Report 2076

MODEL BASIN
WASHINGTON, D.C.

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WAKE ANALYSIS OF SHIP MODELS; SINGLE-SCREW MERCHANT-TYPE

by

Henry M. Cheng
and
Jacques B. Hadler

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HYDROMECHANICS LABORATORY
RESEARCH AND DEVELOPMENT REPORT

November 1965 Report 2076

PRNC-TMB-648 (Rev 1-64)

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S-R011 01 01

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NOTATION

D	Propeller diameter
J_a	Apparent advance coefficient V/nD
n	Propeller revolutions
P	Pressure factor $(V_b^2)_{max}/\overline{V_b^2} - 1$
R	Radius of propeller
r	Radial coordinate
U	Blade element velocity
V	Model or ship velocity
$\underline{V}$	Resultant wake velocity vector
V_b	Resultant velocity
$\bar{V}_b$	Mean resultant velocity
V_r	Radial component of velocity vector
$\bar{V}_r$	Mean radial component of velocity vector
V_t	Tangential component of velocity vector
$\bar{V}_t$	Mean tangential component of velocity vector
$(\tilde{V}_t)_n$	n^{th} harmonic amplitude of tangential velocity
V_{tr}	Transverse component of velocity vector
$\bar{V}_v$	Volumetric velocity
V_x	Longitudinal component of velocity vector (normal to the plane of propeller)
$\bar{V}_x$	Mean longitudinal component of velocity vector
$(\tilde{V}_x)_n$	n^{th} harmonic amplitude of longitudinal velocity
X, Y, Z	Cartesian coordinates
α_h	Projected angle of velocity vector on X-Y plane
α_v	Projected angle of velocity vector on X-Z plane

β Advance angle in degrees

$\bar{\beta}$ Mean advance angle

$\Delta\beta$ Variation of advance angle from its mean

θ Position angle (angular coordinate) in degrees

τ Section shape coefficient

Hull coefficients are in accordance with SNAME-recommended standard.

ABSTRACT

This report, the third of a series on studies of the wake in the propeller plane of ship models, presents the results of the analysis of the wake of single-screw merchant ship models and several naval auxiliaries. The data presented are the interpolated longitudinal and tangential velocity distributions, their computed mean values, the harmonic contents of these velocity components, the maximum variations in the resultant inflow velocity, and the advance angles and their variations. Also included are the calculated volumetric wake velocities. An IBM 7090 computer was used for data processing.

ADMINISTRATIVE INFORMATION

The work reported herein was sponsored by the Bureau of Ships under the CORE Program (S-R011 01 01) of the David Taylor Model Basin.

INTRODUCTION

This is the third of a series of reports on studies of wake in way of propeller plane of ship models. The first two reports[1,2] presented the results of the analysis of the wake of single- and twin-screw naval ship models. This report presents the results of the wake analysis of single-screw merchant ship models and of several naval auxiliaries that have hull characteristics similar to those of merchant ships. A total of 40 models were analyzed. Among them are six naval auxiliary ships for various services such as AE, AFS, AS, and AGS; the remaining 34 models are commonly known as cargo and tanker type ships.

Since this is a collection of a rather large number of models representing a variety of designs and services, the hull characteristics and the stern configurations of these models vary considerably. To present comprehensively the data analyzed and to make meaningful comparisons, these 40 models are divided by their general stern configuration into the following groups:

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[1] References are listed on page 112.

1. Conventional sterns.

   a. Clearwater sterns.

   b. Sterns with rudder shoe.

2. Open sterns with skegs and struts.

3. Special sterns.

The first group is further divided into subgroups according to the fineness of the stern (or roughly, the fineness of the ship). The aft vertical prismatic coefficient C_{PVA} or the block coefficient C_B may be used to characterize this feature. Coefficient C_B is readily available (and can be used as a parameter to form these subgroups:

Subgroup 1 $C_B = 0.5\text{-}0.6$

Subgroup 2 $C_B = 0.6\text{-}0.7$

Subgroup 3 $C_B = 0.7\text{-}0.8$

Although these dividing lines are rather arbitrary, conventional cargo ships usually fall into the first two subgroups, and tankers into the last subgroup.

Most of the models studied here are in the first group, a total of 36 models. Twenty-five of these models have clearwater sterns and 11 have sterns with rudder shoe. Among the models with clearwater sterns are 12 cargo ships, 10 tankers, and 3 naval auxiliaries. Table 1 provides the model data and the major hull coefficients, and Figure 1 shows the hull lines of several models. Among the models that have sterns with rudder shoe are four cargo ships, six tankers, and one naval auxiliary ship (Model 4914) that has an extremely fine hull. Three models (4080-3, 3801, and 3717) have the contraguide feature. The model data and major hull coefficients for this group are listed in Table 2. Hull lines of three representative models are shown in Figure 2.

The two models in the second group, having centerline skegs with 2-arm struts for shaft support, are naval auxiliaries. This type of stern is common among the single-screw naval combatant ships but is not usually found among merchant ships. The two models in the third group have special sterns; one (Model 4883) has a Hogner-type stern, the other (Model 4882) has a centerline skeg and a 2-arm strut at the aft end of the stern. Table

3 gives the model data and the major hull coefficients for these two groups of models. The hull lines of Models 5004, 4912, 4882, and 4883 are shown in Figure 3.

The data reported are the longitudinal and tangential wake velocity distributions in the plane of a propeller, their computed circumferential mean values and harmonic contents at various radii, the maximum variations in the resultant inflow velocity, and the advance angles and their variations. The calculated volumetric mean wake velocities are also presented. Reference 1 discusses the test procedures, the method of data reduction, and the applications of wake data in propeller-ship design.

TEST PROCEDURE AND DATA REDUCTION

The wake surveys were conducted in the deepwater towing tanks at the David Taylor Model Basin. The time period spans approximately 15 years; however, most of the wake surveys were done in the last 5 years.

The Pitot tubes used were either the 5- or 13-hole design. The 13-hole Pitot tube was used for measurements on the models prior to 1955; the 5-hole tube was used for the remainder of the models.

Reference 1 describes in detail the method of mounting and alining the Pitot tube equipment on the model to obtain the desired field points.

The test data are used as input to the computer program for analyses. The procedure for data reduction is similar to the procedure described in Reference 1.

PRESENTATION OF DATA

Two types of information are presented: the test data and the computed results. The test data are obtained from the model experiments at the discrete test points. The computed data are the quantities calculated on the basis of the test data. A standard length on waterline (LWL) of 500 ft and a standard propeller diameter of 20 ft were chosen for models with C_B less than 0.7 and a 600-ft LWL and a 22-ft propeller diameter for models with C_B greater than 0.7.

TEST DATA

The model test data are tabulated in the Appendix. The transverse velocity vectors in the plane of the propeller at the various test points are shown, and the body plane in the proximity of the propeller plane and the propeller shaft struts are also given. Some of the data had been previously published in References 3-14.

COMPUTED DATA

The computed data are presented for the various groups of models as follows:

Conventional Sterns

The data for models with conventional sterns are presented for each of the subgroups. The second and the third subgroups are further divided into smaller groupings according to the stern shape of these models, i.e., whether they be U or V, which is arbitrarily determined by the section shape coefficient τ (see Figure 4 for definition of τ):

Stern Shape	τ
U-shape	less than 0.1
Moderate U-shape	0.1 -- 0.3
Moderate V-shape	0.3 -- 0.4
V-shape	above 0.4

The first subgroup of models with a low block coefficient ($C_B < 0.6$) have τ values falling in the range of the moderate U-shape, except Model 4831 ($\tau = 0.363$).

Figures 5-7 show the interpolated circumferential distribution of the longitudinal and tangential velocity components at the test radii for the various ships grouped according to the subgroupings. The nondimensionalized radii are those of the model propeller designed for the ship. The test data points that the faired curves do not pass through are questionable.

These figures show that the velocity patterns in the circumferential direction at the various tested radii have a characteristic shape. The longitudinal component shows a nearly uniform portion and rather large defects (dip) near the center plane (0- and 180-deg positions). Note that, in general, the range of the nearly uniform portion decreases and the velocity defects increase as the block coefficient increases. The maximum range of the nearly uniform portion is approximately 100 deg (between 60 and 160 deg) for models with low C_B. The maximum magnitude of the velocity dip is about 60-70 percent of the model speed. The rate of change for the angular position is moderate near the top of the disk (0 to 60 deg) but is very large near the bottom (160 to 180 deg). Note also that the retardation of flow near the propeller hub (inner radii) is more pronounced for models with a higher block coefficient.

The tangential components for models with a low block coefficient ($C_B < 0.7$) are, for the most part in the same direction, i.e., having the same sign, except in certain small regions at the bottom of the disk near the hull. This characterizes the upward-inward flow pattern due to displacement of the hull. The magnitude of the tangential component varies continuously along the circumference from zero at the 0- and 180-deg positions with the assumption of symmetry to a maximum of about 15-20 percent of the model velocity that occurs between 40 and 50 deg.

The tangential components for models with $C_B > 0.7$, where the stern contraction is more abrupt, show a downward flow nearing the hub whereas the flow at the outer radii is upward like the others. This exhibits a "vortex" flow, which is more pronounced for the U-shape than for the V-shape, in the plane of the propeller. The maximum magnitude of the tangential component is about 20-25 percent of the model velocity and occurs between the 60- and 90-deg positions.

For Models 4080-3, 3801, and 3717 the stern has the contraguide feature which supposedly creates a flow with favorable tangential components to the propeller; consequently, the flow symmetry is upset. For these models, the wake was surveyed over the entire propeller disk. The effectiveness of this special feature is discussed later.

Model 3801 represents the design of one type of cargo ship, the Victory ship. The Netherlands Ship Model Basin (NSMB) studied the scale effect on wake and published the Victory ship test data. A comparison between the NSMB (only the longitudinal velocity was measured) data for a comparably scaled model and the data for Model 3801 is shown in Figure 8. To a large degree, the agreement is good for the outer radius, but some discrepancy exists at the inner radius.

The circumferential distribution curves of the longitudinal and tangential velocity components are analyzed for their harmonic contents from which the circumferential mean values are obtained. Because of the assumed symmetry about the center vertical plane of this group of models, the circumferential mean of the tangential velocity is zero. The circumferential mean of the longitudinal velocities at various radii are plotted in Figures 9 and 10. The calculated volumetric mean velocity is also shown in these figures; its definition is given in Reference 1. Although the data shown for each subgroup scatter over a wide band, nevertheless, a general shape exists in the radial distribution of the mean longitudinal velocity, and the spread follows a pattern according to the fineness of the stern. Roughly, the smaller the block coefficient, the larger is the mean velocity and vice versa. Figure 11 shows the average mean longitudinal velocity (C_B as a parameter) based on the average values of each subgroup.

The calculated amplitudes of the 1st (shaft frequency) through the 9th harmonics are shown in Figures 12 to 23. Amplitude in the 2nd through the 9th harmonics, where sign is opposite to that of the 1st harmonic, indicates that its phase relationship with that of the 1st harmonic with respect to a reference time (or angular position) is 180 deg apart. Again the data scatter over a wide range, especially for the 1st harmonic. It may appear that the agreement is somewhat better for the higher harmonics because the bands are narrower, but the relative variations in amplitudes of the various models are still fairly large, percentagewise. This indicates that the calculated amplitudes are sensitive to the shape of the distribution curves analyzed. Large hollows and humps may not affect the mean value very much, but they certainly will affect the harmonic contents of the curve. However, in general, the amplitude decreases as the order of the harmonics increases, but the even orders have higher amplitudes than the two neighboring odd orders.

For the purpose of furnishing useful information in analyzing the performance and the cavitation characteristics of a propeller due to nonuniform wakes, the wake data are further analyzed in terms of maximum variations, or fluctuations in the resultant inflow velocities to the propeller blade and in the advance angles.

As shown in Figure 24, the velocity at the blade element depends on the propeller rotational speed. To establish proper geometric relationships, it is necessary to assume certain operating conditions, namely, the advance coefficient J_a. Arbitrary selections of J_a values are made, 0.95 for models with $C_B < 0.7$, and 0.85 for $C_B > 0.7$. The computed quantities show a relatively small change over a wide range of J_a values.[1]

Figures 25 and 26 show, for each subgroup, the calculated mean values of the advance angle $\bar{\beta}$ at various radii and their maximum variations $\pm \Delta\beta$, and the pressure factor P. Again, bands are drawn due to scatter of the data to show the possible range of variations.

Open Sterns with Skegs and Struts

The circumferential distributions of longitudinal and tangential velocity components for Models 4912 and 5004 are shown in Figure 27. The longitudinal components show a nearly uniform portion covering most parts of the propeller disk except in a small region at the top of the disk, which exhibits velocity defect of the order of 30-40 percent. The tangential component shows an almost sinusoidal curve of a shaft frequency except in the region at the top of the disk. The maximum magnitude is of the order of 20 percent. These patterns are typical for models with the open-type stern. These results may be compared with the results of single-screw DE-type models,[1] which have the same type of stern but much finer hulls. For Model 5004, in the small sector of approximately 60 deg at the top of the disk, the wake velocity fluctuates. The measurements for this model were made at closer intervals in this region. For Model 4912, where the intervals of measurement were coarse, this fluctuation was not detected.

Figure 28 shows the radial distributions of mean longitudinal velocity and of calculated volumetric mean velocity. Also shown on this figure are the mean advance angles $\bar{\beta}$, its maximum variations $\pm \Delta\beta$, and the pressure factor P. The amplitudes of the various orders of harmonics of the circumferential distribution curves are shown in Figures 29 and 30.

Special Sterns

The circumferential distributions of the longitudinal and tangential velocity components for the two models in this group (Models 4882 and 4883) are shown in Figure 31. Note that the forebodies of these two models are the same, but their sterns are different designs. Model 4882, has a thin skeg and a 2-arm strut at the aft end, which in essence resembles the open-type stern. Model 4883 has a Hogner-type stern. This difference in stern design creates markedly different wake patterns. The circumferential distributions of both the longitudinal and tangential velocities for Model 4882 are considerably more uniform than those of Model 4883, which could well be expected, but the magnitudes of the differences, which are rather large, are surprising especially the tangential component.

Consequently, the radial distributions of the mean longitudinal and the volumetric velocities, shown in Figure 32, and of the amplitudes of the various harmonics of the longitudinal and tangential velocity components, shown in Figures 33 and 34, for these two models are very much different. The calculated maximum variations in the advance angles and in the inflow velocity are shown in Figure 32.

COMPARISON OF VARIOUS TYPES OF STERN DESIGNS

The results of the study of DE-type ships show that the variations in forebodies have a negligible effect on the wake behind a ship; consequently, the stern wake distribution is affected chiefly by the shape of the stern.

In this report, wake data of several distinctive types of stern designs have been presented. From comparative studies of the data, some light can be shed on the characteristics of wake pattern and the relative merit of the various types of sterns.

Before we can proceed with the comparison, we must set up criteria on which to base our comparison. To improve propulsive performance, a lower longitudinal velocity and a favorable tangential velocity are desirable; to minimize cavitation and vibration problems, a more circumferentially uniform (or less fluctuating) flow, which results in lower harmonic amplitudes, is essential. With this in mind, the following comparisons are made.

Conventional Stern versus Open-Type Stern

Most of the models analyzed here have "conventional" type sterns. The wake data presented for these models show a rather clear common pattern with some consistency. Also presented are data for the open-type stern, which has been used extensively for naval ships and is not common among merchant ships. Because of the large differences in conventional and open stern designs, the wake patterns are distinctively different. This is evident in the circumferential distribution of the longitudinal and tangential velocity components, e.g., Figure 5 versus Figure 27. Consequently, this is also evident in the radial distributions of the mean velocity and of the amplitudes of various harmonics.

From a comparison of the results of these two types of stern designs from the standpoint of minimizing cavitation and vibration problems in terms of uniformity in flow, lower amplitudes in harmonics, and smaller ranges in variations of advance angles, the superiority of the open-type stern is evident. This is further demonstrated by a direct comparison of two models, 4210-5 and 4995, which basically have hull lines similar to the original 0.6 block coefficient Series 60 Model 4210, except that the stern has been modified from the original with a rudder shoe. Model 4210-5 has a clearwater stern and Model 4995 has an open-type stern, which resulted in a slight reduction in block coefficient. The comparative results are shown in Figures 35-38; Model 4995 is also compared with models of the low block coefficient ($0.5 < C_B < 0.6$) subgroup of the conventional stern group.

From the standpoint of the propulsive performance, however, the open-type stern may not show as high a propulsive coefficient as the conventional stern because the longitudinal velocity of the open-type stern is higher.

Remarks on Special Stern Designs

One set of wake data for models with special stern designs has been presented, Models 4882 and 4883. It has been noted that these two variations in stern design created two markedly different wake patterns. Model 4882 gives a more uniform longitudinal velocity, which is comparable to that of an open-type stern, and it also gives a favorable tangential velocity distribution. For minimizing cavitation problems, this design should prove to be a better one; in terms of overall performance, however, it will be penalized, same as the transom type, for its higher longitudinal velocity.[15] Insofar as the vibration problem is concerned, these two designs appear to be comparable.

In many cases, in seeking an appropriate design for certain types of ships, two or more sterns are designed. Model 4723 is a typical example; it has two stern designs; one, a conventional clearwater type, the other, modified as in Figure 1. The comparative data are presented in Figures 39, 40, 41, and 42. Note that the circumferential distributions of longitudinal velocity are quite different, the velocity defect is more uniform for the modified stern than that for the conventional design. Also note that the circumferential distributions of tangential velocities of these two sterns are very much the same in both magnitude and distribution. The mean longitudinal velocities for these two stern designs are comparable and the wake for the modified stern shows stronger odd harmonics in both the longitudinal and tangential components while the conventional design has stronger even harmonics. Figure 40 shows that the modified stern gives less variation in advance angle, which would result in better cavitation characteristics. Otherwise, these two designs are comparable.

Fair-Form Stern versus Contraguide Stern

Three models, 4080-3, 3801, and 3717, have the contraguide feature which supposedly provides favorable inflow velocity to the propeller to improve efficiency. But it was observed that the magnitude and distribution of wake of these models are similar to those of the other models with fair-form sterns of comparable C_B. A direct comparison is shown in Figures 43 through 46 where Model 4080-2 is the same as Model 4080-3 except it has a fair-form stern. Figure 43 shows that the differences in velocity components between these two stern designs at the outer radii are not significant. The fair form gives a larger longitudinal velocity defect at the center vertical plane. This accounts for the larger-$\Delta\beta$ values in Figure 44. For all practical purposes, the wake patterns generated by a contraguide stern is very much similar to that by a fair-form stern, and the tangential velocity component is of the same order of magnitude. From this observation, it is therefore questionable whether the contraguide feature as designed does provide a wake as anticipated. Even if it does offer some gain in propulsion, the risk of cavitation and vibration problems of increasing magnitude should not be overlooked.

The U- and V-Shape Sterns

The data for the conventional stern have been presented in three smaller groupings, according to the stern shapes, U or V. The variation in shape has considerable effect on the wake, but the comparison was not conclusive because many other dissimilarities existed among the models that have not been taken into account. To be able to evaluate this effect, models with systematically varied stern designs must be studied. Fortunately, wake data for two sets of such models are available. Their shape characteristics in terms of C_B and τ are as follows:

Set	Model	C_B	τ	Stern
1	4423	0.741	0.068	U
	4423-1	0.741	0.208	Moderate U
	4423-2	0.741	0.385	Moderate V
2	4393-1	0.645	0.218	Moderate U
	4393	0.645	0.365	Moderate V

Both of these sets of models represent tankers. The hull lines and stern configurations are quite different, however. Figure 47 shows the comparative body plans of the models in Set 1.[16] The data for these two sets of models are analyzed and presented separately in Figures 48 through 55.

These figures show that the stern shape does have considerable effect on the wake pattern, but it seems that the way in which the flow is affected varies, depending upon the fineness of the ship.

Figure 48 shows the circumferential distribution of velocity components of the higher C_B models and indicates that the model with a more U-shaped stern tends to generate a more uniform longitudinal velocity and a large downward velocity in the plane of the propeller near the propeller hub. The more V-shaped stern tends to give a larger fluctuation in the longitudinal velocity and a steeper gradient in the radial direction, as also is shown in Figure 49 for the mean values, whereas the tangential velocity is relatively smaller in magnitude, as is the downward flow nearing the hub. Figures 50 and 51 show the comparative amplitudes of various orders of harmonics of the longitudinal and tangential velocities, respectively. They show characteristic shapes that are, to a large degree, consistent with those shown for the group of models representing tankers with comparable C_B. From this comparison, it appears that the moderate U-shaped stern (Model 4423-1) would provide best cavitation and vibration characteristics.

The results of the models with a lower block coefficient, Models 4393 and 4393-1, shown in Figures 52 through 55, give the relative effects of two sterns, moderate U versus moderate V. They exhibit different relationships from those shown for the higher C_B models in the previous group of figures; the effect is not as pronounced as those for the higher C_B models. The characteristic shapes of these curves show some consistency with those shown for the group of models representing cargo ships with comparable block coefficient, $0.6 < C_B < 0.7$. This comparison shows that the moderate V-shaped stern is better from the standpoint of vibration, whereas the moderate U-shaped stern would result in slightly less cavitation.

The comparative data shows that, in general, a more U-shaped stern tends to provide a more uniform flow, which would show better cavitation and vibration characteristics. A more V-shaped stern tends to show a slightly lower mean velocity; it also shows a larger fluctuation in the flow, which would increase the likelihood of cavitation and vibration problems.

CONCLUSIONS

1. The radial distributions of mean longitudinal velocity and volumetric mean velocity have characteristic shapes. The open-type stern tends to provide a near uniform distribution with a magnitude of approximately 95 percent of the model velocity. The conventional stern provides a distribution with values lower at the inner radii and higher at the outer radii. The magnitudes depend on the fineness and shape of the afterbody; in general, the finer the stern, the higher the values.

2. The harmonic analysis of the longitudinal and tangential velocity components show, in general, that the amplitude decreases as the order of the harmonics increases, but the even order are relatively stronger than the odd.

3. In most of the models analyzed, the tangential velocity variation is large and sinusoidal in nature, because of the upward flow in the propeller plane, which in turn shows up predominantly in the 1st harmonic. This, in conjunction with a large 1st harmonic amplitude of the longitudinal velocity, will cause steady side forces and bending moments, and will result in a shaft-frequency vibration when imperfections exist in the blade geometry that will cause hydrodynamic imbalances.

4. It appears that stern shape has a considerable effect on the wake patterns. Since the data in this report is derived from ships of various designs it is not possible to note a clear-cut statement as to which type of stern is superior from the point of view of overall ship-propeller design. It appears, however, that in general a more U-shaped stern tends to provide a more uniform flow, which would show better cavitation and vibration characteristics, whereas a more V-shaped stern tends to show a slightly lower mean velocity, and also shows a larger fluctuation in the flow, which would increase the likelihood of cavitation and vibration problems.

5. In general, for minimizing the cavitation and vibration problems, the open-type stern (e.g., transom stern with struts supporting the shaft) is superior to the conventional type.

6. A general statement with regard to such special sterns as the Hogner design cannot be made; their merit should be evaluated by the specific propeller-ship design involved.

7. Whether the contraguide sterns as those used on some of the models tested provide favorable wake patterns is questionable.

RECOMMENDATIONS

1. Although the data presented show some similarities among the various models, the derived quantities exhibit a lack of consistency. This indicates that further research is needed to determine the hull characteristics, the hull parameters, and the operating conditions that have significant effect on the wake pattern. Until such a research is accomplished, wake surveys should be conducted on each ship design where the problems of cavitation and vibration are important.

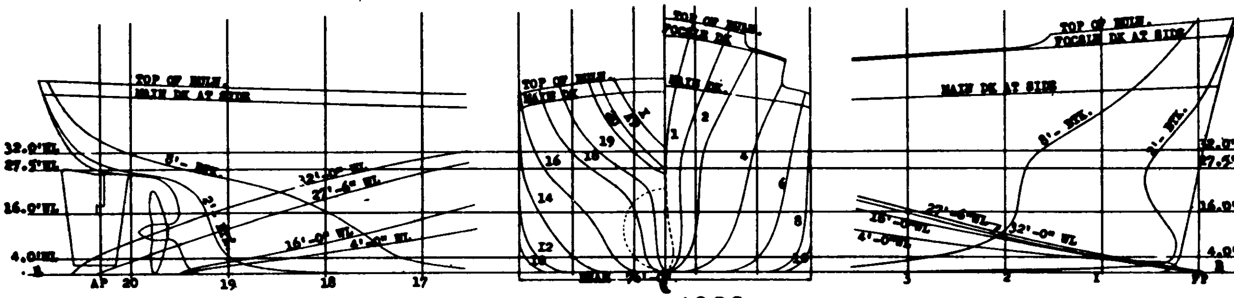
2. Future wake surveys conducted on models with open-type sterns should include a more careful exploration of the region behind the propeller shaft.

3. To properly delineate the velocity distributions on models with conventional sterns, measurements should be made on four or more radii because of the large variations in the radial direction.

4. Wake surveys should be made on models with stern sections systematically varied to determine the influence of section shape upon the cavitation of vibration performance.

ACKNOWLEDGMENTS

The authors wish to express their thanks to the personnel of Max H. Morris, Inc., for assistance in the collection of data and in the preparation of final graphs, and to Mr. George Smith of the Applied Mathematics Laboratory for his help in the computer work.



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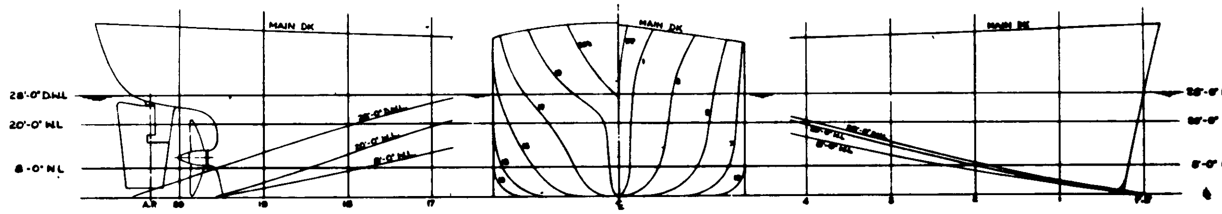

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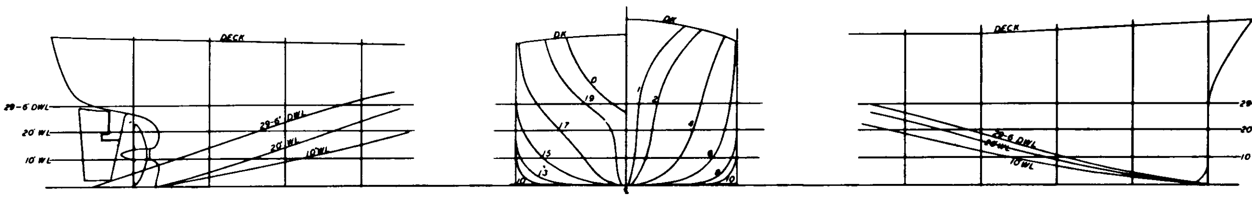

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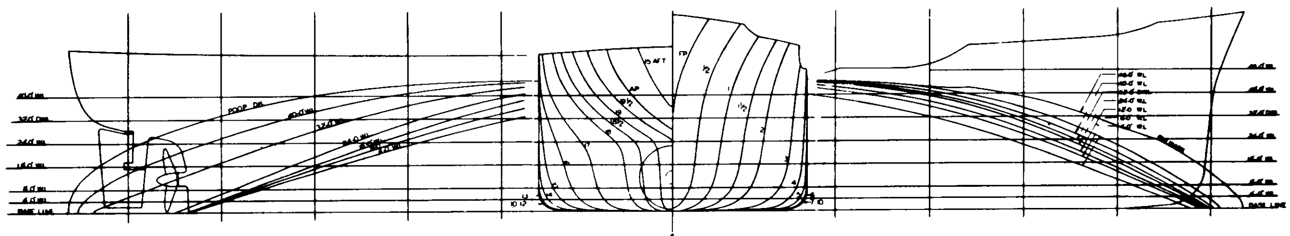

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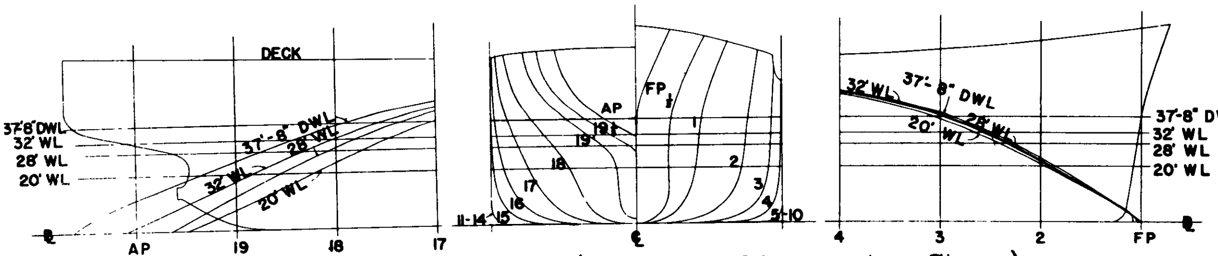

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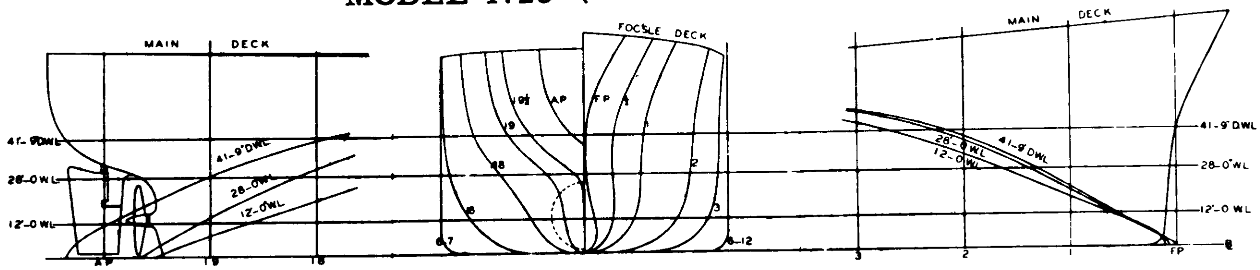

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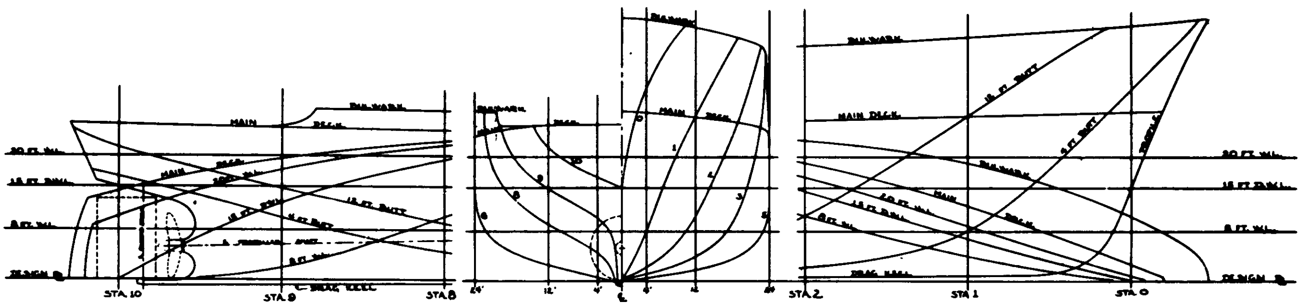
Figure 1 - Lines of Representative Models, Clearwater Stern



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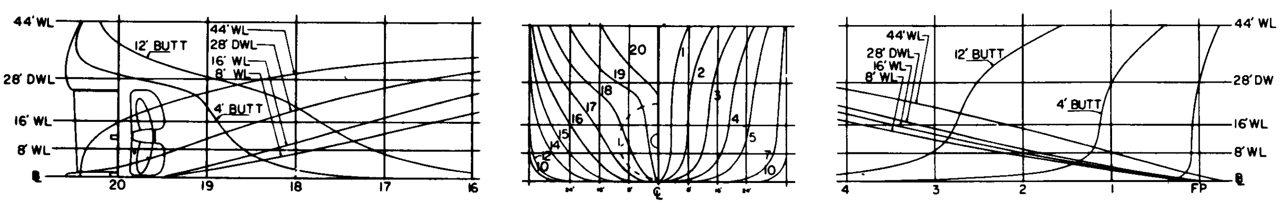

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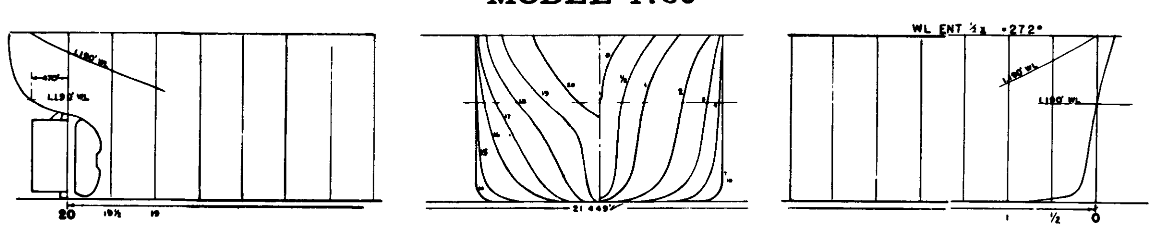
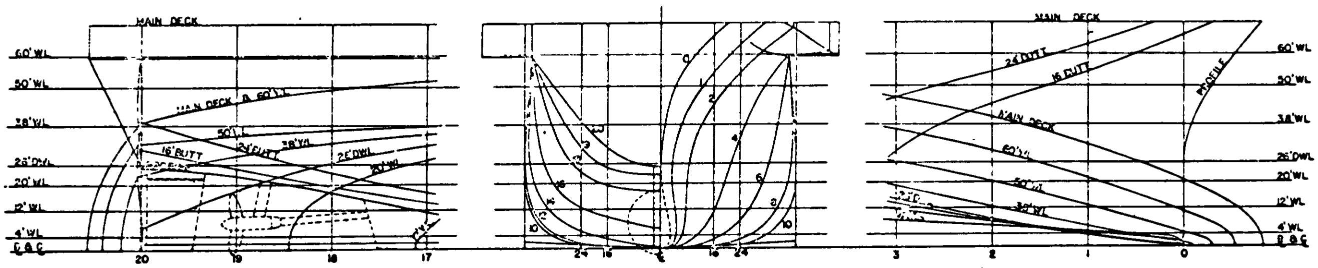
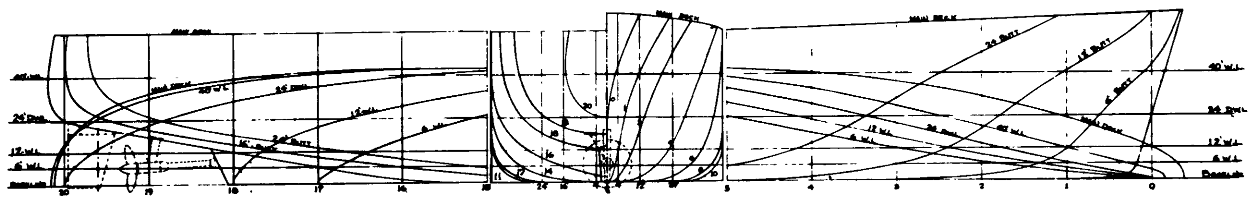


MODEL 4057

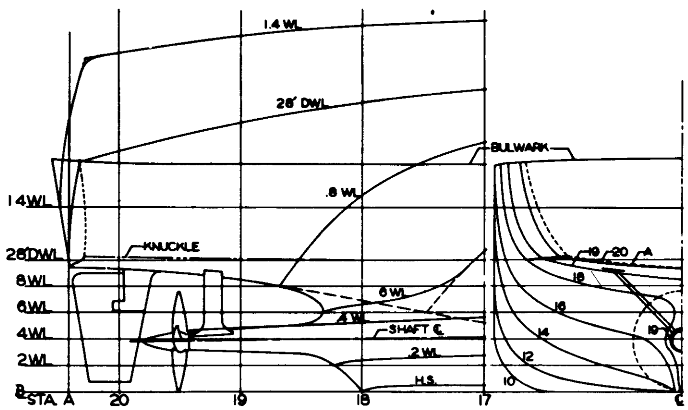
Figure 2 - Lines of Representative Models, Stern with Rudder Shoe



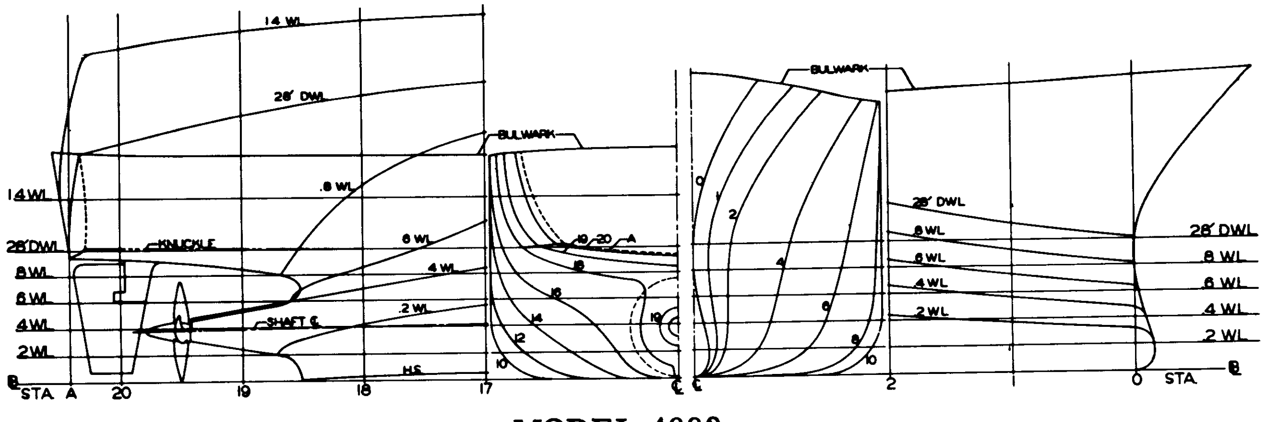
MODEL 5004



MODEL 4912



MODEL 4882



MODEL 4883

Figure 3 - Lines of Representative Models, Open-Type Sterns and Special Sterns

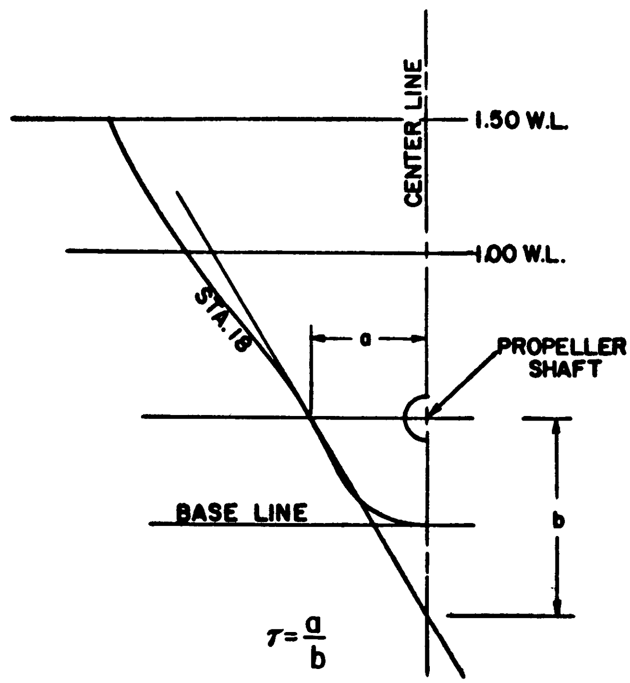


Figure 4 - Definition of Section Shape Coefficient

Figure 5 - Circumferential Distributions of Longitudinal (V_x/V) and Tangential (V_t/V) Velocity Components at Test Radii, C_B < 0.6

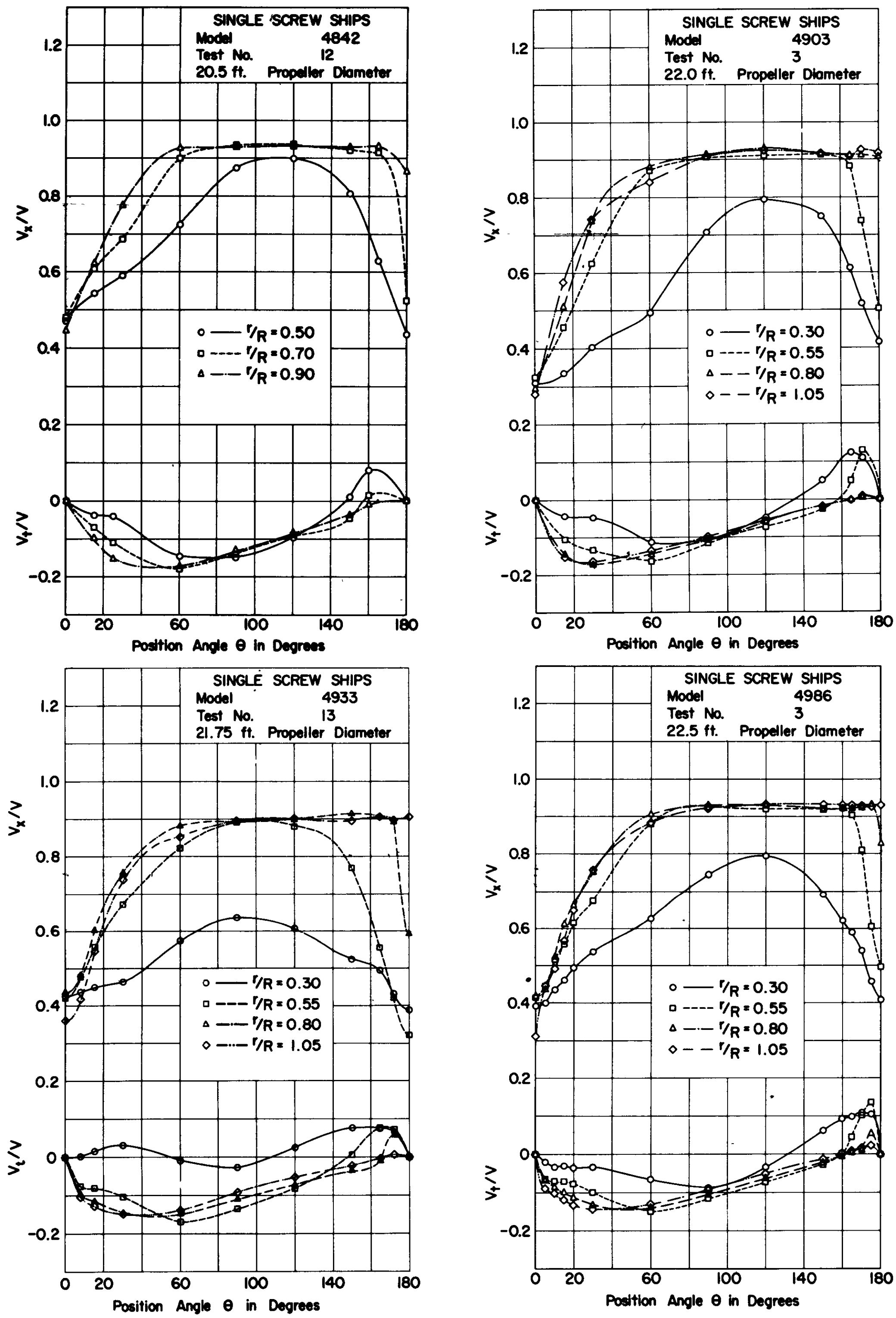


Figure 5a - Conventional Stern

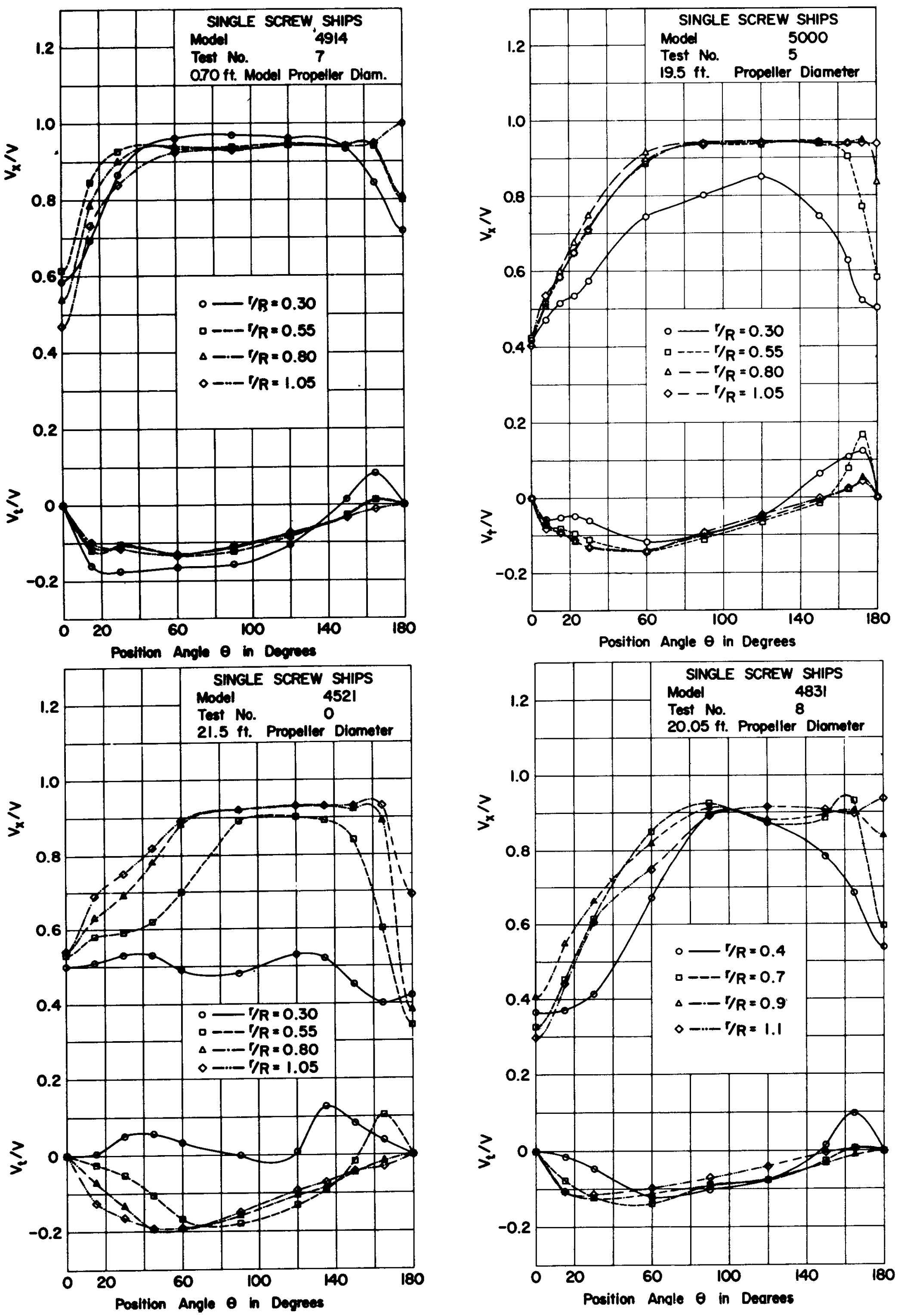


Figure 5b - Naval Auxiliaries

Figure 6 - Circumferential Distributions of Longitudinal (V_x/V) and Tangential (V_t/V) Velocity Components at Test Radii, Conventional Stern, $0.6 < C_B < 0.7$

