NAVY DEPARTMENT
THE DAVID W. TAYLOR MODEL BASIN
WASHINGTON 7, D.C.

COMPARATIVE RESISTANCE DATA FOR FOUR PLANING BOAT DESIGNS

By

Eugene P. Clement

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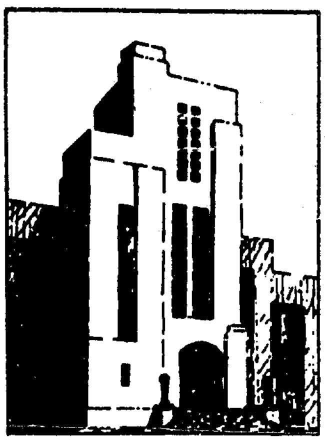

RESEARCH AND DEVELOPMENT REPORT

JANUARY 1957

Report No. 1113

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NOTATION

Symbols

A	Projected area bounded by chines and transom, in plan view
B	Breadth over chines at any point
B_A	Mean breadth over chines, A/L
B_T	Breadth over chines at transom
B_X	Maximum breadth over chines
bhp	Engine brake horsepower
C_{HA}	Draft coefficient, aft; equals draft at 0%L (measured from tangent to mean buttock at stern) multiplied by A/∇
C_{HF}	Draft coefficient, forward; equals draft at 100%L (measured from tangent to mean buttock at stern) multiplied by A/∇
ehp	Effective Horsepower
$F_{n\nabla}$	Froude number based on volume, in any consistent units $v/\sqrt{g\nabla^{1/3}}$
g	Acceleration due to gravity
L	Overall length of the area, A, measured parallel to baseline
LCG	Longitudinal center of gravity location
P	Effective power, ft-lb/sec
R	Total resistance
R_m	Total model resistance, lb
S	Wetted surface, area of
SW/FW	Density ratio, salt water to fresh water

v	Speed
V	Speed, knots
w	Density of water (weight per unit volume)
WL_C	Intersection of chine with solid water, forward of 0%L, ft
WL_K	Wetted length of keel, forward of 0%L, ft
WL_{SP}	Intersection of chine with spray, forward of 0%L, ft
α	Angle with horizontal of tangent to mean buttock at stern, deg
β	Deadrise angle of hull bottom, deg
Δ	Displacement at rest, weight of
τ	Trim angle of hull with respect to attitude as drawn, deg
∇	Displacement at rest, volume of

Subscripts

M,m	Model
S,s	Ship
o	Value at rest

ABSTRACT

Four existing models of planing craft were retested at the Taylor Model Basin's "standard condition" for planing boat models. The test results for each model are presented in a design data sheet. The data are compared to show the effects of differences in hull form. These comparisons are independent of differences in hull loading, in LCG location, or in size of boat. Auxiliary graphs are included to assist in making estimates of speed and power for new designs.

INTRODUCTION

The Taylor Model Basin has accumulated a number of models of planing boats which were tested for smooth water performance in previous years. In general each of these models was built to represent a particular boat and the test results in each case were presented in dimensional form for a boat of specific size. In general the hull forms and the test conditions were unrelated. Data of this kind are not well suited for answering one of the chief questions that arises in design work, - the question as to the relative merit of different hull forms. When planing boat data of the kind referred to above are compared, even in dimensionless form, differences in performance due to differences in hull form are usually confused or obscured by two factors:

(a) By differences in hull loading and LCG location.

(b) By differences in size of boat to which the model resistance is corrected.

Fortunately these kinds of differences can be eliminated by adopting the practice of testing each model at a standard condition of hull loading and LCG location, and correcting the resistance data from each model to the same full size displacement. This has now been done for four of the models of planing boats which were on hand at the Model Basin, and the results are given in the present report.

STANDARD TEST CONDITIONS

Definition of hull loading

The definitions of hull loading and of LCG location for the planing boat need to be selected with some care in order to be significant and useful. Hull loading is defined here as the ratio $\Delta/\nabla^{2/3}$, as proposed in Reference 1*. The suitability of this coefficient can probably best be shown by analogy of the planing boat to the airplane. At high speed a planing boat's chief support is not from buoyancy, but from that type of lift which supports an airplane, i.e., dynamic lift. Accordingly, the important factors affecting the design and performance of the planing hull are not those involving the waterline at rest or the shape of the underwater hull at rest, as in the case of the displacement-type hull; instead, the important factors are those influencing the performance of the planing bottom in providing effective dynamic lift. And, as the projected wing area is of fundamental importance in the case of the airplane, so is the projected bottom area of fundamental importance in the case of the planing boat. It may be pointed out as an objection that when a boat is planing at high speed in smooth water a large proportion of the bottom area is unwetted, and therefore is making no contribution to the dynamic lift. In the more important and critical condition of operation in rough water, however, the entire bottom area contributes periodically to the dynamic lift. Therefore in rough water, and especially in a following sea, the magnitude and disposition of this area assume very great importance.

Now in the case of the airplane a significant relationship involving the wing area is the "wing loading", which is the ratio of the gross weight to the projected wing area. A somewhat similar relationship is significant for the planing boat. However, it is not appropriate to use the identical ratio in this case. The reason for this can probably best be shown by means of an example. Assume that we have a boat 30 feet long with a projected bottom area, A, of 180 ft^2 and a gross weight of 8000 lb, and also a geometrically similar boat 60 feet long and of corresponding weight. The ratio $\frac{\Delta}{A}$, or "bottom loading", for the 30-ft boat is then $\frac{8000}{180} = 44.5$ lb/ft^2. Since the linear dimensions of the large boat are twice those of the small boat, the bottom area of the large boat equals $(2)^2$ times the bottom area of the small boat, and the gross weight of the large boat equals $(2)^3$ times the gross weight of the small boat. The "bottom loading" for the 60-ft boat is then:

$$\frac{\Delta}{A} = \frac{8000 \cdot (2)^3}{180 \cdot (2)^2} = 2 \cdot 44.5 = 89.0 \text{ lb/ft}^2$$

Evidently then, "bottom loading" in lb/ft^2 is a function of absolute size and is therefore unsuitable as a criterion of the

* References are listed on page 8.

relationship between gross weight and bottom area for different sizes of boats. In the example just considered a suitable coefficient would have yielded identical values, since the boats were geometrically similar. If the relationship is changed from Δ/A to $\Delta^{2/3}/A$, the ratio will no longer be affected by absolute size and a useful criterion of loading will have been attained. In the present example $\Delta^{2/3}/A = 2.22$ for both boats. If the ratio is further altered from $\Delta^{2/3}/A$ to $\nabla^{2/3}/A$, a dimensionless ratio is attained which has some physical significance and which is not affected by differences in water density (as between a full size boat in salt water and the corresponding model in fresh water). Inverting this we obtain the area coefficient, $A/\nabla^{2/3}$, as proposed in Reference 1. The value of this area coefficient is 7.2 for both of the boats in the present example. This ratio has a useful physical interpretation; it indicates the ratio of the projected bottom area of the boat to the area of one side of a cube whose volume equals the volume of water displaced at rest.

Definition of LCG location

Analogy to aircraft practice is also useful in arriving at a satisfactory method of defining LCG location. The problem involved is indicated by Figure 1 which shows plan views of the bottoms of two planing boat designs. Design I has a narrow transom, with the centroid of the projected bottom area and the position of maximum breadth relatively far forward. Design II has a wide transom, with the centroid of the projected bottom area and the position of maximum breadth relatively far aft. It seems evident that it would not be correct to consider that these two designs have corresponding center of gravity locations simply if the LCG's of the two designs are located at the same percentage points on the centerline lengths. This would be somewhat the same as if an aerodynamicist were to treat his longitudinal C.G. location in terms of the centerline chord of the wing, without regard to the amount of sweepback of the wing. The aerodynamicist, of course, does not do this; instead he treats the LCG location in terms of the mean aerodynamic chord of the entire wing. A similar effect is achieved for planing boats by DTMB's practice of treating the longitudinal center of gravity in terms of the distance from the centroid of the area, A.

In order to arrive at representative average values of $A/\nabla^{2/3}$ and LCG location, the weights, hull areas and LCG locations for a number of planing boat designs were evaluated in Reference 1. From this evaluation, the standard condition selected for tests of planing boat designs at the Model Basin corresponds to $A/\nabla^{2/3} = 7$, and the LCG located at 6%L aft of the centroid of the area A.

Four models were retested at this standard condition and the results are given in this report in Figures 2 through 5. In addition, Model 3592-1 (Figure 2) was tested at $A/\nabla^{2/3} = 7$, with the LCG at 10%L aft of the centroid of A, and Model 3722 (Figure 5) was tested at $A/\nabla^{2/3} = 8$, with the LCG at 6%L aft of the centroid of A.

DESIGN DATA SHEETS

The test results for each model are presented in a design data sheet, as proposed in Reference 1. The dimensionless speed coefficient used is Froude's number based on volume of water displaced at rest, referred to as $F_{n\nabla}$. The effect of using this speed coefficient is the same as that of using (K). By using $F_{n\nabla}$, however, an unnecessary constant, $\sqrt{4\pi}$, is avoided ($F_{n\nabla} = v/\sqrt{g\nabla^{1/3}}$, whereas (K) $= \sqrt{4\pi} \cdot v/\sqrt{g\nabla^{1/3}}$).

Curves of the dimensionless power coefficient, $\frac{10\,P}{wg^{1/2}\nabla^{7/6}}$ are included in the performance characteristics section of each design data sheet. The advantages of using this power coefficient, and also the speed coefficient $F_{n\nabla}$, are clearly explained in Reference 2.

The main reason for the form in which the performance characteristics are presented is so that the designer can pick the most efficient hull form with the least effort. The curves of R/Δ as they appear in the design data sheets can be compared directly to show the relative merit of different hull forms, throughout the speed range. The same picture of relative merit will be shown by a comparison of the curves of power coefficient. The latter curves are also included for another purpose, however, as will appear later. The curves of α and of $S/\nabla^{2/3}$, for the different designs, can also be compared directly to show how the angle of attack and the wetted areas of different designs compare.

ESTIMATING THE SPEED OF A NEW DESIGN

Auxiliary graphs, Figures 6, 7 and 8 are included to assist in applying the information in the design data sheets to specific design problems. Assume for example that it is desired to estimate the speed of a 50,000 lb boat having an engine horsepower of 1200 bhp; the hull form and loading to be similar to that for Model 3626, which is shown in Figure 3. Since the design data sheet gives resistance and ehp data without appendages it is first necessary to estimate the value of the ratio of ehp without appendages to bhp with appendages. For the present example the value of this ratio would be about 0.5. Then, ehp (without appendages) = 0.5 • bhp (with appendages) = 600. Then from Figure 6, the value of the power coefficient, 10 $P/wg^{1/2}\nabla^{7/6}$ is 3.84. Now the curve of power coefficient in each of the design data sheets was necessarily calculated for a specific full scale displacement. As indicated the displacement assumed was 100,000 lb. Therefore Figure 7 has been prepared to assist in converting between power coefficients at 100,000 lb displacement and power coefficients at other values of displacement. The procedure for the present example is to enter the horizontal scale of Figure 7 with the value of displacement (50,000 lb); then, from this point extend a vertical line to the power coefficient value of 3.84 in the family of curved lines. From this point extend a horizontal line to the scale at the left side of the graph and here read off the value of power coefficient for 100,000 lb displacement (3.80 in this case).

The family of curved lines in Figure 7 indicates constant values of the power coefficient for displacements ranging from 20,000 to 160,000 lb. The horizontal lines, together with the scale at the left of the graph, indicate corresponding constant values of the power coefficient for 100,000 lb displacement. The fact that the value of this dimensionless power coefficient varies with displacement (i.e., with size of boat), is caused, of course, by the fact that the larger of two similar boats will have a higher value of Reynolds' number than the smaller boat when the two are operating at corresponding speeds; therefore the frictional resistance coefficients, and hence also the values of power coefficient, will be lower for the large boat than for the small boat. In the present example the magnitude of the correction for difference in size is very small; the value of the power coefficient is only about 1% less for 100,000 lb displacement than for 50,000 lb displacement. At higher speeds, and with greater differences in displacement, the magnitude of the correction can become appreciable. Figure 7 shows for example that when the value of power coefficient for 20,000 lb displacement equals 8.2, the corresponding value for 100,000 lb displacement is 7.74, which is 5.6% less.

