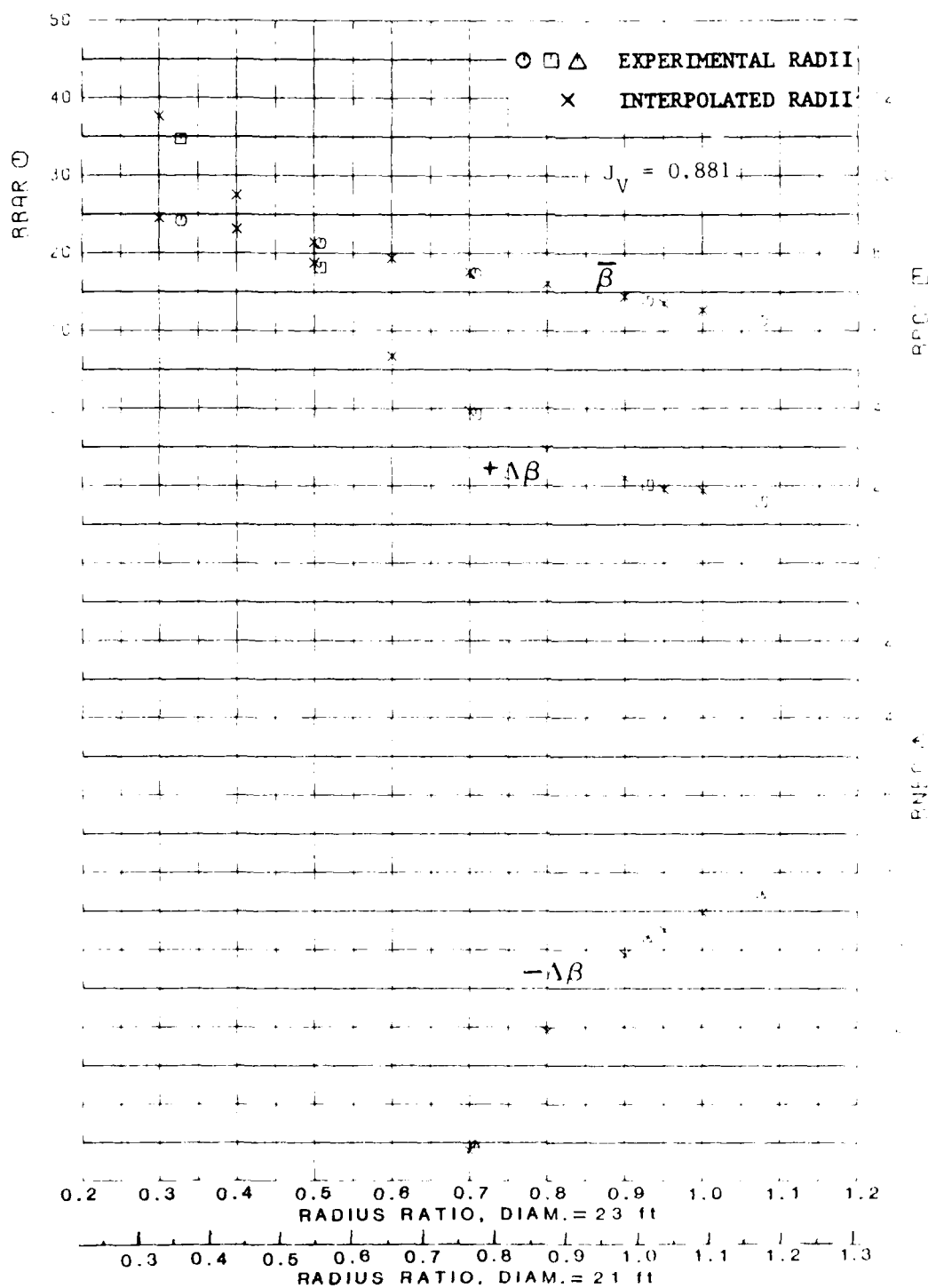


Figure D7 - RADIAL DISTRIBUTION OF THE MEAN ADVANCE ANGLE AND THE MAXIMUM VARIATIONS OF THE ADVANCE ANGLE FOR MODEL 5476 EXPERIMENT 4

FRIMED 3.5 FEET BY THE BOW, DISPLACEMENT 20,000 TONS

Table D1 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS
 $\rho = 21 \text{ ft (6.4 m)}, J_v = 1.01$