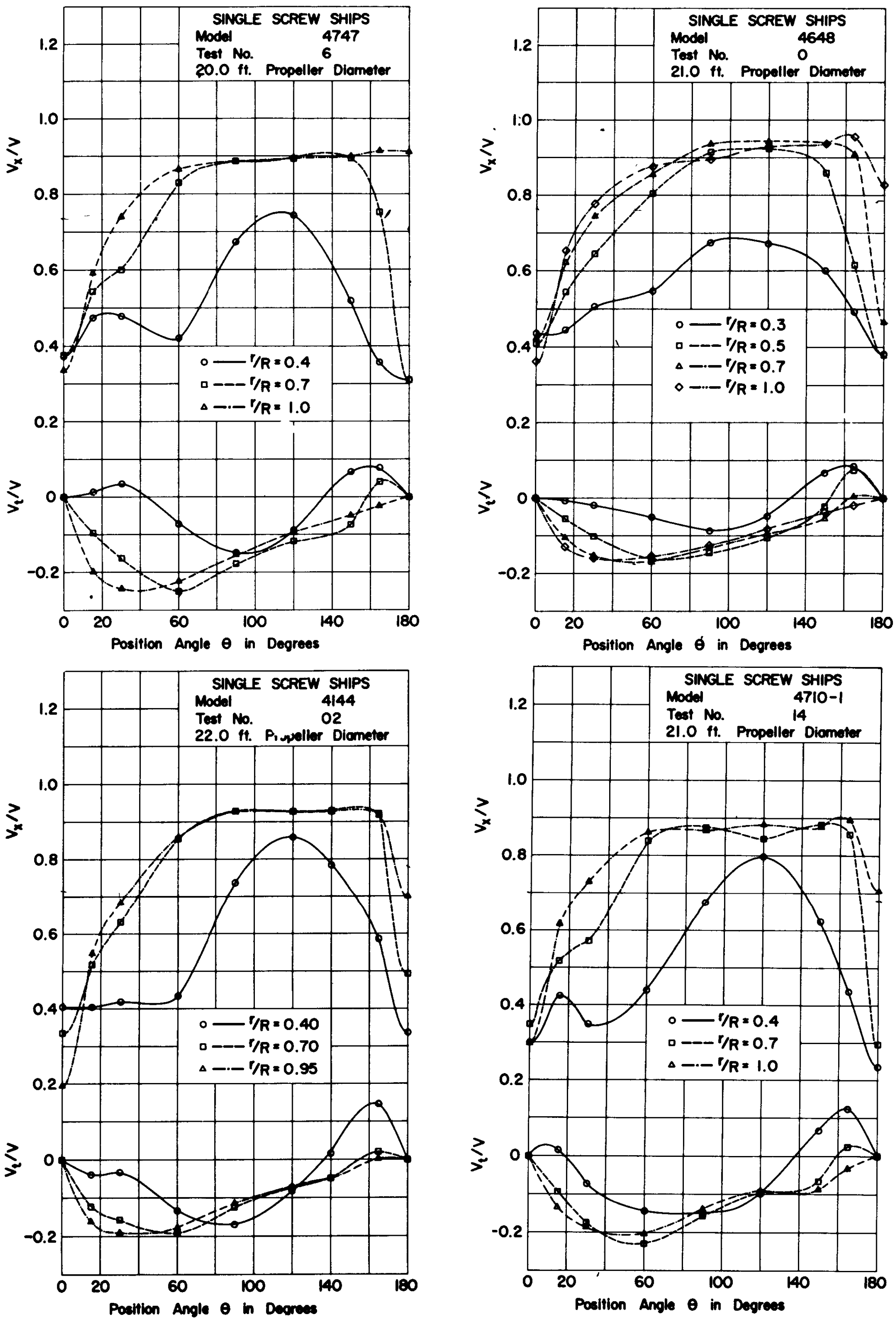
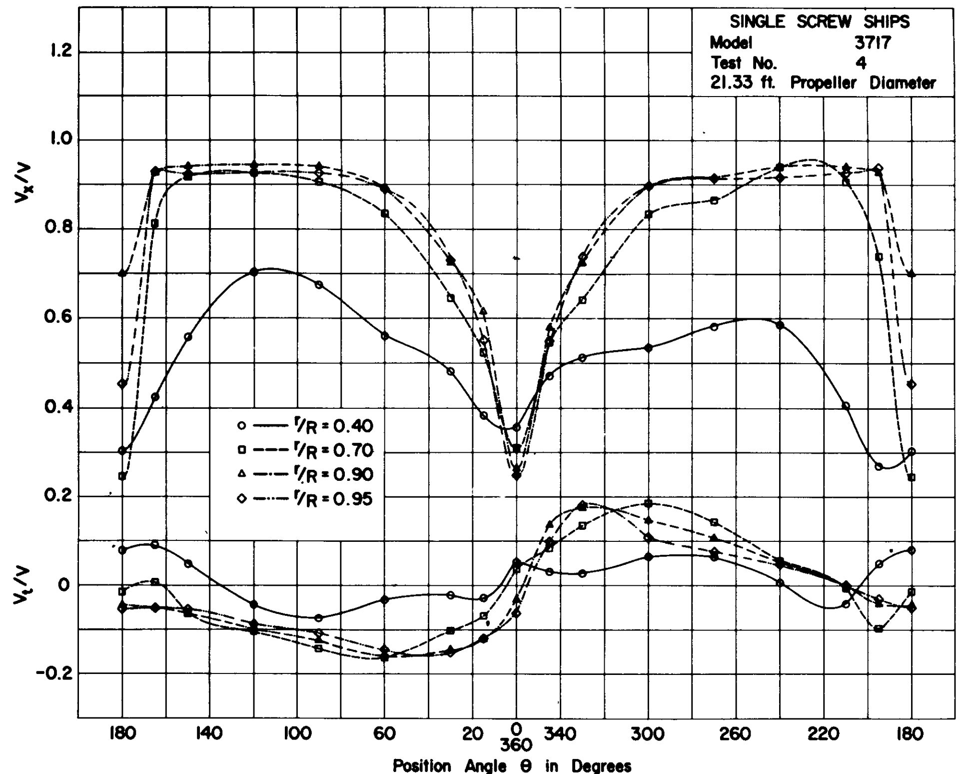


Figure 6a - Moderate U-Shaped Stern



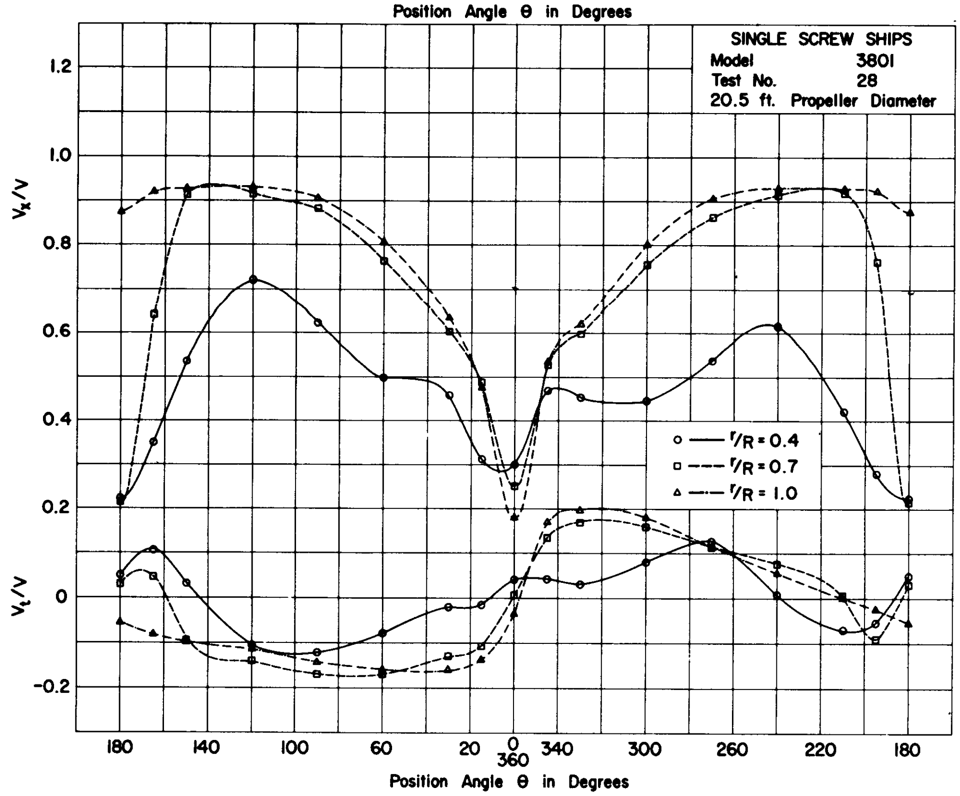


Figure 6b - Moderate U-Shaped Stern, Contraguide

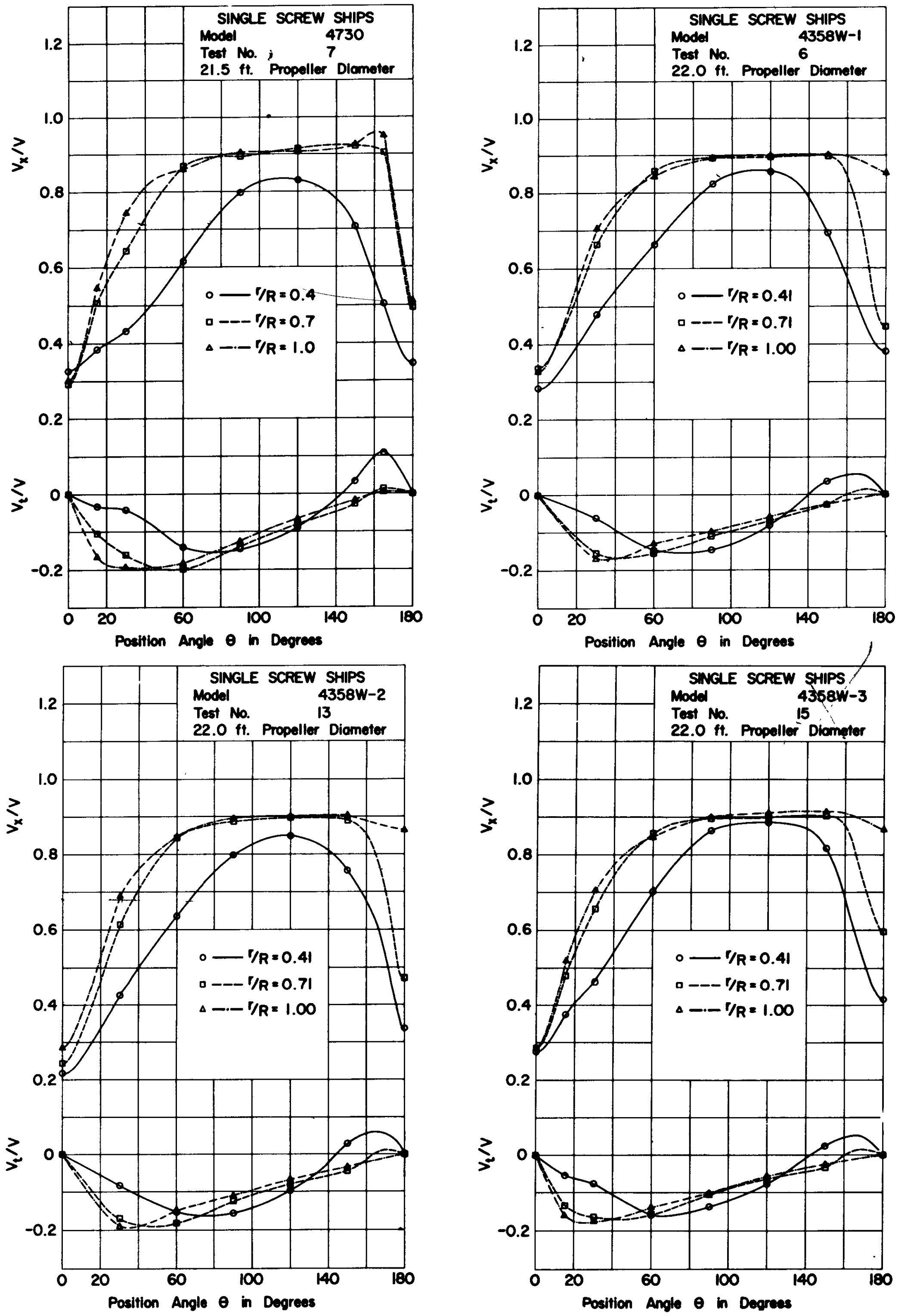
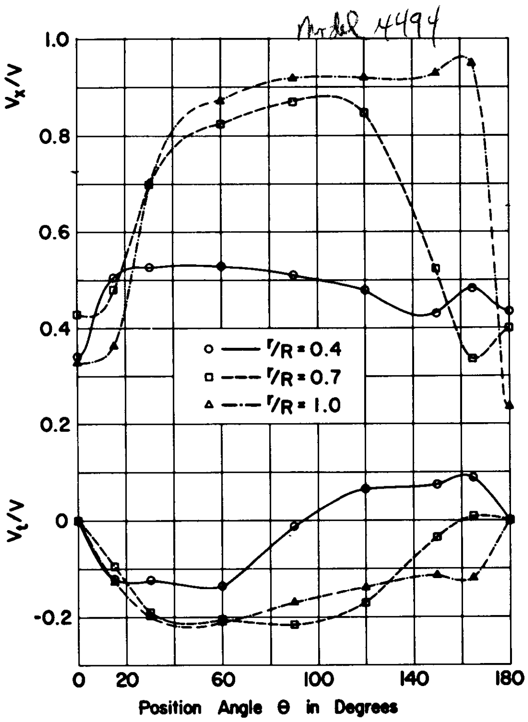
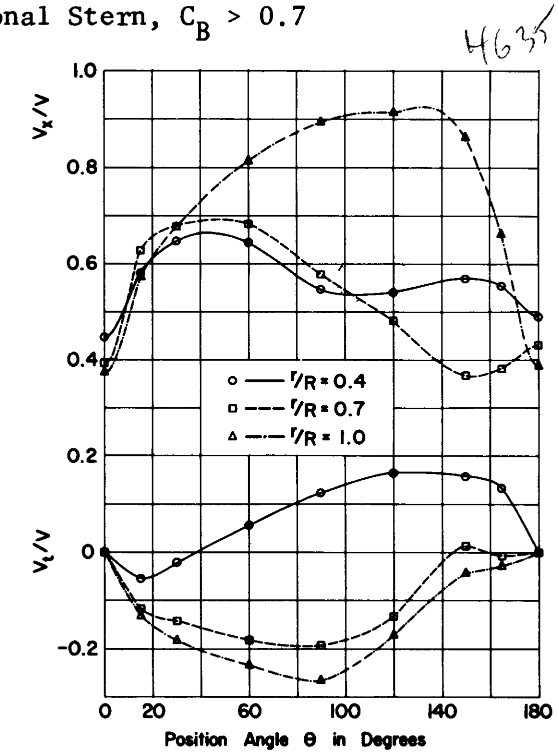


Figure 6c - Moderate V-Shaped Stern

Figure 7 - Circumferential Distributions of Longitudinal (V_x/V) and Tangential (V_t/V) Velocity Components at Test Radii, Conventional Stern, C_B > 0.7





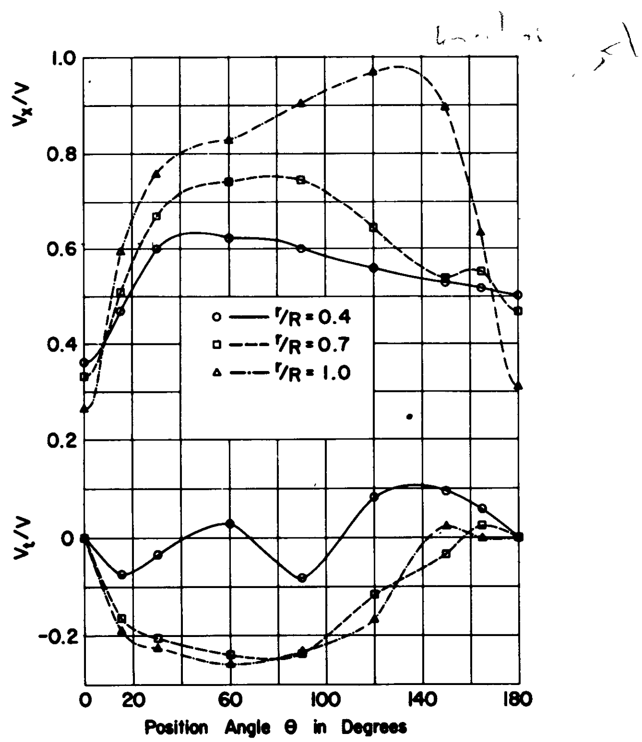


Figure 7a - Moderate U-Shaped Stern

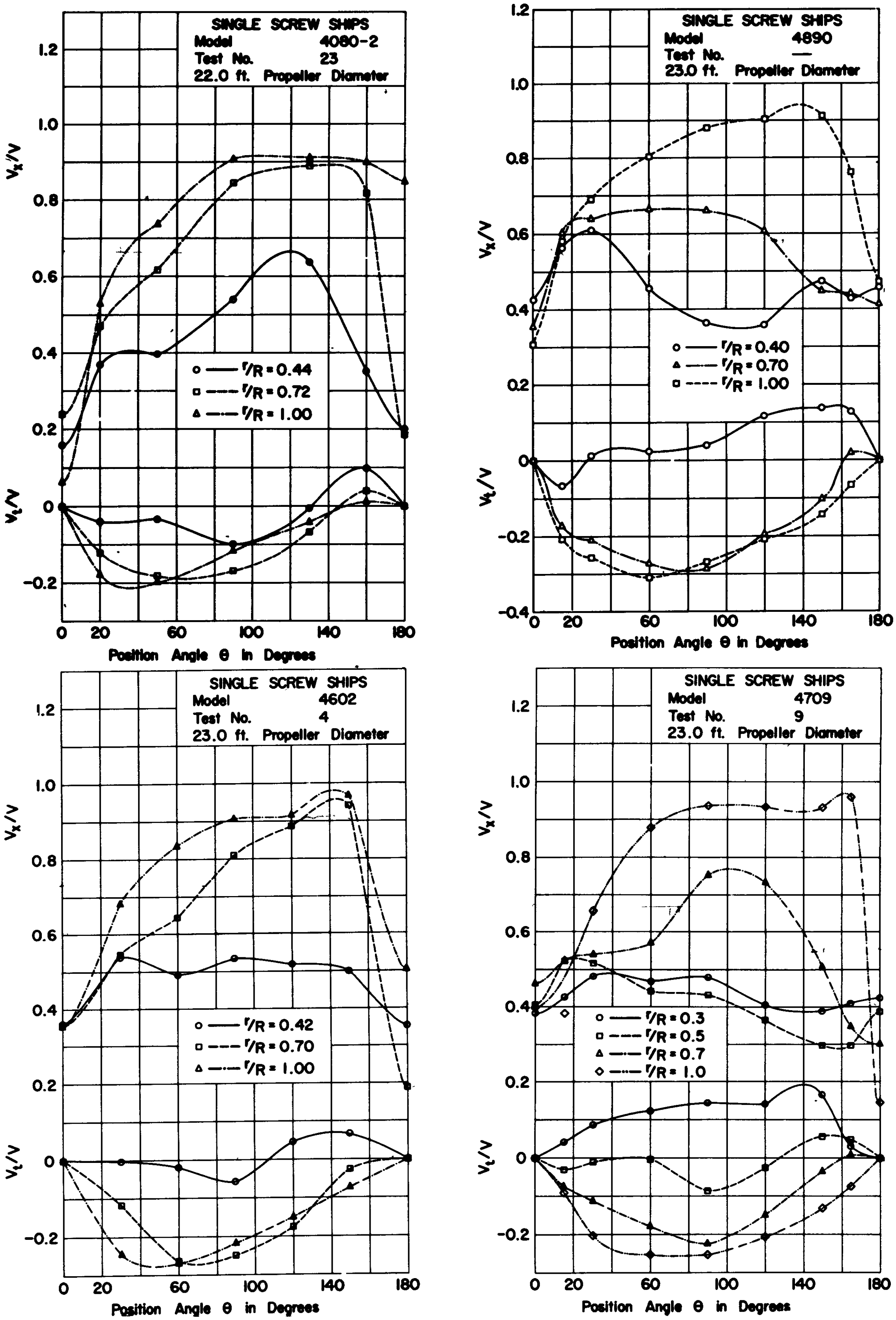


Figure 7b - Moderate V-Shaped Stern

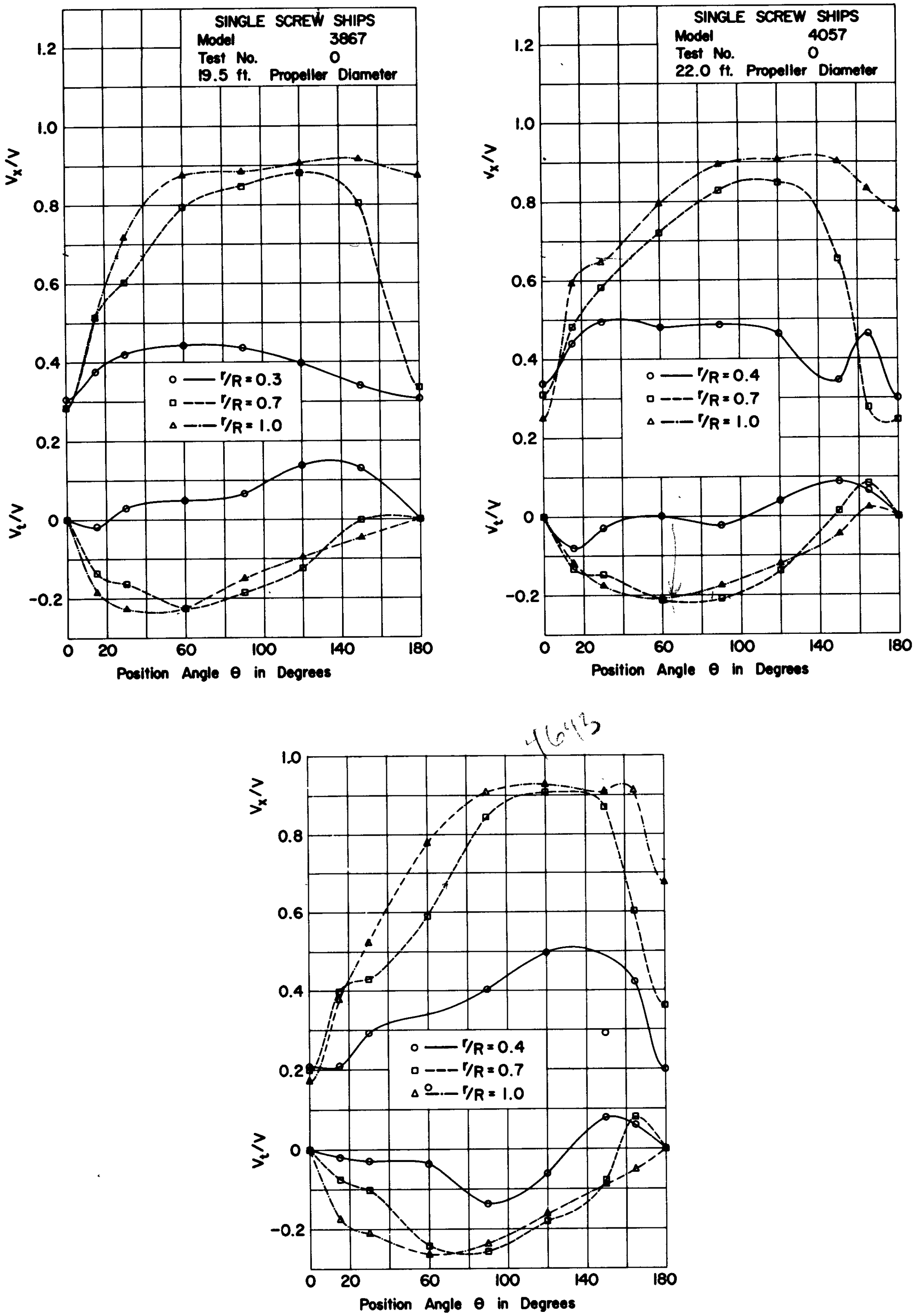


Figure 7c - V-Shaped Stern (Part 1)

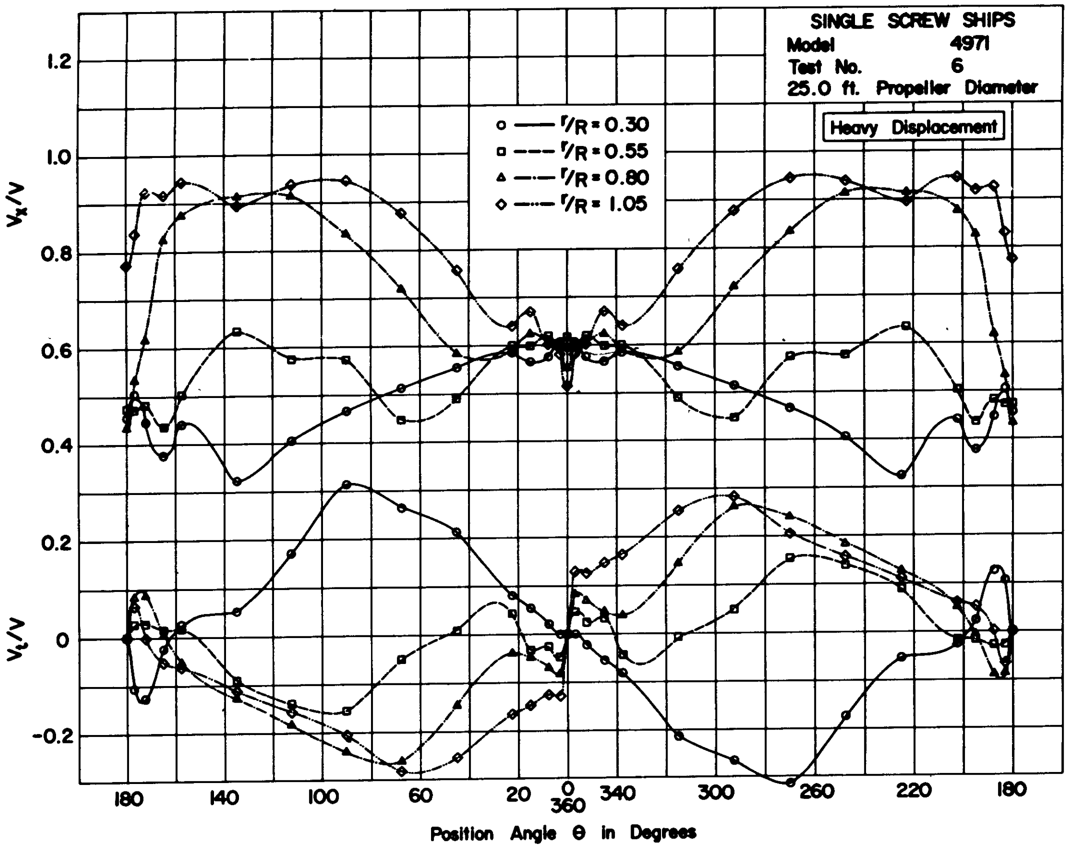


Figure 7d - V-Shaped Stern (Part 2)

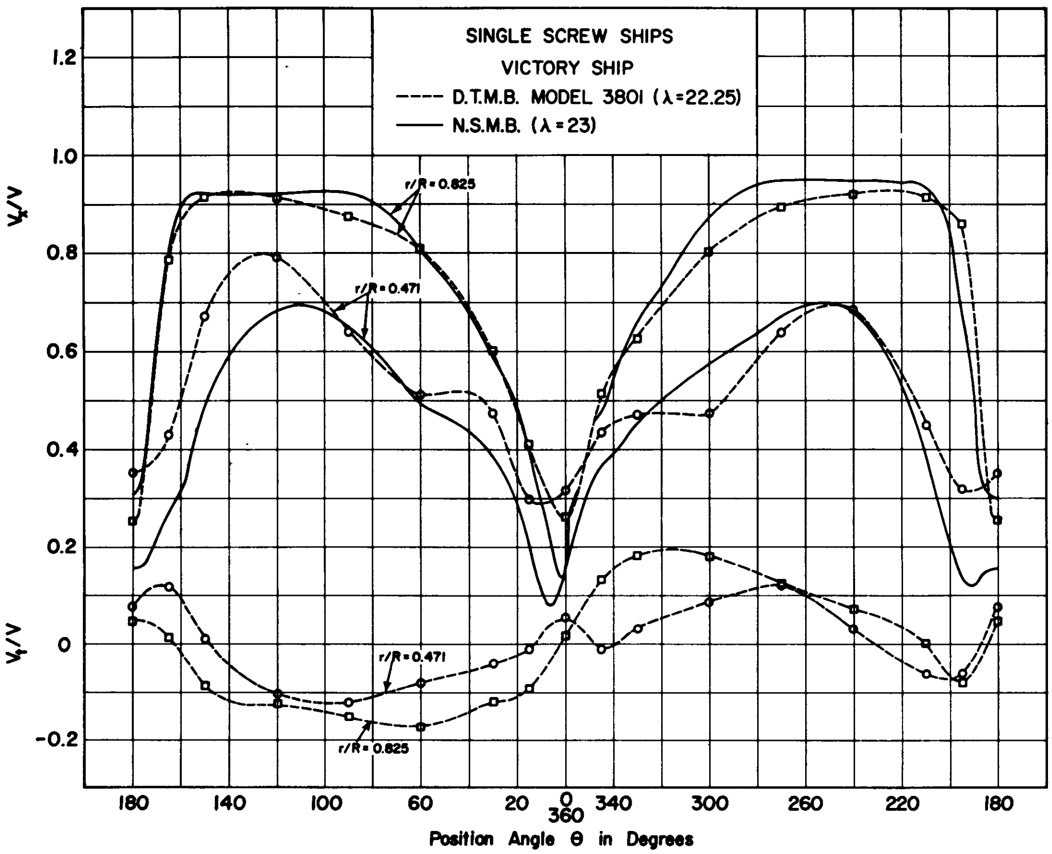


Figure 8 - Comparison of Circumferential Longitudinal (V_x/V) Velocity Distributions of Victory Ship, DTMB versus NSMB

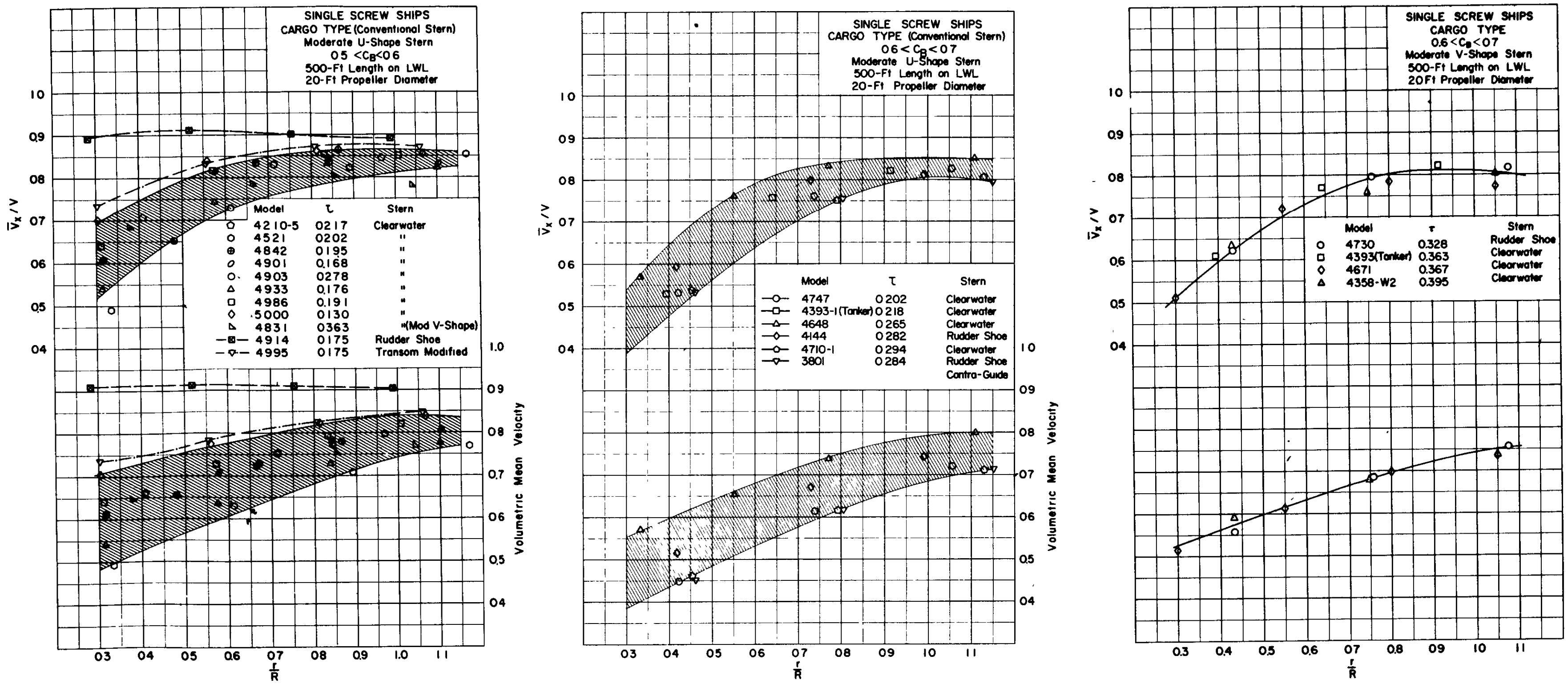


Figure 9 - Mean Longitudinal Velocity ($\bar{V}_x/V$) and Volumetric Mean Velocity, Conventional Stern, C_B < 0.7

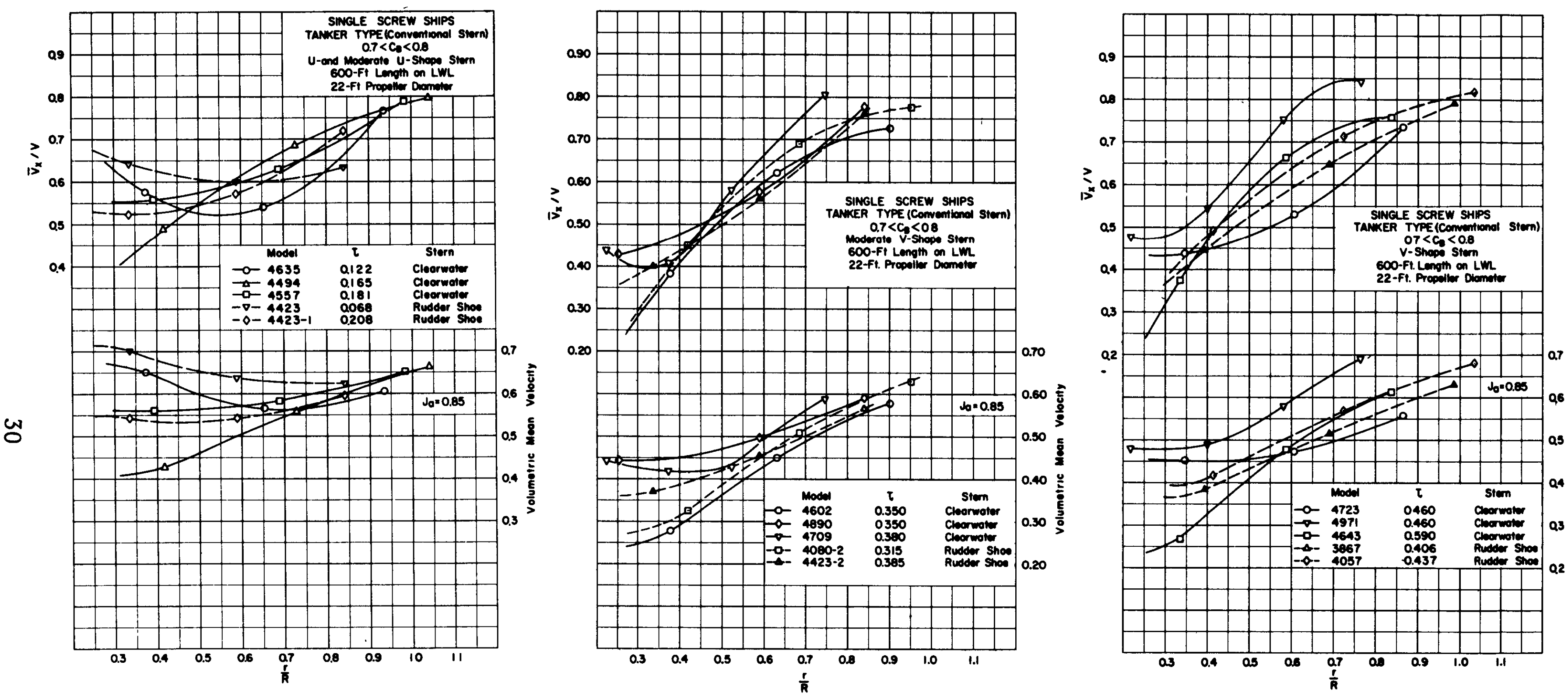


Figure 10 - Mean Longitudinal Velocity ($\bar{V}_x/V$) and Volumetric Mean Velocity, Conventional Stern, $C_B > 0.7$

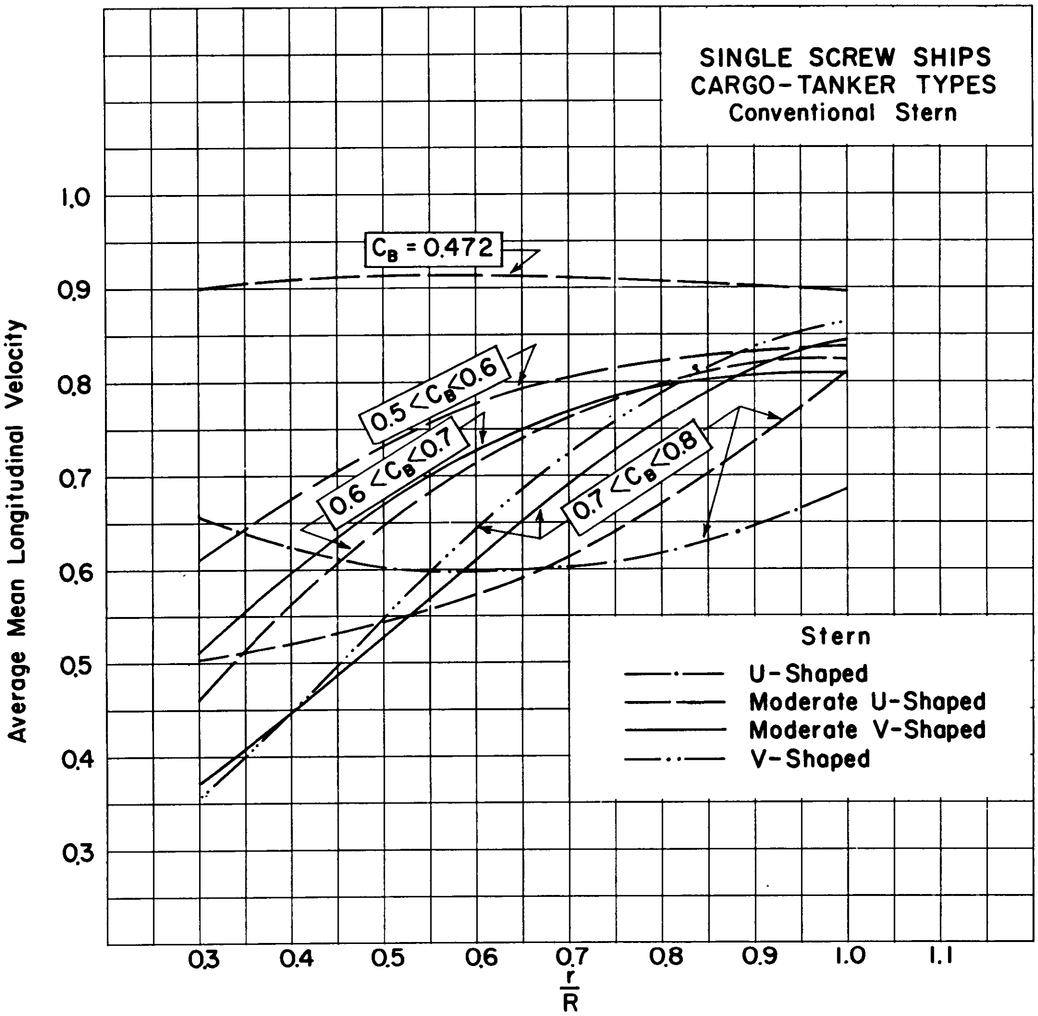


Figure 11 - Average Mean Longitudinal Velocity, Single-Screw Merchant Types, Conventional Stern

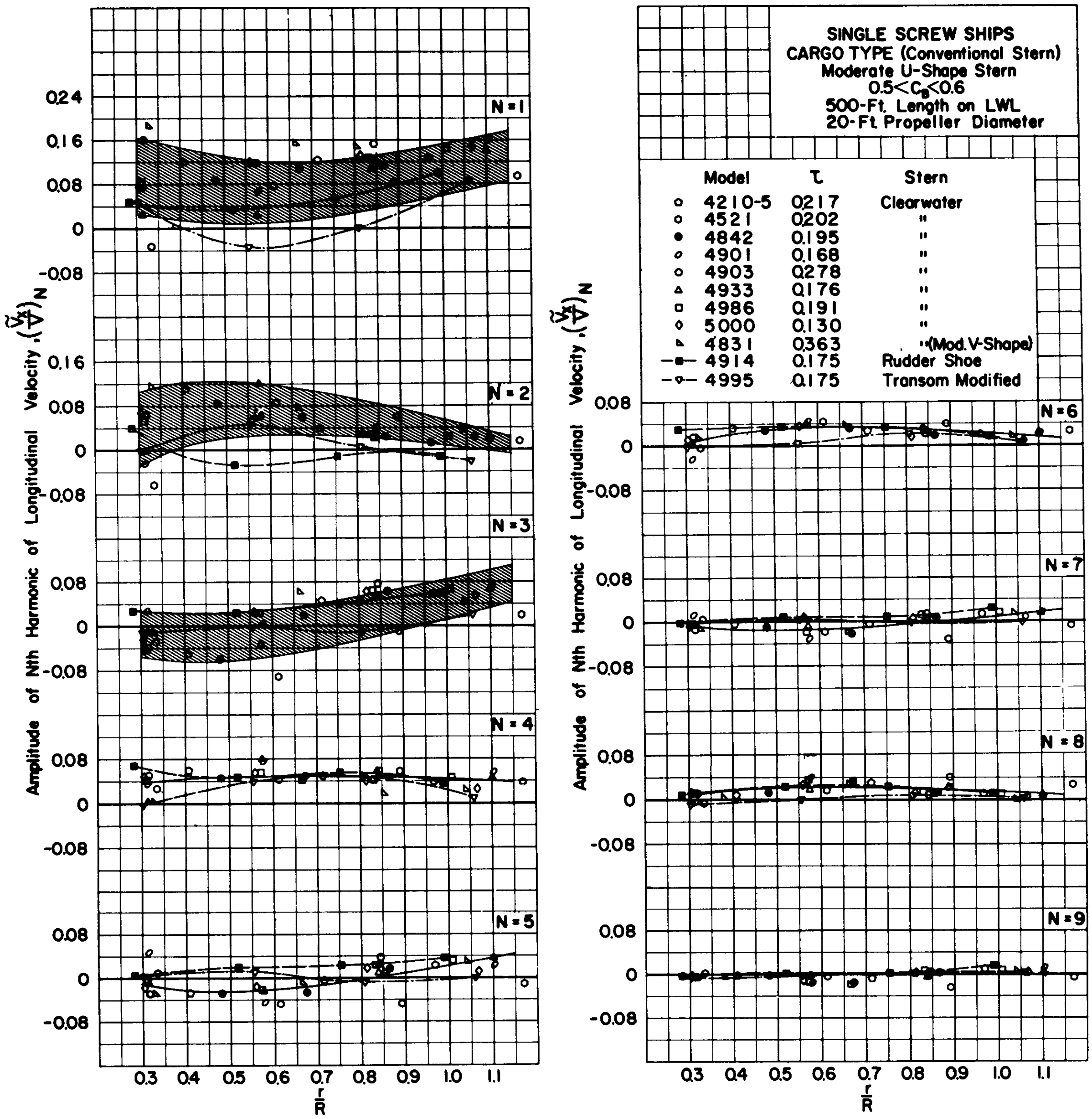


Figure 12 - Amplitudes of Various Harmonics of Longitudinal ($\tilde{V}_x/V$) Velocity, Conventional Stern, Moderate U-Shaped, $0.5 < C_B < 0.6$