The next step in estimating the speed for the 50,000 lb, 1200 bhp boat is to enter the power coefficient curve in Figure 3 with the value of 3.8. The corresponding value of $F_{n\nabla}$ is found to be 3.04. Entering Figure 8 with this value, at a displacement of 50,000 lb, we obtain an estimated speed of 31 knots.

ESTIMATING THE POWER FOR A NEW DESIGN

The information in the design data sheets can also be used for the reverse process, i.e., to estimate the ehp required for a given speed and gross weight. Either the curve of R/Δ or the curve of power coefficient can be used for this calculation. The procedure is essentially the reverse of the procedure just indicated.

COMPARISON OF RESISTANCES

The curves of R/Δ (or of $10\ P/wg^{1/2}\nabla^{7/6}$) in Figures 2, 3, 4 and 5 can be compared directly to show the relative resistances (or power requirements) of the different designs. The resistances are compared in Figure 9. This comparison is on the basis of equal size (i.e., equal area, A, and equal gross weight), equal speed, and corresponding center of gravity location. The remaining differences in resistance are caused by differences in hull form.

As discussed in Reference 1, the superiority of Model 3722 over Model 3720 can be attributed to the much smaller amount of twist in the hull bottom of Model 3722. It is evident from Figure 9 that Models 3626 and 3722 are the two designs which are of the most interest: Model 3626 because it has the least resistance at high speeds, and Model 3722 because it has the lowest average resistance throughout the speed range. The chief difference between the hull forms of Models 3626 and 3722 is that the length/beam ratio of Model 3626 is appreciably lower than that of Model 3722. It was shown in Reference 1 that length/beam ratio has an appreciable influence on resistance; also it was pointed out that the choice of the length/beam ratio for a new design depends to a large extent on the size of the boat and on the type of service intended. For these reasons it is desirable to compare the performance of different hull forms on the basis of equal length/beam ratio. This suggests a graph like Figure 10, in which R/Δ is plotted against length/beam ratio for several different values of the speed coefficient. The data from the four designs reported on here are plotted in this graph. A useful advantage can now be derived from the fact that except for the difference in length/beam ratios, and some difference in the extreme bow portions, Models 3626 and 3722 are very similar. The bow portions are dry in smooth water at all but very low speeds and therefore have no effect on the smooth water resistance for the speeds of significance. Evidently then, lines connecting the data points for Models 3626 and 3722 in Figure 10 will indicate the trend of the effect of length/beam ratio on resistance for the different speeds. Lines of this sort are drawn in the figure. However, instead of depending entirely on the data from only two models, additional data (not included here) from other pairs of models which were similar except for differences in length/beam ratio, were used to guide the slopes to which the lines should be drawn. Accordingly it was possible to extend the lines of Figure 10 over a greater range of length/beam ratio, and to have more confidence in their significance, than if they depended only on the limited data shown.

The lines of Figure 10 illustrate the fact that for speeds below $F_{n\nabla} = 2.5$, planing boat resistance decreases with increasing length/beam ratio. At higher speeds (up to $F_{n\nabla}$ equals about 4.2) the resistance increases with increasing length/beam ratio.

By means of Figure 10 it is now possible to make resistance comparisons which are not affected by differences in length/beam ratio. When resistance data are available for a new design they can be plotted on Figure 10. Then at each speed the vertical distance from the data point for the new design to the line in the graph, will show the difference between the resistance of the new design and a hull of the form represented by Models 3626 and 3722, but having the same length/beam ratio as the new design. Or, alternatively, the resistance curve for the new design can be compared with a curve constructed from Figure 10 using the length/beam ratio of the new design. By eliminating the effect of length/beam ratio in this way it will be possible to see the effects on resistance of the other hull form parameters.

REFERENCES

1. Clement, Eugene P., "Analyzing the Stepless Planing Boat", DTMB Report 1093, November 1956.

2. Nordstrom, H. F., "Some Tests with Models of Small Vessels", Publication No. 19 of the Swedish State Shipbuilding Experimental Tank, 1951.

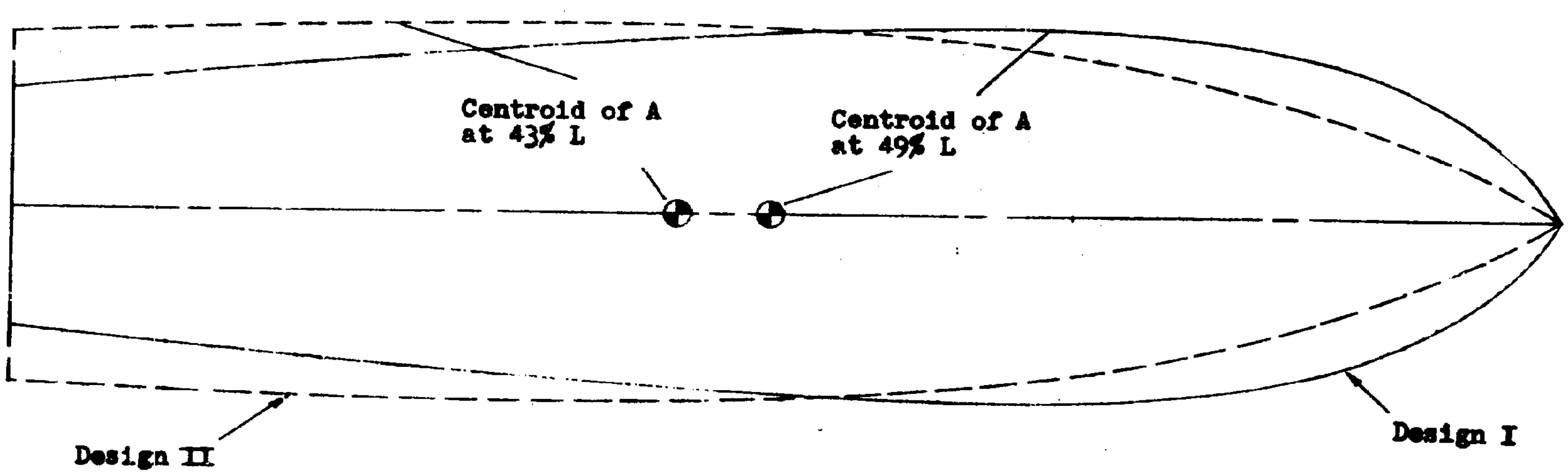
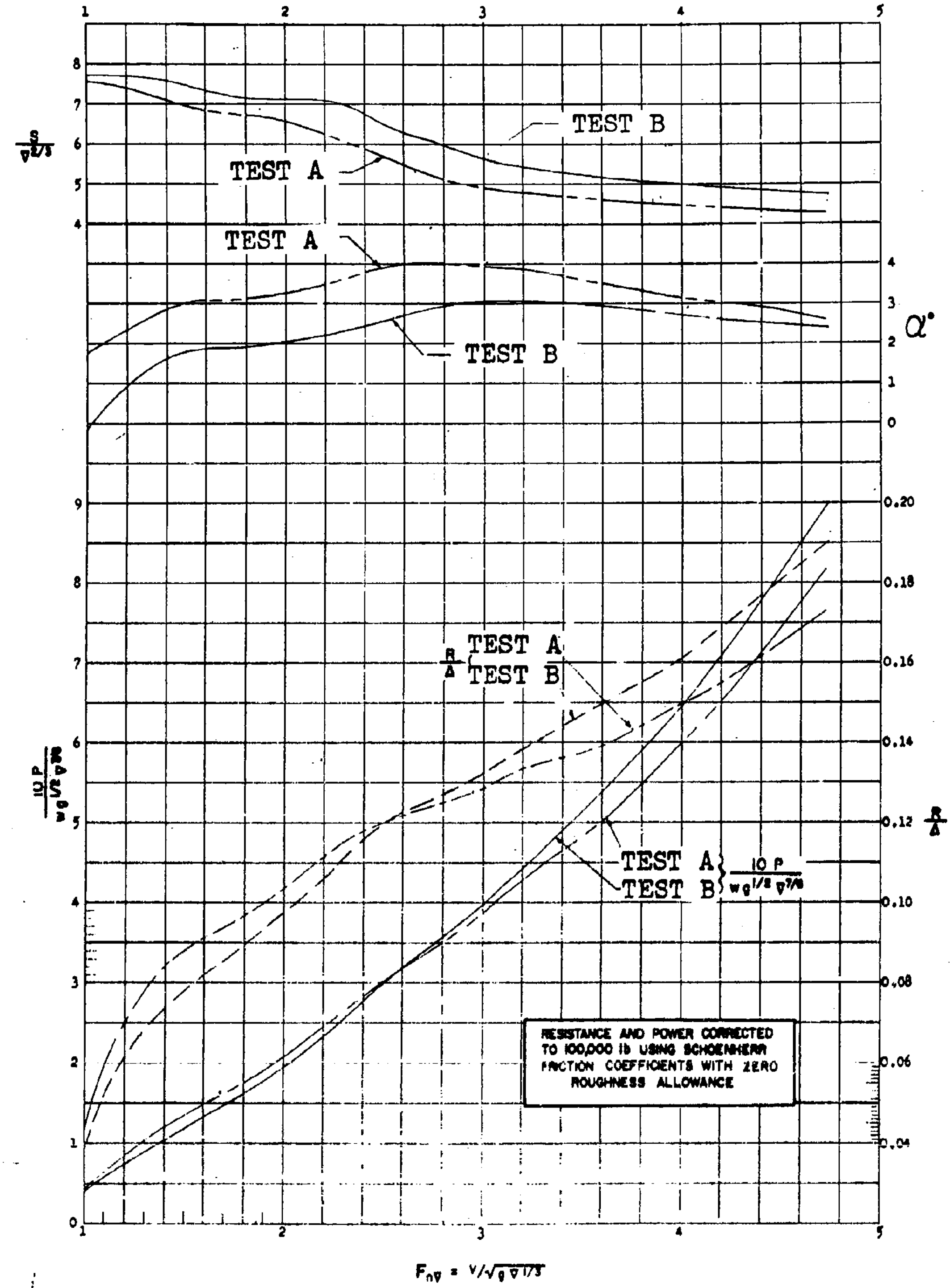


Figure 1 - The Chine Lines in Plan View of Two Planing Boat Designs.