MAJID	=	.354	.556	.774	1.037	1.176	.203	.100	.450	.603	.602	.700	.853	.900	1.000
MAJID	=	.524	.705	.742	.661	.768	.316	.456	.572	.604	.727	.764	.801	.823	.821
MAJID	=	.607	.400	.601	.606	.305	.023	.311	.605	.621	.600	.601	.603	.600	.600
MAJID	=	.374	.634	.644	.605	.643	.143	.143	.306	.605	.642	.646	.643	.633	.630
MAJID	=	.460	.600	.604	.704	.746	.600	.600	.607	.633	.640	.636	.673	.704	.724
MAJID	=	.463	.605	.606	.704	.747	.603	.601	.605	.632	.630	.637	.675	.705	.724
MAJID	=	.615	.704	.141	14.25	11.43	.6021	.6074	.6077	.6312	.6124	14.44	17.86	16.14	14.87
MAJID	=	11.65	.742	.403	.603	.604	.6414	11.80	1.40	.472	.472	.492	.244	.222	.222
MAJID	=	11.65	10.60	.700	.77.10	14.10	.6074	.6074	11.40	11.40	.6740	.6740	.77.50	.77.50	.77.50
MAJID	=	.10.60	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MAJID	=	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40	.14.40
MA															

1. The first group of people who are interested in the
 2.

Table D2 - HARMONIC ANALYSIS OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS									
HARMONIC	=	1	2	3	4	5	6	7	8
PERIODS = .359									
AMPLITUDE =		-.2407	-.1372	.0678	-.0269	.0001	-.0119	.0051	-.0031
PERIODS = .550									
AMPLITUDE =		-.2147	-.2466	-.0060	-.0605	.0351	-.0366	.0197	-.0265
PERIODS = .774									
AMPLITUDE =		-.1970	-.1938	-.0742	-.0751	.0143	-.0295	.0221	-.0279
PERIODS = 1.017									
AMPLITUDE =		-.1926	-.1422	-.0886	-.0576	-.0221	-.0204	-.0066	-.0127
PERIODS = 1.176									
AMPLITUDE =		-.1790	-.1250	-.0891	-.0574	-.0323	-.0214	-.0146	-.0091

AD-AU97 930

DAVID W TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CE--ETC F/G 20/4
MEASUREMENTS OF THE EFFECT OF TRIM ON THE NOMINAL WAKE OF THE N--ETC(U)
MAR 81 M B WILSON, G A HAMPTON
DTNSRDC/SPD-0544-19

UNCLASSIFIED

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Table D3 - HARMONIC ANALYSIS OF LONGITUDINAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII
EXPERIMENT 4

TRIMMED 2.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS								
HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .200								
AMPLITUDE =	-.2687	.0600	.1357	.0144	-.0655	.0296	-.0153	.0311
RADIUS = .300								
AMPLITUDE =	-.2504	-.0754	.0921	-.0131	-.0204	.0012	-.0016	.0080
RADIUS = .400								
AMPLITUDE =	-.2345	-.1723	.0515	-.0355	.0116	-.0195	.0091	-.0097
RADIUS = .500								
AMPLITUDE =	-.2212	-.2307	.0138	-.0530	.0303	-.0326	.0168	-.0220
RADIUS = .600								
AMPLITUDE =	-.2106	-.2354	-.0240	-.0656	.0318	-.0353	.0223	-.0279
RADIUS = .700								
AMPLITUDE =	-.2025	-.2110	-.0569	-.0733	.0226	-.0320	.0242	-.0290
RADIUS = .800								
AMPLITUDE =	-.1949	-.1868	-.0765	-.0722	.0092	-.0279	.0181	-.0258
RADIUS = .900								
AMPLITUDE =	-.1881	-.1632	-.0837	-.0635	-.0078	-.0232	.0047	-.0186
RADIUS = 1.000								
AMPLITUDE =	-.1832	-.1448	-.0881	-.0582	-.0204	-.0206	-.0052	-.0134

Table D4 - HARMONIC ANALYSIS OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RATIOS
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS									
HARMONIC	=	1	2	3	4	5	6	7	8
RADIUS = .359									
AMPLITUDE =		-.0330	-.0120	.0556	-.0100	.0209	-.0033	.0069	-.0027
RADIUS = .556									
AMPLITUDE =		-.1073	-.0268	.0157	-.0003	.0184	-.0139	.0104	-.0098
RADIUS = .774									
AMPLITUDE =		-.1246	-.0364	-.0103	.0010	.0075	-.0017	.0068	-.0094
RADIUS = 1.017									
AMPLITUDE =		-.1205	-.0493	-.0244	-.0056	-.0042	-.0003	-.0017	-.0009
RADIUS = 1.178									
AMPLITUDE =		-.1272	-.0625	-.0323	-.0136	-.0105	-.0067	-.0059	-.0031

Table D5 - HARMONIC ANALYSIS OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE INTERPOLATED RADII
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS

HARMONIC	1	2	3	4	5	6	7	8
RADIUS = .200								
AMPLITUDE =	.0676	.0042	.0992	-.0236	.0179	.0203	-.0004	.0082
RADIUS = .300								
AMPLITUDE =	.6001	-.0064	.0735	-.0144	.0203	.0039	.0047	.0008
RADIUS = .400								
AMPLITUDE =	-.0531	-.0155	.0460	-.0073	.0209	-.0072	.0062	-.0047
RADIUS = .500								
AMPLITUDE =	-.0919	-.0232	.0254	-.0023	.0198	-.0130	.0100	-.0085
RADIUS = .600								
AMPLITUDE =	-.1124	-.0286	.0094	.0005	.0161	-.0106	.0100	-.0103
RADIUS = .700								
AMPLITUDE =	-.1209	-.0329	-.0029	.0013	.0111	-.0047	.0084	-.0103
RADIUS = .800								
AMPLITUDE =	-.1233	-.0373	-.0120	.0006	.0061	-.0009	.0058	-.0078
RADIUS = .900								
AMPLITUDE =	-.1203	-.0420	-.0179	-.0016	.0011	.0006	.0020	-.0032
RADIUS = 1.000								
AMPLITUDE =	-.1202	-.0461	-.0235	-.0049	-.0035	-.0000	-.0012	-.0010

Table D6 - INPUT DATA FOR WAKE SURVEY ANALYSES
EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS

ANGLE	RADIUS =	32°	VT/V	VP/V	ANGLE	RADIUS =	50°	VP/V	ANGLE	RADIUS =	70°	VT/V	VP/V
-3	.122	.001	-.006	-.6	.149	.018	-.005	-.3	.120	.002	.034	.034	
3.2	.126	.011	-.005	3.1	.137	-.005	.071	1.2	.121	.002	.034	.034	
12.2	.205	.041	.131	8.7	.246	-.046	.134	3.0	.257	.012	.153	.153	
21.2	.231	.043	.092	12.1	.271	-.002	.098	5.0	.270	.010	.143	.143	
29.1	.245	.045	.077	15.7	.306	-.022	.087	8.6	.286	.010	.143	.143	
33.0	.301	.024	.050	30.0	.433	-.060	.010	12.1	.356	.042	.082	.082	
51.6	.351	.015	.043	60.6	.410	-.141	-.013	19.4	.347	.055	.040	.040	
64.1	.456	.034	.053	91.4	.938	-.107	.007	24.3	.545	.039	.004	.004	
79.6	.433	.035	.044	116.7	.944	-.074	.045	40.8	.710	.129	.039	.039	
89.5	.558	.054	.072	127.5	.924	-.071	.060	51.5	.848	.147	.049	.049	
93.1	.627	.077	.084	140.0	.920	-.053	.078	64.2	.913	.137	.024	.024	
112.9	.655	.073	.092	152.6	.878	-.016	.099	89.4	.925	.117	.035	.035	
120.3	.788	.049	.115	161.5	.779	.031	.105	120.1	.936	.079	.077	.077	
132.9	.763	.040	.122	167.0	.660	.067	.082	149.0	.932	.046	.094	.094	
150.8	.707	.056	.102	172.3	.554	.075	.089	183.2	.929	.002	.104	.104	
152.6	.647	.054	.094	176.0	.521	.070	-.021	188.5	.929	.002	.115	.115	
163.2	.643	.050	.094	178.5	.452	.047	-.045	195.8	.888	.048	.120	.120	
165.9	.612	.050	.050	179.7	.455	.019	-.058	210.0	.718	.046	.067	.067	
172.4	.559	.067	.023	183.4	.471	-.006	-.044	240.5	.654	.092	.026	.026	
175.9	.528	.067	-.000	187.7	.583	-.051	.007	271.3	.607	.086	.003	.003	
179.6	.515	.042	-.013	192.1	.648	-.063	.044	294.8	.531	.019	.023	.023	
183.2	.510	.042	-.014	201.1	.819	-.011	.110	307.4	.539	.041	.020	.020	
189.6	.499	.073	-.021	204.4	.856	.026	.108	320.0	.687	.065	.069	.069	
192.2	.541	.073	-.015	220.7	.871	.026	.090	332.5	.848	.040	.122	.122	
195.9	.582	.073	.004	231.8	.893	.049	.073	339.7	.921	.018	.115	.115	
210.1	.579	.052	.025	244.1	.896	.079	.052	344.5	.934	.047	.102	.102	
240.6	.794	.049	.094	269.5	.892	.112	.011	352.1	.925	.073	.080	.080	
271.4	.846	.075	.117	300.3	.719	.126	.003	357.5	.903	.109	.042	.042	
296.7	.625	.065	.095	330.6	.390	.041	.032	359.7	.846	.140	.013	.013	
307.5	.376	.044	.062	343.2	.282	.040	.099	360.0	.709	.138	.034	.034	
319.9	.351	.015	.051	348.6	.266	.002	.124	362.5	.520	.082	.015	.015	
332.5	.240	.016	.082	352.2	.186	.013	.145	364.5	.446	.073	.034	.034	
339.4	.220	.044	.099	355.9	.147	.002	.017	369.7	.317	.045	.097	.097	
344.7	.248	.027	.125	359.4	.149	.015	-.006	374.5	.249	.046	.124	.124	
354.0	.251	.003	.127					385.7	.231	.018	.213	.213	
359.7	.122	.001	-.005					387.5	.120	.002	.038	.038	