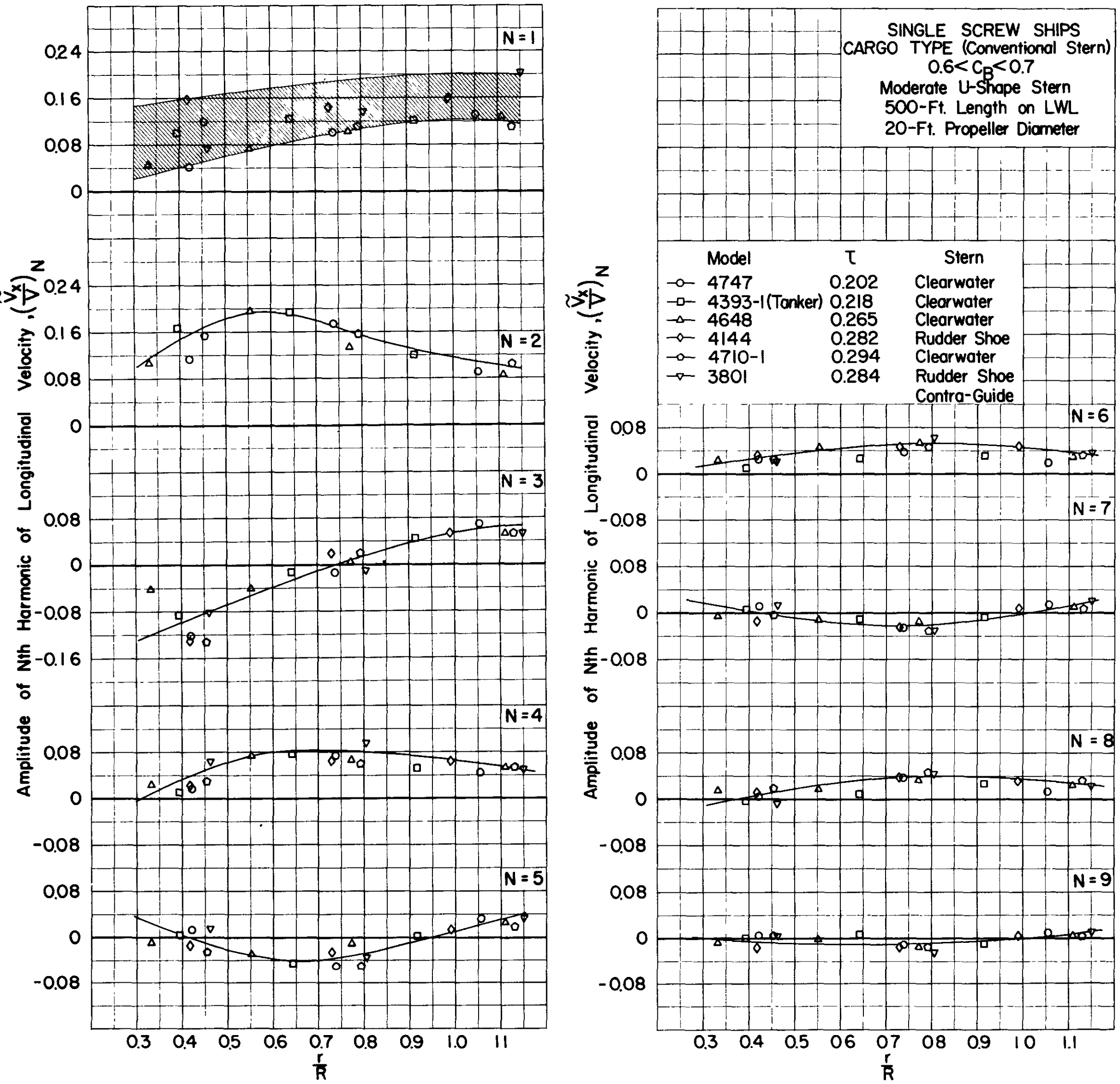


Figure 13 - Amplitudes of Various Harmonics of Longitudinal $(\tilde{V}_x/V)$ Velocity, Conventional Stern, Moderate U-Shaped, $0.6 < C_B < 0.7$

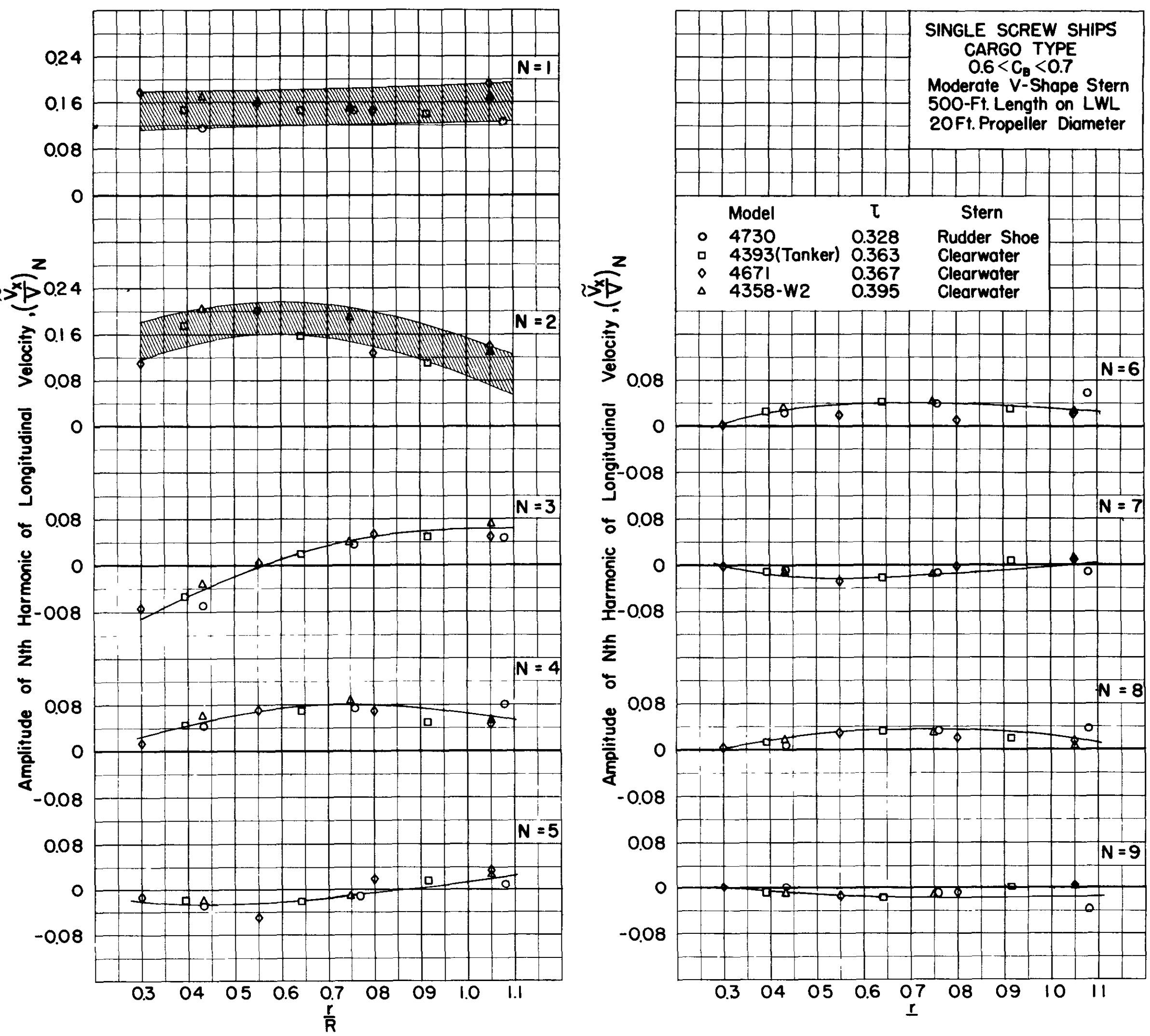


Figure 14 - Amplitudes of Various Harmonics of Longitudinal $(\tilde{V}_x/V)$ Velocity, Conventional Stern, Moderate V-Shaped, $0.6 < C_B < 0.7$

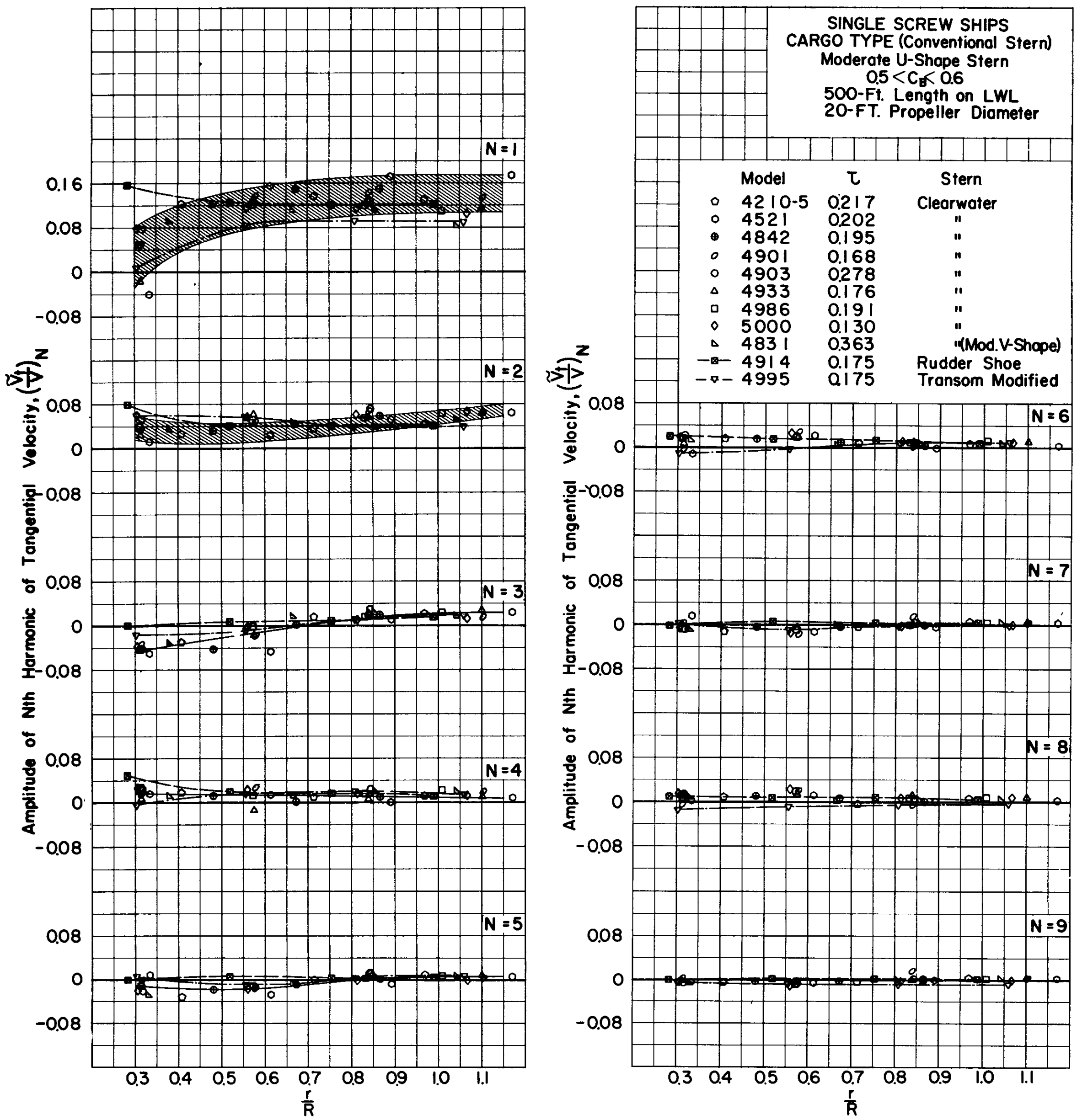


Figure 15 - Amplitudes of Various Harmonics of Tangential $(\tilde{V}_t/V)$ Velocity, Conventional Stern, Moderate U-Shaped, $0.5 < C_B < 0.6$

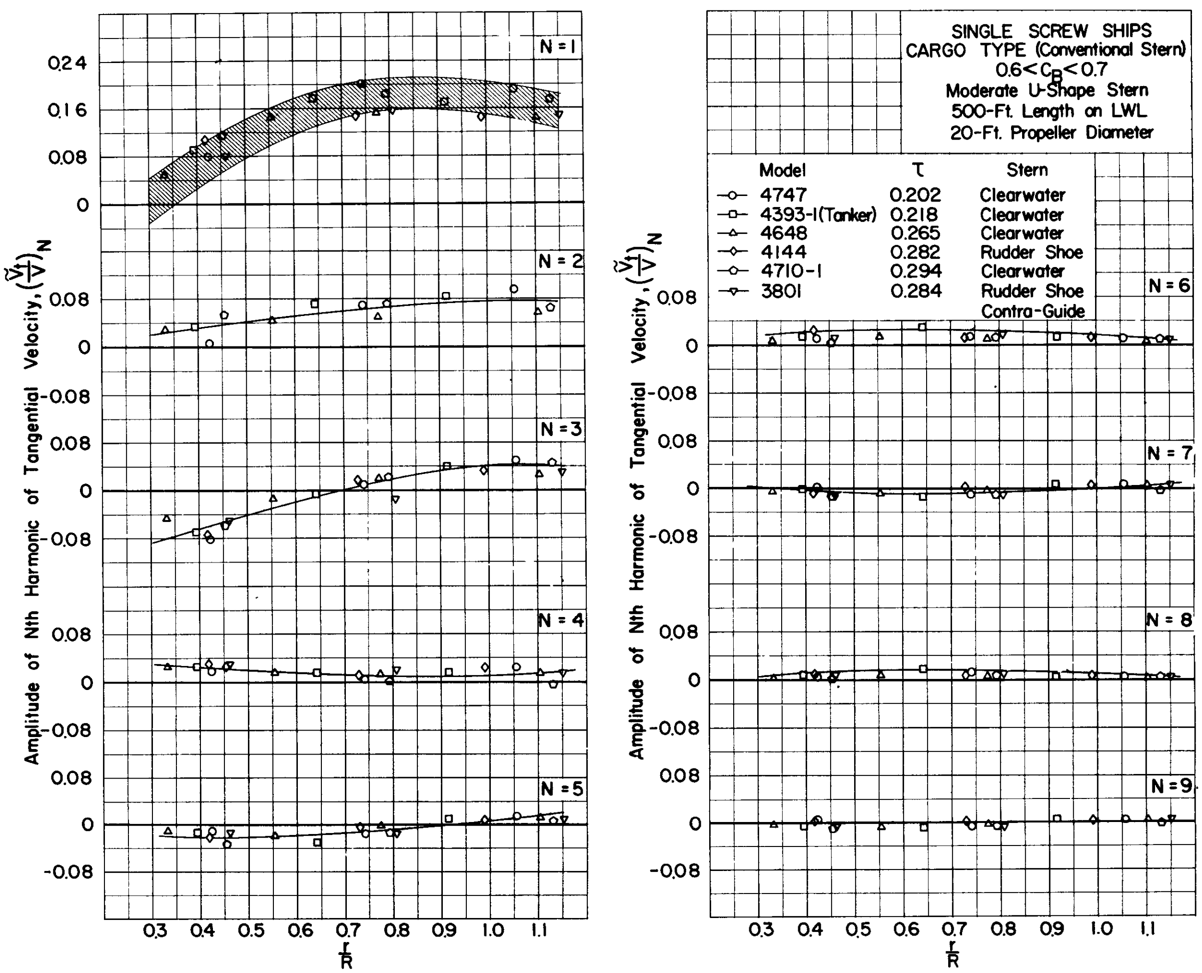


Figure 16 - Amplitudes of Various Harmonics of Tangential ($\tilde{V}_t/V$) Velocity, Conventional Stern, Moderate U-Shaped, $0.6 < C_B < 0.7$

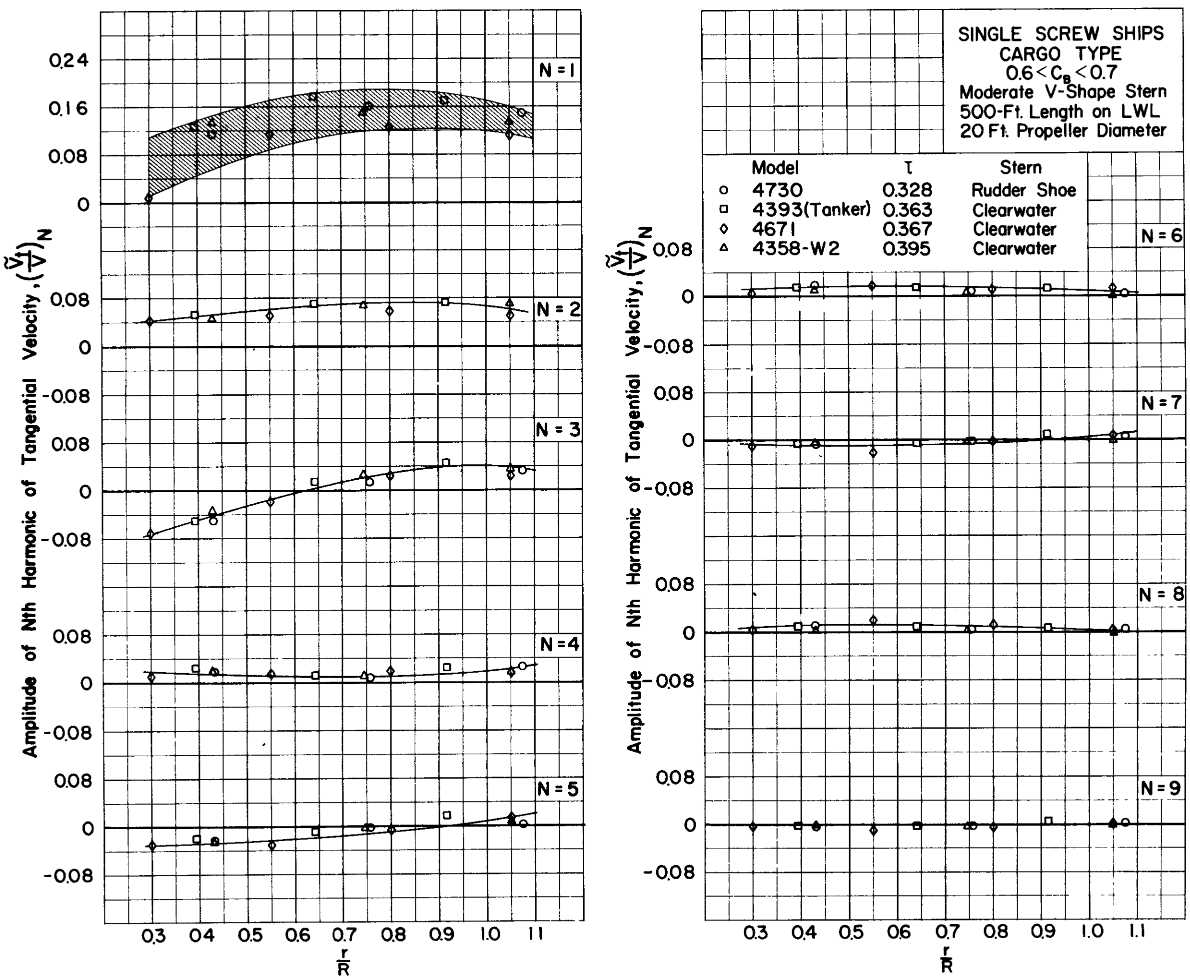


Figure 17 - Amplitudes of Various Harmonics of Tangential $(\tilde{V}_t/V)$ Velocity, Conventional Stern, Moderate V-Shaped, $0.6 < C_B < 0.7$

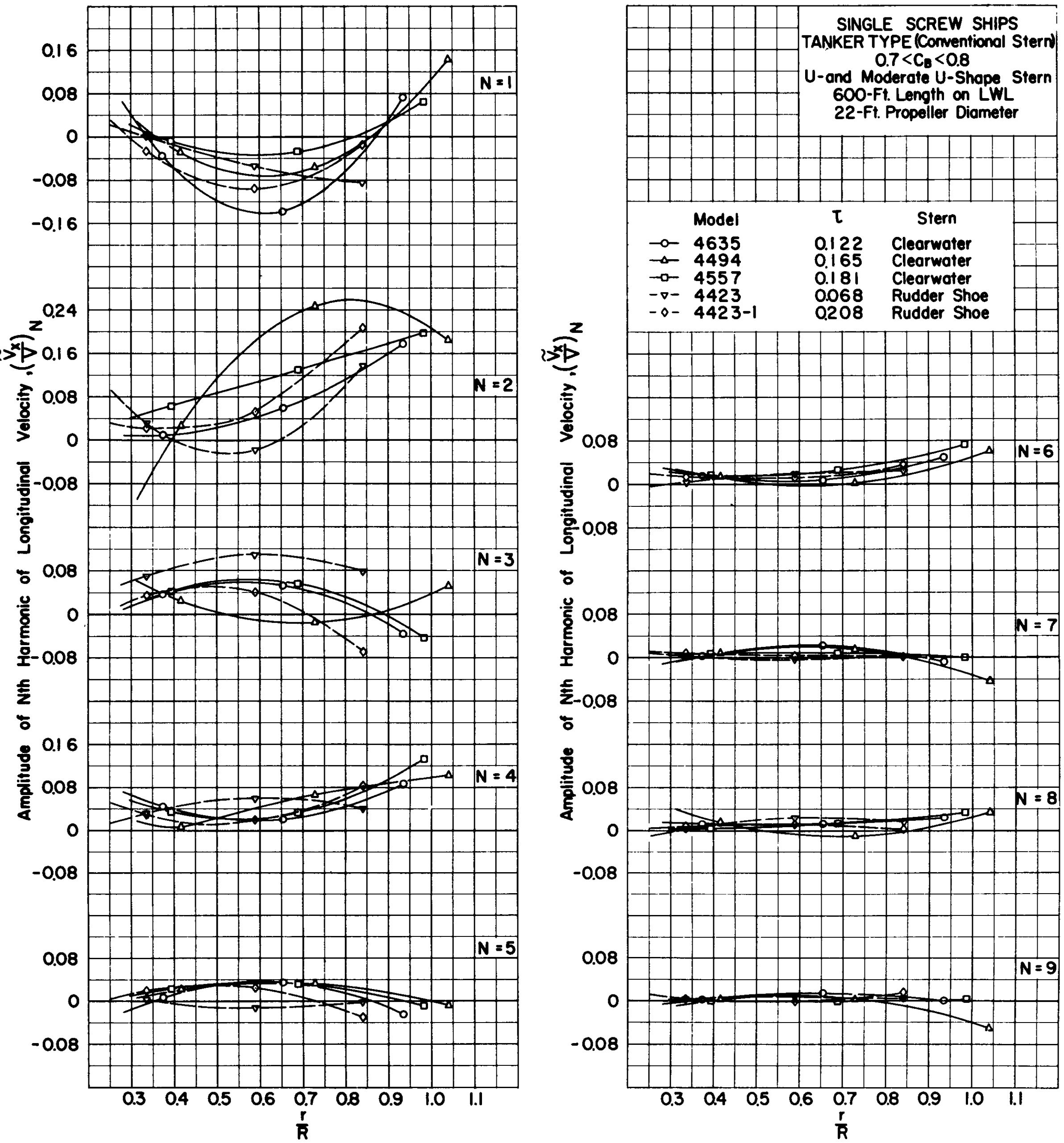


Figure 18 - Amplitudes of Various Harmonics of Longitudinal $(\tilde{V}_x/V)$ Velocity, Conventional Stern, U- and Moderate U-Shaped, $0.7 < C_B < 0.8$

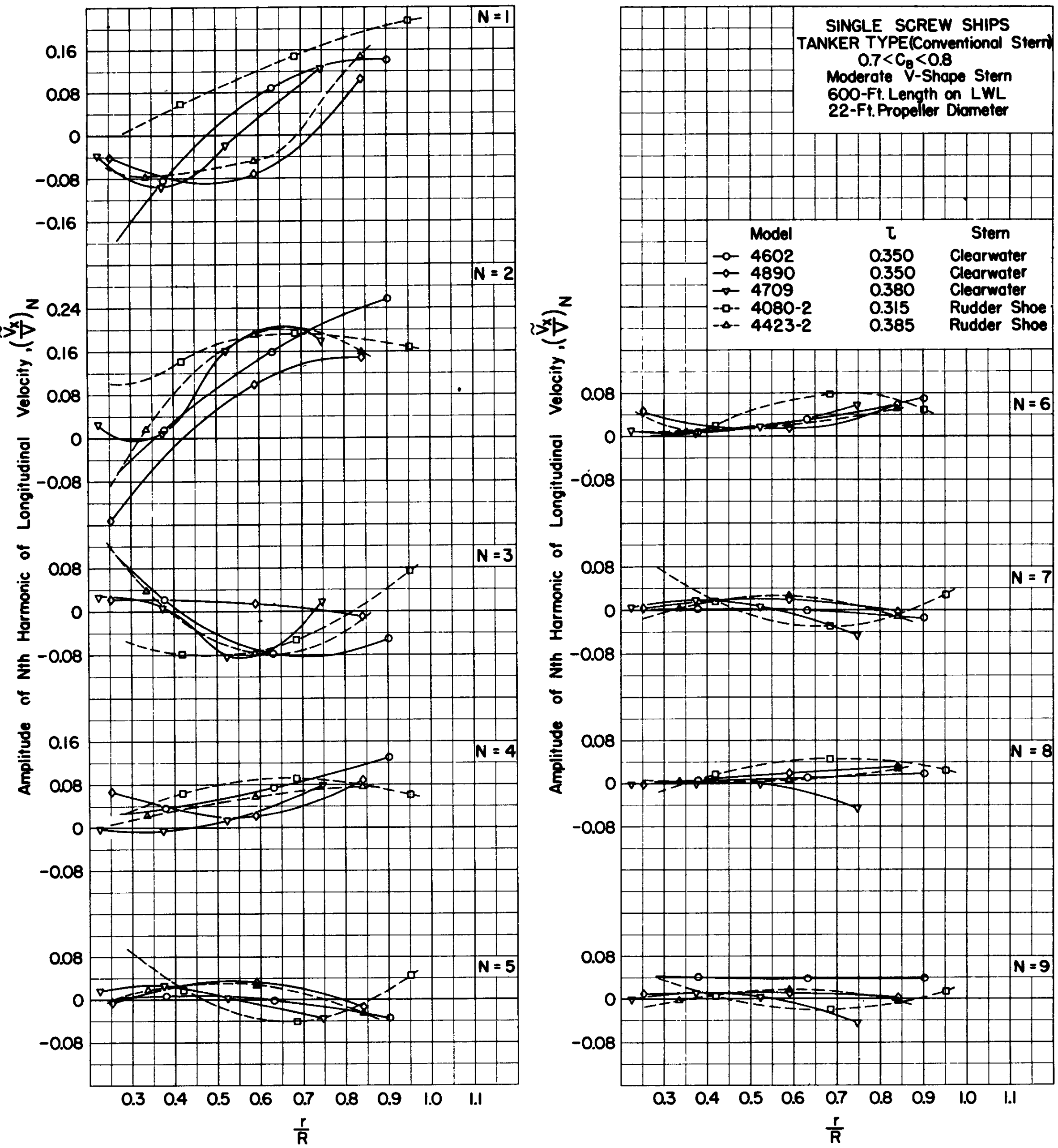


Figure 19 - Amplitudes of Various Harmonics of Longitudinal $(\tilde{V}_x/V)$ Velocity, Conventional Stern, U- and Moderate V-Shaped, $0.7 < C_B < 0.8$

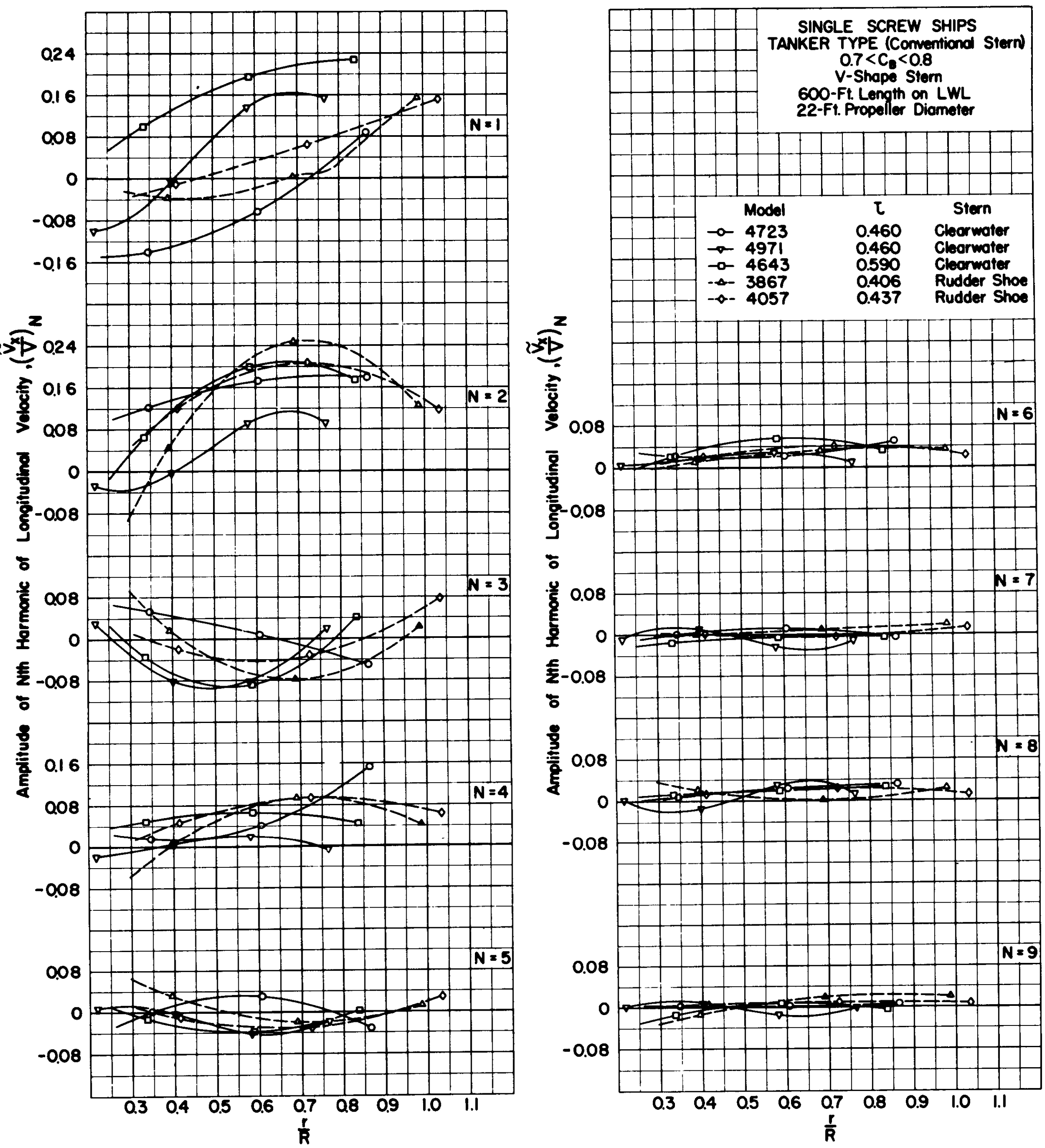


Figure 20 - Amplitudes of Various Harmonics of Longitudinal $(\tilde{V}_x/V)$ Velocity, Conventional Stern, V-Shaped, $0.7 < C_B < 0.8$

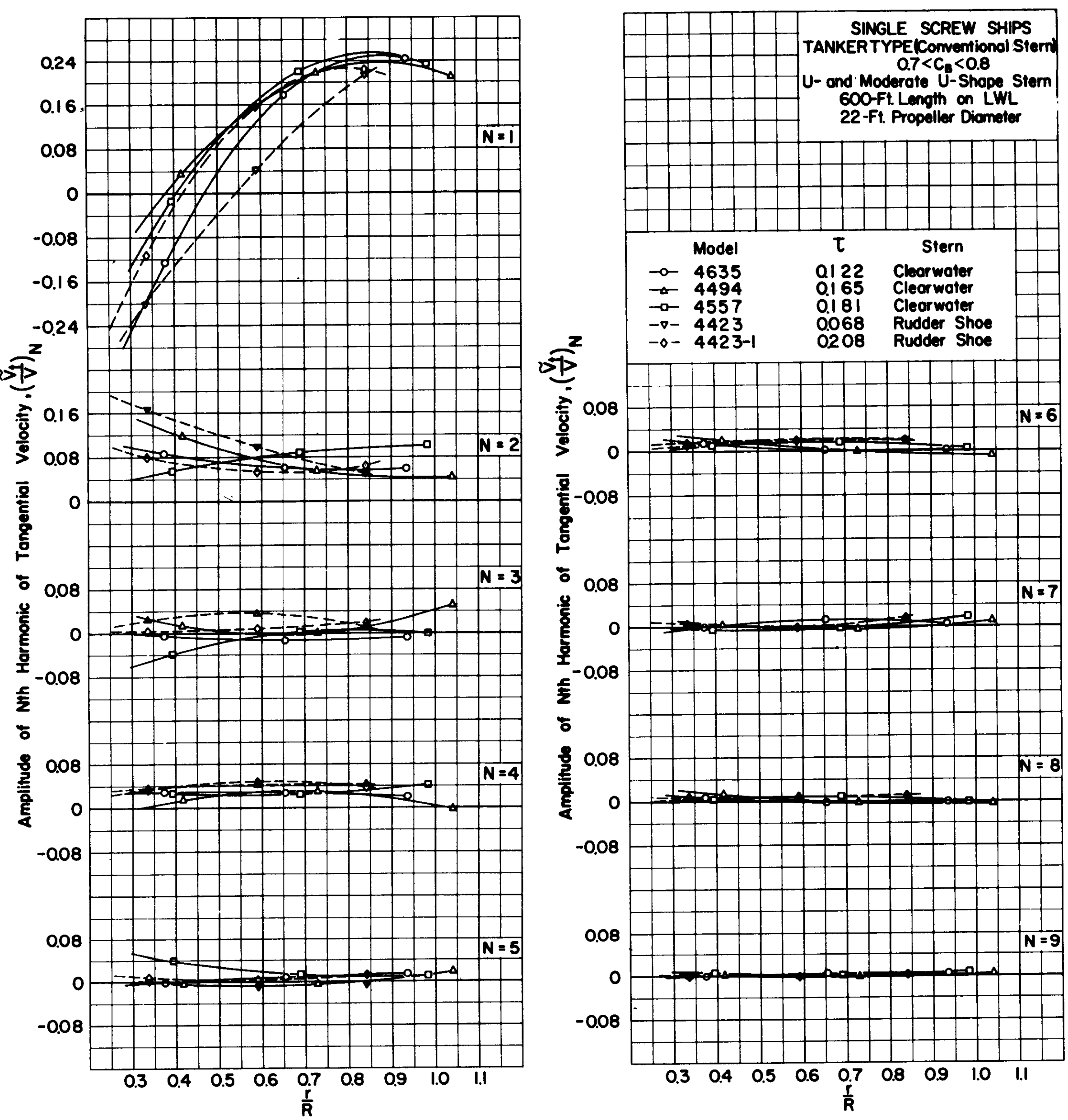


Figure 21 - Amplitudes of Various Harmonics of Tangential $(\tilde{V}_t/V)$ Velocity, Conventional Stern, U- and Moderate U-Shaped, $0.7 < C_B < 0.8$

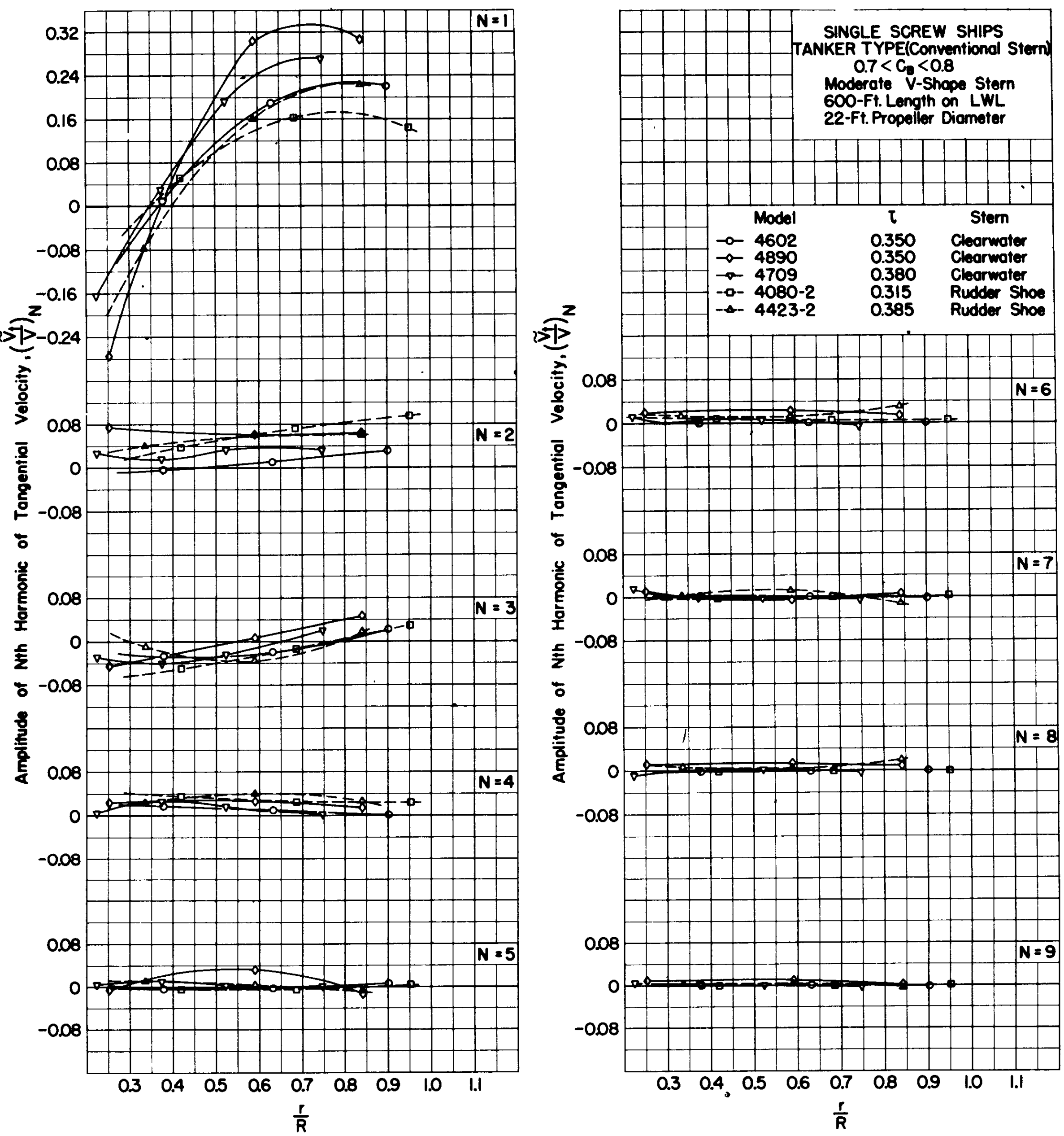


Figure 22 - Amplitudes of Various Harmonics of Tangential ($\tilde{V}_t/V$) Velocity, Conventional Stern, Moderate V-Shaped, $0.7 < C_B < 0.8$

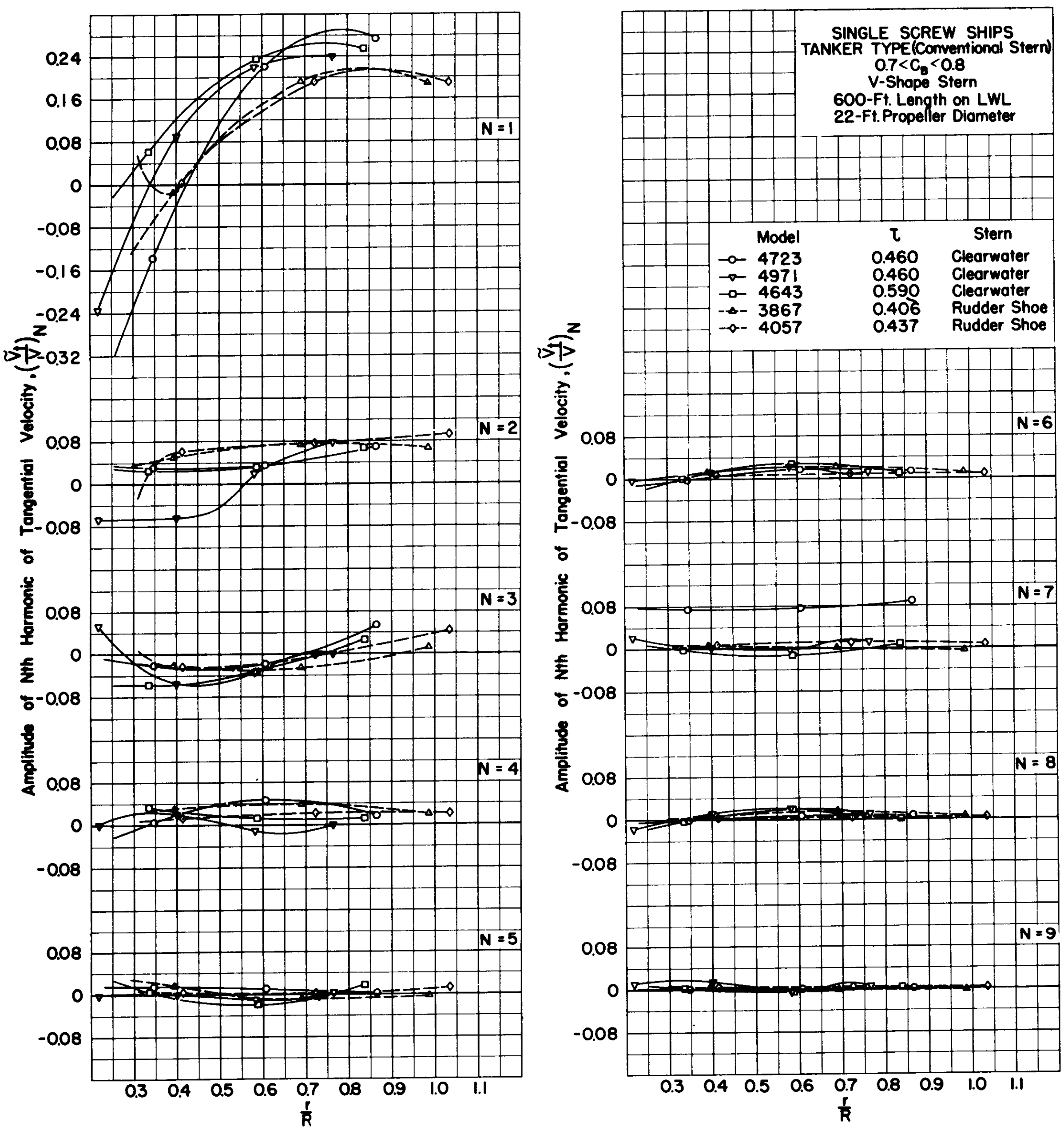


Figure 23 - Amplitudes of Various Harmonics of Tangential $(\tilde{V}_t/V)$ Velocity, Conventional Stern, V-Shaped, $0.7 < C_B < 0.8$