IV PERFORMANCE CHARACTERISTICS



TE	
V_M	R_M
3.91	7.82
4.91	13.43
5.87	16.17
6.86	17.79
7.82	19.64
8.85	21.68
9.86	23.29
10.86	24.31
11.84	25.43
12.82	26.89
13.84	27.94
14.84	29.45
15.72	31.01
16.74	32.80
17.76	34.87
18.72	36.96

2

PLANING BOAT DESIGN DATA SHEET
DAVID W. TAYLOR MODEL BASIN
JUNE 1955

DTMB MODEL 3592-1 1/9 SCALE

MODEL DATA

BASIN HIGH SPEED BASIN
BASIN SIZE 2968'x21'x(10'and 16')
DATE OF TEST 23 FEB 55
WATER TEMP. 68°F
APPENDAGES SPRAY STRIPS
TURBULENCE STIM. NONE
MODEL MATERIAL WOOD
MODEL FINISH PAINT

TEST A

V_M	R_M	WL_K	WL_C	WL_{SP}
3.91	7.82	8.42	4.92	
4.91	13.43	8.25	6.42	6.73
5.87	16.17	8.08	6.08	6.58
6.86	17.79	7.92	5.88	6.58
7.82	19.64	7.75	5.62	6.54
8.85	21.68	7.50	5.29	6.33
9.86	23.29	7.32	4.93	6.10
10.86	24.31	6.96	4.62	5.83
11.84	25.43	6.75	4.42	5.71
12.82	26.89	6.67	4.17	5.46
13.84	27.94	6.58	4.00	5.38
14.84	29.45	6.58	3.83	5.25
15.72	31.01	6.57		
16.74	32.80	6.54	3.54	5.12
17.76	34.87	6.58	3.42	5.08
18.72	36.96	6.58	3.25	5.08

TEST B

V_M	R_M	WL_K	WL_C	WL_{SP}
3.98	7.30	8.46	7.33	7.75
4.97	12.23	8.42	6.96	7.42
5.93	14.76	8.35	6.62	7.25
6.93	16.73	8.28	6.42	7.13
7.90	18.91	8.25	6.17	7.04
8.90	21.37	8.08	5.83	6.88
9.88	23.57	7.92	5.71	6.67
10.90	25.15	7.67	5.33	6.46
11.87	26.53	7.50	5.00	6.29
12.81	28.28	7.35	4.75	6.13
13.85	30.11	7.25	4.58	6.04
14.82	31.79	7.08	4.33	5.92
15.82	33.59	7.08	4.17	5.83
16.76	35.78	7.08	4.04	5.75
17.74	38.14	7.08	3.87	5.75
18.75	40.55	7.04	3.71	5.68

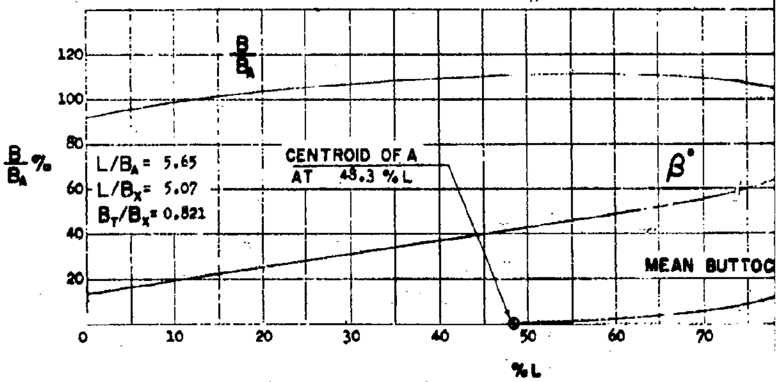
REMARKS:

Relatively high $\frac{L}{B_A}$ ratio and excessive twist (indicated by rate of cha angle β) give poor resistance characteristics at $F_{n\nabla} > 2.8$. Relative sections associated with narrow stern give low resistance at $F_{n\nabla}$ < 2. average resistance at $2.3 < F_{n\nabla} < 2.8$

I TEST CONDITIONS

TEST	Δ_M lb	Δ_S lb	$\frac{A}{\nabla^{2/3}}$	$\frac{L}{\nabla^{1/3}}$	MAXIMUM STABLE $F_{n\nabla}$	τ_o	α_o	DRAFT COEFF. FWD.	DRAFT COEFF. AFT.
A	167.5	125,575	7.00	6.29	--------	1.10° x BOW	+ 0.30°	1.062	1.292
B	167.5	125,575	7.00	6.29	--------	2.10° x BOW	- 0.70°	1.527	0.990

II FORM CHARACTERISTICS



III LINES

MODEL	FULL SIZE
A = 13.536 sq. ft.	A = 1096.4 sq. ft.
L = 8.742 ft.	L = 78.68 ft.
B_A = 1.548 ft.	B_A = 13.93 ft.

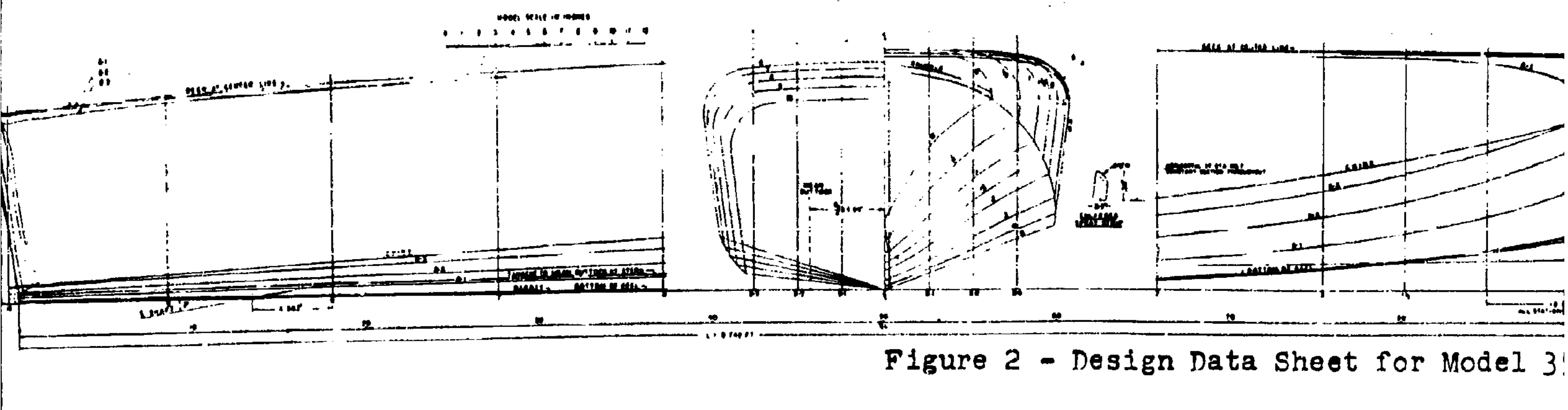


Figure 2 - Design Data Sheet for Model 3

PLANING BOAT DESIGN DATA SHEET
DAVID W. TAYLOR MODEL BASIN
JUNE 1955

DTMB MODEL 3592-1 | 1/9 SCALE | 80 FT. PT 8

3

...EL DATA

...PEED BASIN
...968'x21'x(10' and 16')
...ST 23 FEB 55
... 66°F
... SPRAY STRIPS
... STIM. NONE
...RIAL WOOD
...H PAINT

TEST B

V_M	R_M	WL_K	WL_C	WL_{SP}
3.98	7.30	8.46	7.33	7.75
4.97	12.23	8.42	6.96	7.42
5.93	14.76	8.35	6.62	7.25
6.93	16.73	8.28	6.42	7.13
7.90	18.91	8.25	6.17	7.04
8.90	21.37	8.08	5.83	6.88
9.88	23.57	7.92	5.71	6.67
10.90	25.15	7.67	5.33	6.46
11.87	26.53	7.50	5.00	6.29
12.81	28.28	7.35	4.75	6.13
13.85	30.11	7.25	4.58	6.04
14.82	31.79	7.08	4.33	5.92
15.82	33.59	7.08	4.17	5.83
16.76	35.78	7.08	4.04	5.75
17.74	38.14	7.08	3.87	5.75
18.75	40.55	7.04	3.71	5.68

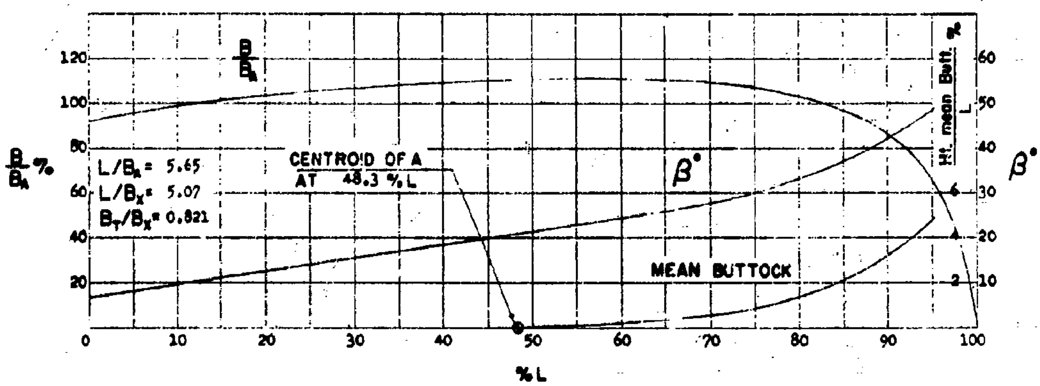
REMARKS:

Relatively high $\frac{L}{B_A}$ ratio and excessive twist (indicated by rate of change of angle β) give poor resistance characteristics at $F_{n\nabla} > 2.8$. Relatively straight sections associated with narrow stern give low resistance at $F_{n\nabla} < 2.3$ and average resistance at $2.3 < F_{n\nabla} < 2.8$

I TEST CONDITIONS

TEST	Δ_M lb	Δ_S lb	$\frac{A}{\nabla^{2/3}}$	$\frac{L}{\nabla^{1/3}}$	MAXIMUM STABLE $F_{n\nabla}$	τ_0	α_0	DRAFT COEFF. FWD.	DRAFT COEFF. AFT.	CG AFT OF CENTROID OF A	LCG % L
A	167.5	125,575	7.00	6.29	--------	1.10° x BOW	+ 0.30°	1.062	1.292	10.0%L	38.3
B	167.5	125,575	7.00	6.29	--------	2.10° x BOW	- 0.70°	1.527	0.990	6.0%L	42.3

II FORM CHARACTERISTICS



III LINES

MODEL	FULL SIZE
A = 13.536 sq. ft.	A = 1096.4 sq. ft.
L = 8.742 ft.	L = 78.68 ft.
B_A = 1.548 ft.	B_A = 13.93 ft.