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Table D6 - INPUT DATA FOR WAKE SURVEY ANALYSES

EXPERIMENT 4

TRIMMED 3.5 FEET BY THE BOW, DISPLACEMENT 26,390 TONS

ANGLE	RADIUS = VX/V	VR/V	VT/V	ANGLE	RADIUS = 1.074 VX/V	VR/V	VT/V
-5	.244	.139	.007	-3	.162	.125	.046
1.5	.254	.131	-.035	3.2	.206	.121	-.035
3.1	.289	.123	-.058	8.7	.302	.067	-.096
3.2	.294	.118	-.036	12.2	.379	.040	-.105
8.5	.355	.070	-.062	21.2	.516	-.016	-.127
12.1	.429	.039	-.082	28.1	.600	-.045	-.150
15.7	.450	.015	-.088	38.0	.728	-.055	-.159
15.8	.501	.009	-.100	51.6	.784	-.025	-.153
30.0	.676	-.058	-.143	64.1	.812	.014	-.138
60.6	.885	-.029	-.138	64.2	.827	.014	-.139
91.3	.917	-.045	-.036	74.6	.834	.045	-.119
91.4	.910	.094	.033	89.5	.837	.062	-.103
116.7	.921	.064	.057	93.1	.836	.074	-.074
116.8	.923	.065	.057	112.9	.845	.063	.074
127.4	.911	-.054	.062	120.3	.950	.059	.082
127.5	.920	-.053	.063	132.9	.855	.045	.084
140.0	.933	-.042	.066	150.8	.864	.029	.085
140.0	.926	-.042	.067	152.6	.859	.027	.085
152.6	.927	-.032	.066	163.2	.849	.019	.084
159.7	.936	-.026	.064	166.9	.814	.081	.081
161.5	.933	-.04	.065	172.4	.874	.078	.078
168.5	.933	-.023	.062	175.9	.876	.074	.074
172.1	.934	-.019	.062	179.6	.873	.005	.070
172.3	.932	-.017	.061	183.2	.871	.013	.070
175.7	.927	.023	.086	184.6	.871	.020	.075
177.5	.860	.050	.106	192.2	.876	.025	.080
177.5	.788	.037	.087	195.9	.878	.025	.080
181.2	.788	-.017	.083	210.1	.860	.038	.082
183.0	.851	-.042	.082	240.6	.874	.065	.075
183.4	.868	-.042	.090	271.4	.864	.105	.052
185.0	.909	-.013	.096	295.7	.844	.149	.010
185.4	.932	.027	.071	307.5	.812	.160	-.020
188.7	.928	.028	.073	319.9	.750	.168	-.052
192.1	.933	.031	.071	332.5	.602	.160	-.034
192.1	.925	.031	.070	339.4	.501	.152	-.016
195.4	.924	.035	.072	344.7	.366	.108	.046
208.3	.931	.040	.072	352.4	.248	.104	.071
208.3	.932	.050	.069	356.0	.244	.093	.097
220.8	.932	.050	.070	359.7	.182	.046	.125
220.7	.920	.050	.070				
231.5	.929	.058	.065				
231.8	.921	.059	.065				
244.1	.915	.072	.060				
244.2	.926	.071	.060				
265.4	.926	.100	.036				
265.5	.915	.100	.041				
300.3	.898	.140	-.023				
310.6	.851	.176	-.041				
343.2	.448	.043	.023				
343.2	.464	.070	.027				
348.6	.413	.043	.056				
348.6	.345	.061	.065				
352.2	.316	.055	.092				
352.2	.326	.049	.100				
355.9	.275	.046	.130				
355.9	.245	.048	.121				
357.8	.251	.034	.137				
359.4	.275	-.009	.134				
359.5	.244	.007	.134				

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