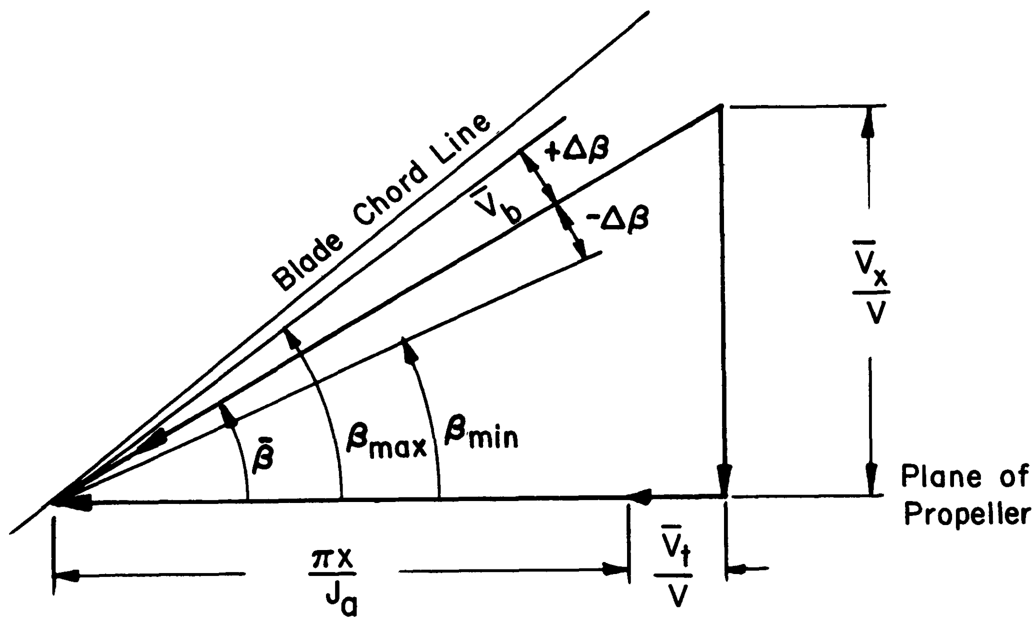


Figure 24 - Velocity Diagram

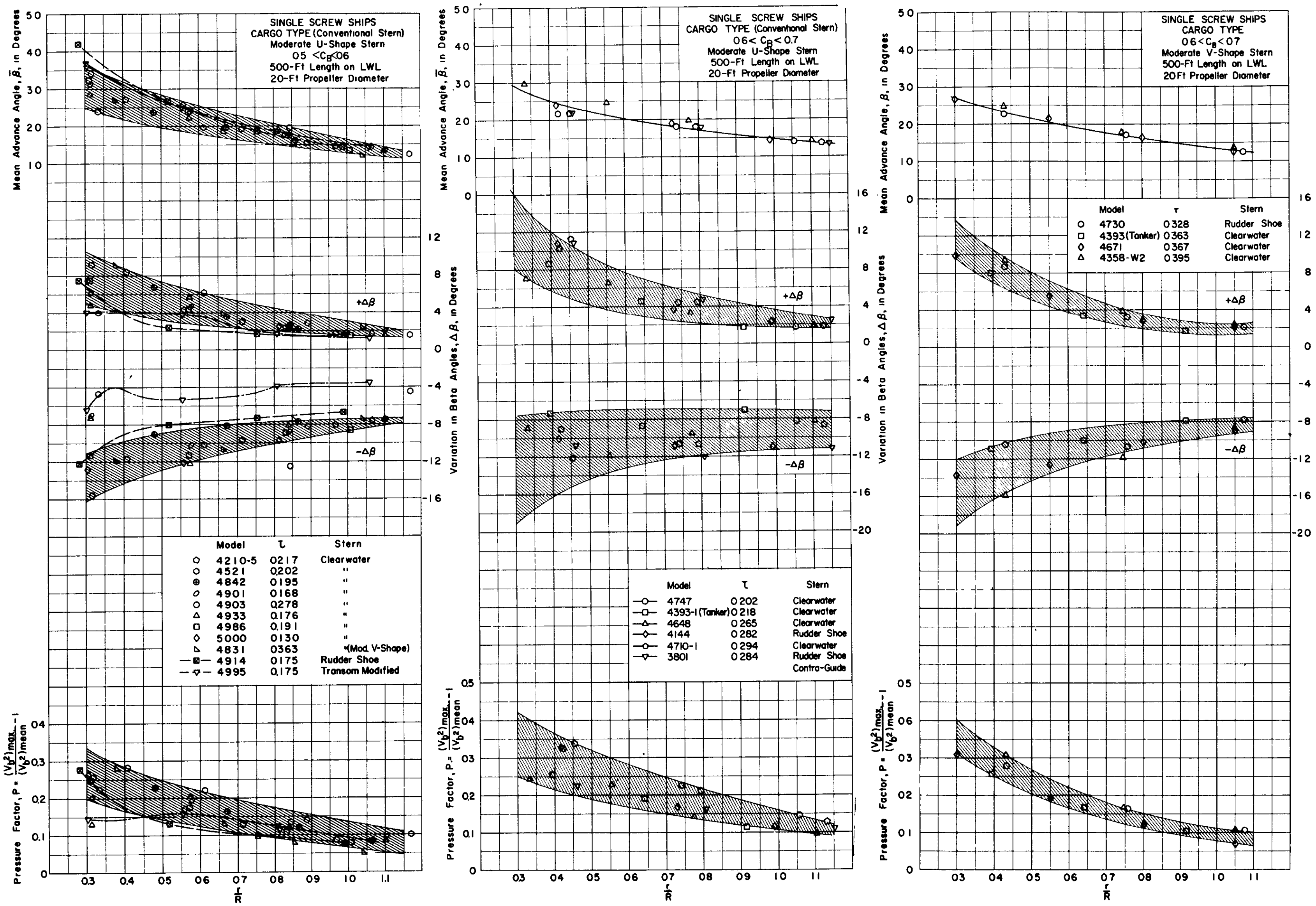


Figure 25 - Mean Advance Angle ($\bar{\beta}$), Variations in Beta Angles ($\Delta\beta$) and Pressure Factor (P), Single-Screw Merchant Types, Conventional Stern, $C_B < 0.7$

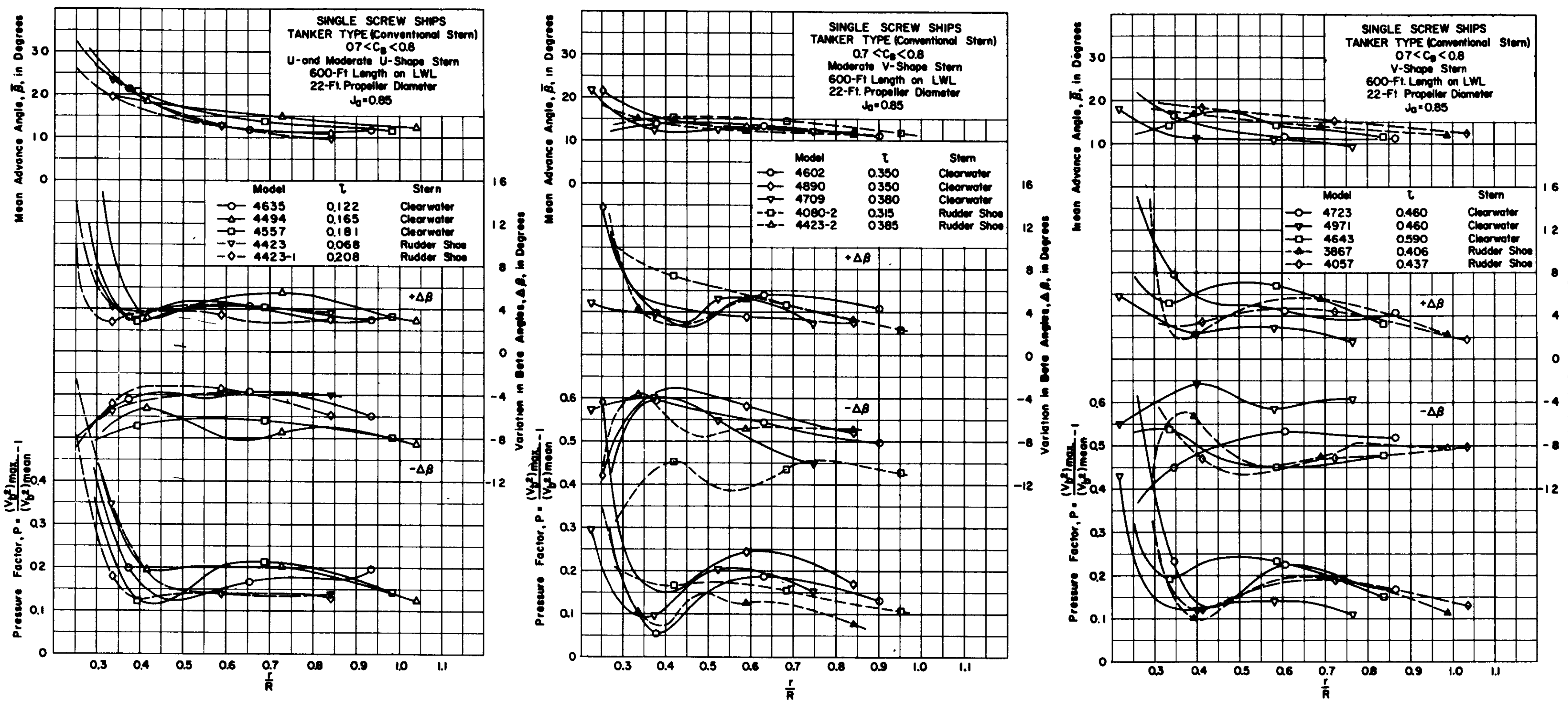


Figure 26 - Mean Advance Angle ($\bar{\beta}$), Variations in Beta Angles ($\Delta\beta$), and Pressure Factor (P), Single-Screw Merchant Types, Conventional Stern, $C_B > 0.7$

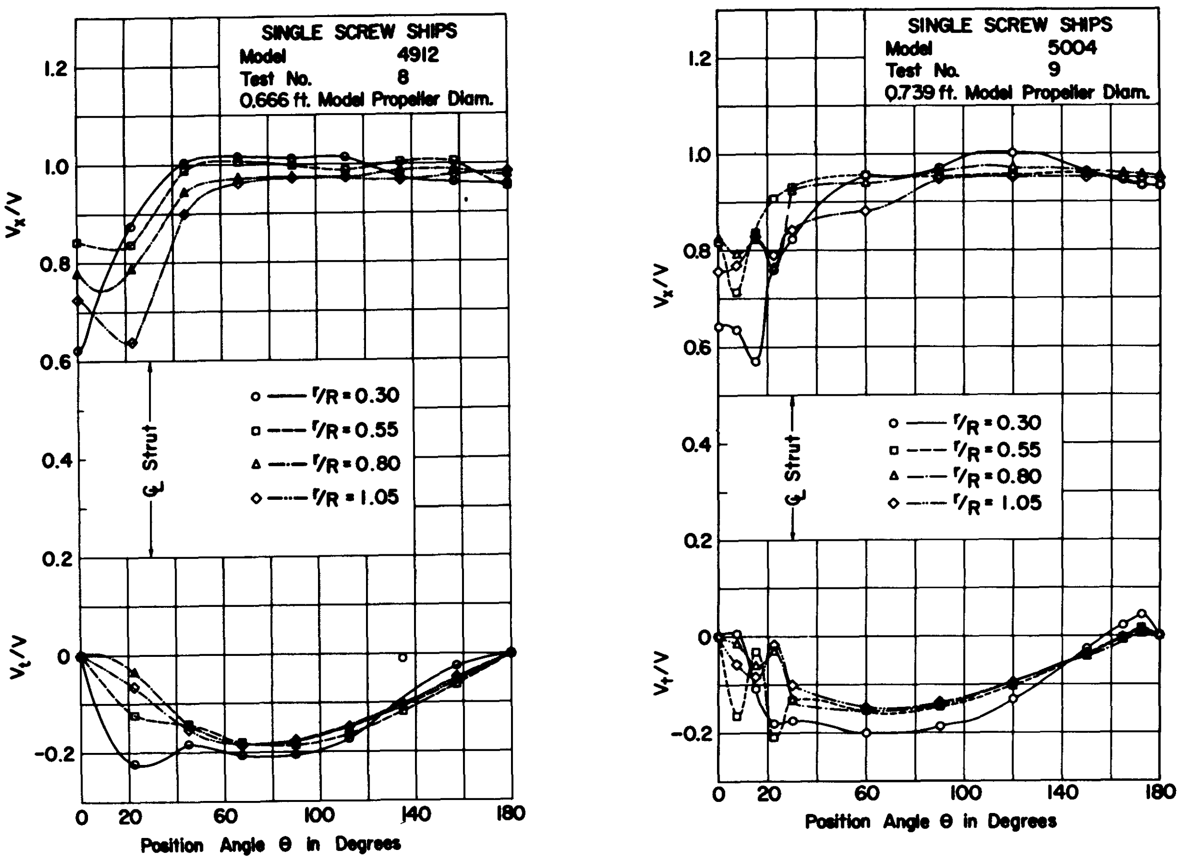


Figure 27 - Circumferential Distributions of Longitudinal (V_x/V) and Tangential (V_t/V) Velocity Components at Test Radii, Open-Type Sterns

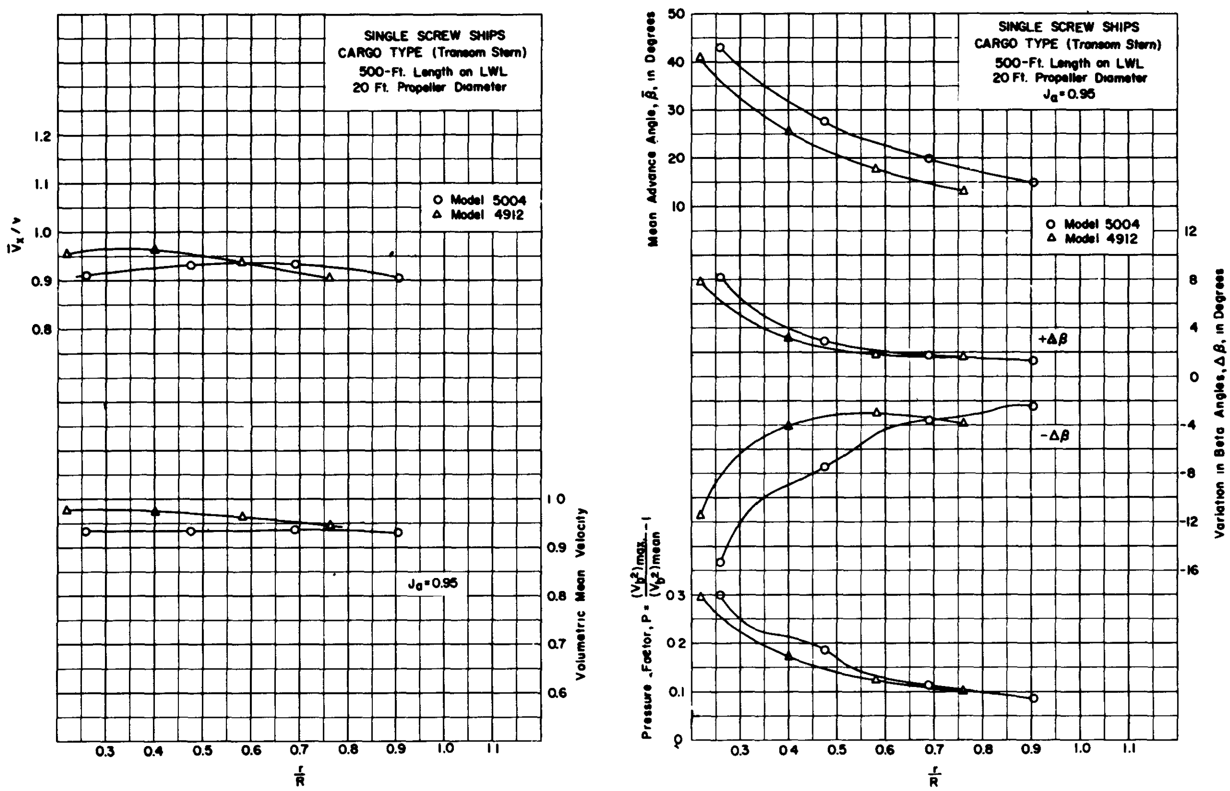


Figure 28 - Mean Longitudinal Velocity ($\bar{V}_x/V$), Mean Advance Angle ($\bar{\beta}$), Variations in Beta Angle ($\Delta\beta$) and Pressure Factor (P), Open-Type Sterns

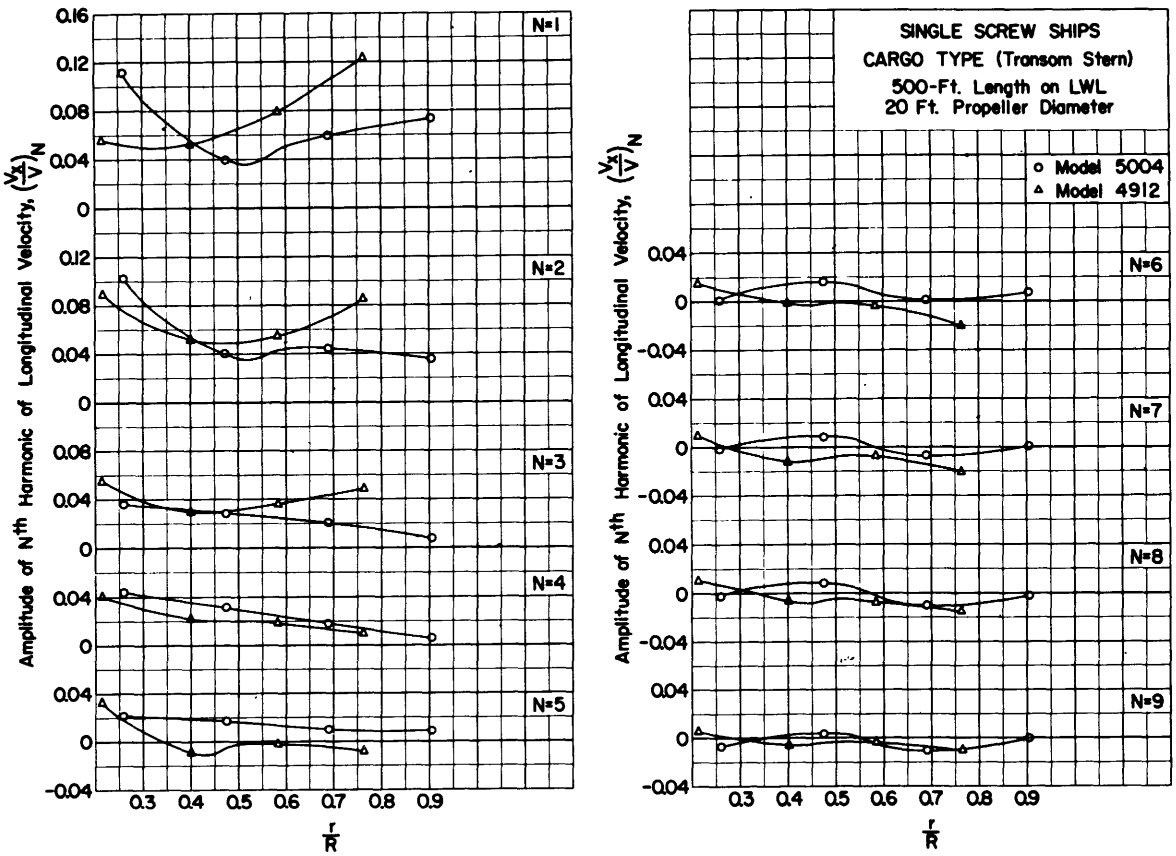


Figure 29 - **Amplitude of Various Harmonics of Longitudinal** $(\tilde{V}_x/V)$ Velocity, Open-Type Sterns

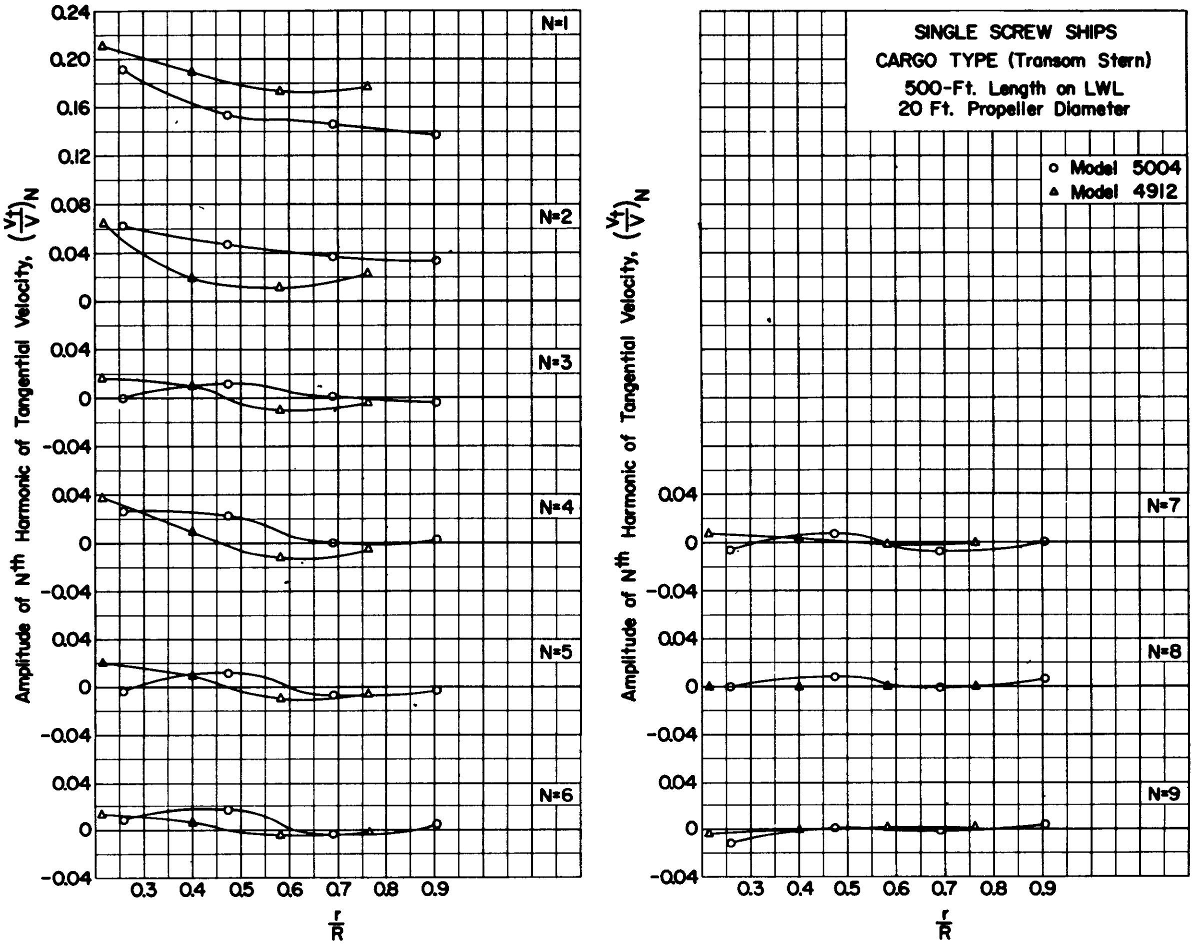


Figure 30 - Amplitude of Various Harmonics of Tangential $(\tilde{V}_t/V)$
Velocity, Open-Type Sterns

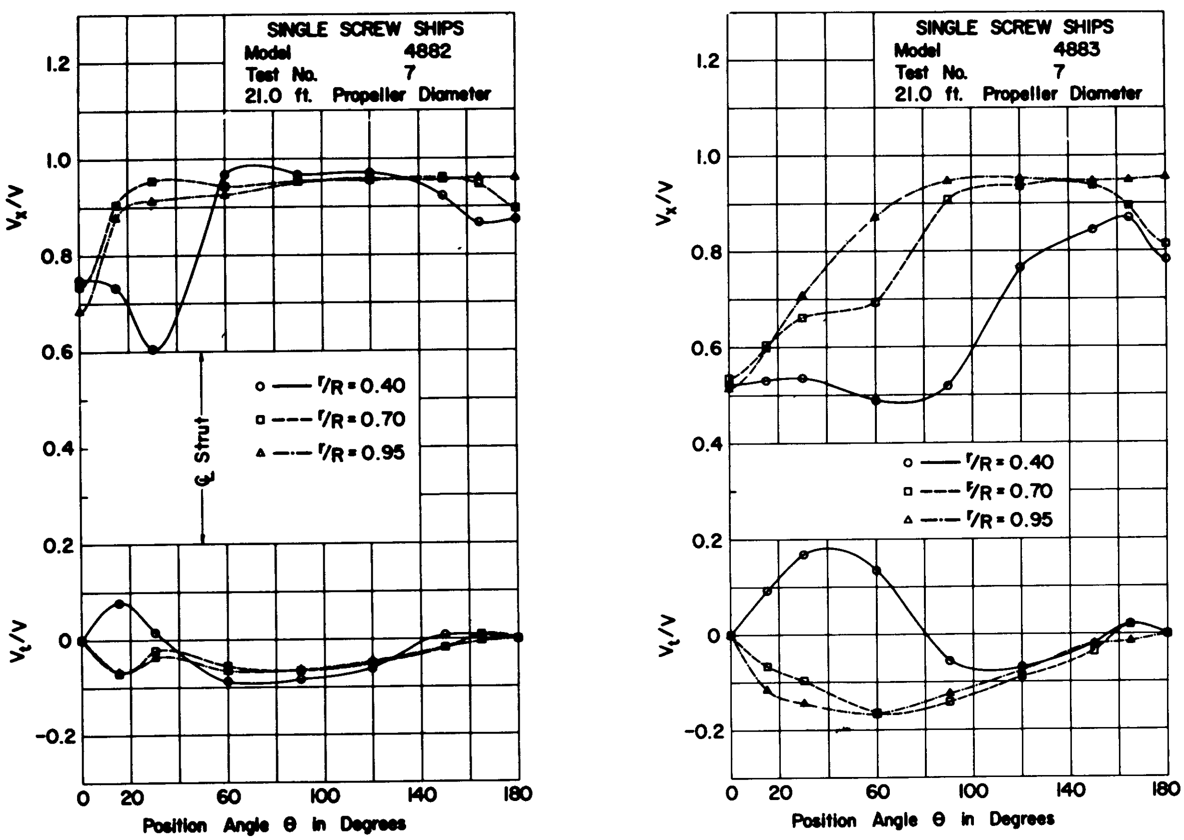


Figure 31 - Circumferential Distributions of Longitudinal $(\tilde{V}_x/V)$ and Tangential (V_t/V) Velocity Components at Test Radii, Special Sterns

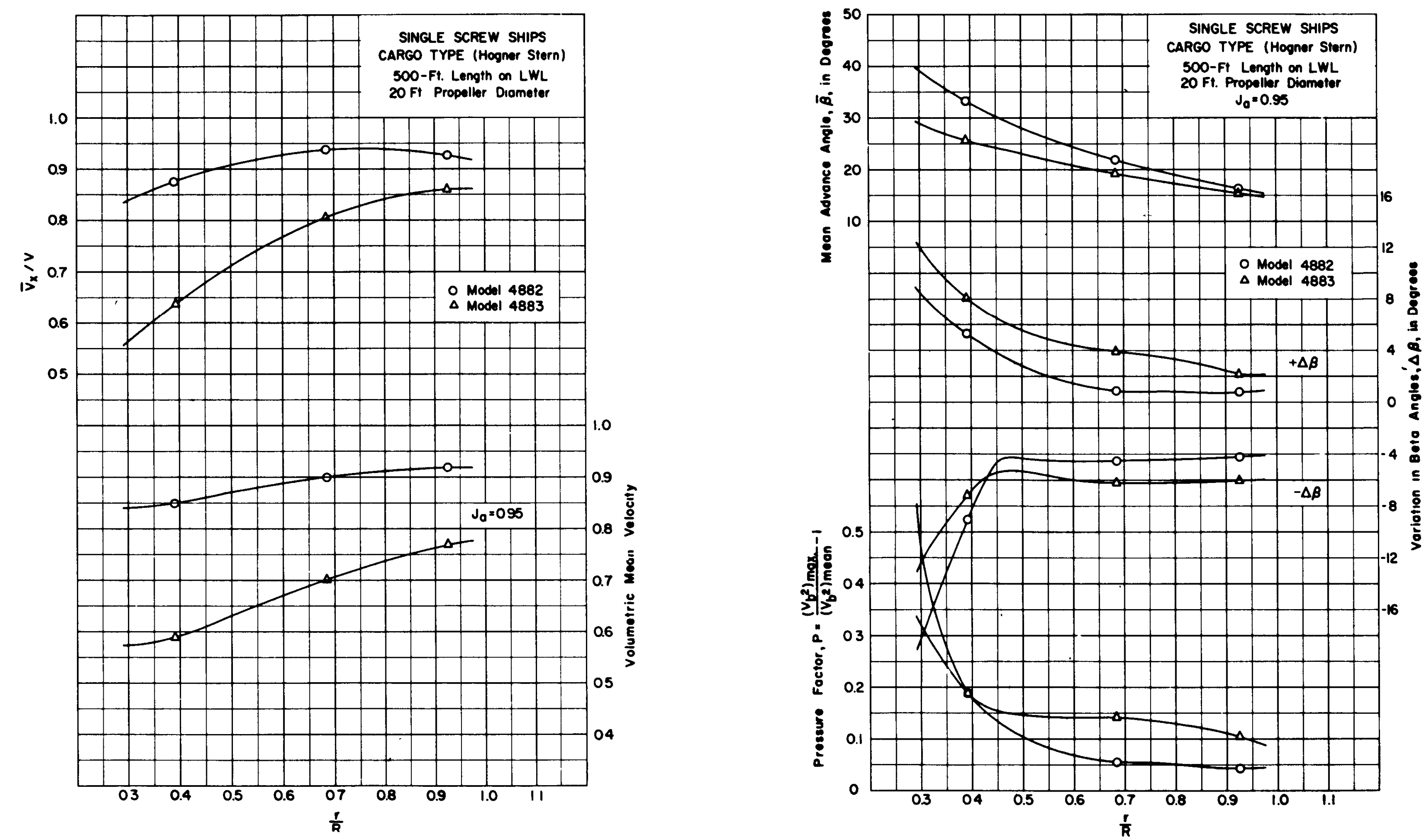


Figure 32 - Mean Longitudinal Velocity ($\bar{V}_x/V$), Mean Advance Angle ($\bar{\beta}$), Variations in Beta Angle ($\Delta\beta$) and Pressure Factor (P), Special Stern

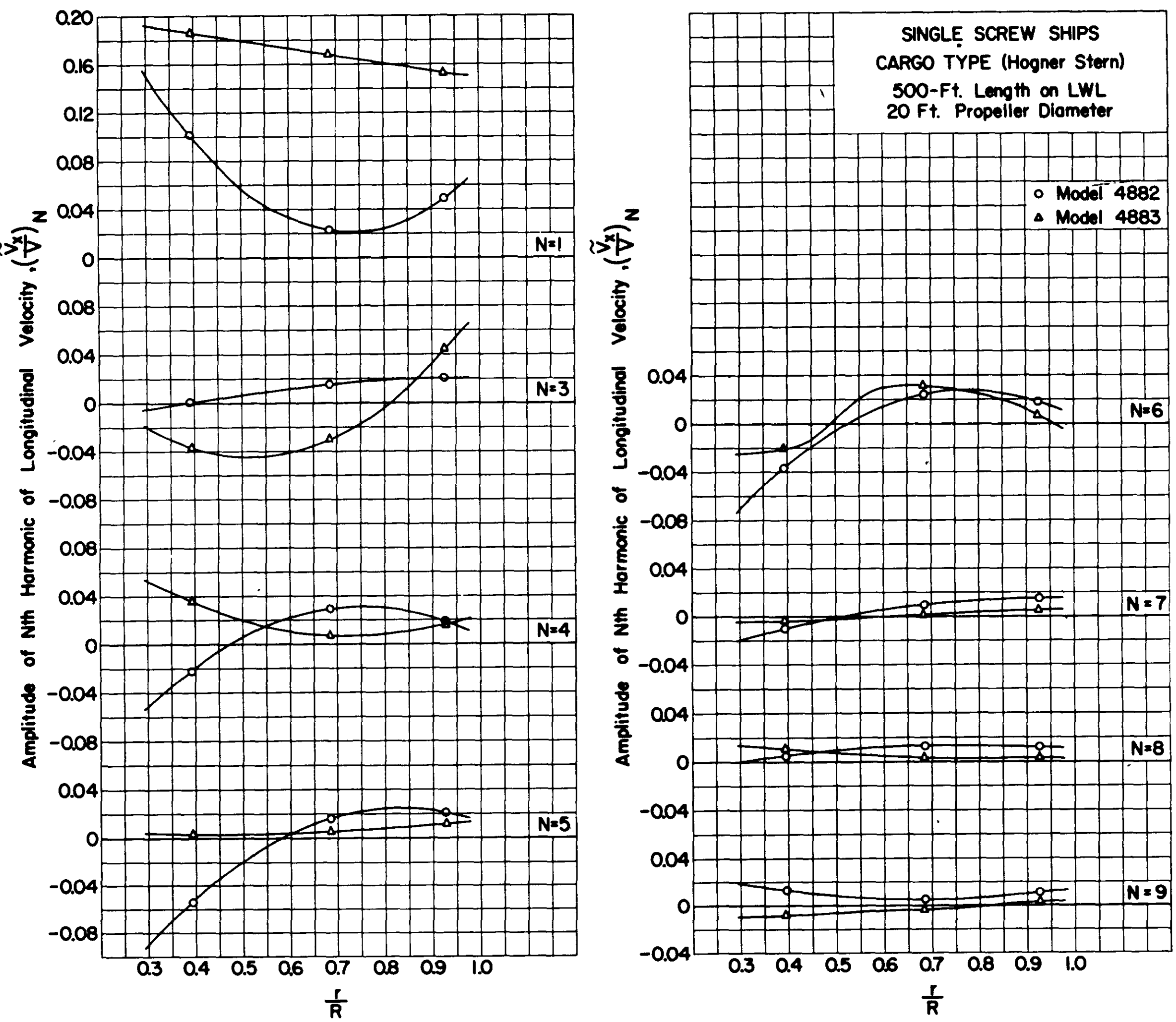


Figure 33 - Amplitude of Various Harmonics of Longitudinal $(\tilde{V}_x/V)$ Velocity, Single-Screw Merchant Types, Special Stern

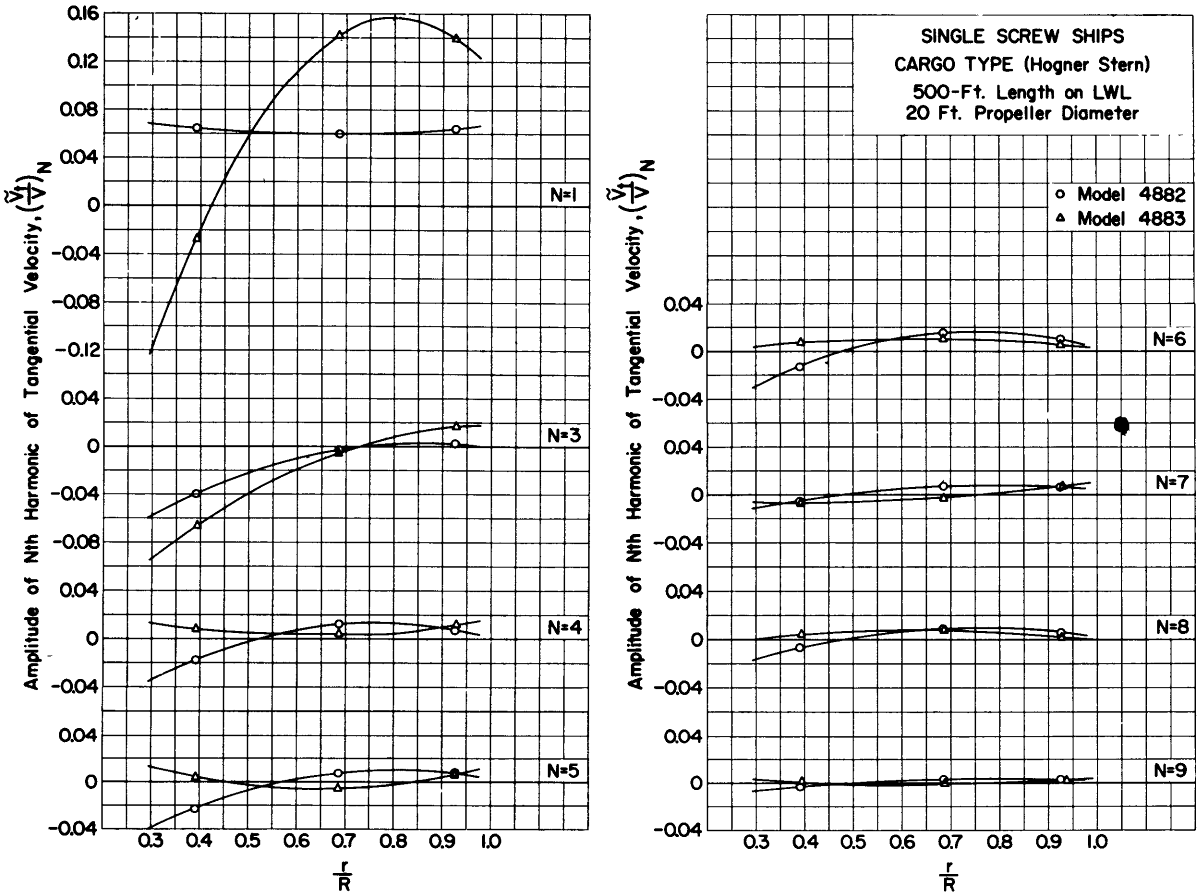


Figure 34 - Amplitude of Various Harmonics of Tangential $(\tilde{V}_t/V)$ Velocity, Special Stern

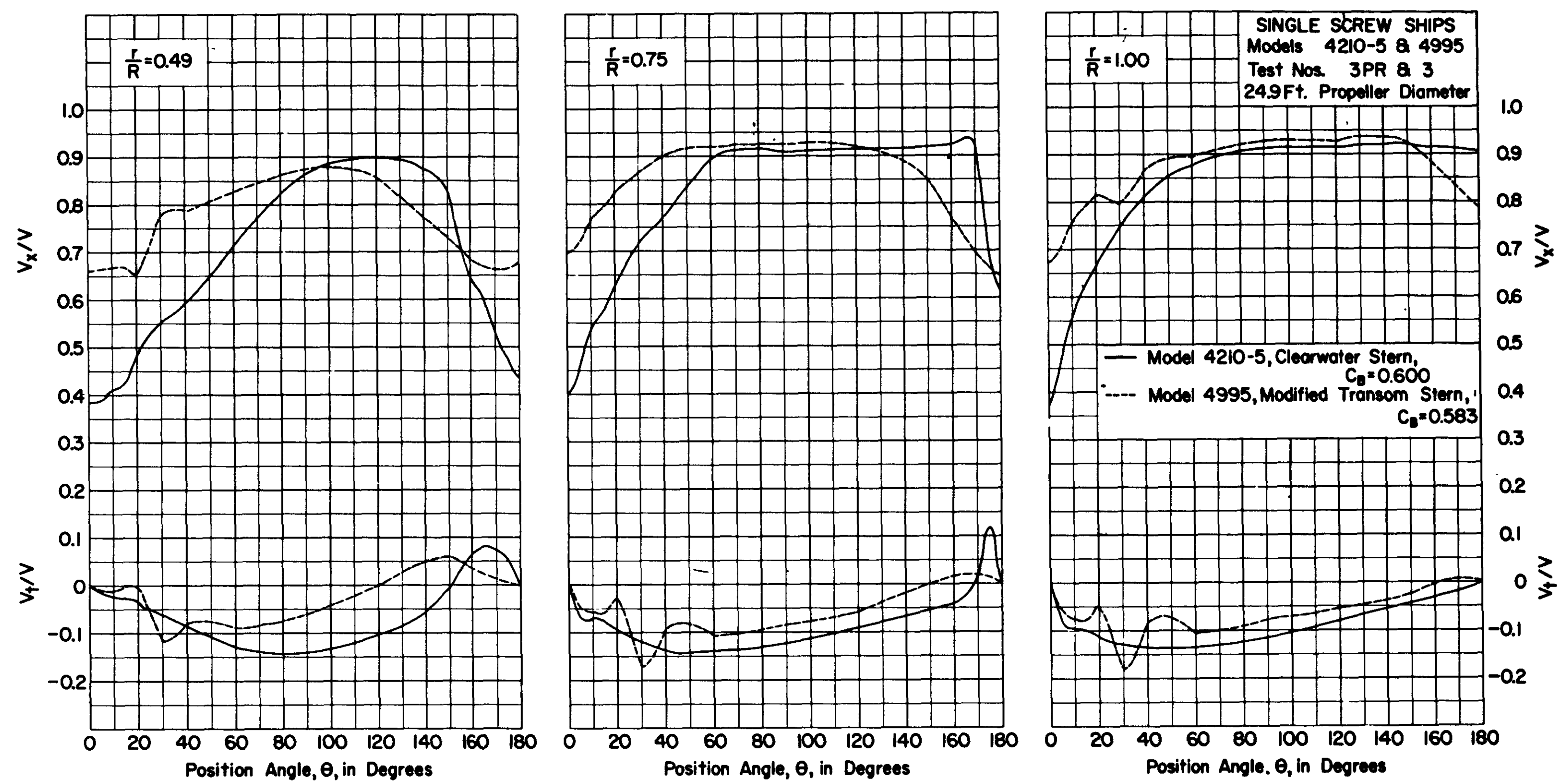


Figure 35 - Circumferential Distributions of Velocity, Conventional Stern versus Modified Transom Stern

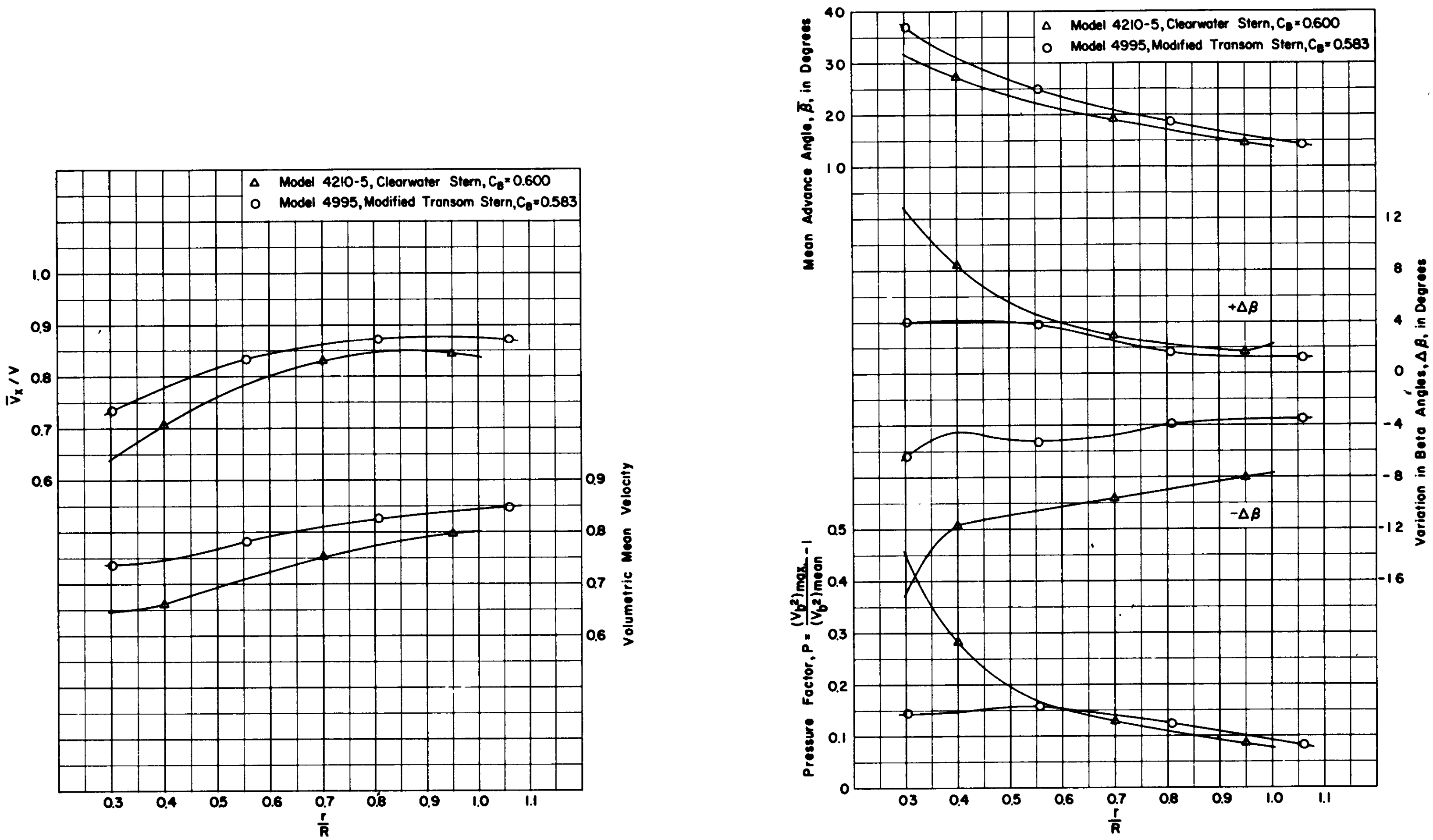


Figure 36 - Mean Longitudinal Velocity ($\bar{V}_x/V$), Volumetric Mean Velocity, Mean Advance Angle ($\bar{\beta}$), Variations in Beta Angle ($\Delta\beta$) and Pressure Factor (P), Conventional Stern versus Modified Transom Stern