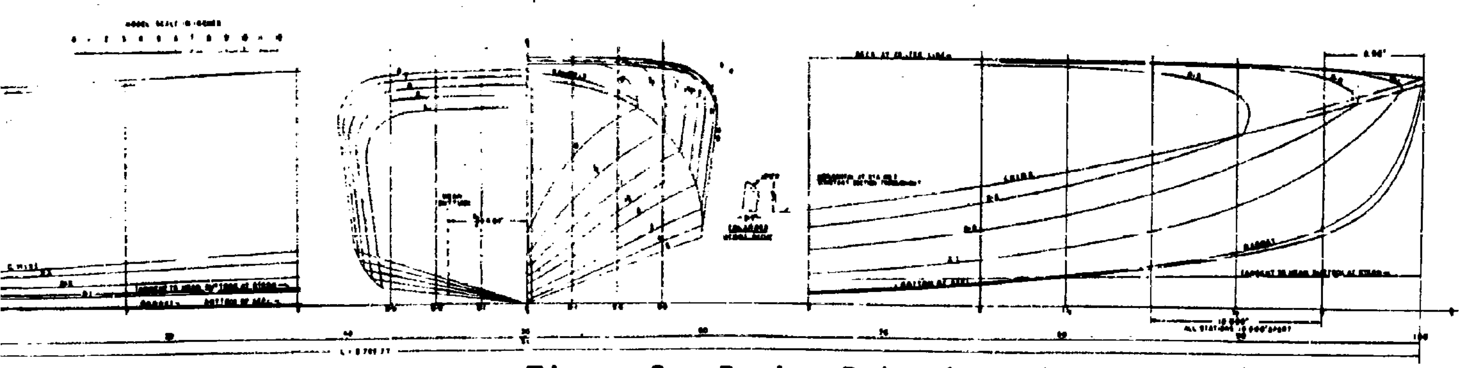
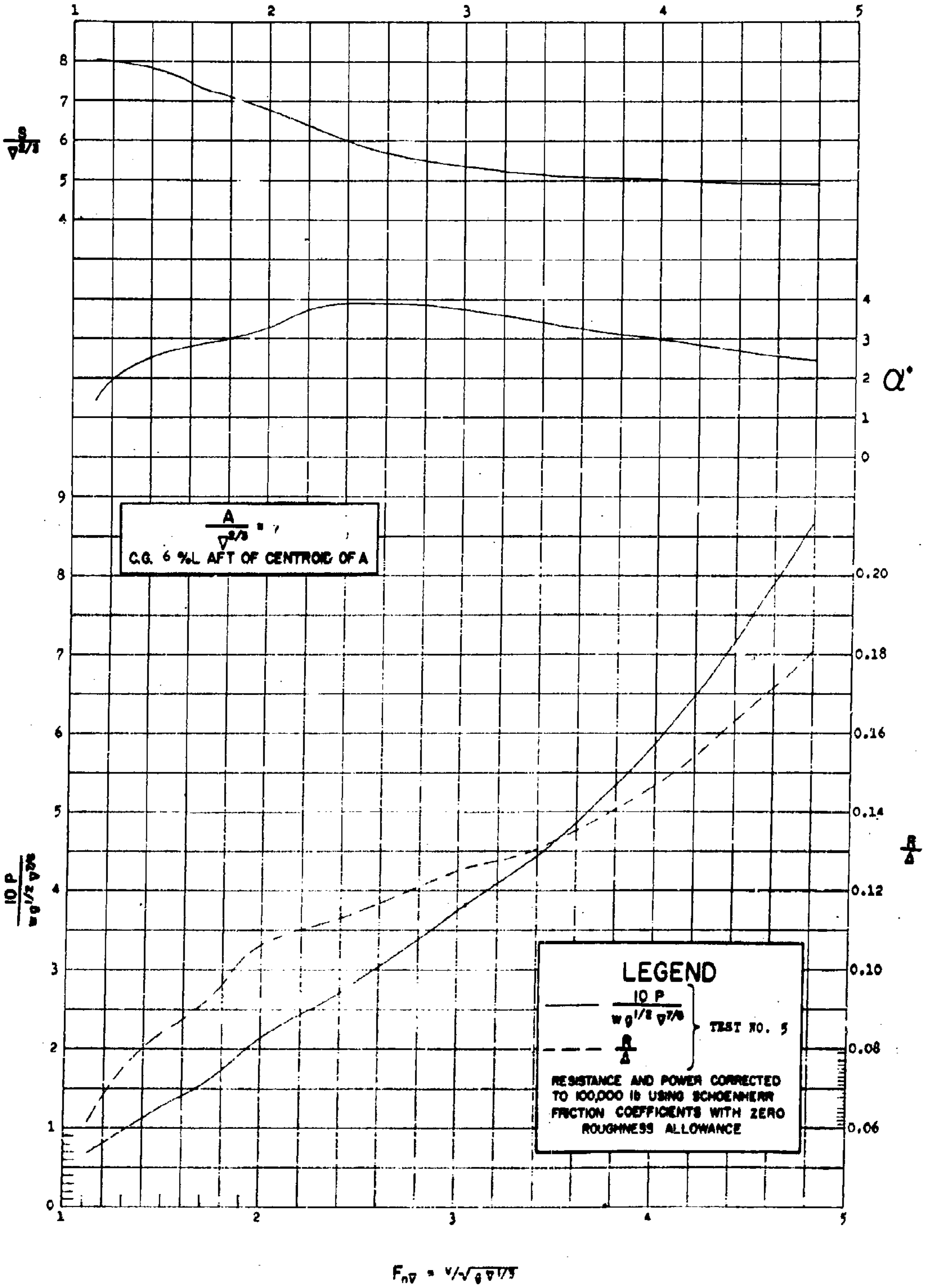


Figure 2 - Design Data Sheet for Model 3592-1

IV PERFORMANCE CHARACTERISTICS



PLANING BOAT DESIGN DATA SHEET
DAVID W. TAYLOR MODEL BASIN

JUNE 1955

DTMB MODEL 3626 $\frac{1}{8.5}$ SCALE 70

2

MODEL DATA

BASIN HIGH SPEED BASIN
BASIN SIZE 2968'x21'x(10'and 16')
DATE OF TEST 6 OCT 54
WATER TEMP. 73°F
APPENDAGES SPRAY STRIPS
TURBULENCE STIM. NONE
MODEL MATERIAL WOOD
MODEL FINISH PAINT
TEST NO. 5

V_M	R_M	WL_K	WL_C	WL_{SP}
4.26	8.82	7.50	6.90	7.60
5.34	11.68	7.45	6.20	7.25
6.40	13.33	7.40	5.70	6.80
7.48	14.98	7.30	5.20	6.20
8.54	16.67	7.10	4.80	5.50
9.60	17.58	6.90	4.40	5.10
10.70	18.79	6.70	4.10	4.80
11.76	19.92	6.65	3.90	4.60
12.82	20.88	6.60	3.70	4.40
13.95	22.39	6.60	3.55	4.35
15.06	24.14	6.65	3.40	4.25
16.08	26.04	6.65	3.25	4.20
17.16	28.30	6.70	3.20	4.25
18.22	30.64	6.75	3.05	4.25

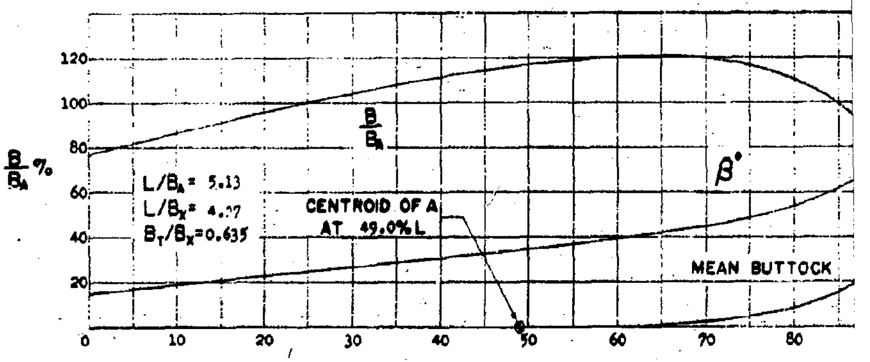
REMARKS:

Average $\frac{L}{B_A}$ ratio and narrow transom give low resistance characteristics at 2.3 $< Fn_\nabla <$ 3.5 and average resistance characteristics at $Fn_\nabla >$ 3.5. Relatively straight buttocks forward give only average resistance characteristics at $Fn_\nabla <$ 2.3.

I TEST CONDITIONS

TEST NO.	Δ_M lb	Δ_S lb	$\frac{A}{\nabla^{2/3}}$	$\frac{L}{\nabla^{1/3}}$	MAXIMUM STABLE $F_{n\nabla}$	τ_o	α_o	DRAFT COEFF. FWD.	DRAFT COEFF. AFT.	CG AFT OF CENTROID OF A
2	98.0	61,900	8.44	6.58	------	2.25° x STERN	+ 1.55°			
3	78.9	49,000	9.75	7.07	------	1.78° x STERN	+ 1.08°			
4	120.8	75,000	7.34	6.13	------	2.68° x STERN	+ 1.98°			
5	129.6	81,850	7.00	5.99	------	0.75° x STERN	+ 0.05°	1.133	1.170	6.0 %L

II FORM CHARACTERISTICS



III LINES

MODEL

A= 11.415 sq. ft.
L= 7.649 ft.
B_A= 1.492 ft.

FULL SIZE

A= 824.73 sq. ft
L= 65.02 ft.
B_A= 12.68 ft.

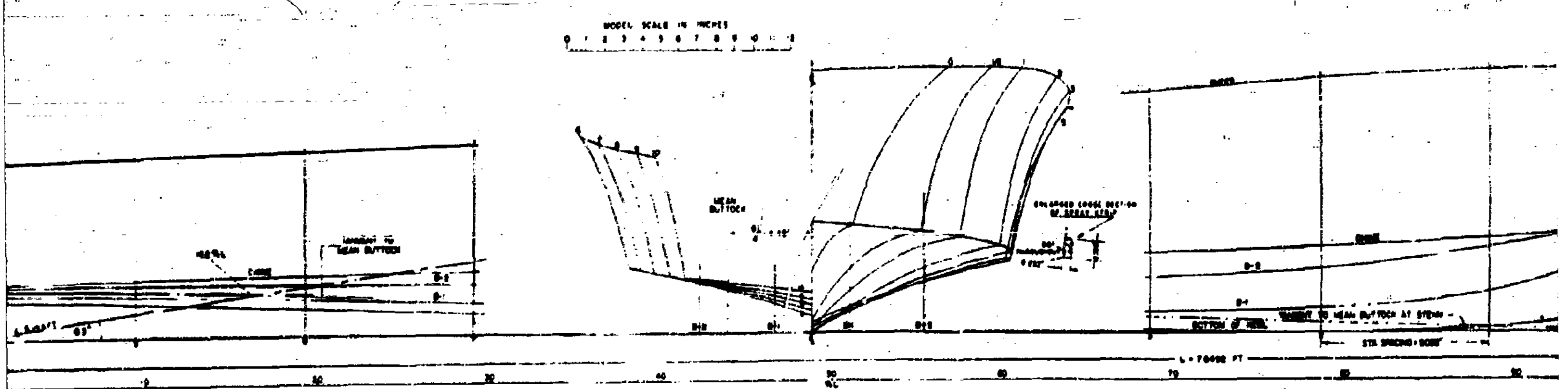


Figure 3 - Design Data Sheet for Model 3

PLANING BOAT DESIGN DATA SHEET
DAVID W. TAYLOR MODEL BASIN

JUNE 1955

DTMB MODEL 3626 $\frac{1}{8.5}$ SCALE 70 FT. ELCO PT BOAT

3

MODEL DATA

BASIN HIGH SPEED BASIN

BASIN SIZE 2968'x21'x(10'and 16')

DATE OF TEST 6 OCT 54

WATER TEMP. 73°F

APPENDAGES SPRAY STRIPS

TURBULENCE STIM. NONE

MODEL MATERIAL WOOD

MODEL FINISH PAINT

TEST NO. 5

V_M	R_M	WL_K	WL_C	WL_{SP}
4.26	8.82	7.50	6.90	7.60
5.34	11.68	7.45	6.20	7.25
6.40	13.33	7.40	5.70	6.80
7.48	14.98	7.30	5.20	6.20
8.54	16.67	7.10	4.80	5.50
9.60	17.58	6.90	4.40	5.10
0.70	18.79	6.70	4.10	4.80
1.76	19.92	6.65	3.90	4.60
2.82	20.88	6.60	3.70	4.40
3.95	22.39	6.60	3.55	4.35
5.06	24.14	6.65	3.40	4.25
6.08	26.04	6.65	3.25	4.20
7.16	28.30	6.70	3.20	4.25
8.22	30.64	6.75	3.05	4.25

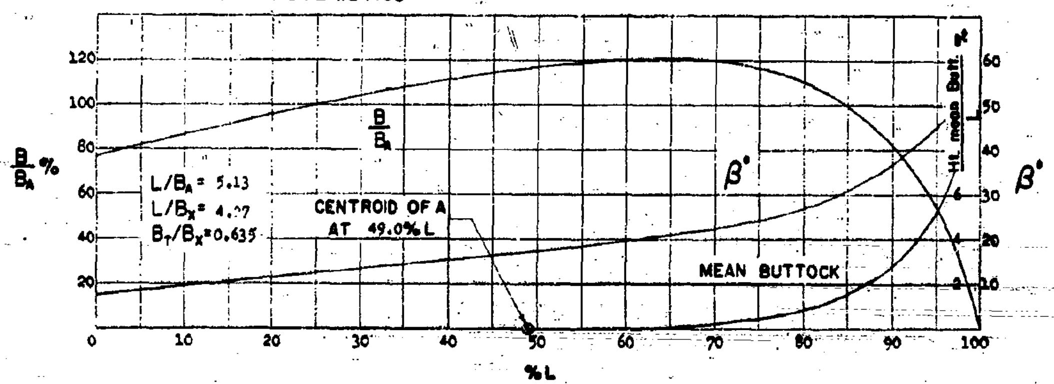
REMARKS:

Average $\frac{L}{B_A}$ ratio and narrow transom give low resistance characteristics at 2.3 $< Fn_\nabla <$ 3.5 and average resistance characteristics at $Fn_\nabla >$ 3.5. Relatively straight buttocks forward give only average resistance characteristics at $Fn_\nabla <$ 2.3.

I TEST CONDITIONS

TEST NO.	Δ_M lb	Δ_S lb	$\frac{A}{\nabla^{2/3}}$	$\frac{L}{\nabla^{1/3}}$	MAXIMUM STABLE $F_{n\nabla}$	τ_o	α_o	DRAFT COEFF. FWD.	DRAFT COEFF. AFT.	CG AFT OF CENTROID OF A	LCG % L
2	98.0	61,900	8.44	6.58	------	2.25° x STERN	+ 1.55°				
3	78.9	49,000	9.75	7.07	------	1.78° x STERN	+ 1.08°				
4	120.8	75,000	7.34	6.13	------	2.68° x STERN	+ 1.98°				
5	129.6	81,850	7.00	5.99	------	0.75° x STERN	+ 0.05°	1.133	1.170	6.0 %L	43.0

II FORM CHARACTERISTICS



III LINES

MODEL

A = 11.415 sq. ft.
L = 7.649 ft.
B_A = 1.492 ft.

FULL SIZE

A = 824.73 sq. ft
L = 65.02 ft.
B_A = 12.68 ft.

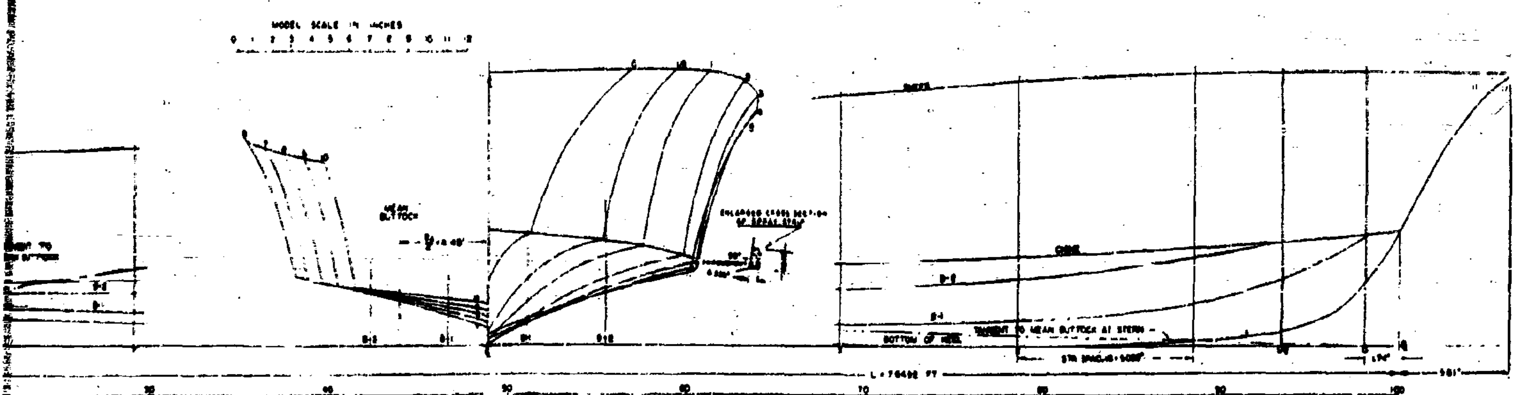
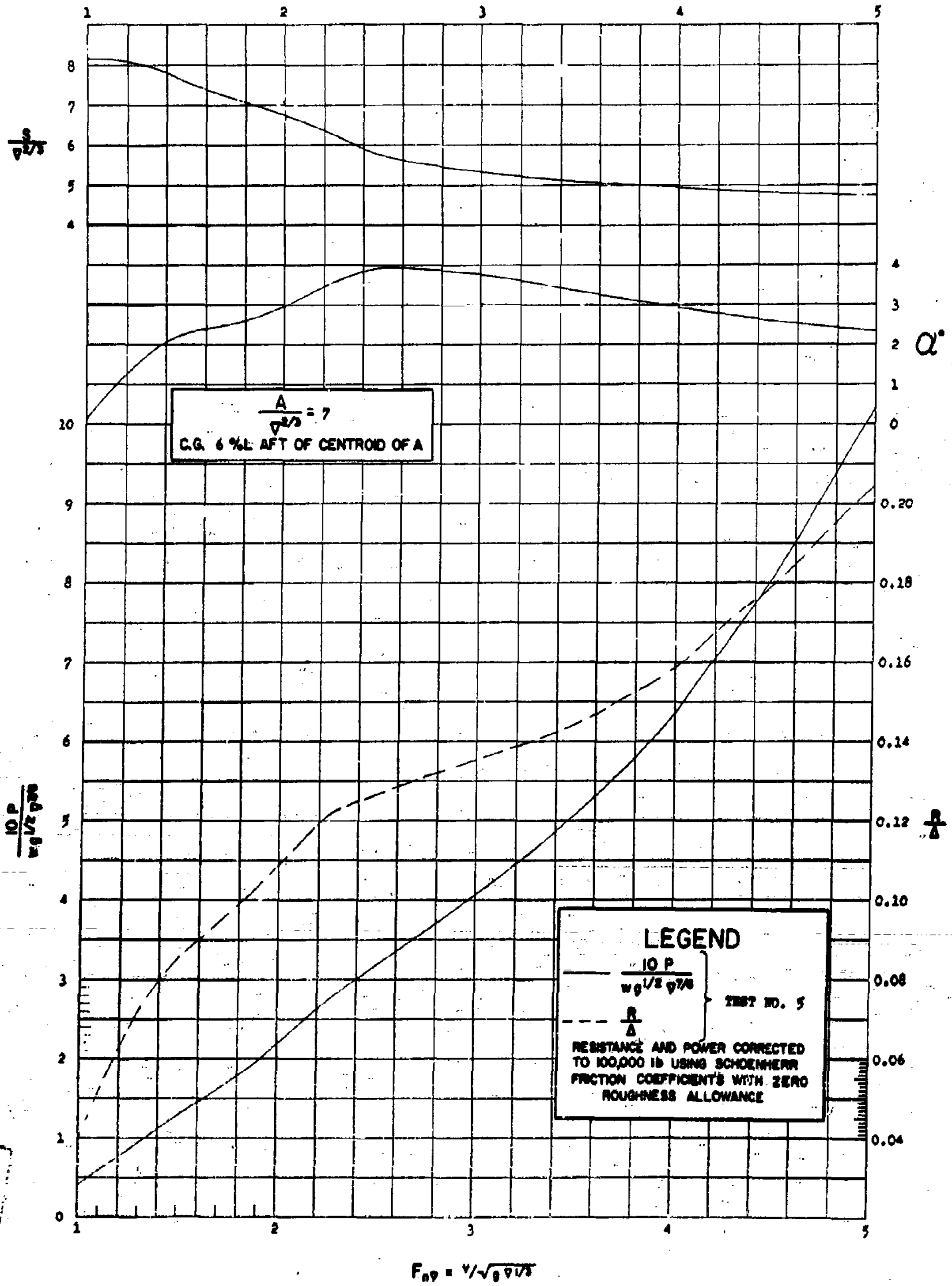
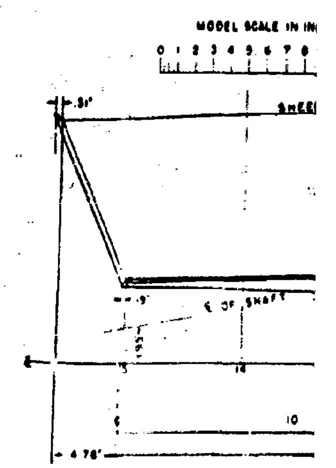


Figure 3 - Design Data Sheet for Model 3626

IV PERFORMANCE CHARACTERISTICS





1

PLANING BOAT DESIGN DATA SHEET
DAVID W. TAYLOR MODEL BASIN

JUNE 1955

DTMB MODEL 3720   1/9 SCALE   79 FT. HIG

REMARKS:

Relatively high $\frac{L}{B_A}$ ratio, excessive twist (indicated by rate of change of β) and pronounced concave sections give average resistance characteristics at $Fn_\nabla < 2$ and poor resistance characteristics at $Fn_\nabla > 2$.

I TEST CONDITIONS

TEST NO.	Δ_M lb	Δ_S lb	$\frac{A}{\nabla^{2/3}}$	$\frac{L}{\nabla^{1/3}}$	MAXIMUM STABLE $F_{n\nabla}$	τ_o	α_o	DRAFT COEFF. FWD.	DRAFT COEFF. AFT.	CG AFT OF CENTROID OF A
1	121.3	89,120	7.78	6.61	--------	0.58° x STERN	+1.12°			13.1%L
2	121.3	89,120	7.78	6.61	--------	1.79° x BOW	−1.25°			2.3%L
3	134.5	98,830	7.26	6.39	--------	1.57° x BOW	−1.03°			3.7%L
4	134.5	98,830	7.26	6.39	--------	0.87° x BOW	−0.33°			7.7%L
5	139.6	104,660	7.00	6.27	--------	1.05° x BOW	−0.51°	1.557	1.123	6.0%L

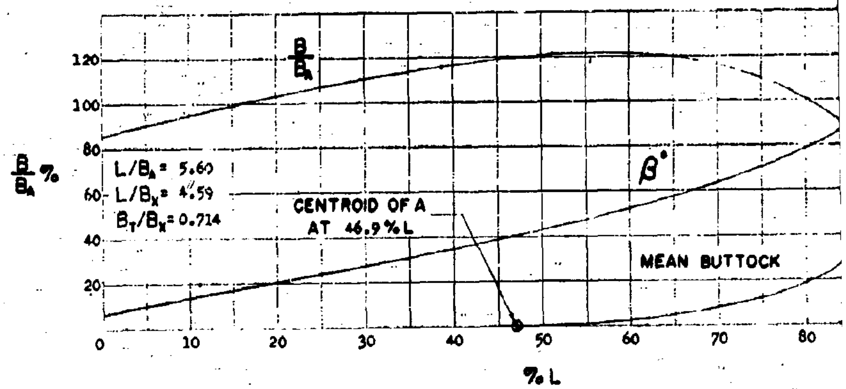
2

MODEL DATA

BASIN HIGH SPEED BASIN
BASIN SIZE 2968'x21'x(10' and 16')
DATE OF TEST 7 DEC 54
WATER TEMP. 63°F
APPENDAGES KEEL & SPRAY STRIPS
TURBULENCE STIM. NONE
MODEL MATERIAL WOOD
MODEL FINISH PAINT
TEST NO. 5

V_M	R_M	WL_K	WL_C	WL_{SP}
3.84	6.37	7.82	6.60	7.40
4.80	10.63	7.72	6.20	7.10
5.74	13.37	7.60	5.77	6.80
6.73	15.35	7.50	5.45	6.60
7.68	17.46	7.40	5.13	6.25
8.64	19.53	7.20	4.73	5.60
9.58	20.56	7.00	4.40	5.15
10.62	21.67	6.80	4.15	4.85
11.53	22.68	6.75	3.95	4.55
12.50	23.78	6.70	3.77	4.40
13.46	24.93	6.70	3.60	4.35
14.41	26.48	6.70	3.40	4.35
15.42	28.18	6.70	3.30	4.35
16.30	30.18	6.70	3.15	4.35
17.28	32.27	6.75	3.00	4.40
18.26	34.76	6.80	3.00	4.45
19.20	37.08	6.80	2.80	4.55

II FORM CHARACTERISTICS



III LINES

MODEL	FULL SIZE
A = 11.993 sq ft	A = 971.4 sq ft
L = 8.200 ft	L = 7.38 ft
B_A = 1.463 ft	B_A = 13.17 ft