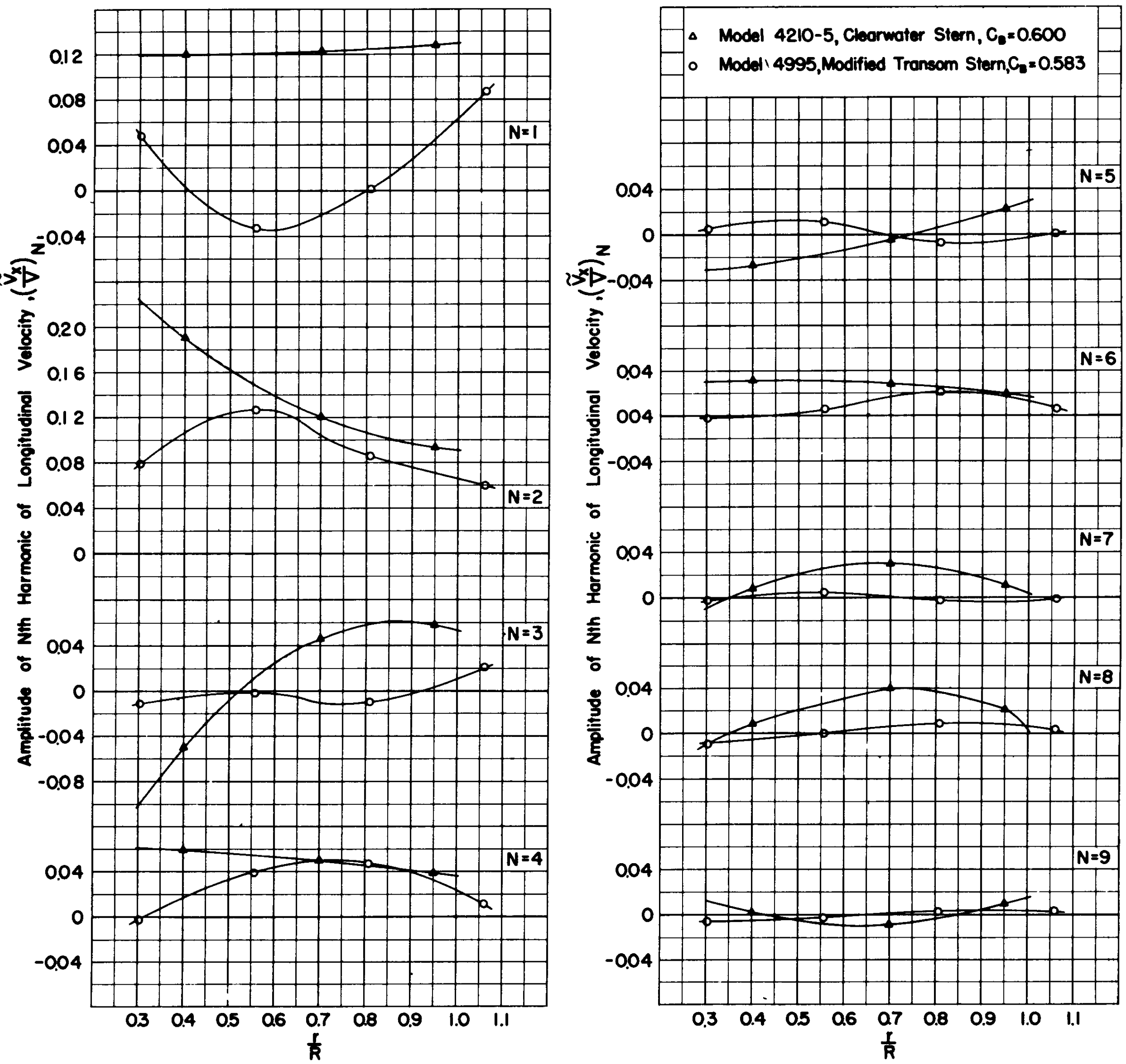


Figure 37 - Amplitudes of Various Harmonics of Longitudinal $(\tilde{V}_x/V)$ Velocity, Conventional Stern versus Modified Transom Stern

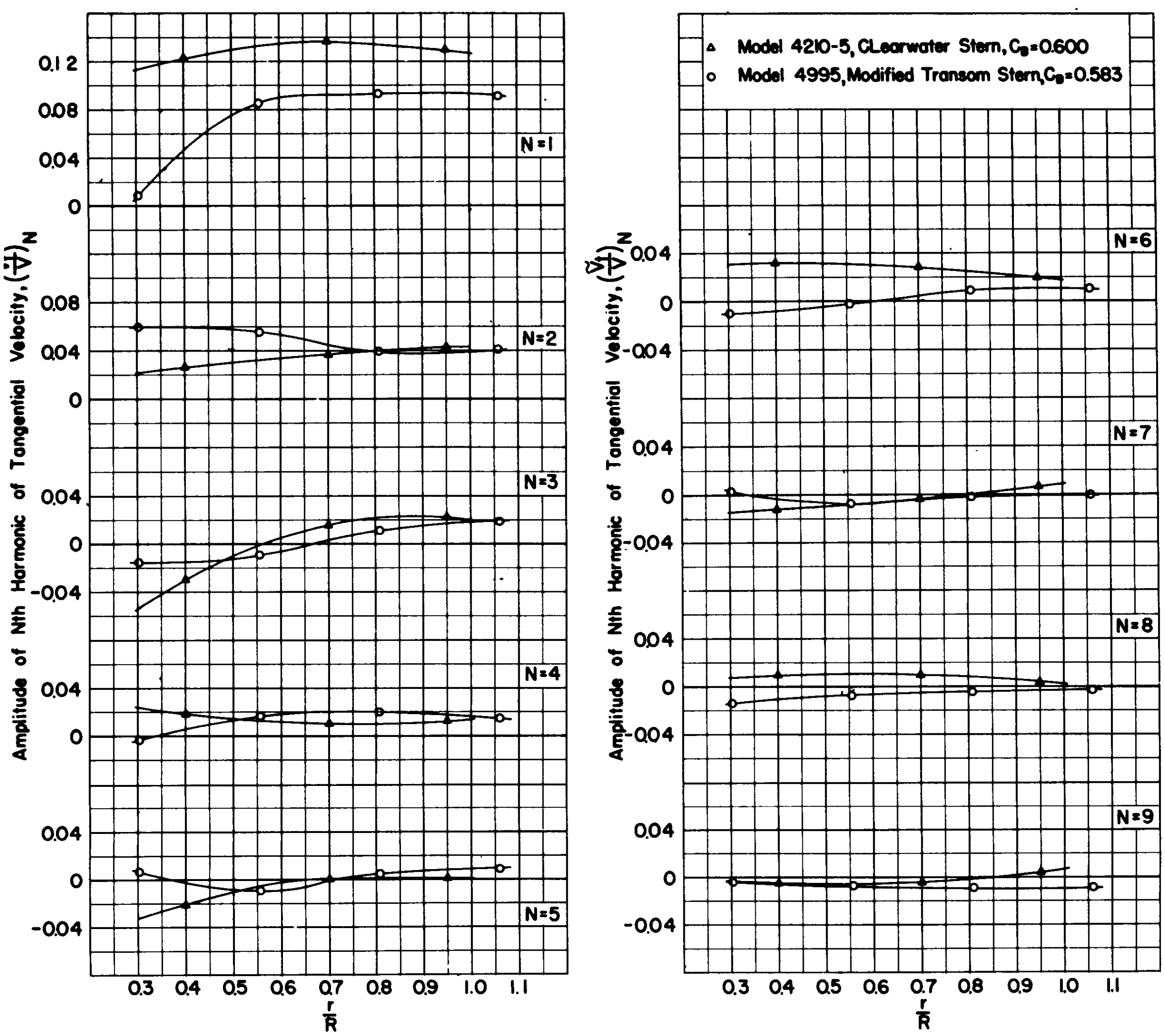


Figure 38 - Amplitudes of Various Harmonics of Tangential $(\tilde{V}_t/V)$ Velocity, Conventional Stern versus Modified Transom Stern

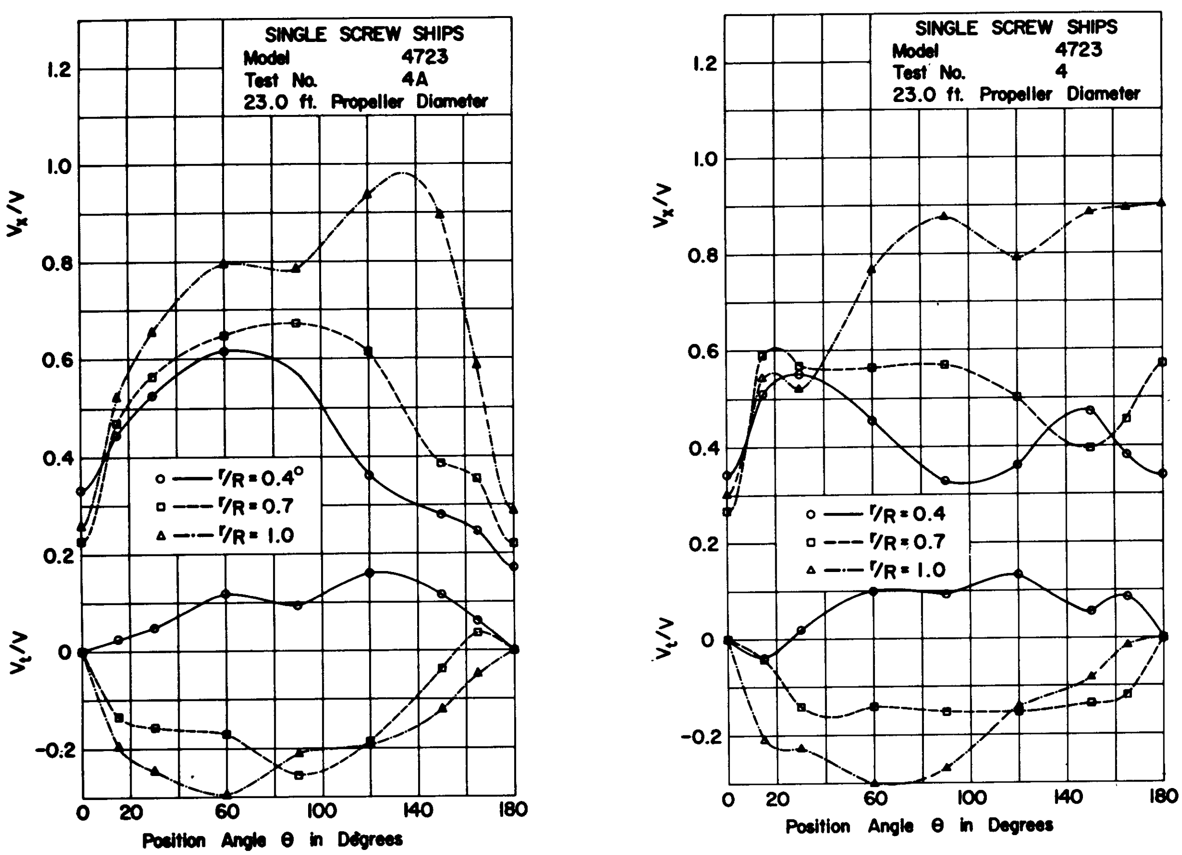


Figure 39 - Comparisons of Velocity Distributions of Model 4723,
Conventional Stern versus Modified Stern

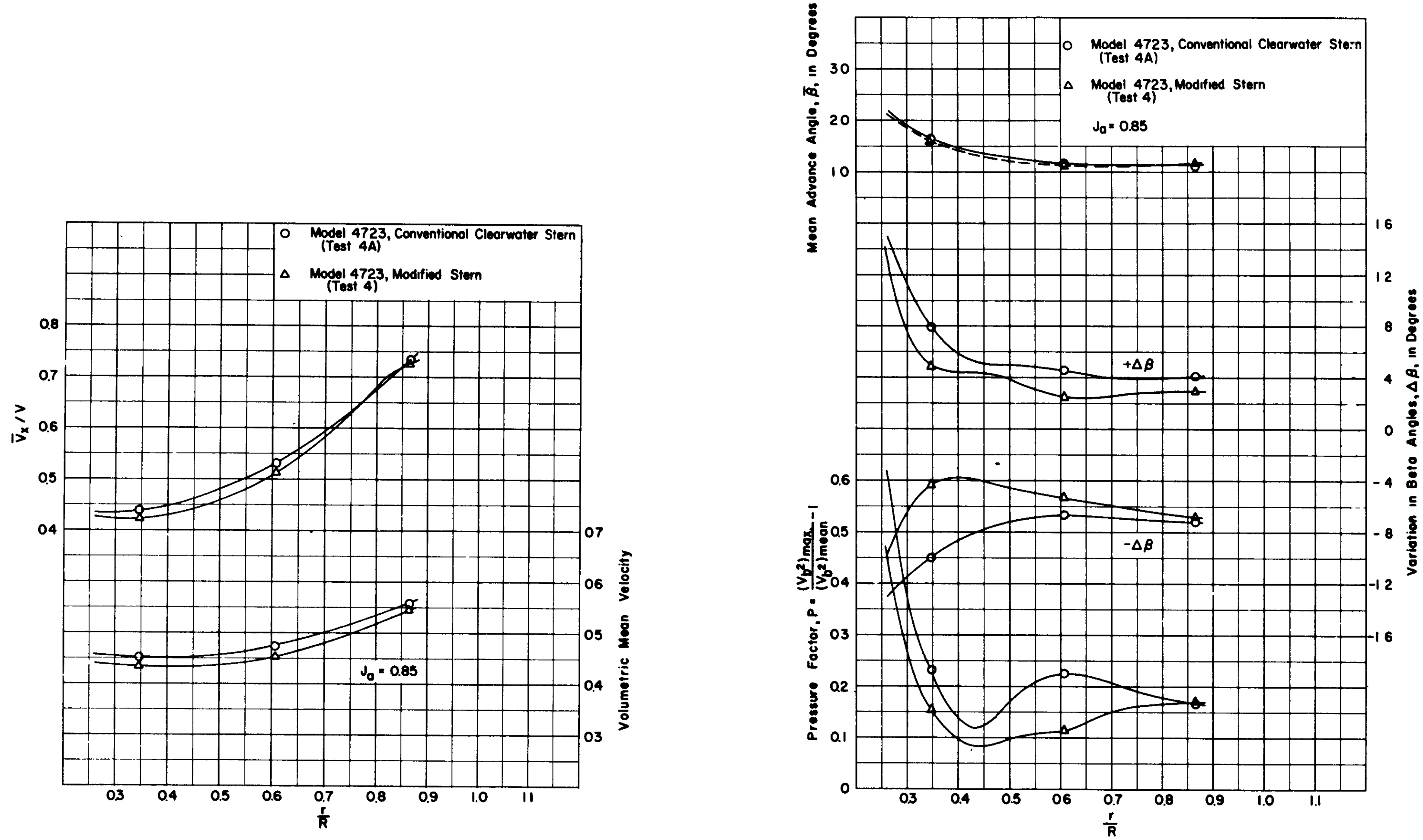


Figure 40 - Mean Longitudinal Velocity ($\bar{V}_x/V$), Volumetric Mean Velocity, Mean Advance Angle ($\bar{\beta}$), Variations in Beta Angles ($\Delta\beta$), and Pressure Factor (P), Model 4723, Conventional Stern versus Modified Stern

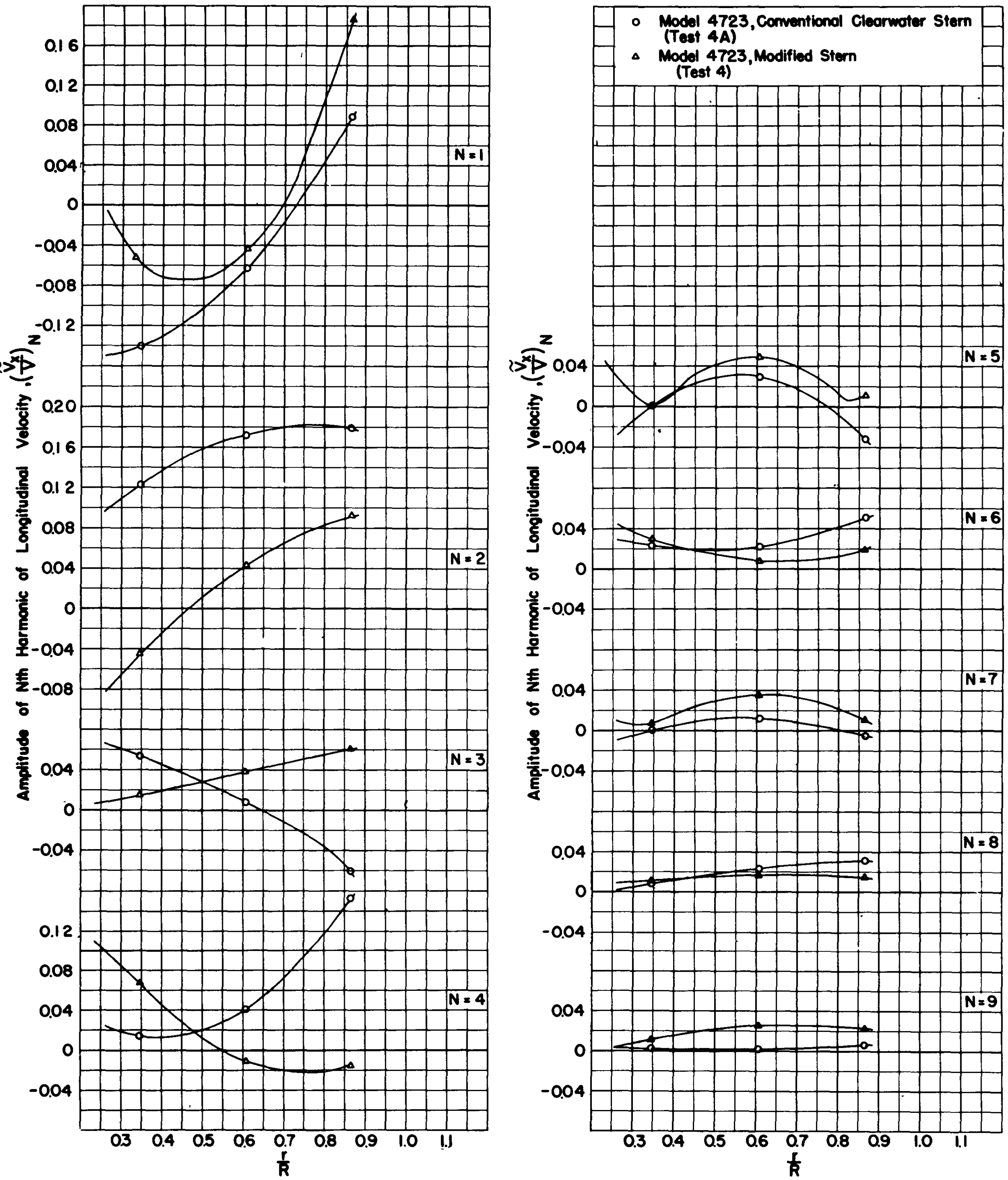


Figure 41 - Amplitudes of Various Harmonics of Longitudinal Velocity ($\tilde{V}_x/V$), Model 4723, Conventional Stern versus Modified Stern

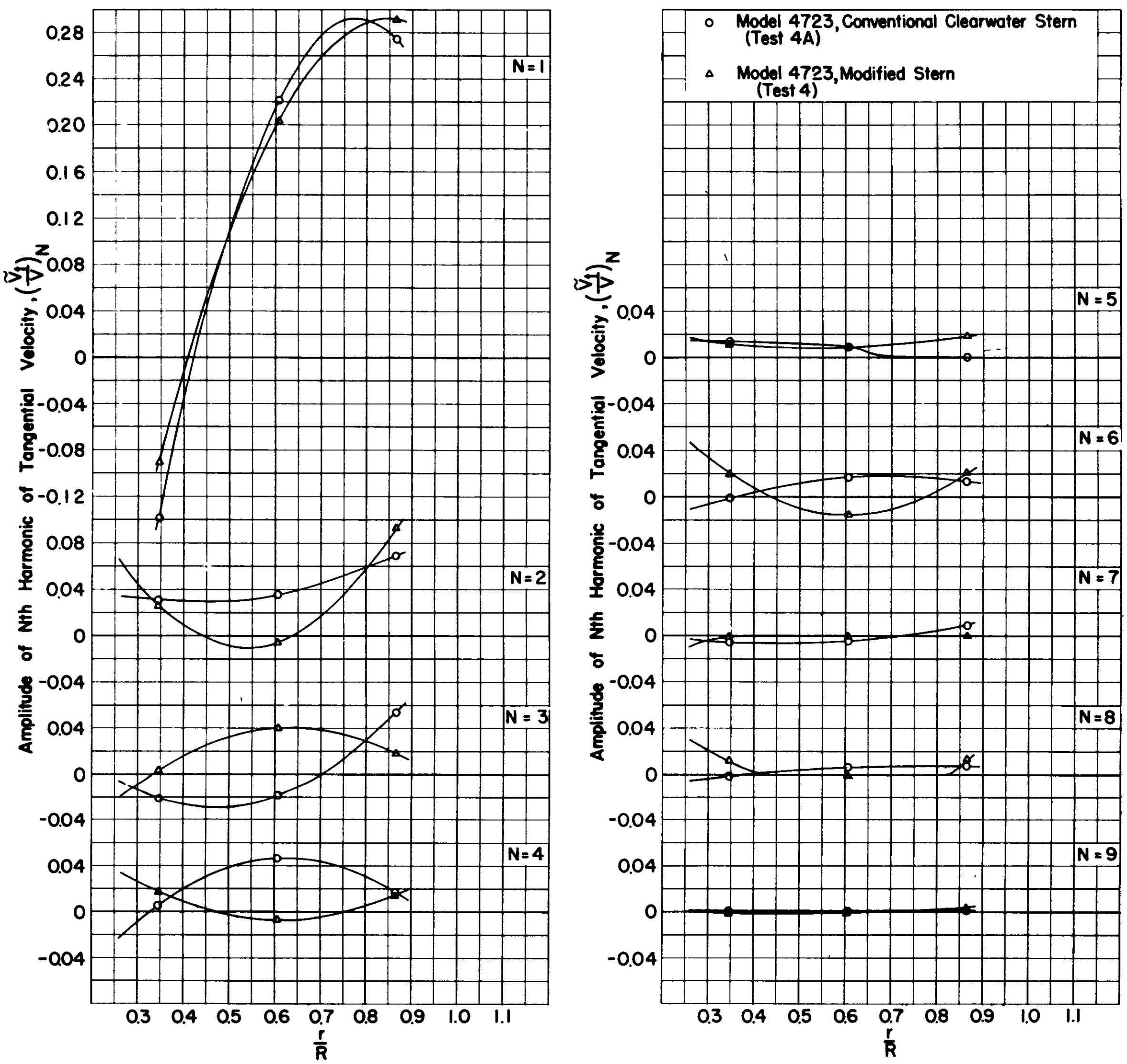


Figure 42 - Amplitudes of Various Harmonics of Tangential Velocity ($\tilde{V}_t/V$), Model 4723, Conventional Stern versus Modified Stern

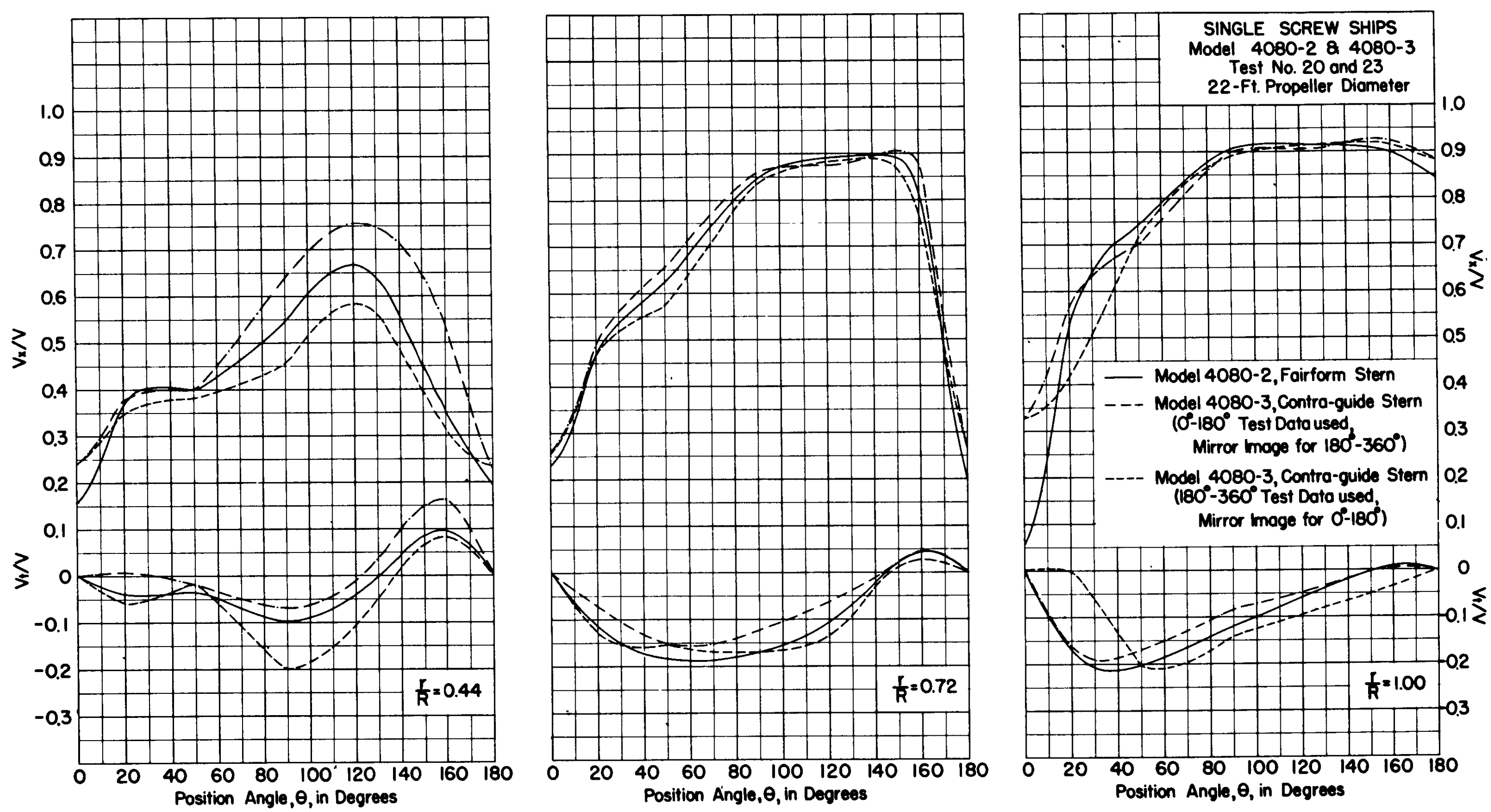
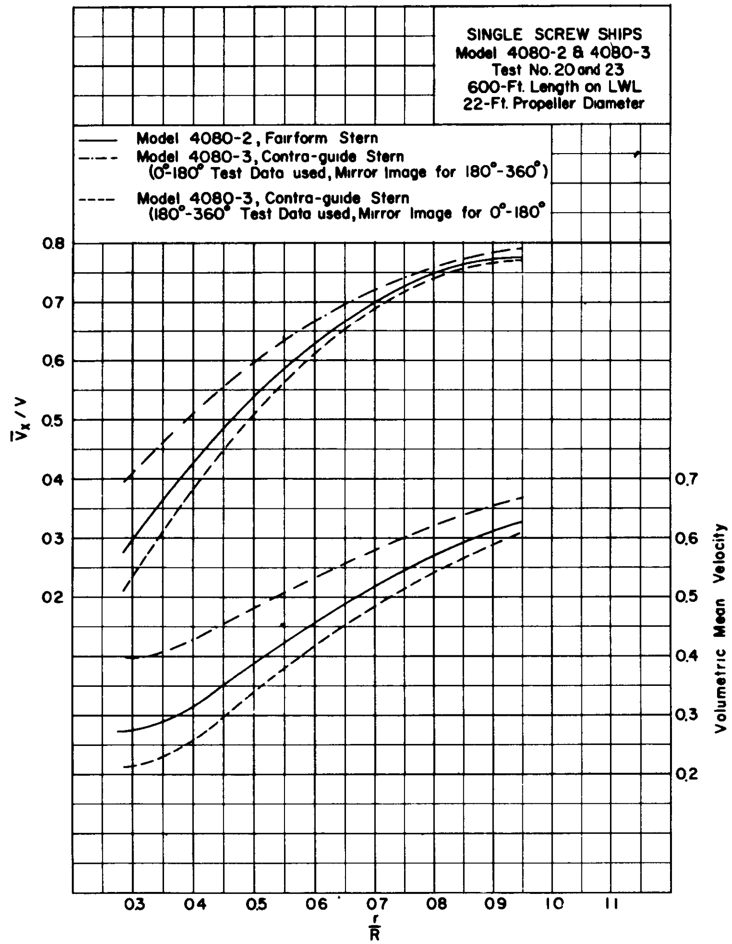


Figure 43 - Circumferential Velocity Distribution, Fair-Form Stern versus Contraguide Stern



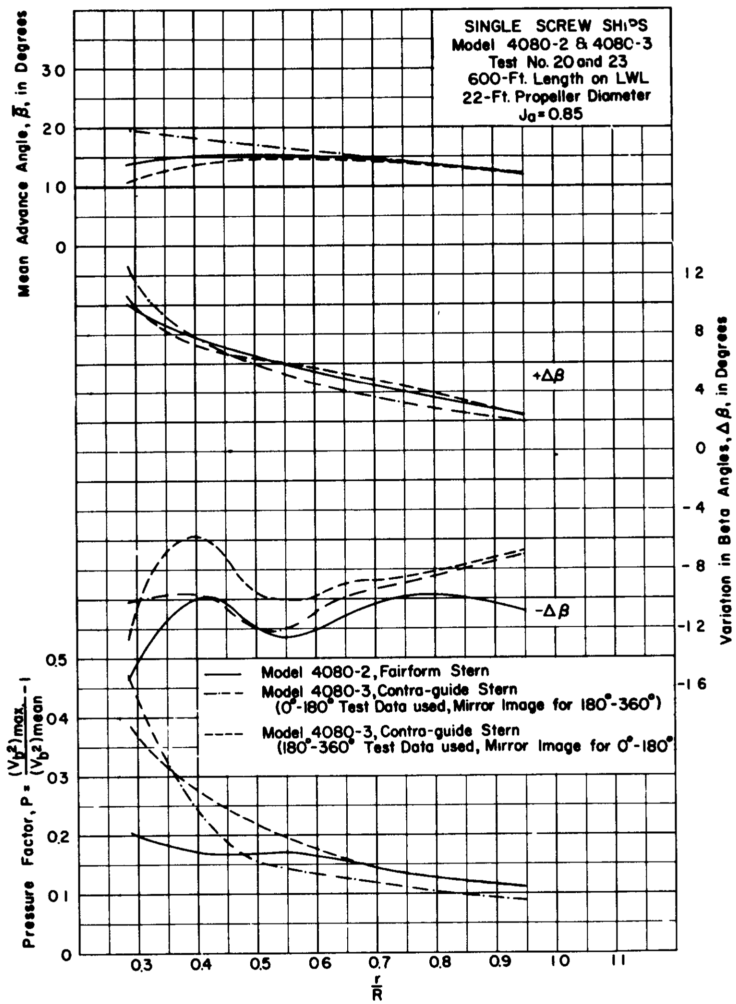


Figure 44 - Mean Longitudinal Velocity ($\bar{V}_x/V$), Volumetric Mean Velocity, Mean Advance Angle ($\bar{\beta}$), Variations in Beta Angles ($\Delta\beta$), and Pressure Factor (P), Fair-Form Stern versus Contraguide Stern

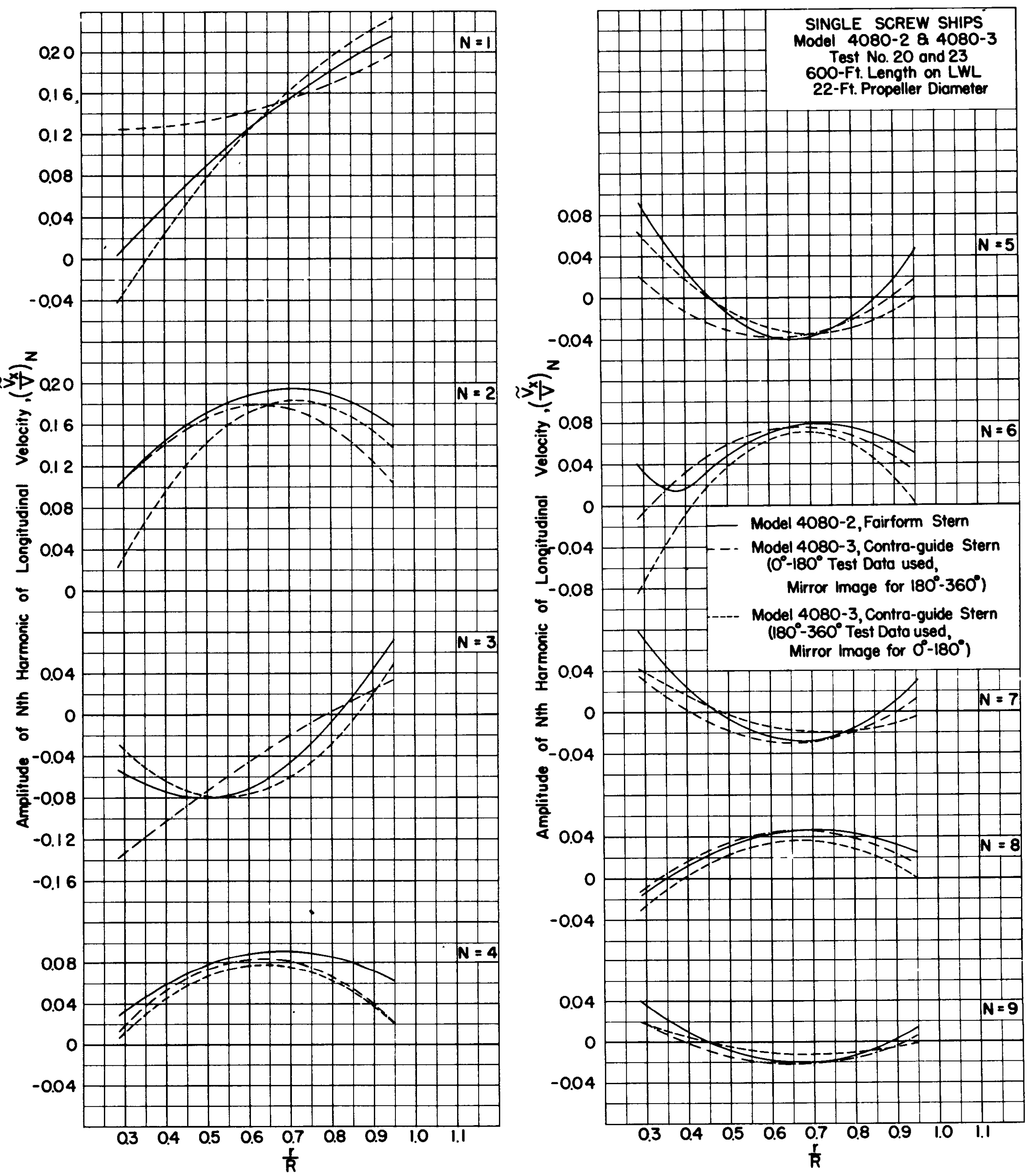


Figure 45 - Amplitudes of Various Harmonics of Longitudinal Velocity $(\tilde{V}_x/V)$, Fair-Form Stern versus Contraguide Stern

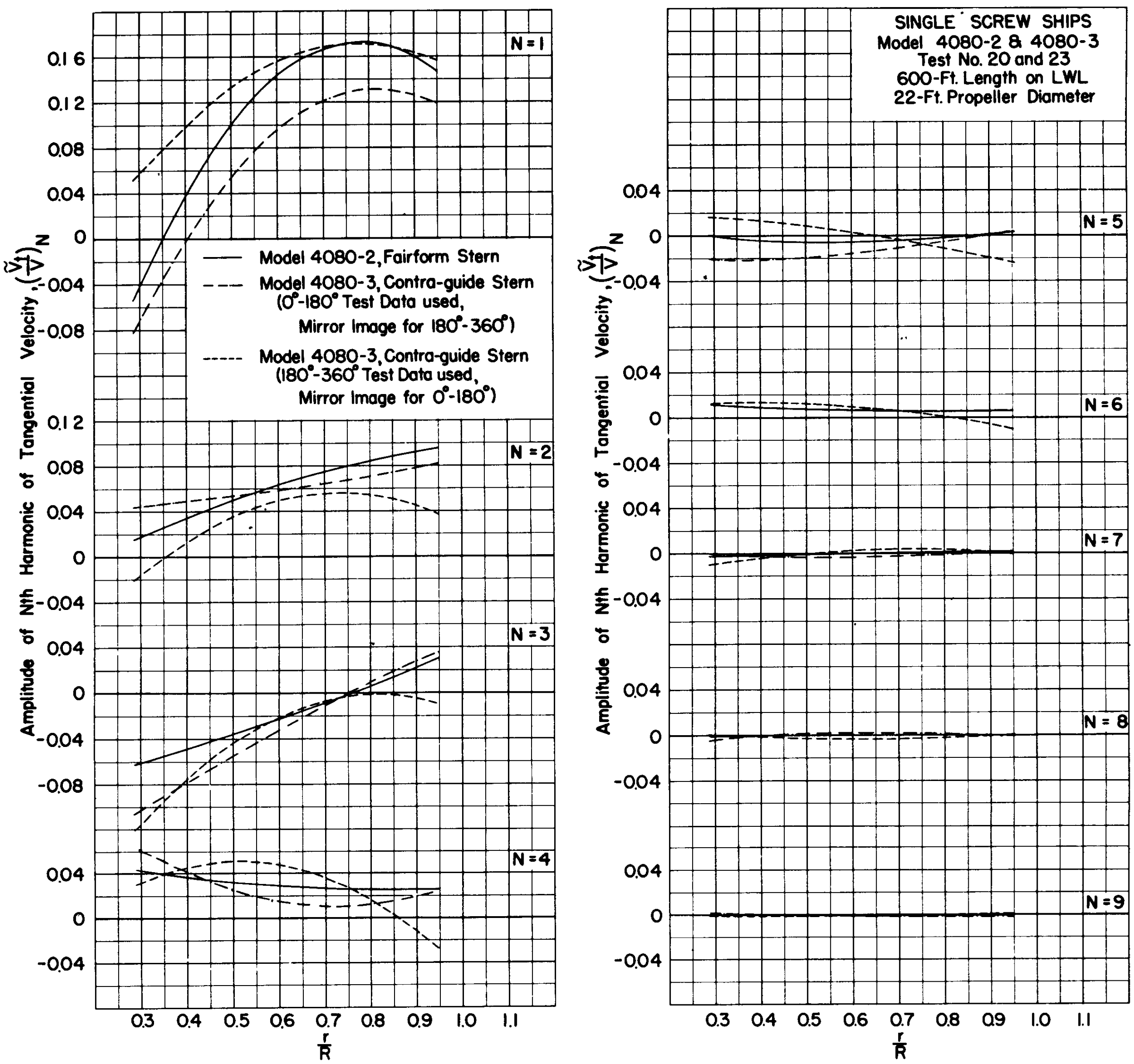


Figure 46 - Amplitudes of Various Harmonics of Tangential Velocity $(\tilde{V}_t/V)$, Fair-Form Stern versus Contraguide Stern

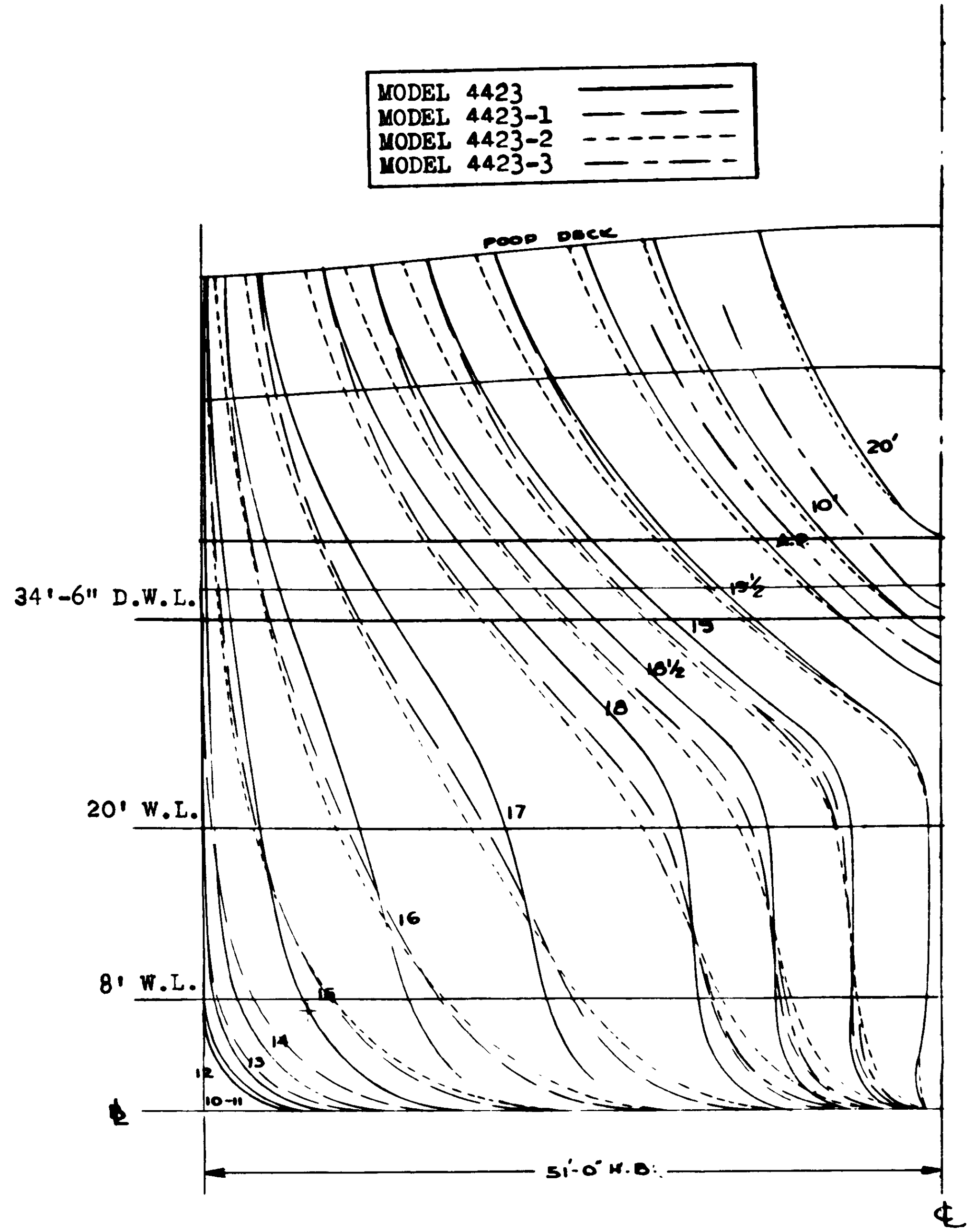


Figure 47 - Comparative Aftbody Plans, Models 4423, 4423-1, and 4423-2

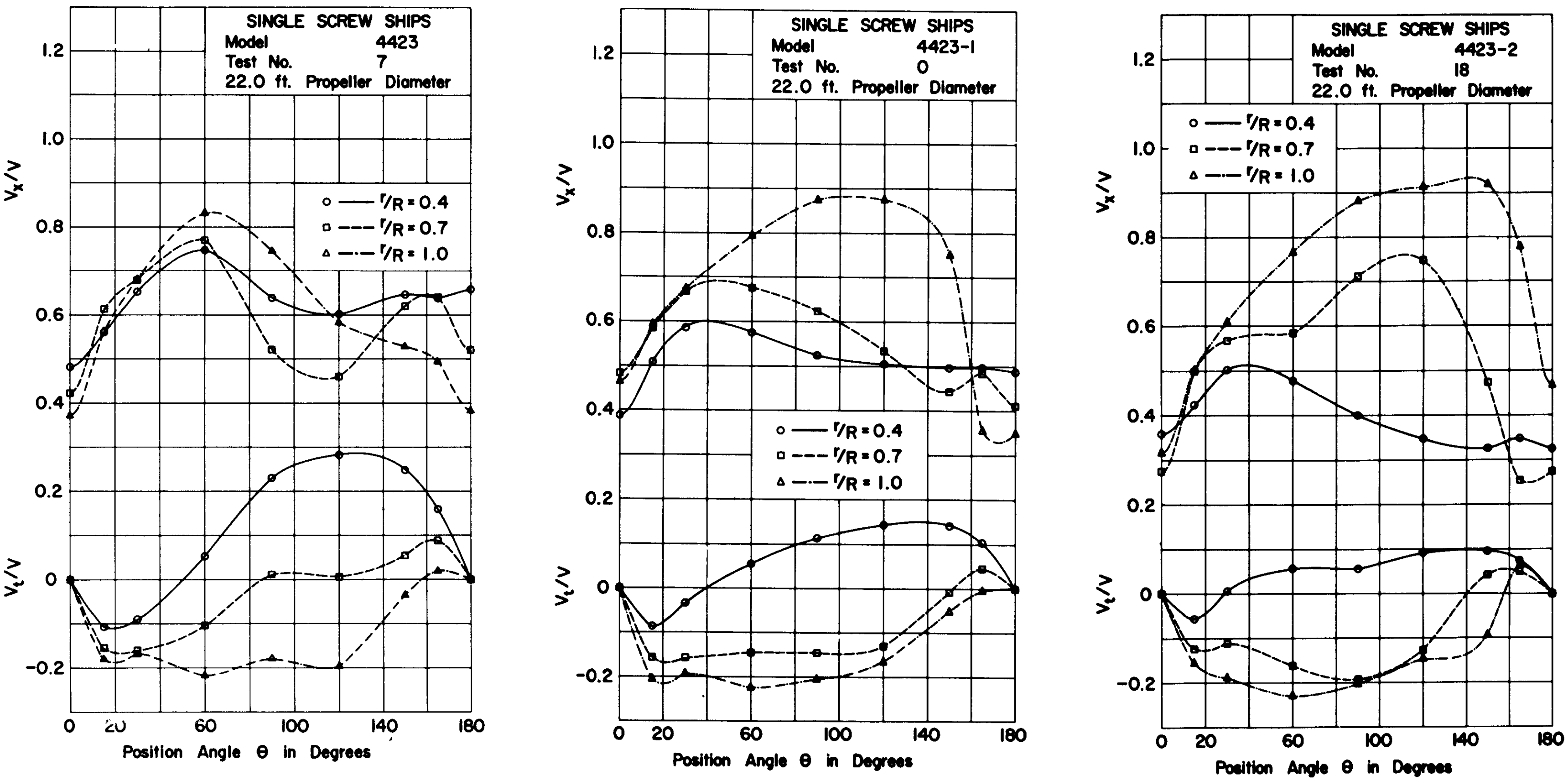


Figure 48 - Circumferential Distributions of Velocities, Models 4423 (U-Shaped), 4423-1 (Moderate U-Shaped) and 4423-2 (Moderate V-Shaped)