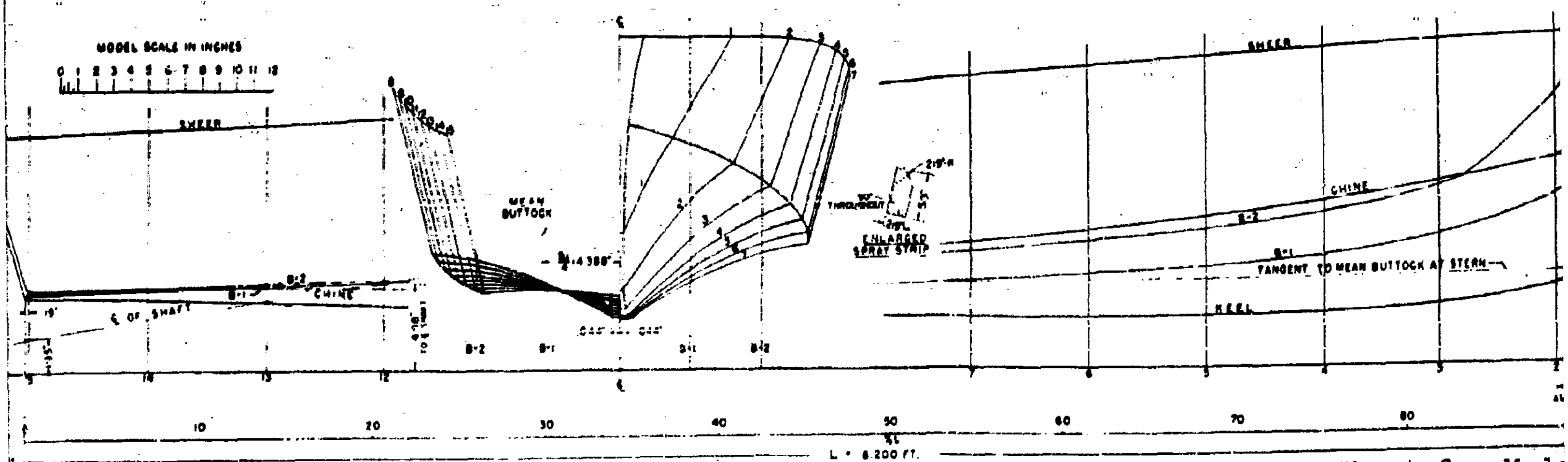


Figure 4 - Design Data Sheet for Mode

PLANING BOAT DESIGN DATA SHEET
DAVID W. TAYLOR MODEL BASIN

JUNE 1955

DTMB MODEL 3720   1/9 SCALE   79 FT. HIGGINS PT BOAT

3

MODEL DATA

N HIGH SPEED BASIN
N SIZE 2968'x21'x(10'and 16')
OF TEST 7 DEC 54
ER TEMP. 63°F
NDAGES KEEL & SPRAY STRIPS
JLENCE STIM. NONE
EL MATERIAL WOOD
EL FINISH PAINT
NO. 5

R_M	WL_K	WL_C	WL_{SP}
6.37	7.82	6.60	7.40
10.63	7.72	6.20	7.10
13.37	7.60	5.77	6.80
15.35	7.50	5.45	6.60
17.46	7.40	5.13	6.25
19.53	7.20	4.73	5.60
20.56	7.00	4.40	5.15
21.67	6.80	4.15	4.85
22.68	6.75	3.95	4.55
23.78	6.70	3.77	4.40
24.93	6.70	3.60	4.35
26.48	6.70	3.40	4.35
28.18	6.70	3.30	4.35
30.18	6.70	3.15	4.35
32.27	6.75	3.00	4.40
34.76	6.80	3.00	4.45
37.08	6.80	2.80	4.55

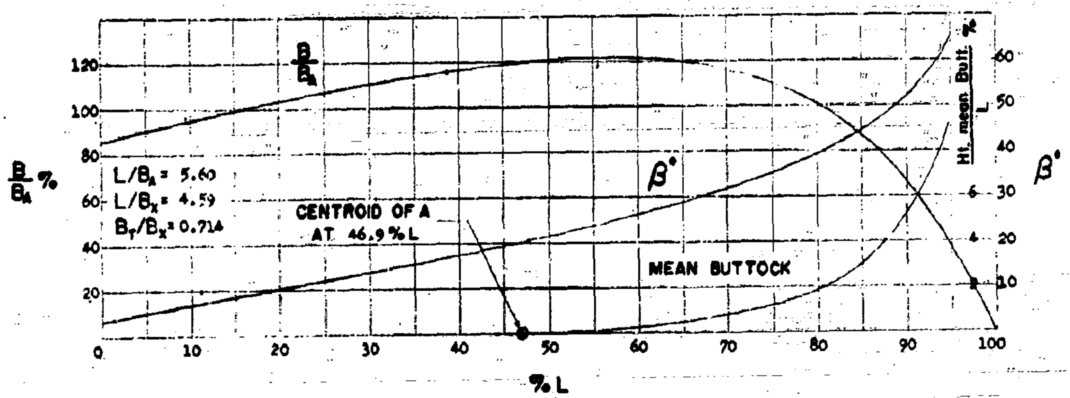
REMARKS

Relatively high $\frac{L}{B_A}$ ratio, excessive twist (indicated by rate of change of angle β) and pronounced concave sections give average resistance characteristics at $Fn_\nabla < 2$ and poor resistance characteristics at $Fn_\nabla > 2$.

I TEST CONDITIONS

TEST NO.	Δ_M lb	Δ_S lb	$\frac{A}{\nabla^{2/3}}$	$\frac{L}{\nabla^{1/3}}$	MAXIMUM STABLE $F_{n\nabla}$	$\tau_\circ$	$\alpha_\circ$	DRAFT COEFF. FWD.	DRAFT COEFF. AFT.	CG AFT OF CENTROID OF A	LCG % L
1	121.3	89,120	7.78	6.61	--------	0.58° x STERN	+ 1.12°			13.1%L	33.8
2	121.3	89,120	7.78	6.61	--------	1.79° x BOW	− 1.25°			2.3%L	44.6
3	134.5	98,830	7.26	6.39	--------	1.57° x BOW	− 1.03°			3.7%L	43.2
4	134.5	98,830	7.26	6.39	--------	0.87° x BOW	− 0.33°			7.7%L	39.2
5	139.6	104,660	7.00	6.27	--------	1.05° x BOW	− 0.51°	1.557	1.123	6.0%L	40.9

II FORM CHARACTERISTICS



III LINES

MODEL	FULL SIZE
A = 11.993 sq ft	A = 971.4 sq ft
L = 8.200 ft	L = 7.38 ft
B_A = 1.463 ft	B_A = 13.17 ft

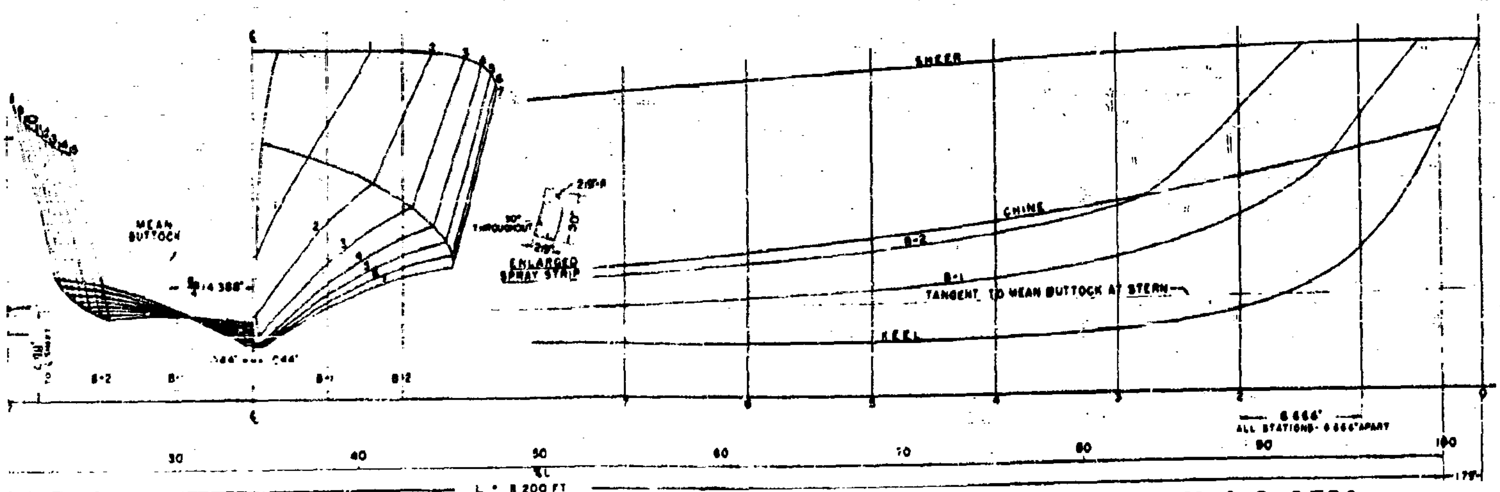
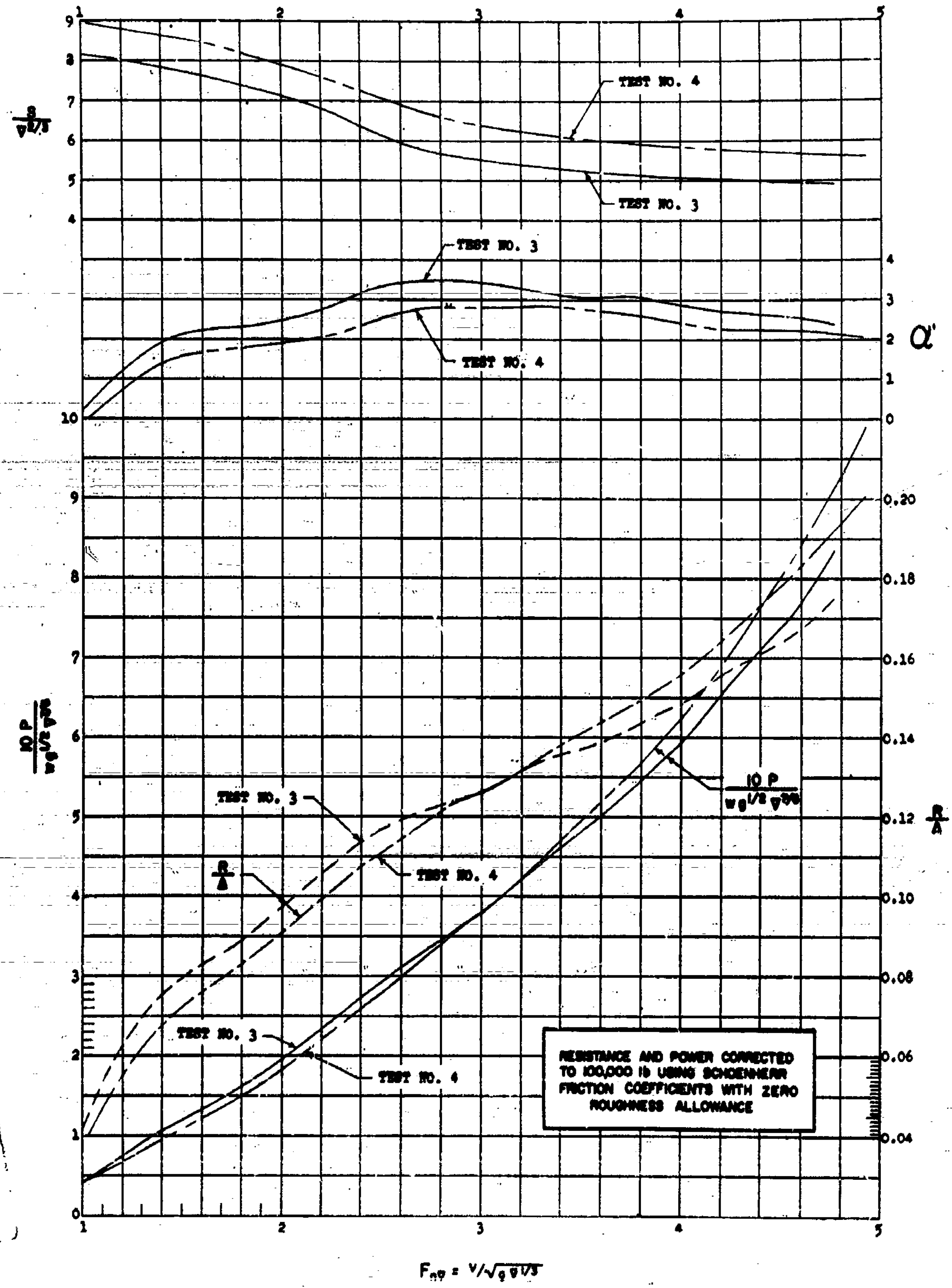


Figure 4 - Design Data Sheet for Model 3720

IV PERFORMANCE CHARACTERISTICS



2

PLANING BOAT DESIGN DATA SHEET
DAVID W. TAYLOR MODEL BASIN

JUNE 1955

DTMB MODEL 3722 1/9 SCALE 80

REMARKS:

Relatively high $\frac{L}{B_A}$ ratio and narrow transom give low resistance chara
at Fn_∇ <3. Average resistance characteristics at $Fn_\nabla > 3$.

MODEL DATA

BASIN HIGH SPEED BASIN
BASIN SIZE 2968'x21'x(10'and 16')
DATE OF TEST 8 FEB 55
WATER TEMP 61°F
APPENDAGES SPRAY STRIPS
TURBULENCE STIM NONE
MODEL MATERIAL WOOD
MODEL FINISH PAINT

TEST NO. 3

V_M	R_M	WL_K	WL_C	WL_{SP}
3.89	6.97	8.22	7.50	8.18
4.87	11.12	8.10	6.95	7.84
5.85	13.46	8.00	6.48	7.53
6.81	15.10	7.95	6.19	7.30
7.77	16.89	7.86	5.91	7.08
8.72	18.83	7.75	5.58	6.60
9.67	20.49	7.53	5.15	5.82
10.69	21.69	7.39	4.82	5.40
11.67	22.76	7.22	4.60	5.72
12.60	24.24	7.19	4.38	4.95
13.60	25.43	7.12	4.20	4.80
14.59	26.84	7.10	4.02	4.67
15.57	28.38	7.10	3.89	4.53
16.53	30.39	7.13	3.73	4.42
17.52	32.10	7.16	3.65	4.40
18.51	34.40	7.20	3.53	4.30

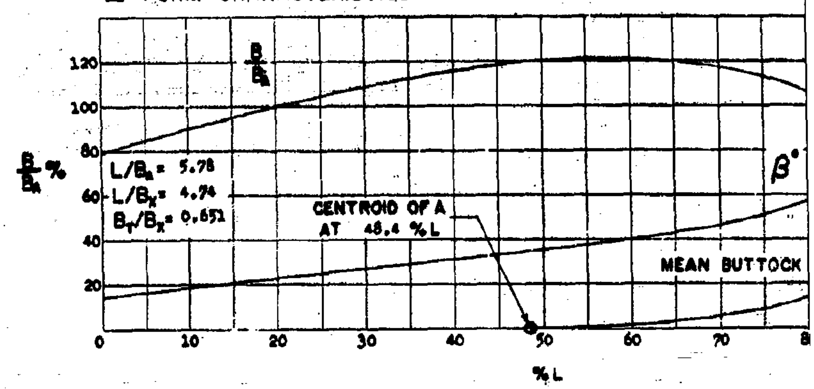
TEST NO. 4

V_M	R_M	WL_K	WL_C	WL_{SP}
3.88	5.58	8.20	7.20	8.02
4.82	8.49	8.09	6.72	7.80
5.82	10.55	8.00	6.22	7.45
6.79	12.08	7.92	5.98	7.22
7.75	13.78	7.90	5.70	7.04
8.72	15.49	7.80	5.41	6.64
9.68	17.02	7.63	5.02	6.00
10.70	18.61	7.50		5.40
11.67	19.75	7.40	4.42	5.10
12.59	21.25	7.35	4.22	4.90
13.60	22.73	7.29	4.02	4.70
14.60	24.32	7.24	3.83	4.60
15.60	26.22	7.27	3.72	4.40
16.56	28.28	7.28	3.60	4.40
17.49	30.45	7.30	3.48	4.30
18.51	33.02	7.30		4.35

I TEST CONDITIONS

TEST NO.	Δ_M lb	Δ_S lb	$\frac{A}{\nabla^{2/3}}$	$\frac{L}{\nabla^{1/3}}$	MAXIMUM STABLE $F_{n\nabla}$	τ_o	α_o	DRAFT COEFF. FWD.	DRAFT COEFF. AFT.
1	128.7	94,500	7.79	6.70	---------	1.60° x BOW	-1.30°	1.795	0.762
2	142.9	105,000	7.25	6.47	---------	0.90° x BOW	-0.60°	1.380	0.994
3	148.0	110,960	7.00	6.36	---------	0.65° x BOW	-0.35°	1.444	1.171
4	121.1	90,790	8.00	6.80	---------	0.75° x BOW	-0.45°	1.409	0.982

II FORM CHARACTERISTICS



III LINES

MODEL	FULL SIZE
A = 12.466 sq ft	A = 1009.8 sq ft
L = 8.488 ft	L = 76.39 ft
B_A = 1.469 ft	B_A = 13.22 ft

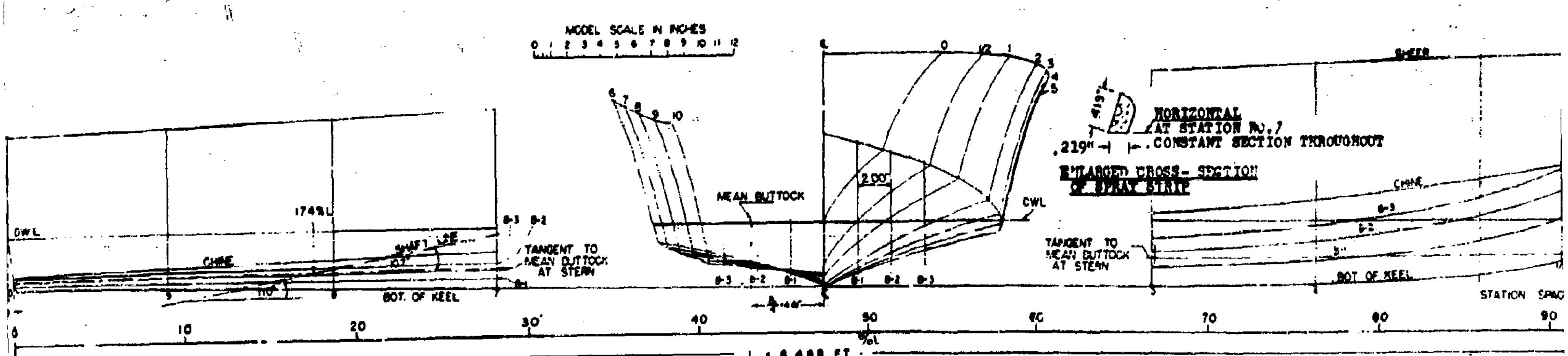


Figure 5 - Design Data Sheet for Model

PLANING BOAT DESIGN DATA SHEET
DAVID W. TAYLOR MODEL BASIN

JUNE 1955

DTMB MODEL 3722 | 1/9 SCALE | 80 FT. ELCO PT BOAT

3

DATA

ASIN
21'x(10'and 16')
PED 55

STRIPS
NONE
WOOD
PAINT

TEST NO. 4				
V_M	R_M	WL_K	WL_C	WL_{SP}
3.88	5.58	8.20	7.20	8.02
4.82	8.49	8.09	6.72	7.80
5.82	10.55	8.00	6.22	7.45
6.79	12.08	7.92	5.96	7.22
7.75	13.78	7.90	5.70	7.04
8.72	15.49	7.80	5.41	6.64
9.68	17.02	7.63	5.02	6.00
0.70	18.61	7.50		5.40
1.67	19.75	7.40	4.42	5.10
2.59	21.25	7.35	4.22	4.90
3.60	22.73	7.29	4.02	4.70
4.60	24.32	7.24	3.83	4.60
5.60	26.22	7.27	3.72	4.40
6.56	28.28	7.28	3.60	4.40
[illegible].49	30.45	7.30	3.48	4.30
8.51	33.02	7.30		4.35

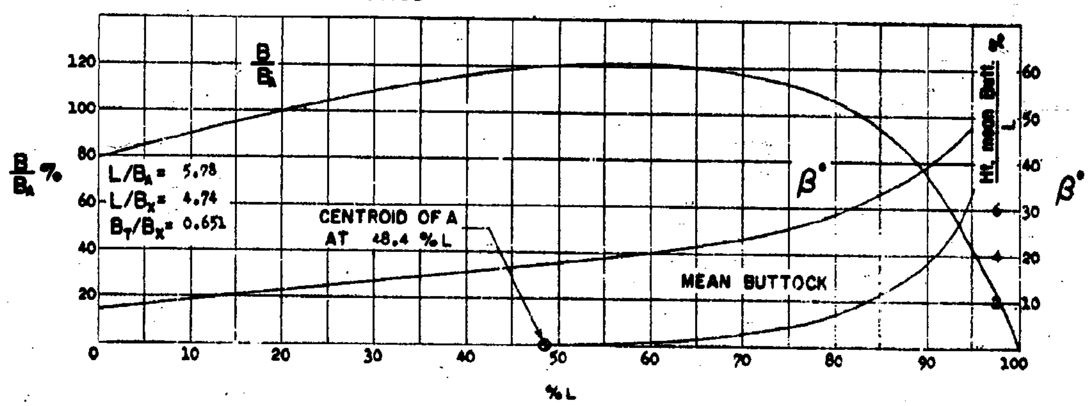
REMARKS:

Relatively high $\frac{L}{B_A}$ ratio and narrow transom give low resistance characteristics at Fn_∇ < 3. Average resistance characteristics at Fn_∇ > 3.

I TEST CONDITIONS

TEST NO.	Δ_M lb	Δ_S lb	$\frac{A}{\nabla^{2/3}}$	$\frac{L}{\nabla^{1/3}}$	MAXIMUM STABLE $F_{n\nabla}$	τ_o	α_o	DRAFT COEFF. FWD.	DRAFT COEFF. AFT.	CG AFT OF CENTROID OF A	LCG %L
1	128.7	94,500	7.79	6.70	--------	1.60° x BOW	-1.30°	1.795	0.762	2.1%L	46.3
2	142.9	105,000	7.25	6.47	--------	0.90° x BOW	-0.60°	1.380	0.994	5.1%L	43.3
3	148.0	110,960	7.00	6.36	--------	0.65° x BOW	-0.35°	1.444	1.171	6.0%L	42.4
4	121.1	90,790	8.00	6.80	--------	0.75° x BOW	-0.45°	1.409	0.982	6.0%L	42.4