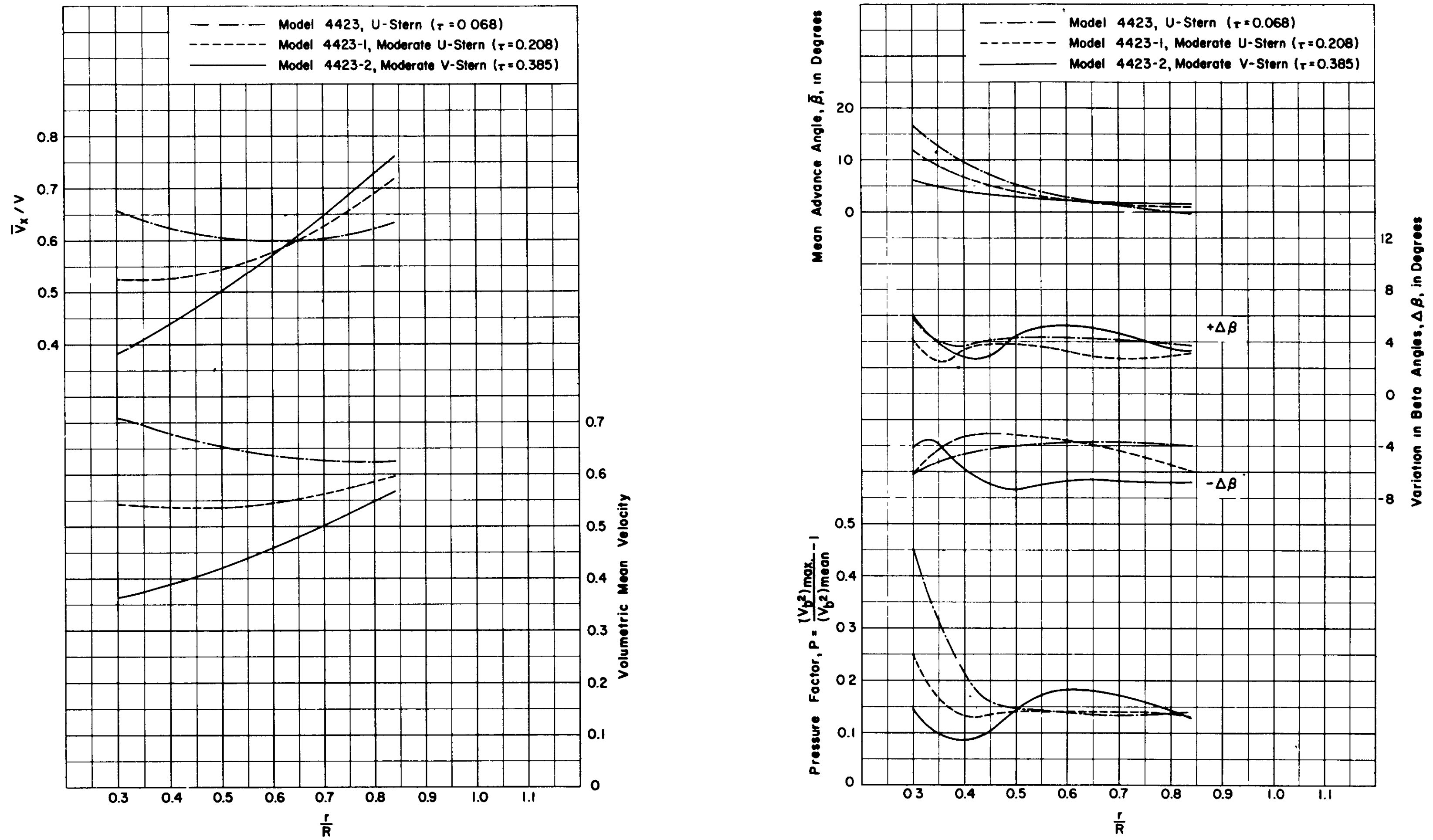


Figure 49 - Comparative $\bar{V}_x/V$, Volumetric Mean Velocity, $\bar{\beta}$, $\Delta\beta'$, and P, U- versus V-Shaped Sterns, C_B = 0.741

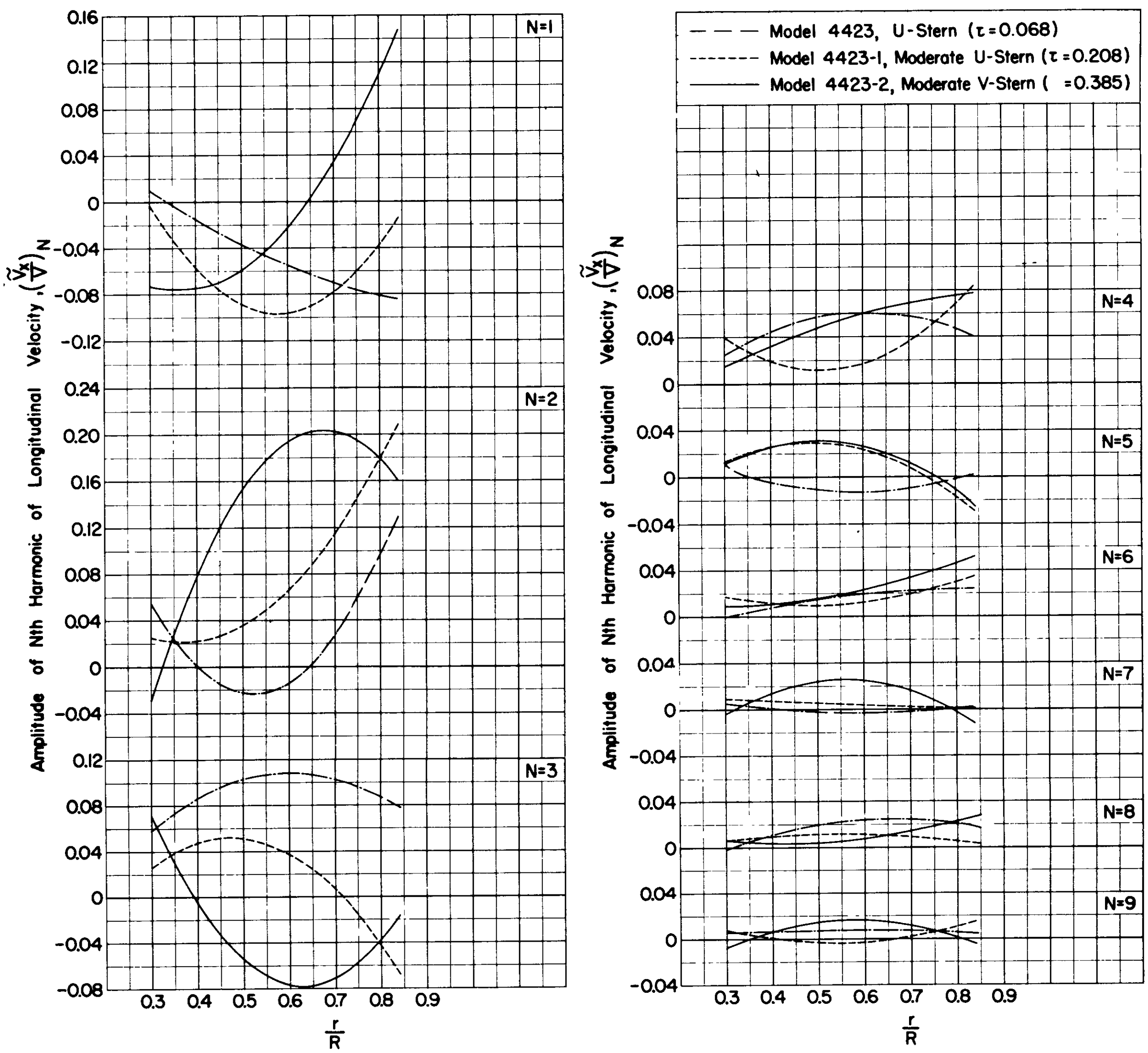


Figure 50 - Comparative $\tilde{V}_x/V$, U- versus V-Shaped Sterns, C_B = 0.741

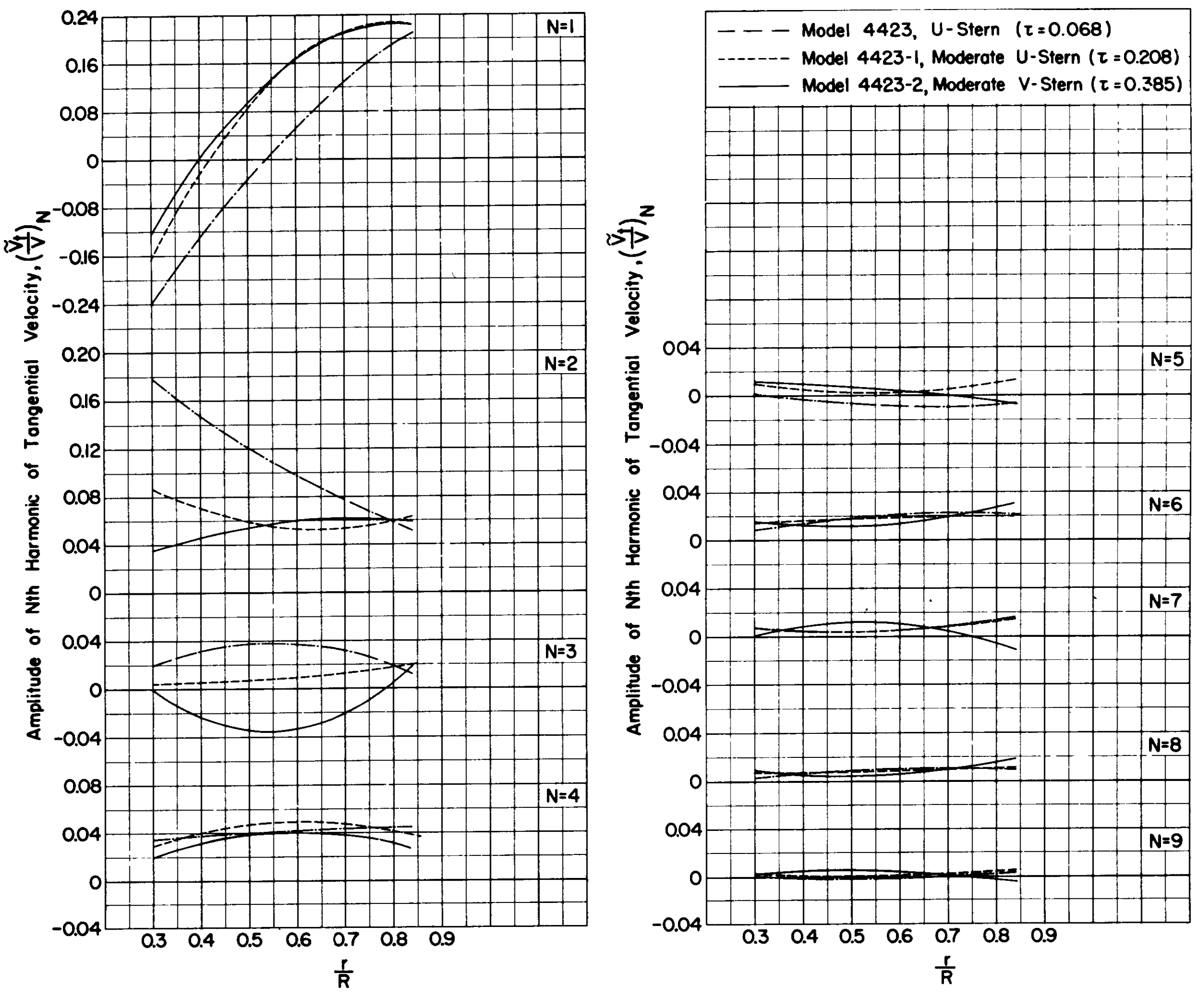


Figure 51 - Comparative $\tilde{V}_t/V$, U- versus V-Shaped Sterns, $C_B = 0.741$

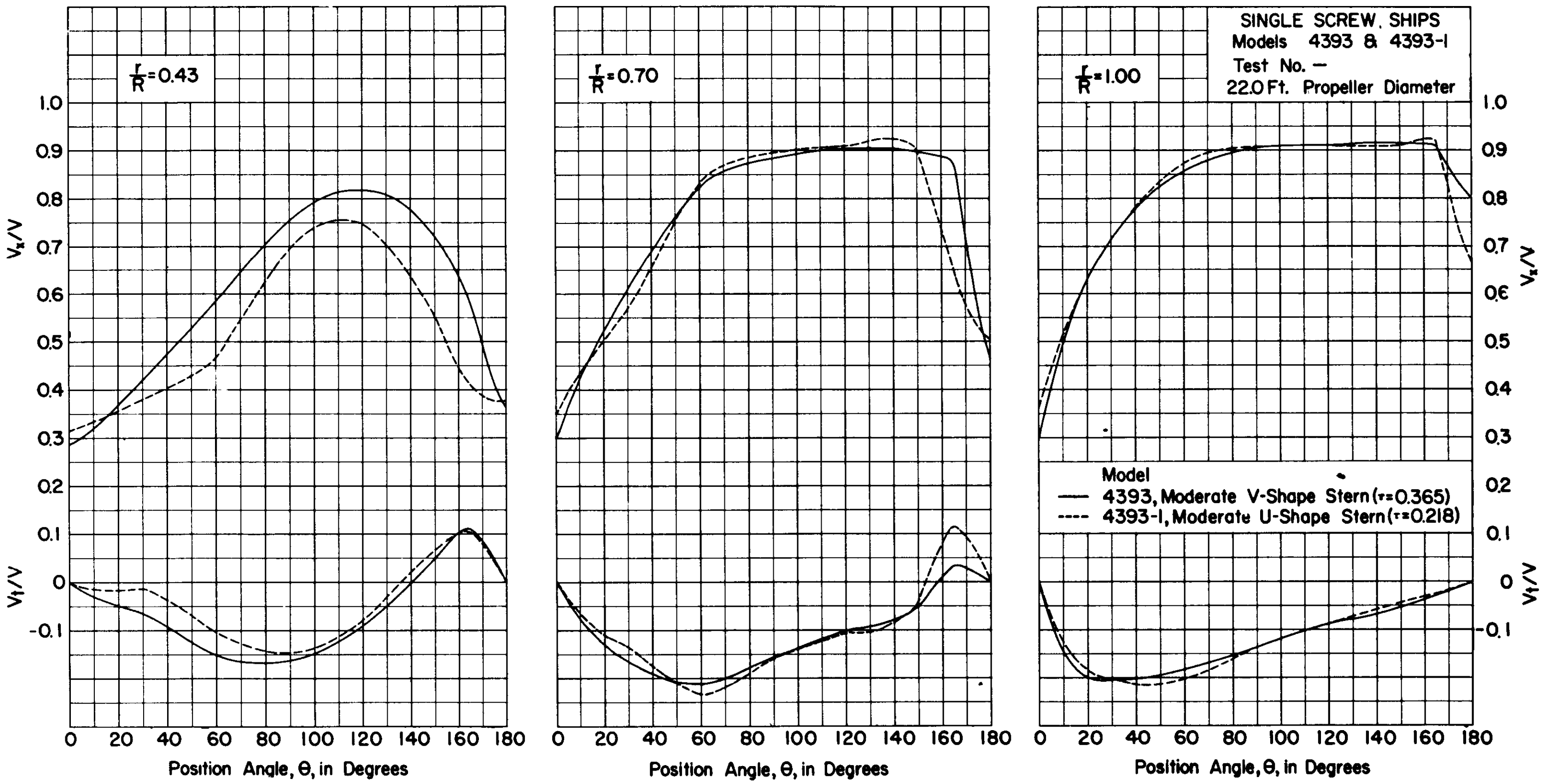


Figure 52 - Comparative Circumferential Distributions of Velocities, Models 4393 (Moderate V-Shaped) and 4393-1 (Moderate U-Shaped), $C_B = 0.645$

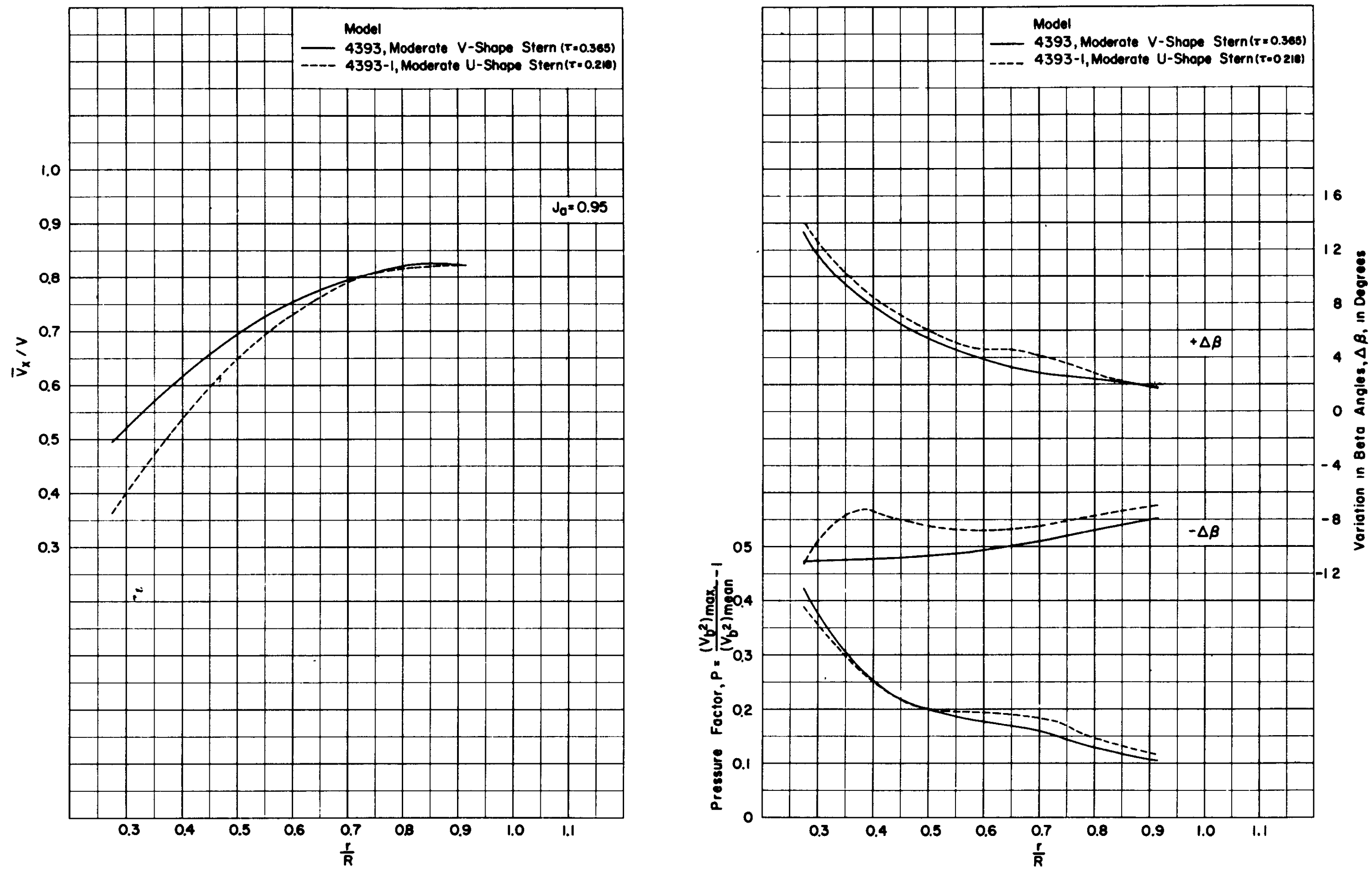


Figure 53 - Comparative $\bar{V}_x/V$, β, Δβ, and P, U- versus V-Shaped Sterns, C_B = 0.645

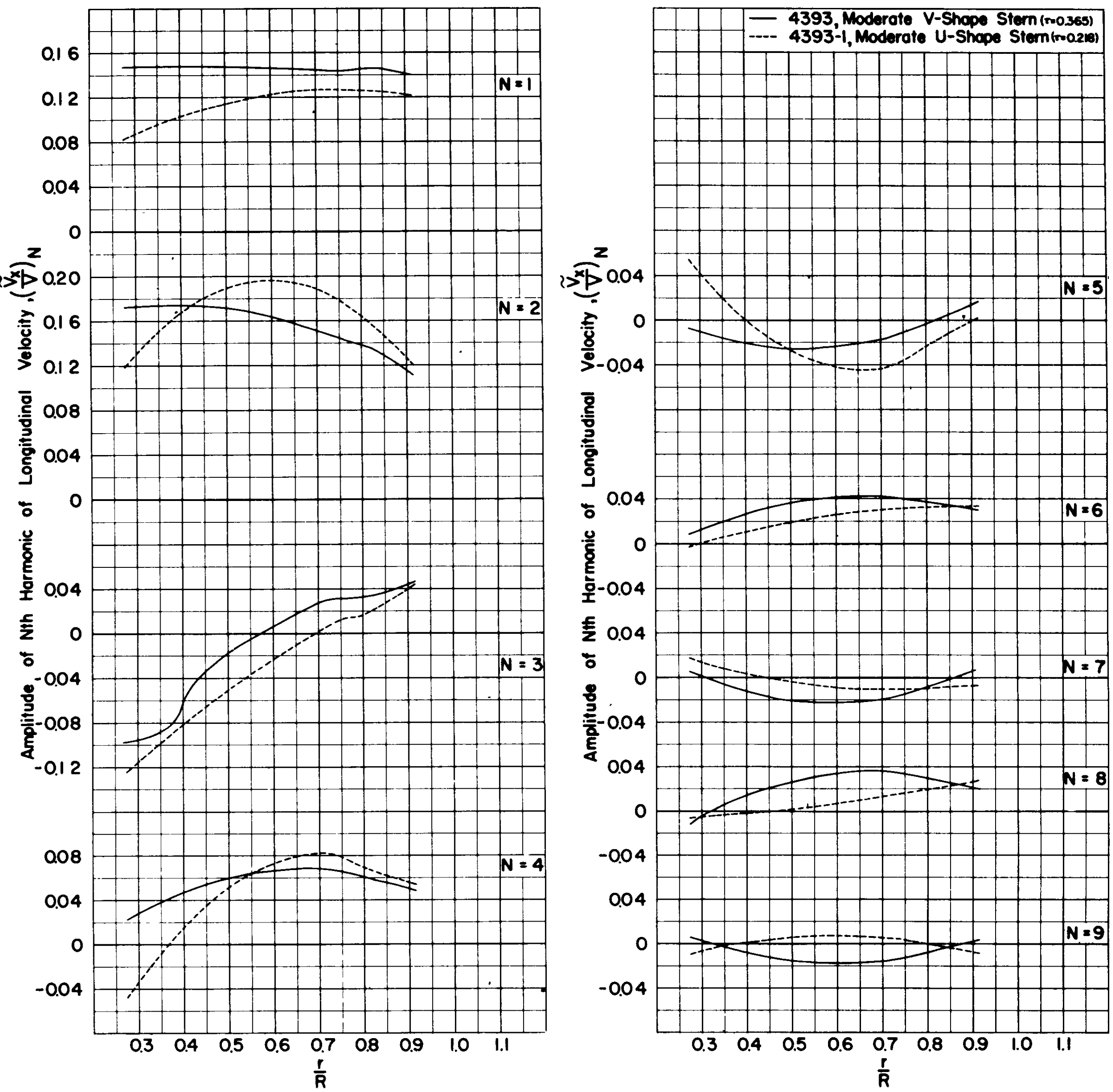


Figure 54 - Comparative $\tilde{V}_x/V$, U- versus V-Shaped Sterns, $C_B = 0.645$

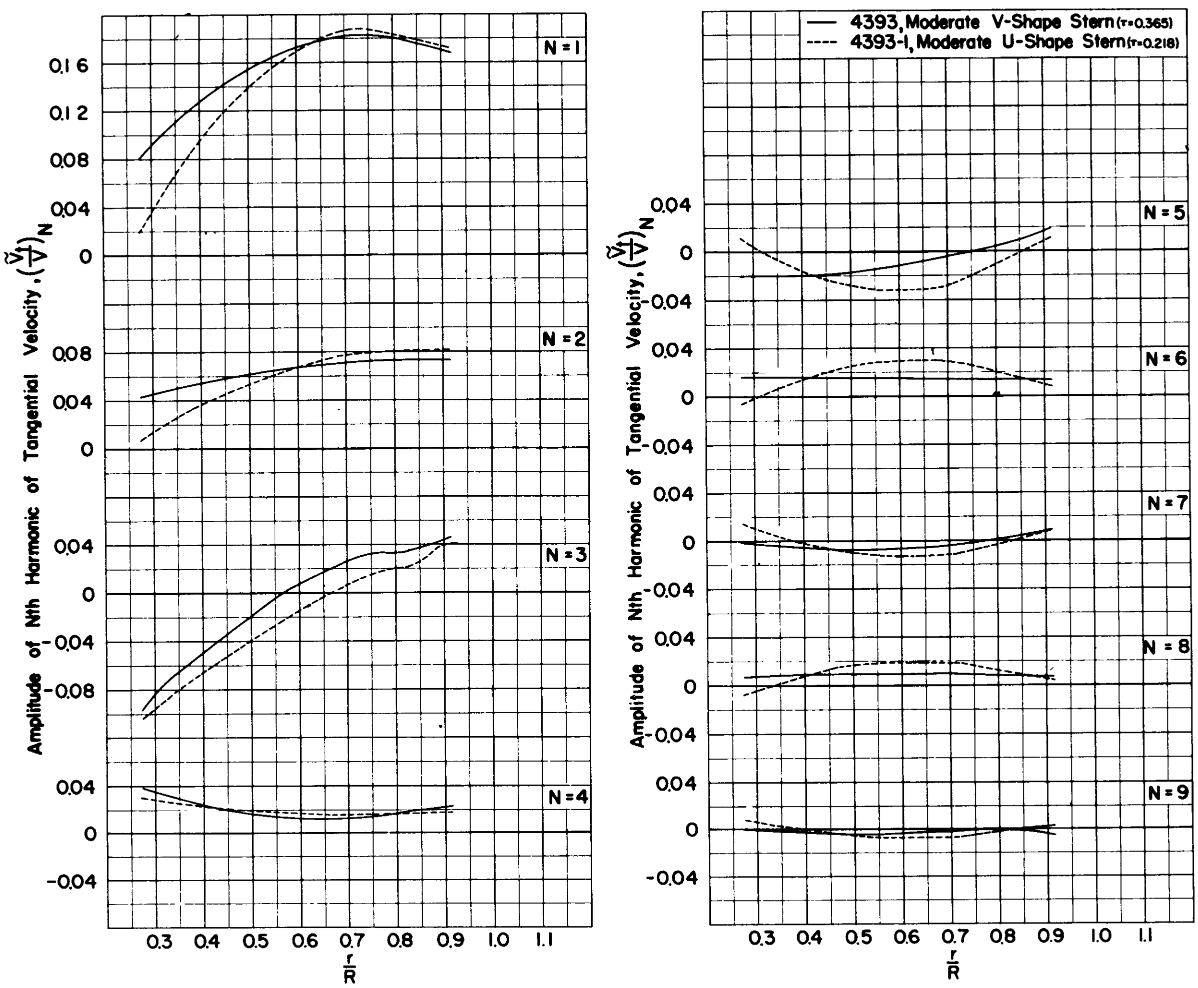


Figure 55 - Comparative $\tilde{V}_t/V$, U- versus V-Shaped Sterns, C_B = 0.645

TABLE I

Model Data (Clearwater Stern)

Service *	C	C	C	C	C	C	C	C	C	C	C	C
Particulars:	Model 4210-5	Model 4358W-2	Model 4648	Model 4671	Model 4710-1	Model 4747	Model 4842	Model 4901	Model 4903	Model 4933	Model 4986	Model 4995**
Length on LWL, L_{WL} Ft	20.37	21.65	19.73	22.72	18.80	21.57	20.76	20.24	18.95	20.50	21.01	20.53
Beam, B Ft	2.67	3.14	2.67	3.23	2.755	3.32	2.93	2.90	2.728	3.01	3.19	2.667
Draft, H Ft	1.07	1.12	1.16	1.22	1.155	1.228	1.11	1.12	0.982	1.15	1.05	1.067
Displacement, FW Ton	0.950	1.283	1.101	1.504	1.057	1.532	1.07	1.11	0.791	1.136	1.04	0.947
Test Velocity, V Kn	4.38	4.07	3.54	4.17	3.62	3.94	4.22	4.27	3.91	3.97	4.54	3.82
$V/\sqrt{L_{WL}}$	0.970	0.874	0.798	0.876	0.836	0.850	0.927	0.95	0.886	0.878	0.990	0.842
Propeller Diameter, D Ft	0.83	0.910	0.872	0.912	0.850	0.910	0.800	0.851	0.800	0.861	0.875	0.830
Advance Coeff., $J_a = V/nD$	0.922	0.962	1.048	--	0.987	0.923	0.97	1.01	1.09	--	0.941	0.967
Ship - Model Scale, λ	30.00	24.175	24.080	24.176	24.682	21.978	25.622	25.857	27.497	25.291	25.702	30.00
LWL Coefficients:												
C_B	0.600	0.607	0.600	0.605	0.636	0.626	0.569	0.548	0.560	0.577	0.532	0.583
C_P	0.615	0.619	0.610	0.62	0.648	0.639	0.577	0.559	0.571	0.586	0.553	0.597
C_X	0.977	0.981	0.986	0.969	0.982	0.980	0.985	0.981	0.981	0.986	0.962	0.977
C_{PA}	--	0.65	0.63	0.63	0.64	0.65	0.60	0.57	0.57	0.58	0.56	0.60
C_{PVA}	--	0.81	0.81	0.78	0.81	0.81	0.73	0.76	0.78	0.75	0.74	0.68
L_R/L_{WL}	0.50	0.50	0.50	0.51	0.469	0.504	0.50	0.49	0.50	0.51	0.492	0.50
L_{WL}/B	7.49	6.88	6.88	7.04	6.824	6.49	7.09	6.98	6.95	6.82	6.59	7.71
B/H	2.50	2.82	2.46	2.64	2.386	2.70	2.63	2.42	2.78	2.62	3.04	2.50
$\Delta_{SW}/(0.01\ L_{WL})^3$	122.0	130.1	147.5	131.9	164.0	157.0	122.8	138.1	119.5	135.7	115.6	112.5

Service *	N	N	N	T	T	T	T	T	T	T	T	T	T
Particulars:	Model 4521	Model 4831	Model 5000	Model 4393	Model 4494	Model 4557	Model 4602	Model 4635	Model 4643	Model 4709	Model 4723	Model 4890	Model 4971
Length on LWL, L_{WL} Ft	19.28	19.98	18.38	20.0	22.40	22.476	20.320	22.903	24.490	24.350	26.33	26.32	25.07
Beam, B Ft	2.88	2.97	2.680	2.667	3.150	3.078	2.720	3.214	3.250	3 010	3.696	3.597	3.52
Draft, H Ft	1.06	0.97	0.938	1.069	1.310	1.165	1.070	1.143	1.300	1.260	1.365	1.35	1.31
Displacement, FW Ton	0.966	0.912	0.652	1.022	1.90	1.64	1.21	1.76	2.27	2.03	2.85	2.812	2.511
Test Velocity, V Kn	4.25	3.88	4.11	3.65	3.51	3.46	3.13	3.31	3.18	2.77	3.33	3.16	3.15
$V/\sqrt{L_{WL}}$	0.954	0.869	0.959	0.818	0.742	0.729	0.694	0.691	0.643	0.561	0.649	0.615	0.628
Propeller Diameter, D Ft	0.860	0.755	0.748	0.733	0.852	·0.811	0.671	0.786	0.562	0.666	0.833	0.811	0.641
Advance Coeff., $J_a = V/nD$	0.908	0.908	0.995	0.886	0.733	0.775	0.807	0.820	0.718	0.698	0.594	0.735	0.666
Ship - Model Scale, λ	--	--	--	30.00	23.46	27.124	34.25	28.00	32.00	34.5	27.6	28.357	37.5
LWL Coefficients:													
C_B	0.590	0.566	0.507	0.645	0.715	0.730	0.740	0.746	0.780	0.791	0.773	0.792	0.782
C_P	0.610	0.610	0.527	0.656	0.723	0.740	0.740	0.765	0.790	0.795	0.781	0.795	0.785
C_X	0.966	0.928	0.963	0.982	0.989	0.993	0.989	0.985	0.994	0.994	0.989	0.995	0.996
C_{PA}	0.62	0.62	0.55	0.674	--	0.700	0.700	0.700	0.740	0.730	--	0.730	0.730
C_{PVA}	0.79	0.73	0.75	--	--	0.870	0.860	0.870	0.870	0.870	--	0.860	0.85
L_R/L_{WL}	0.50	0.50	0.49	0.50	--	0.46	0.44	0.41	0.40	0.37	--	0.43	0.37
L_{WL}/B	6.69	6.71	6.86	7.50	7.12	7.30	7.48	7.13	7.53	8.08	7.13	7.32	7.12
B/H	2.72	3.07	2.86	2.49	2.41	2.64	2.54	2.81	2.49	2.39	2.71	2.66	2.69
$\Delta_{SW}/(0.01\ L_{WL})^3$	139.0	117.6	108.1	131.4	168.2	148.7	147.8	150.8	158.8	144.9	160.7	158.6	163.9

* C - Cargo, T - Tanker, N - Naval Auxiliary

**Modified Transom with extended shaft

TABLE 2

Model Data (Stern with Rudder Shoe)

Service *		C	C	C	C	T	T	T	T	T	T	N
Particulars:		Model 3717	Model 3801	Model 4144	Model 4730	Model 3867	Model 4057	Model 4080-2	Model 4080-3	Model 4121-1	Model 4423-2	Model 4914
Length on LWL, L_{WL}	Ft	20.035	20.00	21.841	19.86	25.65	21.92	21.00	21.00	24.377	25.666	18.55
Beam, B	Ft	2.86	2.787	3.144	2.80	3.40	3.028	2.763	2.763	3.256	3.677	3.36
Draft, H	Ft	1.203	1.262	1.117	1.12	1.413	1.19	1.067	1.067	1.298	1.244	1.05
Displacement, FW	Ton	1.244	1.312**	1.281	1.04	2.46	1.65	1.20	1.20	2.166	2.416	0.86
Test Velocity, V	Kn	3.40	3.81	4.07***	3.60	3.51	3.13	3.38	3.38	3.00	3.18	3.97
$V/\sqrt{L_{WL}}$		0.760	0.850	0.870	0.808	0.694	0.669	0.737	0.737	0.607	0.628	0.921
Propeller Diameter, D	Ft	0.853	0.922	0.910	0.862	0.975	0.792	0.733	0.733	0.591	0.792	0.700
Advance Coeff., $J_a = V/nD$		0.958	1.104	0.962	0.943	0.859	0.781	0.911	0.897	0.760	0.726	0.840
Ship - Model Scale, λ		25.00	22.25	24.175	24.983	20.00	27.74	30.00	30.00	25.80	27.74	--
LWL Coefficients:												
C_B		0.647	0.669	0.600	0.602	0.722	0.748	0.699	0.699	0.755	0.741	0.472
C_P		0.658	0.678	0.612	0.612	0.740	0.754	0.711	0.711	0.760	0.746	0.567
C_X		0.982	0.987	0.981	0.983	0.976	0.993	0.983	0.983	0.994	0.993	0.833
C_{PA}		0.637	0.663	0.629	0.61	--	0.698	--	--	0.712	0.694	0.57
C_{PVA}		--	--	--	0.80	--	0.856	--	--	--	--	0.60
L_R/L_{WL}		0.483	0.45	0.50	0.51	--	0.413	--	--	--	0.46	0.49
L_{WL}/B		7.00	7.18	6.95	7.09	7.54	7.24	7.59	7.59	7.49	6.98	5.52
B/H		2.38	2.21	2.81	2.50	2.41	2.55	2.59	2.59	2.51	2.96	3.20
$\Delta_{SW}/(0.01\ L_{WL})^3$		158.4	168.0	126.4	136.9	150.4	160.6	133.4	133.4	153.7	147.1	138.6
Type of Stern		Contra-guide	Contra-guide	--	--	--	--	--	Contra-guide	--	--	--

* C - Cargo, T - Tanker, N - Naval Auxiliary

** Two Displacements Tested

***Three Speeds Tested

TABLE 3

Model Data (Transom Stern with Skeg and Struts, and Special Sterns)

Service *		N	N	C	C
Particulars:		Model 4912	Model 5004	Model 4882	Model 4883
Length on LWL, L_{WL}	Ft	22.96	21.15	18.82	18.82
Beam, B	Ft	3.15	2.99	2.829	2.829
Draft, H	Ft	0.889	0.948	0.978	0.939
Displacement, FW	Ton	1.075	0.872	0.772	0.768
Test Velocity, V	Kn	3.46	3.82	4.30	4.30
$V/\sqrt{L_{WL}}$		0.723	0.969	0.99	0.99
Propeller Diameter, D	Ft	0.666	0.739	0.732	0.732
Advance Coeff., $J_a = V/nD$		0.779	0.969	0.889	0.923
Ship - Model Scale, λ		--	--	28.636	28.636
LWL Coefficients:					
C_B		0.602	0.523	0.534	0.553
C_P		0.628	0.579	0.551	0.571
C_X		0.958	0.904	0.969	0.968
C_{PA}		0.65	0.61	0.54	0.58
C_{PVA}		0.72	0.67	0.58	0.68
L_R/L_{WL}		0.49	0.475	0.51	0.51
L_{WL}/B		7.29	7.07	6.65	6.65
B/H		3.54	3.15	2.89	3.01
$\Delta_{SW}/(0.01\ L_{WL})^3$		91.3	94.82	119.0	118.0
Type of Stern		℄ Skeg - strut	℄ Skeg - struts	Skeg with struts	Hogner

* C - Cargo, T - Tanker, N - Naval Auxiliary

APPENDIX

MODEL TEST DATA

Stern Type	Block Coeff.	Section Shape	Model	Page
Conventional	$C_B < 0.6$	Moderate U	4914	80
			4521	81
			4903	82
			4933	83
			4986	84
			5000	85
		Moderate V	4831	86
Conventional	$0.6 < C_B < 0.7$	Moderate U	3717	87
			3801	88
			4648	90
			4710-1	91
			4747	92
		Moderate V	4671	93
			4730	94
			4358W-1	95
			4358W-2	96
			4358W-3	97
Conventional	$0.7 < C_B < 0.8$	U	4423	98
		Moderate U	4635	99
			4557	100
			4423-1	101
		Moderate V	4080-2	102
			4602	103
			4709	104
		V	3867	105
			4057	106
			4723	107
			4643	108
Open			4912	109
			5004	110
Special			4882	111

VELOCITY SURVEY IN WAY OF THE PROPELLER AGS MODEL 4914	
MODEL DIMENSIONS	
LENGTH (LWL)	18.55 FT
BEAM	3 36 FT
DRAFT	1 05 FT
DISPLACEMENT	0 860 TONS F W.
PROPELLER DIAMETER	0.700 FT
SPEED	3.97 KT
TEST 7 MAY 1962	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE 4.0 FT FWD OF THE A.P.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

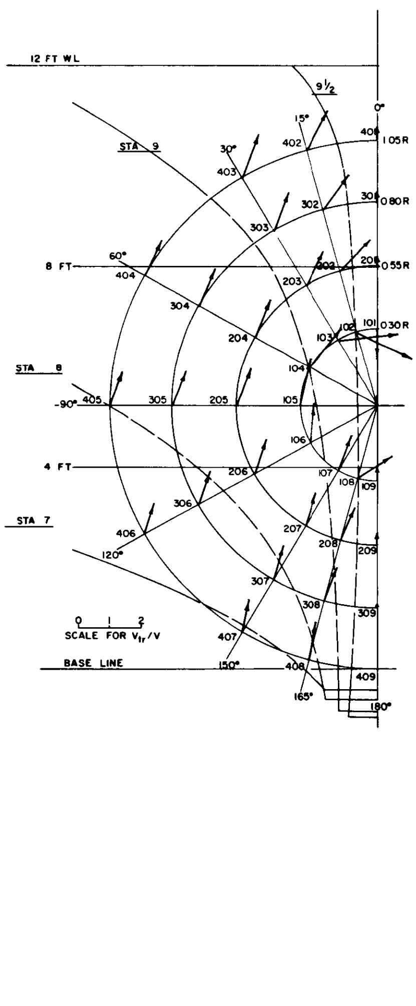


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 584	0	0 112
102	0 692	-0 160	0 120
103	0 867	-0 174	0 074
104	0 961	-0 164	0 017
105	0 969	-0 157	0 038
106	0 960	-0 107	0 078
107	0 934	0 016	0 119
108	0 844	0 082	0 098
109	0 718	0	0 064
201	0 612	0	-0 026
202	0 847	-0 120	-0 075
203	0 927	-0 106	-0 075
204	0 933	-0 132	-0 020
205	0 938	-0 123	0 044
206	0 947	-0 063	0 090
207	0 940	-0.028	0 112
208	0 941	0 013	0 117
209	0 800	0	0 044
301	0 538	0	-0 037
302	0 785	-0 110	-0 094
303	0 900	-0 107	-0 092
304	0 940	-0 130	-0 018
305	0 932	-0 112	0 039
306	0 943	-0 079	0 086
307	0 939	-0 030	0 112
308	0 942	0 011	0 117
309	0 807	0	0 007
401	0 469	0	-0 048
402	0 733	-0 100	-0 110
403	0 840	-0 114	-0 097
404	0 924	-0 132	-0 013
405	0 930	-0 109	0 038
406	0 946	-0 076	0 081
407	0 940	-0 033	0 109
408	0 947	-0 011	0 130
409	0 999	0	--

VELOCITY SURVEY IN WAY OF THE PROPELLER
AE-21
MODEL 4521

MODEL DIMENSIONS

LENGTH (LWL),	19.28 FT
BEAM	2.88 FT
DRAFT	1.06 FT
DISPLACEMENT	0.966 TONS F W.
PROPELLER DIAMETER	0.860 FT
SPEED	4.25 KT

TEST 0
JANUARY 1959

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 12.74 FT FWD OF THE A. P. THE DUMMY HUB AND FAIRWATER WERE IN PLACE.

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

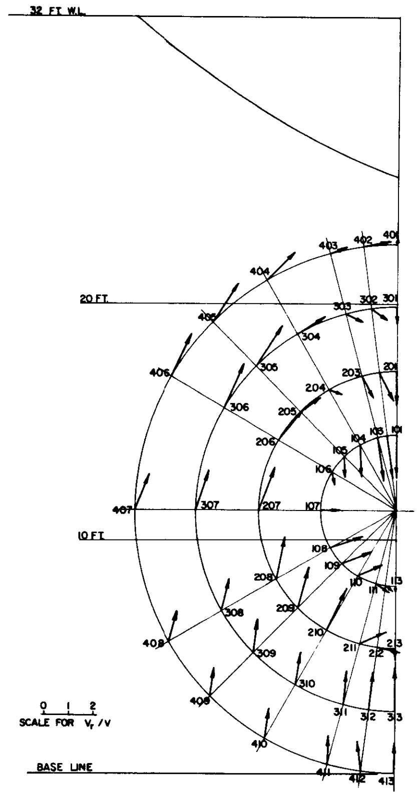


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 500	0	0 180
102	0 500	-0 007	0 182
103	0 510	0 005	0 174
104	0 530	0 051	0 109
105	0 530	0 057	0 057
106	0 490	0 033	0 042
107	0 480	0	0 080
108	0 530	0 008	0 134
109	0 520	0 127	0 127
110	0 450	0 082	0 059
111	0 400	0 039	-0 031
112	0 400	0 053	-0 013
113	0 420	0	-0 020
201	0 530	0	0 140
202	0 560	-0 043	0 127
203	0.580	-0 025	0 100
204	0 590	-0 051	0 052
205	0 620	-0 106	0 022
206	0 700	-0 168	0 032
207	0 890	-0 180	0 070
208	0 900	-0 132	0 111
209	0 890	-0 092	0 149
210	0 840	-0 016	0 187
211	0 600	0 103	0 079
212	0 460	0 102	-0 042
213	0 340	0	-0 040
301	0 540	0	0 070
302	0 600	-0 072	0 061
303	0 630	-0 072	0 040
304	0 690	-0 135	-0 014
305	0 780	-0 198	-0 042
306	0 880	-0 196	-0 019
307	0 920	-0 160	0 050
308	0 930	-0 106	0 096
309	0 930	-0 085	0 113
310	0 920	-0 048	0 123
311	0 890	-0 017	0 140
312	0 790	-0 001	0 161
313	0 380	0	0 180
401	0 540	0	-0 030
402	0 640	-0 122	-0.004
403	0 690	-0 124	0 001
404	0 750	-0 164	-0 044
405	0 820	-0 191	-0 043
406	0 890	-0 192	-0 007
407	0 920	-0 150	0 060
408	0 930	-0 093	0 100
409	0 930	-0 071	0 113
410	0 930	-0 043	0 114
411	0 930	-0 031	0 116
412	0 900	-0 026	0 117
413	0 690	0	0.130

VELOCITY SURVEY IN WAY OF THE PROPELLER CARGO SHIP MODEL 4903	
MODEL DIMENSIONS	
LENGTH (LWL)	18 95 FT
BEAM	2.728 FT
DRAFT	0.982 FT
DISPLACEMENT	0.791 TONS F W.
PROPELLER DIAMETER	0.800 FT
SPEED	3.91 KT
TEST - AUGUST 1962	

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION.

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t AND V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT CENTERLINE 1.67 FT AFT OF STATION 19-1/2

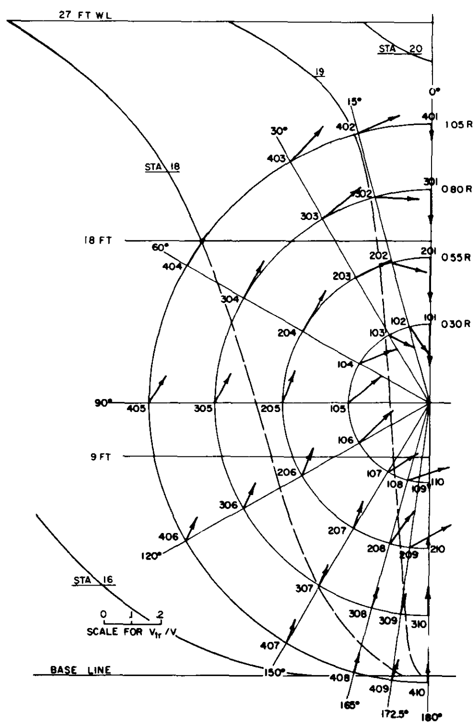


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0.310	0	0 15
102	0.335	-0 043	0 11
103	0 405	-0 047	0 08
104	0 595	-0 114	0 09
105	0 709	-0.105	0 12
106	0 795	-0 046	0.16
107	0 750	0 050	0 11
108	0 612	0 122	0 08
109	0.517	0 111	0.02
110	0.417	0	-0 02
201	0 325	0	0.15
202	0 456	-0.105	0.06
203	0 625	-0 133	0 01
204	0.872	-0 163	-0 01
205	0 908	-0 116	0.05
206	0 910	-0.074	0 09
207	0 915	-0 025	0 10
208	0 883	0 048	0 13
209	0 739	0 131	0 10
210	0 504	0	0 03
301	0 293	0	0 12
302	0.510	-0.144	0 04
303	0.738	-0 171	-0.03
304	0 881	-0 145	-0.01
305	0 912	-0 109	0 05
306	0.931	-0 059	0.09
307	0 917	-0 018	0 09
308	0 913	-0 002	0 09
309	0 912	0 006	0 08
310	0 909	0	0 11
401	0.280	0	0 06
402	0 575	-0.153	-0 02
403	0.743	-0.163	-0.05
404	0.841	-0 137	0.01
405	0.907	-0 098	0 06
406	0 925	-0.054	0.08
407	0 918	-0.016	0.09
408	0.911	-0.002	0.08
409	0.926	0 010	0.08
410	0.917	0	0.07

VELOCITY SURVEY IN WAY OF THE PROPELLER CARGO MODEL 4933	
MODEL DIMENSIONS	
LENGTH (LWL)	20 50 FT
BEAM	3.01 FT
DRAFT	1.15 FT
DISPLACEMENT	1 136 TONS F W
PROPELLER DIAMETER	0 861 FT
SPEED	3 97 KT
TEST 13 JUNE 1963	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT CENTERLINE 13.53 FT FWD OF THE A.P (C_L OF RUDDER STOCK).

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

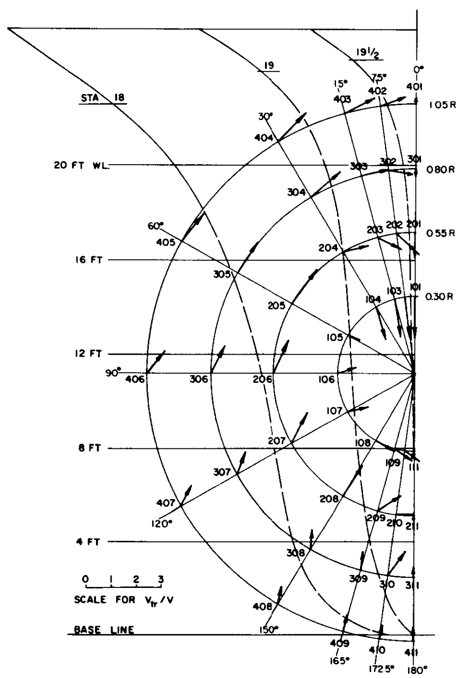


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 425	0	0 160
102	0 435	0 001	0 158
103	0 449	0 017	0 155
104	0 463	0 032	0 134
105	0 574	-0 009	0 052
106	0 636	-0 026	0 080
107	0 608	0 026	0 089
108	0 522	0 077	0 005
109	0 494	0 074	-0 027
110	0 431	0 064	-0 035
111	0 387	0	-0 032
201	0 419	0	0 100
202	0 477	-0 077	0 096
203	0 557	-0 080	0 068
204	0 672	-0 103	0 028
205	0 823	-0 170	0 020
206	0 892	-0 134	0 060
207	0 880	-0 081	0 113
208	0 770	0 005	0 145
209	0 557	0 075	0 077
210	0 419	0 071	0 009
211	0 320	0	-0 021
301	0 434	0	0 028
302	0 482	-0 097	0 027
303	0 603	-0 114	0 002
304	0 757	-0 144	-0 029
305	0 882	-0 149	0 004
306	0,894	-0 110	0 056
307	0 899	-0 042	0 076
308	0 914	-0 035	0 074
309	0 910	-0 011	0 077
310	0 894	0 058	0 106
311	0 590	0	0 044
401	0 359	0	-0 027
402	0 418	-0 105	-0 025
403	0 546	-0 129	-0 029
404	0 740	-0 148	-0 048
405	0 852	-0 138	0 016
406	0 897	-0 091	0 067
407	0 902	-0 052	0 076
408	0 895	-0 022	0 070
409	0 908	-0 003	0 065
410	0 899	0 007	0 058
411	0 906	0	0 058

VELOCITY SURVEY IN WAY OF THE PROPELLER		
CARGO SHIP		
MODEL 4986		
MODEL DIMENSIONS		
LENGTH (LWL)	21.01	FT
BEAM	3.19	FT
DRAFT	1.05	FT
DISPLACEMENT	1.04	TONS F W
PROPELLER DIAMETER	0.875	FT
SPEED	4.54	KT
TEST 3		
AUGUST 1964		

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION.

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION.

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION.

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE.

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t AND V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT CENTERLINE 8.1 FT FORWARD OF STATION 20

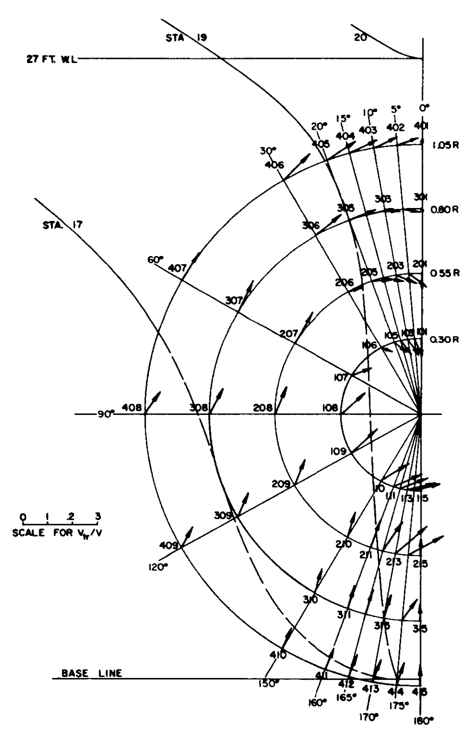


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0.392	0	0.081
102	0.400	-0.021	0.080
103	0.436	-0.032	0.075
104	0.460	-0.026	0.067
105	0.494	-0.030	0.054
106	0 537	-0.028	0.036
107	0 626	-0.065	0.047
108	0 746	-0 088	0.090
109	0.795	-0.034	0.132
110	0 692	0 062	0 116
111	0 622	0.092	0.082
112	0 590	0.098	0 068
113	0 541	0 110	0.048
114	0 456	0 104	0 035
115	0 409	0	0.029
201	0 415	0	0.063
202	0.443	-0 063	0 059
203	0.517	-0 072	0 045
204	0.558	-0.071	0.033
205	0 616	-0.078	0.017
206	0 676	-0.100	0.002
207	0 882	-0 149	-0.004
208	0 928	-0 115	0.040
209	0.920	-0 072	0.085
210	0 921	-0 027	0.103
211	0 921	0.001	0 115
212	0.904	0 045	0 136
213	0 811	0.104	0.130
214	0 605	0 136	0 087
215	0 496	0	0 062
301	0 419	0	0 017
302	0 433	-0 066	0 015
303	0 524	-0 087	0 009
304	0 611	-0.100	-0 003
305	0 663	-0.113	-0 011
306	0.754	-0 132	-0.028
307	0 905	-0.139	-0 011
308	0 903	-0 106	0 051
309	0.931	-0.064	0 084
310	0 921	-0 022	0 096
311	0.921	-0 004	0.096
312	0.923	0 005	0.097
313	0.923	0.016	0.093
314	0 934	0.055	0.086
315	0 829	0	0 068
401	0.311	0	-0 027
402	0 444	-0 090	-0.023
403	0 490	-0 103	-0.028
404	0 567	-0 120	-0.027
405	0 649	-0 134	-0.035
406	0 756	-0 143	-0 040
407	0 881	-0 130	0 003
408	0 923	-0 092	0 063
409	0 934	-0 051	0 084
410	0 934	-0 012	0 089
411	0 932	0 002	0 089
412	0 931	0 009	0 089
413	0.932	0 017	0 090
414	0.929	0 022	0 087
415	0.932	0	0.084

VELOCITY SURVEY IN WAY OF THE PROPELLER	
MODEL 5000	
MODEL DIMENSIONS	
LENGTH (LWL)	18.38 FT
BEAM	2.680 FT
DRAFT	0 938 FT
DISPLACEMENT	0.652 TONS F W.
PROPELLER DIAMETER	0 748 FT
SPEED	4.11 KT
TEST 5	
AUGUST 1964	

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THF ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED.

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t AND V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT CENTERLINE 1 7 FT AFT OF STATION 19-1/2

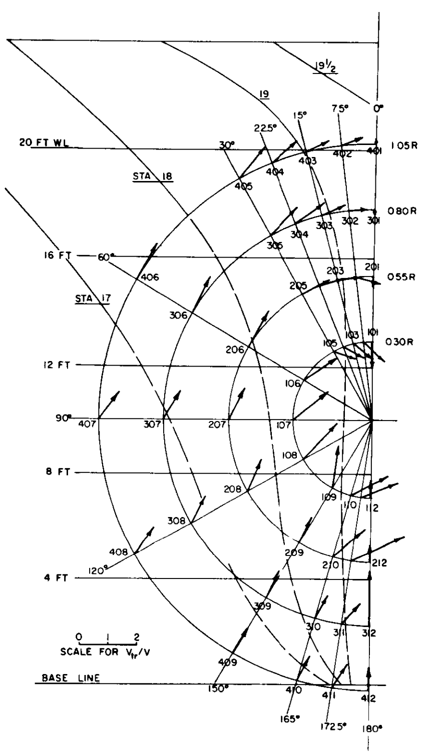


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x V	V_t/V	V_r/V
101	0 42	0	0.09
102	0.47	-0 06	0 08
103	0 51	-0 05	0 07
104	0 54	-0 05	0 06
105	0 57	-0 06	0.06
106	0 75	-0 12	0 06
107	0 80	-0 10	0 12
108	0 85	-0.05	0 16
109	0 75	0 06	0 14
110	0 63	0 11	0 10
111	0 52	0 12	0 07
112	0.50	0	0 06
201	0 42	0	0 09
202	0.47	-0 06	0 08
203	0 51	-0.05	0.07
204	0.54	-0 05	0 06
205	0 57	-0 06	0.06
206	0 75	-0 12	0.06
207	0 80	-0 10	0 12
208	0.85	-0 05	0 16
209	0 75	0 06	0.14
210	0 90	0 08	0 13
211	0 77	0 17	0 11
212	0 50	0	0.06
301	0 41	0	0.02
302	0 51	-0 06	0
303	0 60	-0.09	-0.02
304	0 67	-0 12	-0 03
305	0 75	-0 13	-0.04
306	0 92	-0 14	-0.01
307	0 94	-0 10	0 06
308	0 94	-0.06	0 09
309	0 94	-0 01	0 10
310	0 94	0 02	0 09
311	0 95	0 05	0.08
312	0 83	0	0.20
401	0 40	0	-0 02
402	0 54	-0.08	-0.02
403	0 58	-0 09	-0 02
404	0 65	-0 11	-0 04
405	0 71	-0 13	-0 05
406	0.89	-0 14	0
407	0 94	-0 09	0 07
408	0 94	-0 05	0 10
409	0.94	0	0 10
410	0 94	0.02	0 09
411	0 94	0 04	0 09
412	0.94	0	0.08

VELOCITY SURVEY IN WAY OF THE PROPELLER AFS MODEL 4831	
MODEL DIMENSIONS	
LENGTH (LWL)	19 98 FT
BEAM	2.97 FT
DRAFT	0 97 FT
DISPLACEMENT	0.912 TONS F W.
PROPELLER DIAMETER	0 755 FT
SPEED	3 88 KT
TEST 8 AUGUST 1960	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE 3.18 FT FWD OF THE A P

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

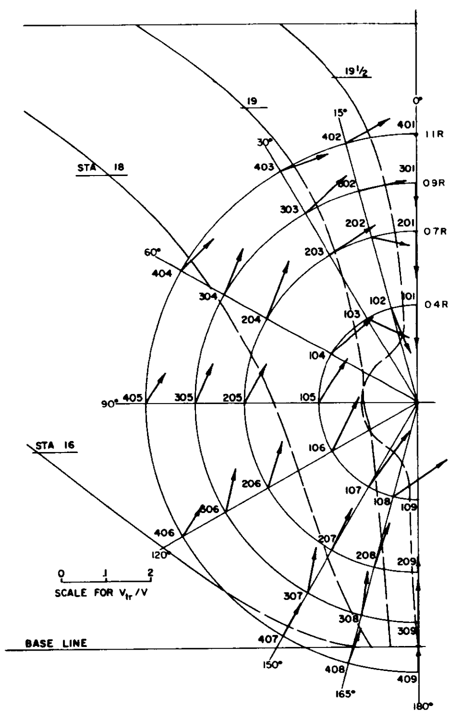


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 368	0	0 102
102	0 371	-0 015	0 114
103	0 414	-0 046	0 086
104	0 670	-0 122	0 038
105	0 895	-0 101	0 067
106	0 871	-0 076	0 115
107	0 784	0 015	0 158
108	0 682	0 098	0 110
109	0 535	0	0
201	0 327	0	0 107
202	0 452	-0 078	0 037
203	0 617	-0 122	-0 008
204	0 850	-0 139	-0 024
205	0 925	-0 089	0 049
206	0 872	-0 077	0 085
207	0 883	-0 027	0 112
208	0 931	0 008	0 105
209	0 593	0	0 034
301	0 407	0	0 052
302	0 549	-0 109	0 006
303	0 662	-0 123	-0 028
304	0 819	-0 112	-0 015
305	0 914	-0 091	0.038
306	0 882	-0 074	0 070
307	0 893	-0 034	0 100
308	0 904	-0 011	0 099
309	0 838	0	-0 094
401	0 298	0	-0 005
402	0 441	-0 108	-0 030
403	0 605	-0 113	0 020
404	0 749	-0 098	0 024
405	0 890	-0 070	0 046
406	0 914	-0 041	0 075
407	0 908	-0 004	0 084
408	0 897	0 007	0 082
409	0 938	0	0 058

VELOCITY SURVEY IN WAY OF THE PROPELLER
CARGO
MODEL 3717

MODEL DIMENSIONS

LENGTH (LWL)	20.035 FT
BEAM	2.860 FT
DRAFT	1.203 FT
DISPLACEMENT	1 244 TONS F.W.
PROPELLER DIAMETER	0.853 FT
SPEED	3.40 KT

TEST 4
JULY 1955

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 11 FT FWD OF STA 20.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

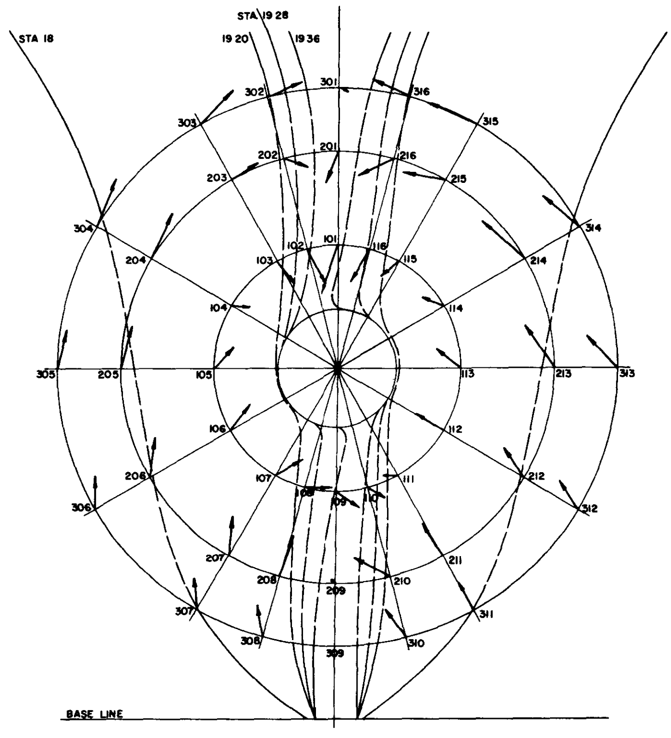


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V
101	0.356	0.052
102	0 383	-0.028
103	0.481	-0 021
104	0.561	-0.031
105	0 676	-0.073
106	0 704	-0.042
107	0.558	0 049
108	0 425	0.091
109	0 303	0.080
110	0.269	0.049
111	0 406	-0.042
112	0 586	0.007
113	0 582	0 063
114	0.533	0.063
115	0.512	0 028
116	0.471	0 031
201	0 310	0.038
202	0.523	-0 069
203	0 645	-0 101
204	0.836	-0.164
205	0 906	-0 143
206	0.927	-0 104
207	0 916	-0.063
208	0.812	0 007
209	0 245	-0.014
210	0.739	-0.098
211	0.906	-0 007
212	0.937	0.056
213	0.864	0 143
214	0 833	0.185
215	0 641	0 136
216	0.544	0 084
301	0.262	-0.031
302	0.613	-0 122
303	0.725	-0.146
304	0 892	-0.160
305	0 941	-0 125
306	0.944	-0 098
307	0 941	-0 063
308	0 927	-0 049
309	0 700	-0 045
310	0 927	-0.042
311	0 941	0
312	0 941	0.052
313	0 916	0.108
314	0 896	0.146
315	0.722	0.174
316	0.579	0.136
401	0.248	-0 063
402	0 550	-0.120
403	0 739	-0.153
404	0.889	-0.146
405	0.927	-0.108
406	0.927	-0.087
407	0 923	-0 052
408	0 930	-0.050
409	0.453	-0.052
410	0.937	-0.030
411	0.927	0
412	0.916	0.045
413	0.913	0.076
414	0.896	0.108
415	0.739	0 181
416	0.550	0.100

VELOCITY SURVEY IN WAY OF THE PROPELLER CARGO SHIP MODEL 3801	
MODEL DIMENSIONS	
LENGTH (LWL)	20.00 FT
BEAM	2.787 FT
DRAFT	1.262 FT
DISPLACEMENT	HEAVY
PROPELLER DIAMETER	0.922 FT
SPEED	3.40 KT
TEST 25 MAY 1955	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 6.323 FT FWD OF THE A.P.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED.
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION.
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION.
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE.
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r.

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

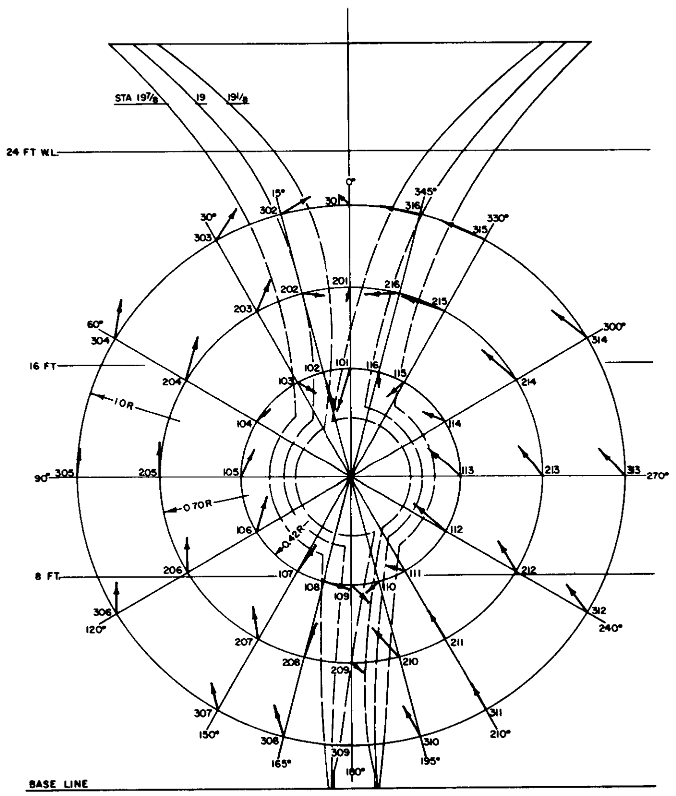


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 316	0.054	0.166
102	0.297	-0.012	0.161
103	0.474	-0.040	0.074
104	0.509	-0.079	0.023
105	0.638	-0.120	0.058
106	0.791	-0.104	0.108
107	0.672	0.010	0.133
108	0.431	0 118	-0 002
109	0 353	0 076	-0.071
110	0.319	-0 061	-0.027
111	0.469	-0.060	0.065
112	0.686	0 031	0.153
113	0 638	0 119	0 127
114	0.474	0.065	0.060
115	0.471	0.031	0.067
116	0.434	-0 010	0 056
201	0.260	0 014	0.047
202	0.410	-0.092	0.038
203	0.600	-0.120	-0 087
204	0.806	-0.173	-0.041
205	0.873	-0.150	-0.006
206	0.911	-0.124	0.069
207	0.914	-0.088	0.109
208	0 785	0.012	0.151
209	0.254	0.046	-0.039
210	0 860	-0.080	0 148
211	0 914	0	0.130
212	0 919	0.070	0.121
213	0.893	0.125	0.095
214	0.802	0.180	0.061
215	0.624	0.181	0.035
216	0.514	0.131	0.036
301	0.143	0.051	-0.048
302	0 466	-0 132	-0.039
303	0.646	-0.140	-0.071
304	0.809	-0.161	-0 059
305	0.895	-0 122	0.011
306	0.924	-0.102	0.060
307	0.924	-0.076	0.078
308	0.906	-0.067	0.110
309	0.850	-0.050	--
310	0.920	-0.034	0 126
311	0.925	0	0.120
312	0.933	0.051	0.121
313	0.912	0.119	0.159
314	0.783	0.176	0.070
315	0.648	0.196	0.024
316	0.517	0.162	-0.004

VELOCITY SURVEY IN WAY OF THE PROPELLER

CARGO

MODEL 3801

MODEL DIMENSIONS

LENGTH (LWL)	20.000 FT
BEAM	2.787 FT
DRAFT	1.262 FT
DISPLACEMENT	LIGHT
PROPELLER DIAMETER	0.922 FT
SPEED	3.81 KT

TEST 28

JUNE 1955

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 6.323 FT FWD OF THE A.P.

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION.

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION.

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE.

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

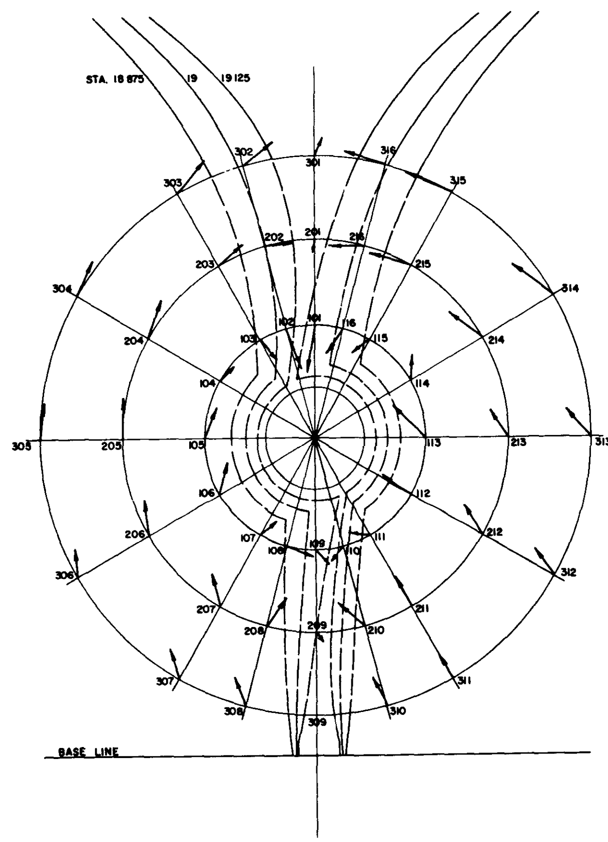


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0.300	0.041	0 189
102	0.313	-0 015	0.162
103	0 457	-0.020	0.097
104	0 497	-0.078	0.018
105	0.623	-0 121	0 046
106	0 721	-0.105	0 100
107	0.536	0.032	0 085
108	0.350	0.106	-0.010
109	0 223	0 049	-0.045
110	0 281	-0 055	-0 040
111	0.421	-0.070	0.053
112	0 615	0 008	0.134
113	0 536	0.126	0.130
114	0.444	0.079	-0.060
115	0 452	0 031	0 085
116	0.468	0.042	0 115
201	0.252	0.006	0.049
202	0.486	-0 107	0 013
203	0.602	-0.130	-0.026
204	0.763	-0 170	-0 034
205	0 883	-0 169	-0.007
206	0.915	-0.140	0 060
207	0.915	-0 093	0.100
208	0.642	0.046	0.120
209	0.215	0.029	-0.030
210	0.763	-0.090	0.131
211	0.918	0 005	0.132
212	0.913	0.075	0.130
213	0.863	0.113	0.077
214	0 755	0 159	0 070
215	0.597	0.168	0.041
216	0.526	0 134	0.032
301	0.179	-0 034	-0 073
302	0 476	-0.137	-0.058
303	0.634	-0.160	-0 068
304	0 807	-0 159	-0.051
305	0.907	-0.143	0.021
306	0.931	-0.114	0.050
307	0.928	-0.099	0.092
308	0.921	-0.061	0.123
309	0.875	-0.055	--
310	0.923	-0.023	0.126
311	0.928	0	0.110
312	0.928	0.065	0.116
313	0 906	0.113	0.100
314	0.800	0.180	0.080
315	0.619	0.196	0.025
316	0.534	0.169	-0.013

VELOCITY SURVEY IN WAY OF THE PROPELLER CARGO SHIP MODEL 4648	
MODEL DIMENSIONS	
LENGTH (LWL)	19.73 FT
BEAM	2.67 FT
DRAFT	1.16 FT
DISPLACEMENT	1.101 TONS F.W.
PROPELLER DIAMETER	0.872 FT
SPEED	3.54 KT
TEST 0 MAY 1958	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT AT A POINT 3.95 FT FWD OF STA 20. THE DUMMY HUB AND FAIRWATER WERE IN PLACE.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION.
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

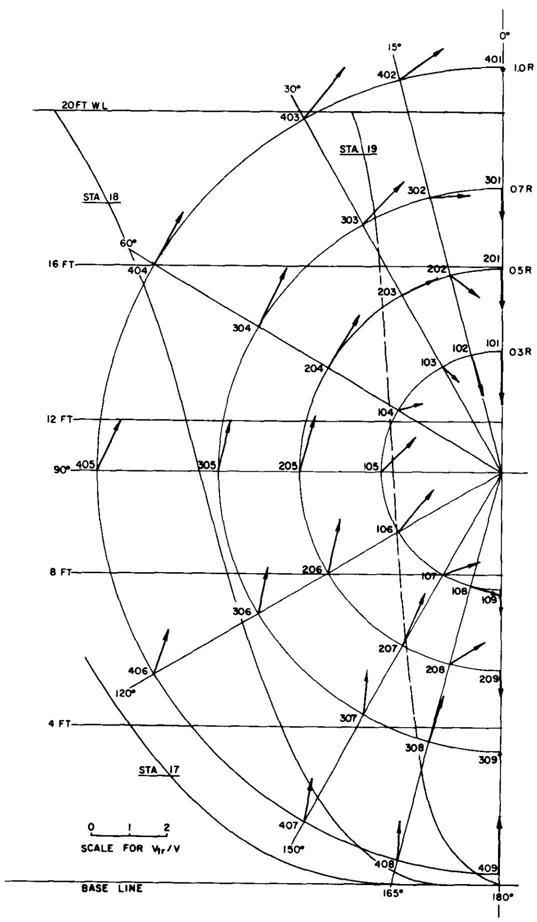


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 437	0	0 139
102	0 446	-0 007	0 113
103	0 507	-0 019	0 060
104	0 548	-0 050	0 053
105	0 676	-0 087	0 095
106	0 673	-0 048	0 141
107	0 601	0 066	0 079
108	0 493	0 083	-0 003
109	0 381	0	-0 065
201	0.408	0	0 103
202	0 545	-0 057	0 072
203	0 644	-0 102	0 006
204	0 806	-0 162	0 004
205	0 914	-0 146	0 045
206	0 922	-0 107	0 101
207	0 860	-0 021	0 150
208	0 617	0 075	0 077
209	0 378	0	-0 071
301	0 422	0	0 078
302	0 622	-0 107	0 020
303	0 745	-0 151	-0 042
304	0.856	-0 169	-0 009
305	0 937	-0 133	0 038
306	0 942	-0 094	0 083
307	0 939	-0 053	0 109
308	0.910	0 006	0 125
309	0 464	0	-0 011
401	0 361	0	0 011
402	0 653	-0 130	-0 049
403	0 777	-0 160	-0 065
404	0 876	-0 155	-0 006
405	0 895	-0 128	0 061
406	0.931	-0 081	0 093
407	0 937	-0 038	0.107
408	0 957	-0 020	0 100
409	0 828	0	0 150

VELOCITY SURVEY IN WAY OF THE PROPELLER CARGO MODEL 4710-1	
MODEL DIMENSIONS	
LENGTH (LWL)	18.8 FT
BEAM	2 755 FT
DRAFT	1 155 FT
DISPLACEMENT	1.057 TONS F.W
PROPELLER DIAMETER	0 850 FT
SPEED	3 62 KT
TEST 14 OCTOBER 1958	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT AT STA 19 1/2.

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

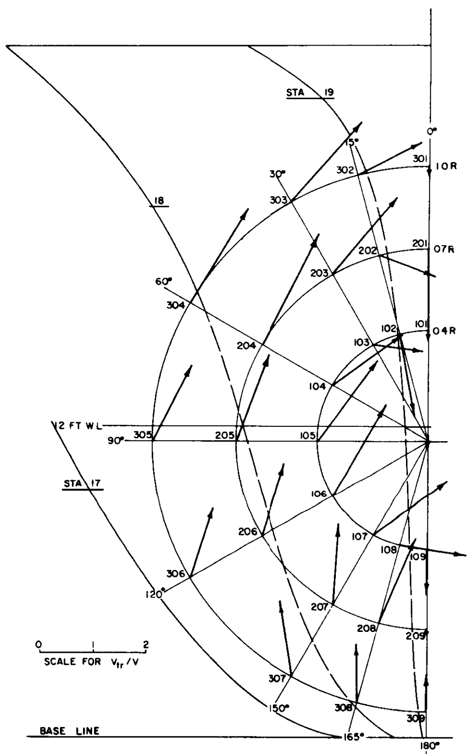


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	--	--	--
102	0 424	0 016	0.157
103	0 350	-0 072	0 057
104	0 440	-0 144	0 066
105	0 676	-0 148	0 108
106	0.798	-0 099	0 168
107	0 625	0 068	0 156
108	0 438	0 122	0 015
109	0.234	0	0 085
201	0 349	0	0 172
202	0 520	-0 093	0 067
203	0 571	-0 176	-0 002
204	0 840	-0 230	-0 011
205	0 876	-0 158	0 059
206	0 845	-0 096	0 101
207	0 883	-0 067	0 135
208	0 858	0 025	0 168
209	0 295	0	-0 013
301	0 297	0	0 021
302	0 620	-0 135	-0 027
303	0 730	-0 186	-0 063
304	0 863	-0 203	0 009
305	0 867	-0.139	0 073
306	0 883	-0 091	0 097
307	0 877	-0.088	0 104
308	0 898	-0.032	0.101
309	0 709	0	0 072

VELOCITY SURVEY IN WAY OF THE PROPELLER CARGO MODEL 4747	
MODEL DIMENSIONS	
LENGTH (LWL)	21 57 FT
BEAM	3.32 FT
DRAFT	1 228 FT
DISPLACEMENT	1 532 TONS F.W
PROPELLER DIAMETER	0.910 FT
SPEED	3.94 KT
TEST 6 JUNE 1959	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT AT A POINT 12.3 FT FWD OF THE A P. THE DUMMY HUB AND FAIRWATER WERE IN PLACE.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

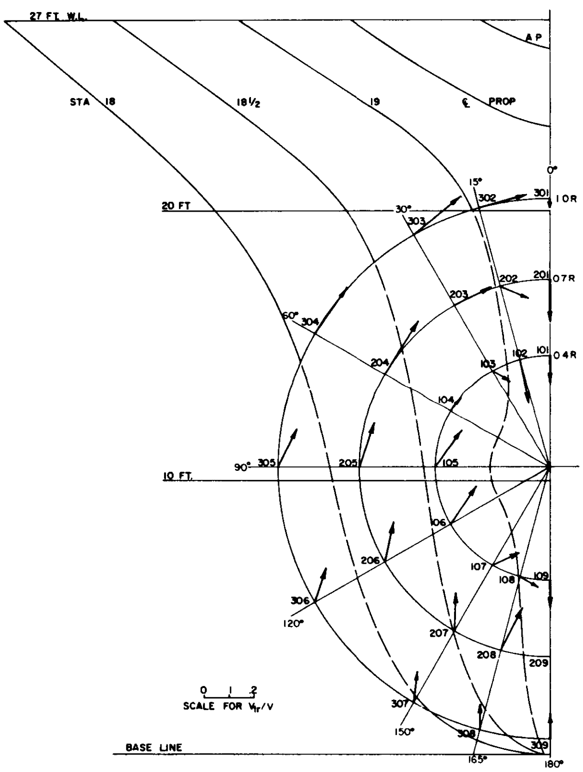


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x V	V_t V	V_r V
101	0 373	0	0 115
102	0 476	0 013	0 184
103	0 478	0 034	0 080
104	0 421	-0 072	0 011
105	0 675	-0 149	0 108
106	0 745	-0 090	0 153
107	0 519	0 065	0 096
108	0 357	0 077	-0 022
109	0 309	0	-0 109
201	0 375	0	0 171
202	0 543	-0 096	0 076
203	0 600	-0 162	0 012
204	0 830	-0 251	0 009
205	0 888	-0 178	0 063
206	0 894	-0 119	0 108
207	0 896	-0 073	0 130
208	0 753	0 040	0 183
209	0 309	0	0 002
301	0 336	0	0 031
302	0 592	-0 199	-0 004
303	0 741	-0 243	-0 043
304	0 865	-0 225	0 022
305	0 885	-0 154	0 077
306	0 897	-0 094	0 107
307	0 900	-0 050	0 111
308	0 915	-0 024	0 094
309	0 912	0	0 092

VELOCITY SURVEY IN WAY OF THE PROPELLER CARGO SHIP MODEL 4671	
MODEL DIMENSIONS	
LENGTH (LWL)	22 72 FT
BEAM	3.23 FT
DRAFT	1 22 FT
DISPLACEMENT	1.504 TONS F W
PROPELLER DIAMETER	0 912 FT
SPEED	4 17 KT
TEST 16 MAY 1963	

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R).

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION.

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION.

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t AND V_r.

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V.

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT 1 217 FT AFT OF STA. 19-1/2

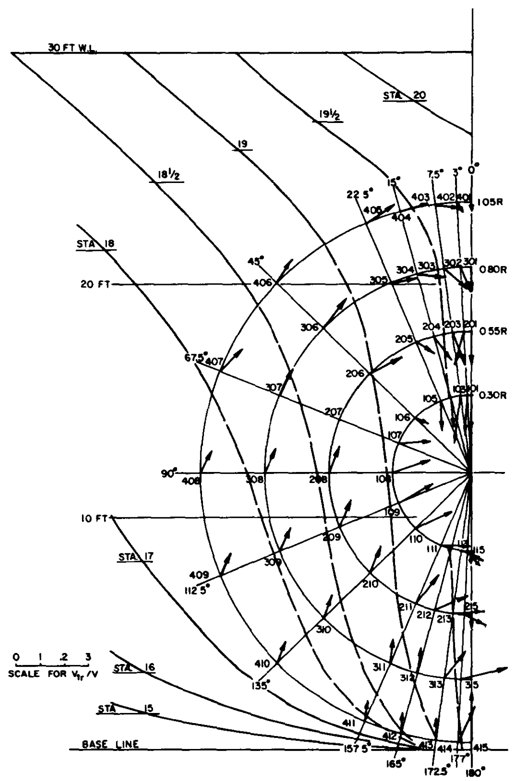


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 26	0	0.16
102	0.24	0.02	0 17
103	0 33	0.06	0.20
104	0 31	0.02	0 13
105	0.29	0.04	0.12
106	0 34	-0.03	0.09
107	0 47	-0.06	0.12
108	0.60	-0.06	0 15
109	0.72	-0 02	0.16
110	0.71	0 06	0.15
111	0.59	0.12	0.05
112	0.53	0 11	0
113	0 50	0.10	-0 03
114	0 45	0.06	-0.06
115	0 44	0	-0 05
201	0 31	0	0 14
202	0 29	0.04	0 14
203	0 33	-0 03	0.14
204	0 37	-0.04	0.11
205	0.43	-0 05	0 07
206	0 65	-0.15	0 04
207	0 84	-0.14	0.02
208	0 87	-0 12	0.05
209	0.88	-0 09	0 08
210	0 89	-0 05	0 11
211	0.84	0.04	0 15
212	0.70	0 12	0.10
213	0.58	0.13	0 03
214	0 40	0 09	-0 04
215	0 36	0	-0 06
301	0 32	0	0 09
302	0 29	-0 03	0.10
303	0 36	-0.08	0.09
304	0.49	-0 11	0.04
305	0.59	-0 13	0 02
306	0.80	-0 15	-0 02
307	0 83	-0 13	0.01
308	0 87	-0 11	0.05
309	0 88	-0.08	0.08
310	0.89	-0.05	0.09
311	0 88	-0 02	0.10
312	0.89	-0 01	0 10
313	0.88	0 07	0 12
314	0.66	0 19	0 06
315	0 43	0	-0.01
401	0.28	0	0.03
402	0.20	-0 02	0 05
403	0.31	-0 09	0.02
404	0.48	-0 12	-0 01
405	0 55	-0.14	-0.03
406	0.73	-0 12	-0 03
407	0.78	-0.12	0 05
408	0.88	-0.10	0 05
409	0.90	-0 07	0 07
410	0.90	-0.04	0.08
411	0 89	-0.02	0.09
412	0.89	-0.01	0.08
413	0.89	-0.01	0.08
414	0.87	0 07	0.16
415	0.70	0	0.22

VELOCITY SURVEY IN WAY OF THE PROPELLER	
CARGO	
MODEL 4730	
MODEL DIMENSIONS	
LENGTH (LWL)	19 86 FT
BEAM	2 80 FT
DRAFT	1 120 FT
DISPLACEMENT	1 040 TONS F W
PROPELLER DIAMETER	0 862 FT
SPEED	3 60 KT
TEST 7	
JANUARY 1959	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 6 75 FT FWD OF STA 20 THE DUMMY HUB AND FAIRWATER WERE IN PLACE.

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

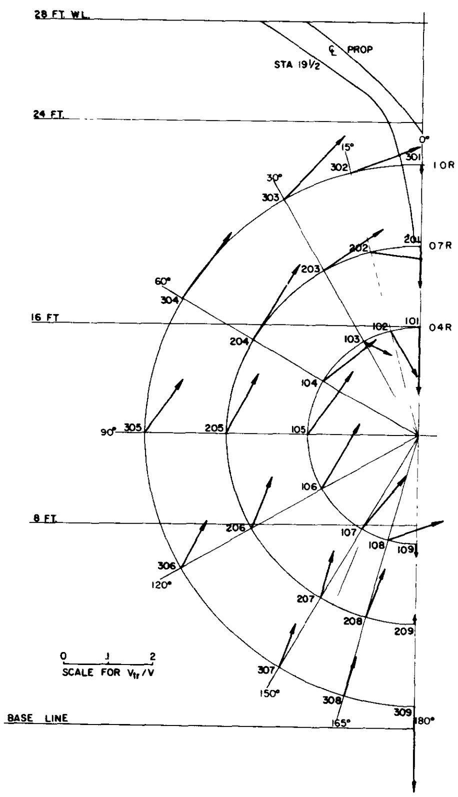


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x V	V_t V	V_r/V
101	0 327	0	0 147
102	0 385	-0 031	0 113
103	0 432	-0 041	0 058
104	0 616	-0 142	0 056
105	0 799	-0 148	0 105
106	0 830	-0 090	0 148
107	0 708	0 032	0 155
108	0 502	0 109	0 074
109	0 346	0	-0 020
201	0 291	0	0 095
202	0 508	-0 106	0 040
203	0 645	-0 162	-0 016
204	0 870	-0 200	-0 001
205	0 893	-0 141	0 071
206	0 917	-0 081	0 103
207	0 921	-0 029	0 110
208	0 906	0 013	0 120
209	0 493	0	0 018
301	0 301	0	0 022
302	0 547	-0 168	-0 022
303	0 746	-0 194	-0 061
304	0 859	-0 184	0 014
305	0 907	-0 126	0 085
306	0 909	-0 066	0 105
307	0 926	-0 017	0 103
308	0 950	0 002	0 095
309	0 509	0	-0 192

VELOCITY SURVEY IN WAY OF THE PROPELLER

CARGO

MODEL 4358W-1

MODEL DIMENSIONS	
LENGTH (LWL)	21.84 FT
BEAM	3.14 FT
DRAFT	1.12 FT
DISPLACEMENT	1.281 TONS F.W.
PROPELLER DIAMETER	0.910 FT
SPEED	4.07 KT

TEST 6

JANUARY 1951

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 1.11 FT FWD OF STA 20. BILGE KEELS, RUDDER SHOE, DUMMY HUB AND FAIRWATER WERE IN PLACE.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION.
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

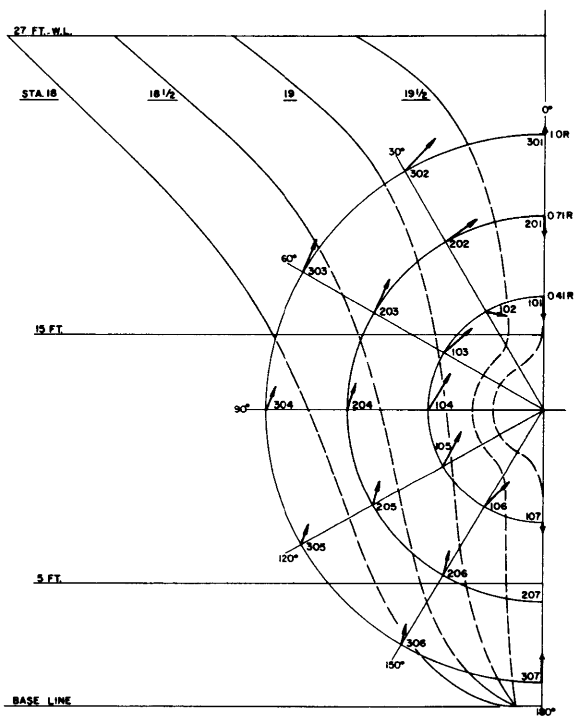


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 284	0	0 096
102	0.480	-0 061	0 055
103	0.663	-0 146	0.051
104	0 823	-0.146	0 083
105	0.856	-0 082	0.130
106	0 693	0 035	0 141
107	0 381	0	-0 040
201	0 338	0	0.075
202	0 663	-0 154	-0 015
203	0.858	-0.155	-0 020
204	0 892	-0.110	0 031
205	0.894	-0 070	0.067
206	0.896	-0.028	0 095
207	0 447	0	-0.004
301	0.328	0	-0 029
302	0.707	-0.171	-0 059
303	0.843	-0.129	-0 021
304	0.893	-0 098	0.035
305	0 900	-0 060	0 062
306	0 901	-0.026	0 076
307	0 853	0	0.112

VELOCITY SURVEY IN WAY OF THE PROPELLER	
CARGO	
MODEL 4358W-2	
MODEL DIMENSIONS	
LENGTH (LWL)	21.66 FT
BEAM	3.14 FT
DRAFT	1 12 FT
DISPLACEMENT	1.283 TONS F.W.
PROPELLER DIAMETER	0.910 FT
SPEED	4.07 KT
TEST 13	
FEBRUARY 1951	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 5.78 FT FWD OF STA 20. BILGE KEELS, DUMMY HUB AND FAIRWATER WERE IN PLACE.