II FORM CHARACTERISTICS



III LINES

MODEL

A = 12.466 sq ft
L = 8.488 ft
B_A = 1.469 ft

FULL SIZE

A = 1009.8 sq ft
L = 76.39 ft
B_A = 13.22 ft

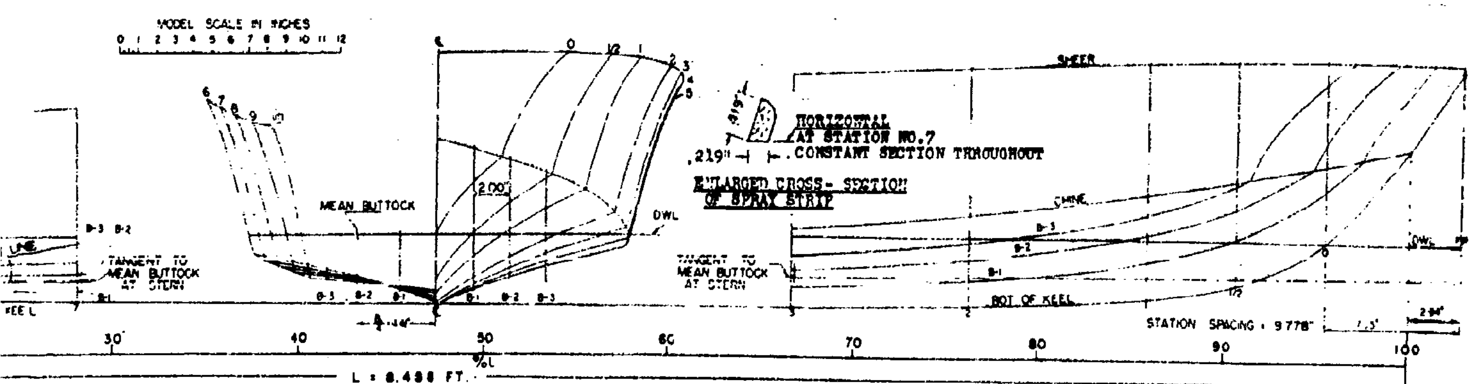


Figure 5 - Design Data Sheet for Model 3722

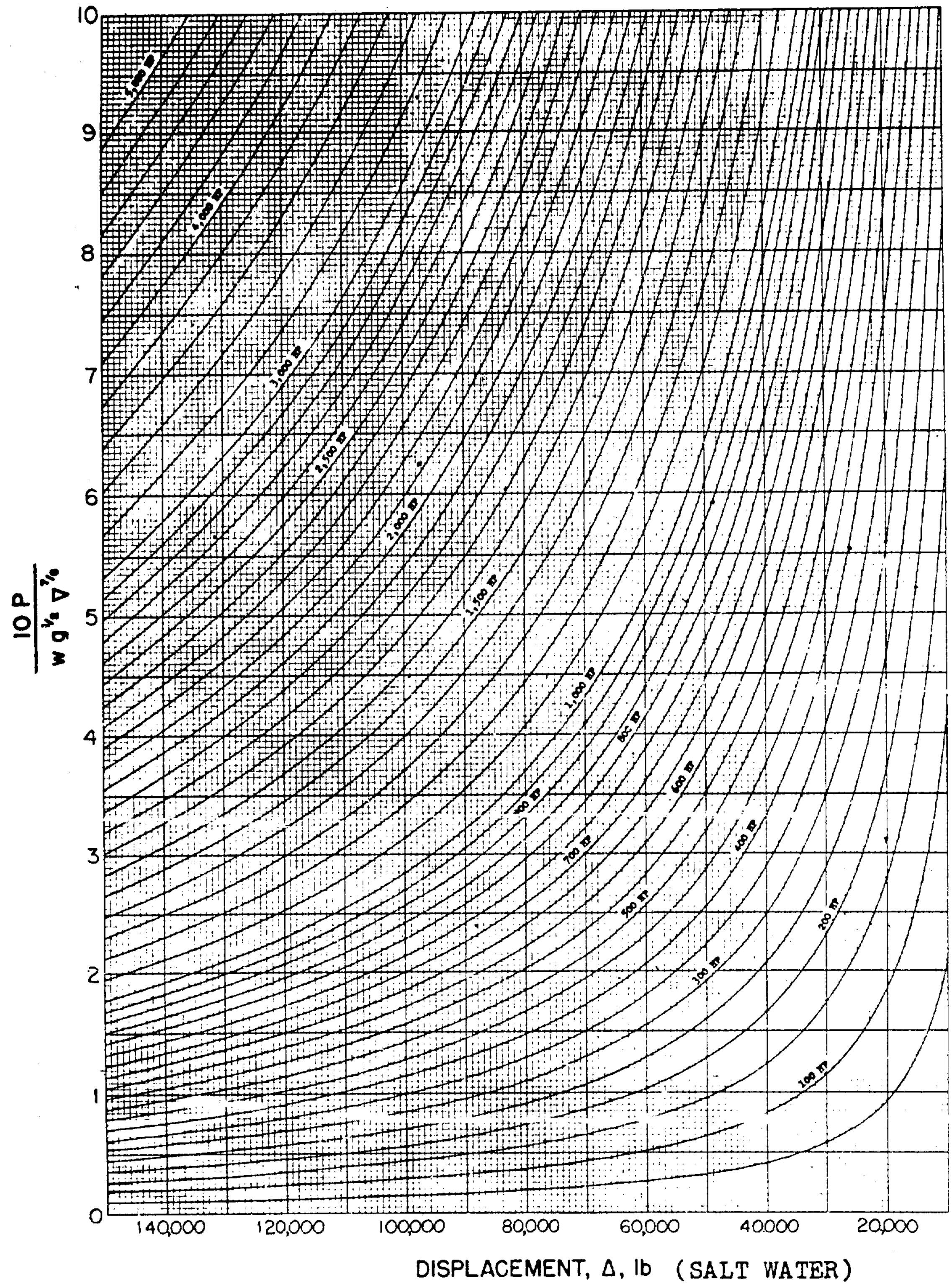
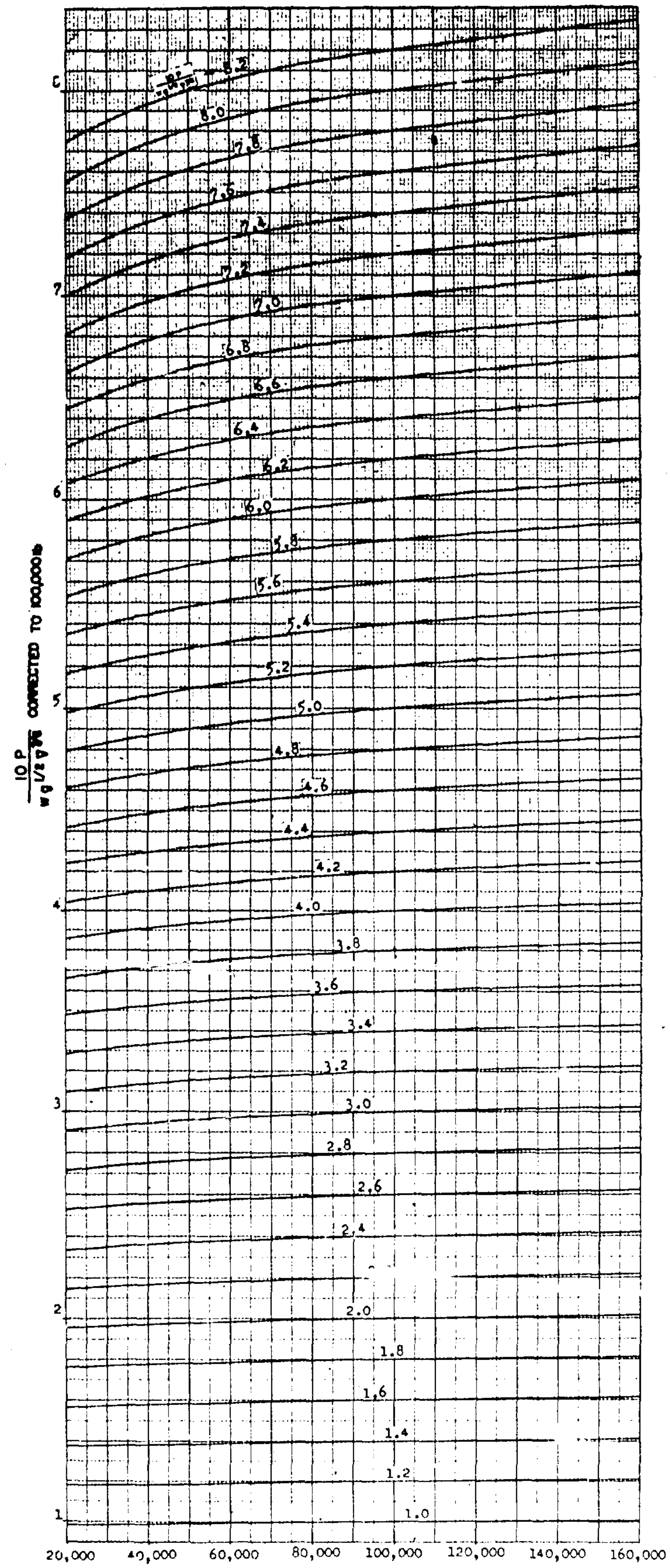


Figure 6 - Variation of Power Coefficient with Displacement and Effective Horsepower.



Displacement, Δ ,lb (Salt Water)

Figure 7 - Chart for Converting Power Coefficients at 100,000 Pounds Displacement to Other Values of Displacement.

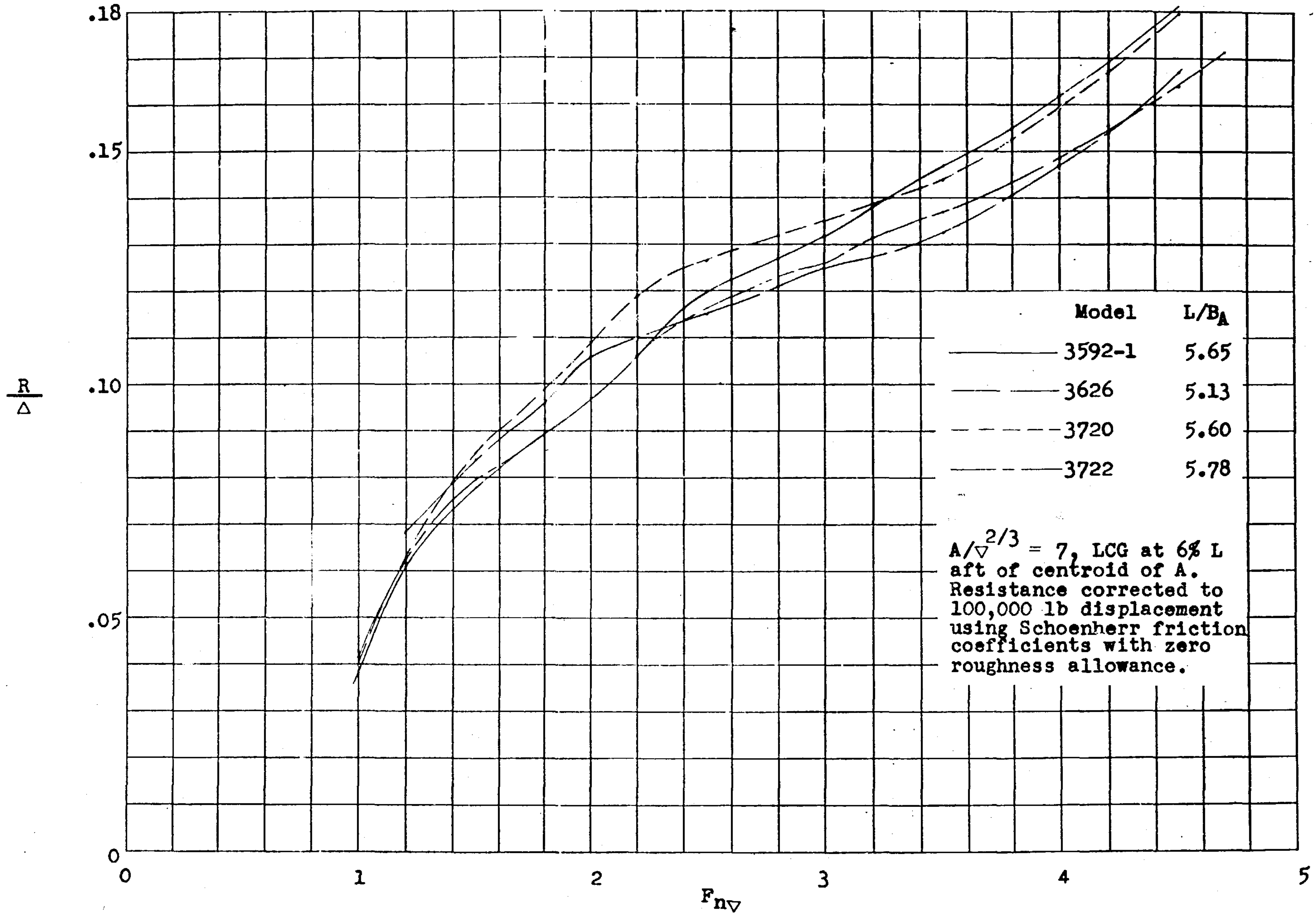


Figure 9 - A Comparison of the Resistance of Four Planing Boat Designs.