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION.

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE.

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r.

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

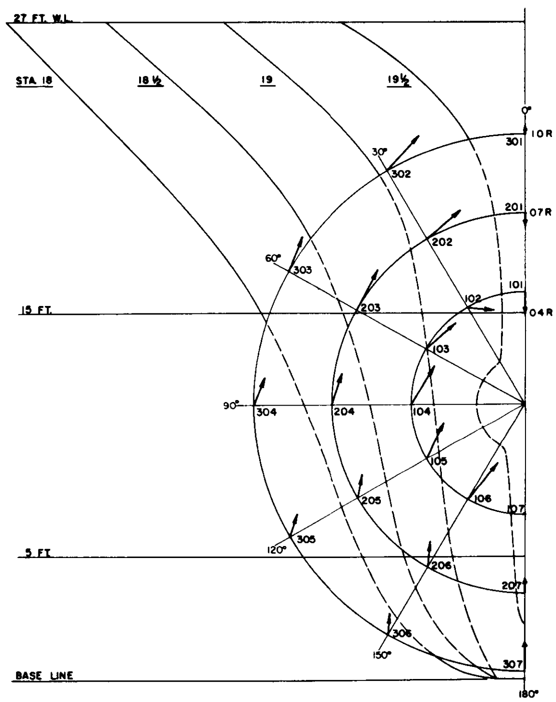


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 218	0	0.090
102	0 428	-0 081	0.058
103	0 638	-0 152	0 047
104	0.799	-0.156	0.091
105	0.850	-0.098	0 138
106	0 757	0 029	0 189
107	0 336	0	0.006
201	0.246	0	0.048
202	0.615	-0 170	-0.024
203	0.844	-0.182	-0 007
204	0 886	-0 125	0.043
205	0 897	-0 080	0.073
206	0 889	-0.045	0.098
207	0 471	0	0 070
301	0 285	0	-0.031
302	0 690	-0 191	-0.062
303	0 846	-0 148	-0 019
304	0 895	-0 110	0.043
305	0 900	-0 067	0.070
306	0.904	-0 033	0 081
307	0.863	0	0.104

VELOCITY SURVEY IN WAY OF THE PROPELLER CARGO MODEL 4358W-3	
MODEL DIMENSIONS	
LENGTH (LWL)	21 65 FT
BEAM	3 14 FT
DRAFT	1 12 FT
DISPLACEMENT	1 283 TONS F W
PROPELLER DIAMETER	0 910 FT
SPEED	4.07 KT
TEST 15 APRIL 1951	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 4 FT FWD OF STA 20 BILGE KEELS, DUMMY HUB AND FAIRWATER WERE IN PLACE

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

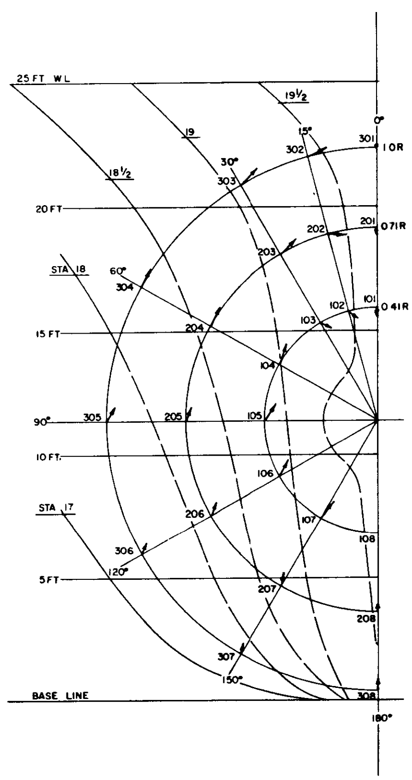


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 275	0	0 075
102	0 375	-0 055	0 072
103	0 465	-0 078	0 050
104	0 701	-0 159	0 044
105	0 862	-0 137	0 083
106	0 885	-0 079	0 121
107	0 817	0 024	0 173
108	0 413	0	0
201	0 285	0	0 066
202	0 480	-0 133	0 029
203	0 658	-0 164	-0 028
204	0 858	-0 158	-0 014
205	0 895	-0 106	0 039
206	0 889	-0 065	0 069
207	0 901	-0 036	0 093
208	0 594	0	0 060
301	0 282	0	-0 025
302	0 520	-0 160	-0 041
303	0 706	-0 176	-0 056
304	0 846	-0 139	-0 012
305	0 899	-0 103	0 059
306	0 910	-0 057	0.069
307	0 913	-0 026	0 073
308	0 867	0	0 114

VELOCITY SURVEY IN WAY OF THE PROPELLER TANKER MODEL 4423	
MODEL DIMENSIONS	
LENGTH (LWL)	25.666 FT
BEAM	3.677 FT
DRAFT	1.244 FT
DISPLACEMENT	2.419 TONS F.W.
PROPELLER DIAMETER	0 792 FT
SPEED	3.18 KT
TEST 7 MARCH 1952	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 6.75 FT FWD OF STA 20. RUDDER, DUMMY HUB AND FAIRWATER WERE IN PLACE.

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION.

V IS THE SHIP SPEED.

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE.

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

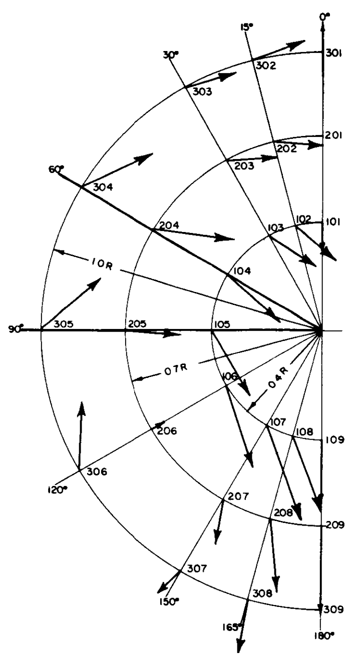


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 482	0	0 107
102	0 560	-0 106	0 145
103	0 653	-0 090	0 164
104	0.748	0 052	0 237
105	0.639	0 231	0 130
106	0.601	0 282	-0 065
107	0.647	0 249	-0.237
108	0 640	0.160	-0.228
109	0 659	0	-0 211
201	0 421	0	0
202	0 614	-0 155	0 047
203	0.679	-0 160	0 075
204	0 770	-0 105	0 254
205	0.521	0 012	0 195
206	0 460	0 005	0 048
207	0 620	0 054	-0 158
208	0 641	0 089	-0 245
209	0 520	0	-0 331
301	0.372	0	-0 105
302	0 563	-0 180	-0 018
303	0 680	-0 169	0 041
304	0 833	-0.218	0 150
305	0 746	-0.178	0 200
306	0.583	-0 198	0 129
307	0 528	-0 035	-0.112
308	0 495	0 020	-0.192
309	0 384	0	-0.279

VELOCITY SURVEY IN WAY OF THE PROPELLER TANKER MODEL 4635	
MODEL DIMENSIONS	
LENGTH (LWL)	22 093 FT
BEAM	3 214 FT
DRAFT	1.143 FT
DISPLACEMENT	1 76 TONS F W
PROPELLER DIAMETER	0 786 FT
SPEED	3 31 KT
TEST 10 AUGUST 1957	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 13.60 FT FWD OF THE A P THE DUMMY HUB AND FAIRWATER WERE IN PLACE THE SHAFT LINE RISES 0 4155 IN. PER FOOT.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

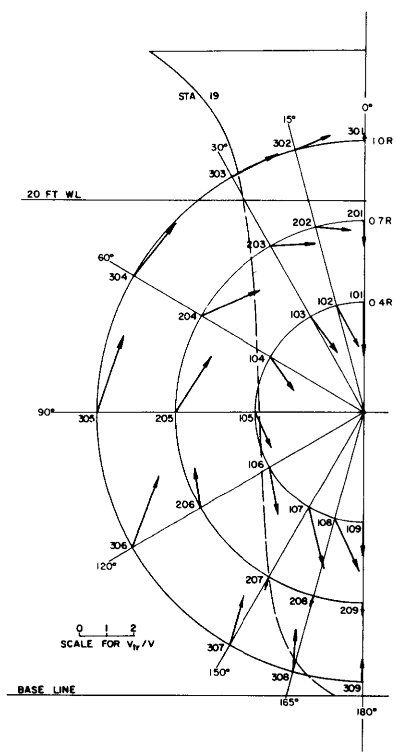


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 447	0	0 176
102	0 580	-0 055	0 169
103	0 647	-0 021	0 159
104	0 644	0 055	0 133
105	0 546	0 123	0 053
106	0 540	0 163	-0 056
107	0 569	0 157	-0 160
108	0 555	0 132	-0 157
109	0 490	0	-0 109
201	0 394	0	0 073
202	0 627	-0 118	0 040
203	0 676	-0 143	0 069
204	0 682	-0 182	0 142
205	0 578	-0 192	0 131
206	0 481	-0 134	0 053
207	0 369	0 013	-0 055
208	0 383	-0 007	-0 040
209	0 431	0	-0 046
301	0 375	0	-0 024
302	0 573	-0 132	-0 011
303	0 675	-0 182	0 010
304	0 812	-0 234	0.044
305	0 891	-0 265	0.099
306	0 911	-0 173	0 211
307	0 861	-0 044	0 183
308	0 661	-0 030	0 151
309	0 387	0	0 082

VELOCITY SURVEY IN WAY OF THE PROPELLER TANKER MODEL 4557	
MODEL DIMENSIONS	
LENGTH (LWL)	22.476 FT
BEAM	3.078 FT
DRAFT	1 165 FT
DISPLACEMENT	1 64 TONS F.W.
PROPELLER DIAMETER	0 811 FT
SPEED	3.46 KT
TEST 9 FEBRUARY 1955	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 8.5 FT FWD OF STA 20. DUMMY HUB AND FAIRWATER WERE IN PLACE.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

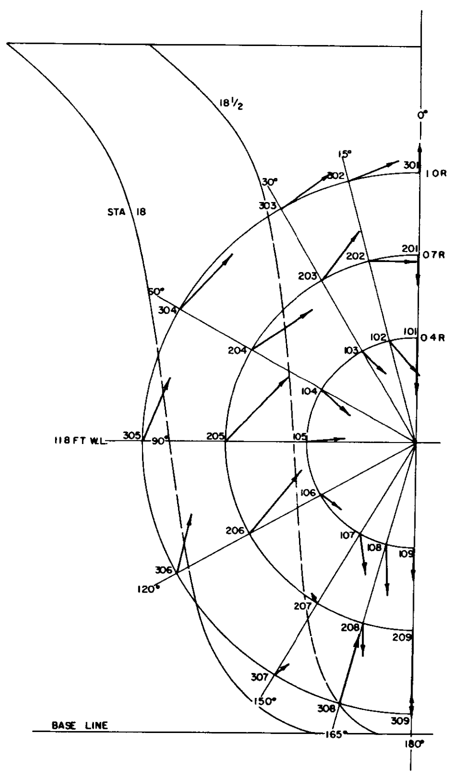


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 363	0	0 208
102	0 470	-0 074	0.149
103	0 600	-0 034	0 111
104	0 621	0 030	0 129
105	0.600	-0 081	0 122
106	0 433	0 082	0.043
107	0 530	0 095	-0 121
108	0 519	0 059	-0 182
109	0 502	0	-0 119
201	0 331	0	0.116
202	0 511	-0 164	0 044
203	0 667	-0 203	-0 092
204	0 740	-0 237	0 107
205	0 745	-0 237	0 215
206	0 644	-0 115	0 274
207	0 468	-0 034	0 019
208	0 554	0 025	-0 113
209	0 468	0	-0.312
301	0 265	0	-0.108
302	0 594	-0 190	-0 031
303	0.757	-0 224	-0 030
304	0 826	-0 257	0 051
305	0 902	-0 231	0 089
306	0 965	-0 167	0 150
307	0 896	0 024	0 062
308	0 638	-0 002	0 250
309	0 310	0	0 057

VELOCITY SURVEY IN WAY OF THE PROPELLER
TANKER
MODEL 4423-1

MODEL DIMENSIONS

LENGTH (LWL)	25 666 FT
BEAM	3 677 FT
DRAFT	1 244 FT
DISPLACEMENT	2 418 TONS F.W.
PROPELLER DIAMETER	0 792 FT
SPEED	3.23 KT

TEST 21
MAY 1952

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 6.75 FT FWD OF STA 20. RUDDER, DUMMY HUB AND FAIRWATER WERE IN PLACE.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- ϕ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION.
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION.
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE.
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V.

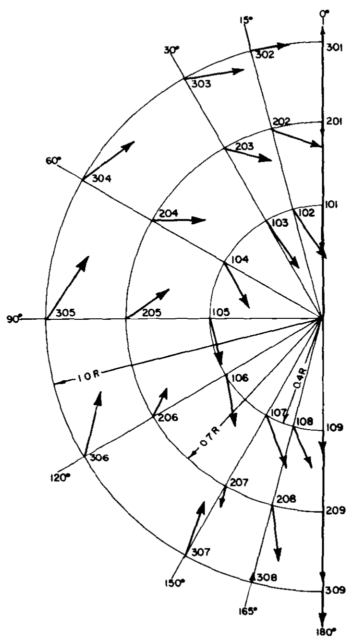


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 413	0	0 163
102	0.499	-0.071	0.197
103	0 592	-0 014	0 195
104	0 570	0.087	0 137
105	0.519	0 149	0 036
106	0 507	0.160	-0 062
107	0.514	0 152	-0.136
108	0.520	0 100	-0 126
109	0 497	0	-0.119
201	0.364	0	0 053
202	0 585	-0.147	0 100
203	0 605	-0 116	0.111
204	0.617	-0.092	0 148
205	0.506	-0 104	0 140
206	0.485	-0.062	0.082
207	0.482	0 018	-0 065
208	0.492	0.073	-0.181
209	0 437	0	-0.252
301	0.281	0	-0.055
302	0 531	-0.133	0.014
303	0 625	-0 159	0.059
304	0.744	-0.202	0.081
305	0.796	-0.216	0.137
306	0 853	-0 172	0 160
307	0 676	-0.038	0 196
308	0 339	-0 003	0.033
309	0.311	0	-0 145

VELOCITY SURVEY IN WAY OF THE PROPELLER TANKER MODEL 4080-2	
MODEL DIMENSIONS	
LENGTH (LWL)	21.00 FT
BEAM	2 763 FT
DRAFT	1.067 FT
DISPLACEMENT	1.20 TONS F W.
PROPELLER DIAMETER	0 733 FT
SPEED	3.38 KT
TEST 23 APRIL 1949	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t AND V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

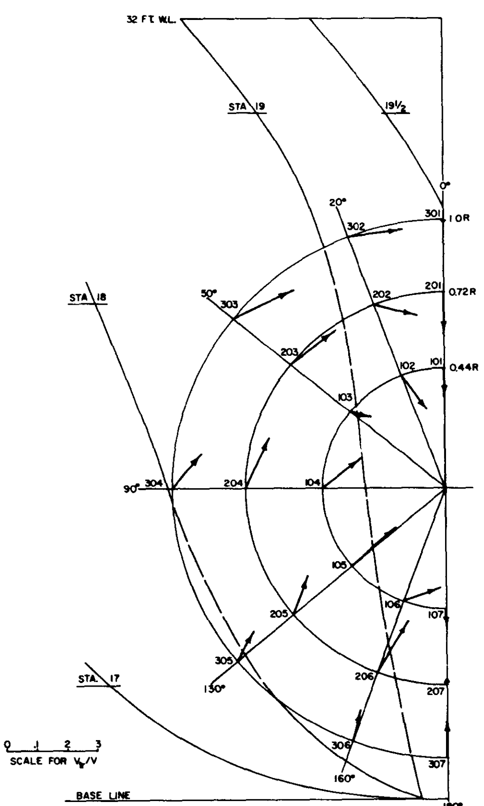


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0.159	0	0.096
102	0 370	-0 040	0.133
103	0 398	-0.032	0.065
104	0.540	-0 099	0 127
105	0 637	-0 004	0 195
106	0 351	0 099	0 086
107	0 201	0	-0.058
201	0.240	0	0 139
202	0 470	-0.121	0 083
203	0.618	-0 181	0.046
204	0 844	-0.169	0.079
205	0 889	-0.068	0.120
206	0 817	0 040	0.193
207	0 185	0	0.019
301	0 062	0	0.008
302	0.530	-0 178	0.039
303	0.738	-0 199	0.096
304	0 908	-0.116	0.099
305	0.910	-0.041	0.107
306	0.899	0.012	0 105
307	0.847	0	0 119

VELOCITY SURVEY IN WAY OF THE PROPELLER TANKER MODEL 4602	
MODEL DIMENSIONS	
LENGTH (LWL)	20.320 FT
BEAM	2.720 FT
DRAFT	1.070 FT
DISPLACEMENT	1.21 TONS F.W.
PROPELLER DIAMETER	0.671 FT
SPEED	3.13 KT
TEST 4 DECEMBER 1955	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 11.84 FT FWD OF THE A.P. THE DUMMY HUB AND FAIRWATER WERE IN PLACE.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE.
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

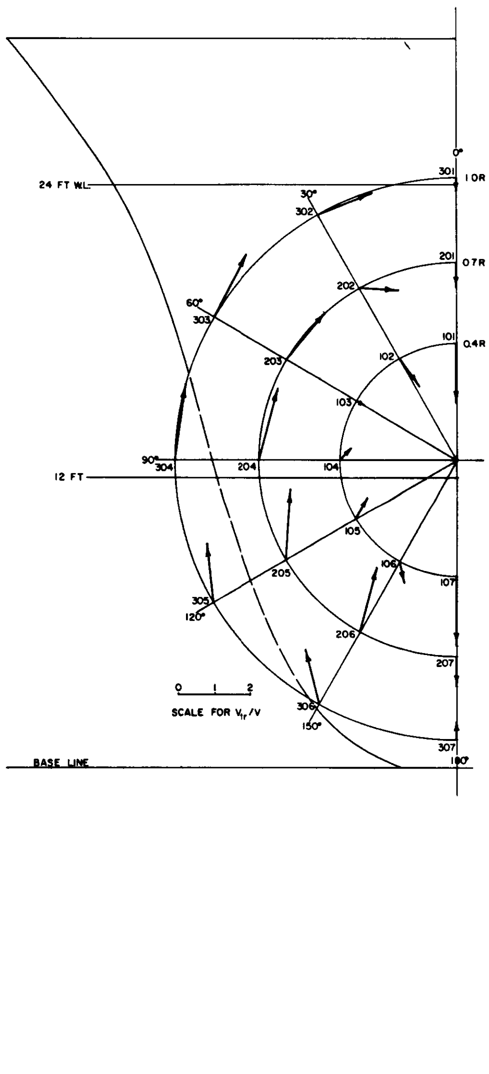


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0.360	0	-0.032
102	0.538	0 003	0.091
103	0.490	0 020	0.053
104	0.533	0 057	0.160
105	0.518	-0.046	0.196
106	0.500	-0.066	0 039
107	0.355	0	0 019
201	0 354	0	0.010
202	0 546	0 117	0 064
203	0 646	0.263	0.079
204	0 810	0 248	0.107
205	0.885	0 175	0.159
206	0.941	0 026	0.235
207	0 190	0	0.040
301	0 354	0	0.005
302	0 682	0 245	0.008
303	0.834	0 269	0 009
304	0 905	0.217	0 107
305	0 914	0.150	0 116
306	0 967	0.074	0 136
307	0.504	0	0 002

VELOCITY SURVEY IN WAY OF THE PROPELLER TANKER MODEL 4709	
MODEL DIMENSIONS	
LENGTH (LWL)	24 350 FT
BEAM	3 010 FT
DRAFT	1 260 FT
DISPLACEMENT	2 03 TONS F W
PROPELLER DIAMETER	0 666 FT
SPEED	2.77 KT
TEST 9 JUNE 1958	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT AT A POINT 15.5 FT FWD OF STA 20 DUMMY HUB AND FAIRWATER WERE IN PLACE.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION.
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

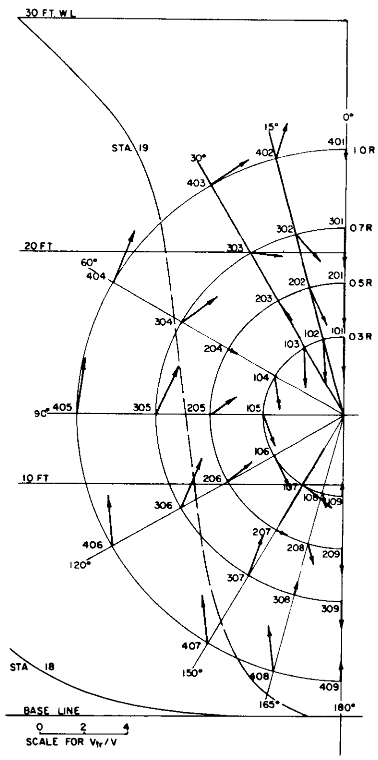


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 383	0	0.175
102	0 426	0 041	0 190
103	0 482	0 085	0 164
104	0 468	0 121	0 097
105	0 479	0 143	0 049
106	0 405	0 140	-0 016
107	0 389	0 165	-0 033
108	0 410	0 030	-0 050
109	0 424	0	0 046
201	0 406	0	0 200
202	0.522	-0.031	0 182
203	0 516	-0 011	0.112
204	0 442	-0 004	0 044
205	0 432	-0 086	0 113
206	0.364	-0 026	0 138
207	0 296	0 056	0 004
208	0 296	0 048	-0 096
209	0 388	0	-0 119
301	0 461	0	0 172
302	0 523	-0 075	0 142
303	0 539	-0 113	0 084
304	0 571	-0 178	0 071 -
305	0 752	-0 223	0 102
306	0 732	-0 149	0 184
307	0 507	-0 036	0 184
308	0 348	0 007	0 062
309	0 300	0	-0 125
401	0 398	0	0 041
402	0 381	-0 091	-0 137
403	0 657	-0 202	-0 014
404	0 877	-0 252	-0 038
405	0.935	-0 252	0 035
406	0 933	-0 206	0.099
407	0 931	-0 131	0 167
408	0 958	-0 074	0 188
409	0.145	0	0.088

VELOCITY SURVEY IN WAY OF THE PROPELLER

TANKER

MODEL 3867

MODEL DIMENSIONS

LENGTH (LWL)	25.650 FT
BEAM	3 400 FT
DRAFT	413 FT
DISPLACEMENT	2.46 TONS F W.
PROPELLER DIAMETER	0.975 FT
SPEED	3 51 KT

TEST –

JUNE 1951

THE VELOCITY MEASUREMENTS WERE MADE ALONG THE PROPELLER RAKE LINE ON THREE TRANSVERSE PLANES AT

0.3 R 6.400 FT FWD OF A.P.
0.7 R 5.833 FT FWD OF A.P.
1.0 R 5.416 FT FWD OF A.P.

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE.

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

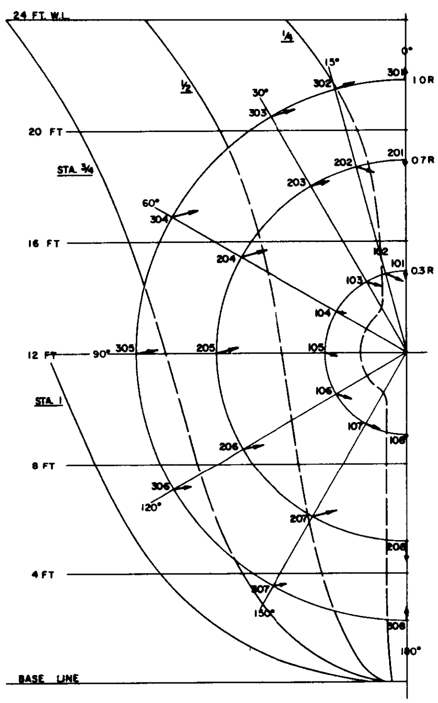


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 305	0	0.173
102	0 377	-0 018	0.169
103	0.420	0.031	0 134
104	0.441	0.049	0.077
105	0.437	0.065	0 089
106	0.397	0 138	0 035
107	0 340	0 131	-0 045
108	0 306	0	-0 053
201	0 283	0	0 032
202	0 515	-0.137	0 076
203	0.602	-0.162	0.037
204	0.793	-0 226	0.048
205	0.847	-0 185	0 096
206	0.880	-0 125	0 143
207	0.802	-0 001	0.221
208	0 333	0	-0 225
301	0.283	0	-0.076
302	0 515	-0 184	-0.022
303	0 718	-0.224	0 016
304	0 874	-0 224	0 044
305	0.883	-0.149	0.093
306	0.904	-0.097	0.120
307	0 915	-0 046	0.112
308	0 872	0	0 138

VELOCITY SURVEY IN WAY OF THE PROPELLER
TANKER
MODEL 4057

MODEL DIMENSIONS

LENGTH (LWL)	21 92 FT
BEAM	3 028 FT
DRAFT	1 190 FT
DISPLACEMENT	1 65 TONS F.W
PROPELLER DIAMETER	0 792 FT
SPEED	3 51 KT

TEST 0
FEBRUARY 1952

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 6.75 FT FWD OF STA 20. BILGE KEELS, DUMMY HUB AND FAIRWATER WERE IN PLACE.

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

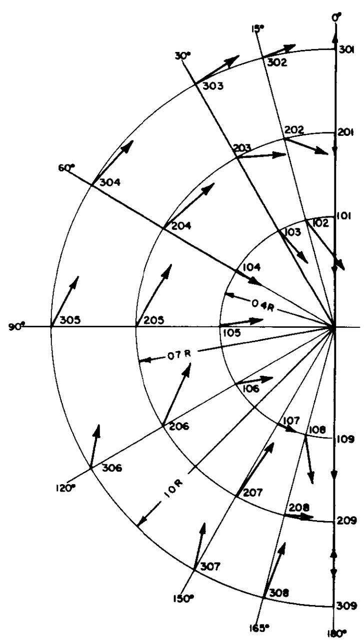


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0.338	0	0 187
102	0.441	-0.079	0.204
103	0.496	-0.028	0.145
104	0.480	0.002	0.091
105	0 488	-0.022	0.138
106	0 464	0 041	0.113
107	0 346	0.090	-0.002
108	0 465	0.067	-0.157
109	0 301	0	-0 140
201	0.311	0	0.069
202	0 482	-0 133	0.091
203	0.582	-0.146	0.069
204	0 720	-0.213	0.069
205	0.829	-0 209	0.117
206	0.847	-0 138	0.187
207	0.653	0.014	0.224
208	0 277	0.085	0.017
209	0.246	0	-0.172
301	0 250	0	-0.044
302	0.592	-0 117	-0.012
303	0.645	-0.174	-0.010
304	0.797	-0 207	0.043
305	0.895	-0 175	0.094
306	0.906	-0 119	0.105
307	0.902	-0.044	0.140
308	0.832	0.025	0.202
309	0.778	0	0.180

VELOCITY SURVEY IN WAY OF THE PROPELLER

TANKER

MODEL 4723

MODEL DIMENSIONS

LENGTH (LWL)	26 33 FT
BEAM	3.696 FT
DRAFT	1 365 FT
DISPLACEMENT	2 85 TONS F W
PROPELLER DIAMETER	0 833 FT
SPEED	3.33 KT

TEST 4

OCTOBER 1958

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT AT A POINT 12 6 FT FWD OF STA 20 DUMMY HUB AND FAIRWATER WERE IN PLACE

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

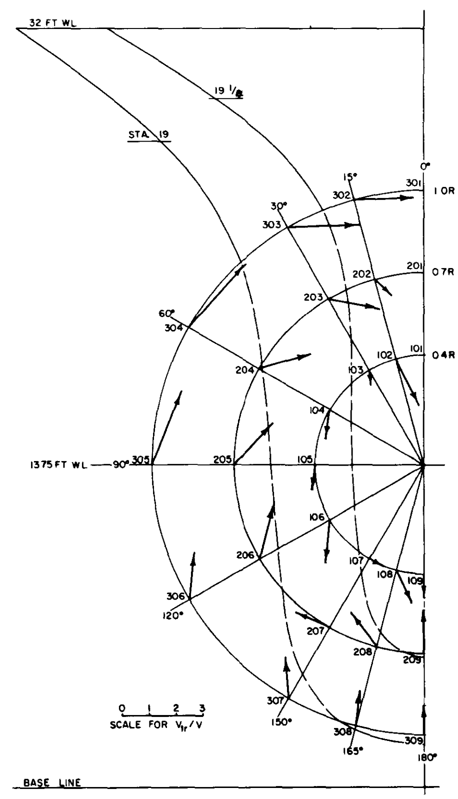


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 342	0	--
102	0 512	-0 040	0 187
103	0 551	0 020	0 047
104	0 454	0 100	0 040
105	0 328	0 093	-0 010
106	0 361	0 134	-0 092
107	0 474	0 057	-0 002
108	0 380	0 087	-0.106
109	0 340	0	-0 083
201	0.266	0	--
202	0 590	-0 043	0 072
203	0 567	-0 142	0 122
204	0 563	-0 141	0 134
205	0 569	-0 153	0 146
206	0 502	-0 154	0 151
207	0 395	-0 136	-0 015
208	0 454	-0 119	0 093
209	0 570	0	0 154
301	0 300	0	--
302	0 544	0 209	0 045
303	0.520	0 226	0 116
304	0 767	0.302	0 059
305	0 877	0 270	0 110
306	0 791	0 142	0 101
307	0 886	0 083	0 124
308	0 893	0 015	0.124
309	0 902	0	0 108

VELOCITY SURVEY IN WAY OF THE PROPELLER TANKER MODEL 4643	
MODEL DIMENSIONS	
LENGTH (LWL)	24 490 FT
BEAM	3.250 FT
DRAFT	1 300 FT
DISPLACEMENT	2.27 TONS F W
PROPELLER DIAMETER	0.562 FT
SPEED	3 18 KT
TEST 0 MAY 1957	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT A POINT 6 95 FT AFT OF STA 19 1/2 DUMMY HUB AND FAIRWATER WERE IN PLACE THE SHAFT ANGLE IS 1 75° FROM THE BASE PLANE

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

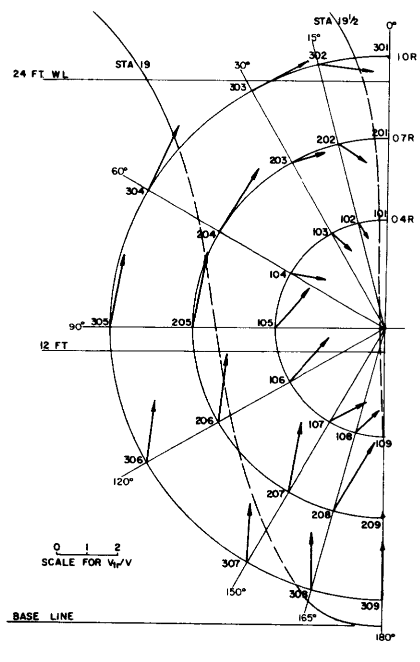


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 210	0	0
102	0 210	-0 020	0 060
103	0 292	-0 030	0 083
104	0 159	-0 037	0 107
105	0 401	-0 136	0 112
106	0 496	-0 062	0 184
107	0 291	0 077	0 116
108	0 420	0 060	0 080
109	0 200	0	0
201	0 200	0	0
202	0 397	-0 076	0 081
203	0 429	-0 103	0 026
204	0 589	-0 243	0 005
205	0 844	-0 256	0 047
206	0 906	-0 180	0 136
207	0 869	-0 079	0 223
208	0 601	0 080	0 258
209	0 360	0	0 019
301	0 173	0	0 005
302	0 377	-0 176	0 067
303	0.523	-0 211	0 002
304	0 778	-0 264	-0 022
305	0 906	-0 239	0 048
306	0 925	-0 163	0 126
307	0 906	-0 090	0 173
308	0 909	-0 053	0 181
309	0 672	0	0 197

VELOCITY SURVEY IN WAY OF THE PROPELLER	
AS-33	
MODEL 4912	
MODEL DIMENSIONS	
LENGTH (LWL)	22 96 FT
BEAM	3 15 FT
DRAFT	0 889 FT
DISPLACEMENT	1 075 TONS F W
PROPELLER DIAMETER	0.666 FT
SPEED	3 46 KT
TEST 8	
APRIL 1962	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE CENTERLINE OF THE SHAFT 7 11 FT AFT OF STA 19.

- r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)
- θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION
- V IS THE SHIP SPEED
- V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION
- V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION
- V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE
- V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

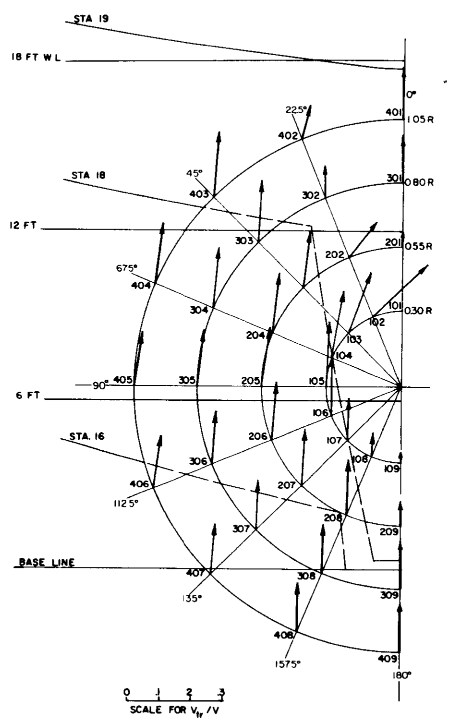


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 622	0	0 001
102	0 875	-0 224	-0 008
103	1 004	-0 183	-0 084
104	1 017	-0 208	-0 046
105	1 011	-0 205	0 012
106	1 014	-0 173	0 075
107	0 973	-0 090	0 099
108	0 961	-0 024	0 070
109	0 958	0	0 050
201	0 842	0	-0 076
202	0 838	-0 124	-0 070
203	0 988	-0 142	-0 109
204	1 006	-0 180	-0 052
205	0 998	-0 185	0 024
206	0 988	-0 164	0 082
207	1 004	-0 119	0 134
208	1 003	-0 063	0 162
209	0 953	0	0 180
301	0 776	0	-0 152
302	0 785	-0 037	-0 093
303	0 944	-0 143	-0 129
304	0 971	-0 183	-0 056
305	0 975	-0 176	0 021
306	0 972	-0 149	0 074
307	0 987	-0 108	0 116
308	0 988	-0 056	0 148
309	0 975	0	0 150
401	0 723	0	-0 160
402	0 638	-0 066	-0 088
403	0 900	-0 155	-0 135
404	0 962	-0 186	-0 052
405	0 971	-0 177	0 026
406	0 972	-0 145	0 085
407	0 967	-0 103	0 122
408	0 977	-0 048	0 144
409	0 982	0	0 152

VELOCITY SURVEY IN WAY OF THE PROPELLER	
AGS	
MODEL 5004	
MODEL DIMENSIONS	
LENGTH (LWL)	21 15 FT
BEAM	2 99 FT
DRAFT	0 948 FT
DISPLACEMENT	0.872 TONS F W
PROPELLER DIAMETER	0.739 FT
SPEED	3.82 KT
TEST 9	
NOVEMBER 1964	

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t AND V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr}/V

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT CENTERLINE 3 75 FT AFT OF STATION 19

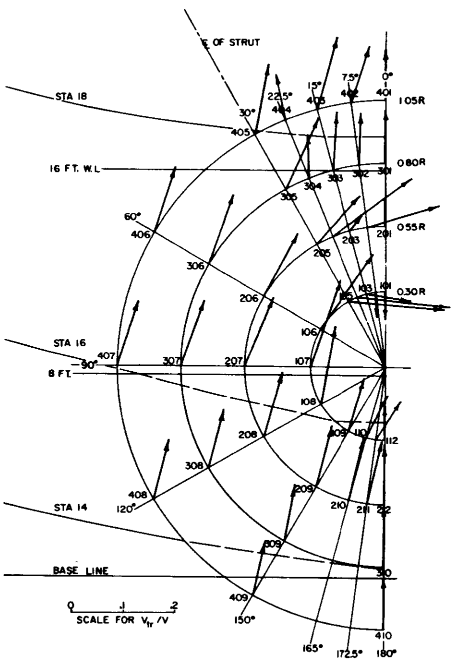


TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x V	V_t V	V_r V
101	0 643	0	0 061
102	0 637	0 006	0 053
103	0 571	-0 108	0 048
104	0 761	-0 182	0 098
105	0 824	-0 176	0.111
106	0 953	-0.201	0 021
107	0 971	-0 188	0 065
108	1 015	-0.131	0 112
109	0 966	-0.026	0.125
110	0 943	0 023	0 102
111	0 936	0.045	0.091
112	0.932	0	0.080
201	0 817	0	-0 054
202	0 714	-0 164	-0 028
203	0 838	-0 032	-0 042
204	0 909	-0 210	-0.055
205	0.933	-0.134	-0.044
206	0.957	-0.157	-0.005
207	0 953	-0 147	0 061
208	0 958	-0 103	0 107
209	0 959	-0.037	0.138
210	0.948	-0.003	0.144
211	0 937	0 016	0.141
212	0 934	0	0.137
301	0 824	0	-0.019
302	0 792	-0 016	-0.110
303	0 824	-0.063	-0 120
304	0 762	-0.032	-0.084
305	0.923	-0.134	-0 097
306	0.940	-0.156	-0.026
307	0.965	-0.144	-0.051
308	0 973	-0.094	0.094
309	0.965	-0 043	0 118
310	0.955	0	0.117
401	0.755	0	-0.105
402	0 769	-0.057	-0.112
403	0 830	-0.084	-0.135
404	0.791	-0.017	-0.099
405	0 844	-0 101	-0.117
406	0 884	-0 148	-0.029
407	0 947	-0.137	0.050
408	0 953	-0 095	0 096
409	0 952	-0 038	0.116
410	0 949	0	0 115

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12. Weaver, A. H., Jr., "Powering Characteristics and Velocity Survey in Way of the Propeller for a 770-Foot Tanker Represented by Model 4643," David Taylor Model Basin Report 1161 (Jul 1957).

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15. Dillion, E. Scott, "Ship Design for Improved Cargo Handling," Trans. SNAME, Vol 70, 1962.

16. Nichols, W. O., Rubin, M. L., and Danielson, R. V., "Some Aspects of Large Tanker Design," Trans. SNAME, Vol 68, 1960.

VELOCITY SURVEY IN WAY OF THE PROPELLER CARGO MODEL 4882	
MODEL DIMENSIONS	
LENGTH (LWL)	18 82 FT
BEAM	2.829 FT
DRAFT	0.978 FT
DISPLACEMENT	0.772 TONS F W.
PROPELLER DIAMETER	0 732 FT
SPEED	4.3 KT
TEST 7 MAY 1961	

THE VELOCITY MEASUREMENTS WERE MADE IN A PLANE WHICH IS PERPENDICULAR TO THE CENTERLINE OF THE PROPELLER SHAFT AND INTERSECTS THE SHAFT LINE AT STA 19 1/2. THE SHAFT LINE SLOPE IS 0 149 IN RISE PER FOOT FWD. DUMMY HUB AND FAIRWATER WERE USED.

r/R IS THE DISTANCE FROM THE PROPELLER AXIS (r) EXPRESSED AS A RATIO OF THE PROPELLER RADIUS (R)

θ IS THE ANGLE MEASURED FROM THE TOP OF THE PROPELLER DISK IN A COUNTERCLOCKWISE DIRECTION

V IS THE SHIP SPEED

V_x IS THE LONGITUDINAL (NORMAL TO THE PLANE OF SURVEY) COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE ASTERN DIRECTION

V_t IS THE TANGENTIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE IN THE COUNTERCLOCKWISE DIRECTION

V_r IS THE RADIAL COMPONENT OF THE WATER VELOCITY AND IS POSITIVE TOWARD THE SHAFT CENTERLINE

V_{tr} IS THE TRANSVERSE COMPONENT OF THE WATER VELOCITY AND IS THE VECTOR SUM OF V_t and V_r

THE VECTOR SHOWN IN THE DIAGRAM IS IN THE DIRECTION OF V_{tr} WITH A MAGNITUDE EQUAL TO V_{tr} V

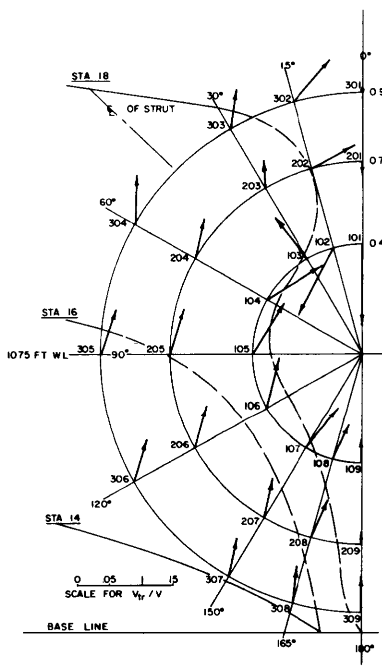

TABLE OF COMPONENT RATIOS

POSITION NUMBER	V_x/V	V_t/V	V_r/V
101	0 749	0	0 129
102	0 732	0 079	0 099
103	0 605	0 013	-0 078
104	0 967	-0 088	0 047
105	0 967	-0 084	0 048
106	0 970	-0 061	0 062
107	0 922	0 008	0 082
108	0 866	0 006	0 058
109	0 872	0	0 043
201	0 734	0	0 024
202	0 905	-0 072	-0 017
203	0 955	-0 024	-0 037
204	0 942	-0 055	-0 015
205	0 954	-0 067	0 023
206	0 956	-0 050	0 050
207	0 960	-0 019	0 064
208	0 948	0 010	0 066
209	0 897	0	0 018
301	0 682	0	-0 006
302	0 879	-0 068	-0 048
303	0 912	-0 039	-0 046
304	0 924	-0 066	-0 036
305	0 950	-0 066	0 024
306	0 957	-0 046	0.049
307	0 955	-0 020	0 059
308	0 959	-0 005	0 062
309	0 959	0	0 057

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UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author) David Taylor Model Basin Department of the Navy Washington, D.C. 20007	2a REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b GROUP

3 REPORT TITLE

WAKE ANALYSIS OF SHIP MODELS; SINGLE-SCREW MERCHANT-TYPE

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final

5. AUTHOR(S) (Last name, first name, initial)

Cheng, Henry M., Hadler, Jacques B.

6. REPORT DATE	7a TOTAL NO. OF PAGES	7b. NO. OF REFS
November 1965	124	16

8a. CONTRACT OR GRANT NO. b. PROJECT NO. Subproject S-R011 01 01 c. Task 0401 d.	9a ORIGINATOR'S REPORT NUMBER(S) Report 2076 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. AVAILABILITY/LIMITATION NOTICES

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Bureau of Ships Department of the Navy Washington, D.C. 20025

13 ABSTRACT

This report, the third of a series on studies of the wake in the propeller plane of ship models, presents the results of the analysis of the wake of single-screw merchant ship models and several naval auxiliaries. The data presented are the interpolated longitudinal and tangential velocity distributions, their computed mean values, the harmonic contents of these velocity components, the maximum variations in the resultant inflow velocity, and the advance angles and their variations. Also included are the calculated volumetric wake velocities. An IBM 7090 computer was used for data processing.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Wake						
Propeller						
Cavitation						
Vibration						
Merchant Ships						
Digital Computer						

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